Equity Considerations in the Assessment of The Bayh-Dole Act

by

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ABSTRACT

Extant evaluation studies of the Bayh-Dole Act of 1980 have focused primarily on its effects on the pace of innovation and on the norms and practices of academic research but neglected other public values. Seeking to redress this shortcoming, I begin by examining Bayh-Dole with respect to other relevant public values following the *Public Value Failure* approach. From that analysis, equity emerges as a pressing issue. I define equity issues, in a loosely *Rawlsian* sense, as situations of unfair distribution of political power and economic resources.

My analysis identifies a business model of offices of technology transfer—that I call "nurturing start-ups"—that is likely to become a standard of practice. This model can foster either firm competition or concentration in emerging industries and will therefore have an impact on the distribution of economic benefits from innovation. In addition, political influence to reform Bayh-Dole is allocated disproportionately in favor of those who stand to gain from this policy. For instance, elite universities hold a larger share of the resources and voice of the university system. Consequently, adjusting the nurturing start-ups model to foster competition and increasing cooperation among universities should lead to a more equitable distribution of economic benefits and political voice in technology transfer.

Conventional policy evaluation is also responsible for the neglect of equity considerations in Bayh-Dole studies. Currently, "what is the policy impact?" can be answered far more systematically than "why the impact matters?" or "is this policy designed and implemented legitimately?" The problem lies with the consequentialist theory of value that undergirds evaluation. Hence, I propose a deontological theory of evaluation to reaffirm the discipline's commitment to democratic policy making.

To Beatriz, Alberto, Dario, *in memoriam* Ernestina

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INTRODUCTION

1.1 The Research Problem.

Before the end of his single term, President Carter signed into law the Bayh-Dole Act (henceforth the Act) granting universities, not-for-profit organizations, and small businesses the right to retain title to inventions that emerged from federally funded research. This policy is central to the U.S. innovation system and particularly critical to the subsystem comprised by universities. A glimpse into the resources involved in this subsystem may give a sense of the importance of this policy. In 2008, $31.2 billion or 21.6% of the total federal R&D budget was allocated to universities (NSF, 2010a; 2010b). This $31.2 billion represents 60% of the total R&D funds in the university system and is allocated primarily among 297 research universities (Carnegie Classification, 2010). Furthermore, the 213 universities that responded to the Association of University Technology Managers (AUTM) 2009 survey reported filing 12,981 new patent applications and being issued 3,537 new patents that year, and deriving a total licensing revenue of $2.4 billion or 4.7% of the systems' R&D budget (AUTM, 2010).[1]

Further testimony of the importance of Bayh-Dole is the volume of evaluation studies of this legislation. The *Web of Science* citation index has 161 articles with the phrase "Bayh-Dole" in their topic, *Science Direct* has 400 articles with the

[1] Consider this the minimum of patents issued and licensing revenues collected, because not all universities participate in the ATUM survey.

phrase anywhere in the manuscript, and *Google Scholar* has 221 with the phrase in the title of the article and 5900 with the phrase anywhere co-occurring with words that mean "evaluation" (searched on March 22, 2010). Nevertheless, the vast majority of this evaluation literature, however detailed and rigorous, has neglected a very important set of public values and policy outcomes. Specifically, most evaluation studies of Bayh-Dole address its effects on either the pace of innovation (Henderson, Jaffe, and Trajtenberg, 1998; Heller and Eisenberg, 1998; Jaffe and Lerner, 2004; Jensen and Thursby, 2001; Mowery et al., 2004; Rafferty, 2008; Sampat, Mowery and Ziedonis, 2003; Shapiro, 2000; Thursby and Thursby, 2006; Walsh, Arora, and Cohen, 2003) or the culture and organization of academic research (Greenberg, 2007; Judson, 2004; Slaughter, 1990; Slaughter and Leslie, 1997; Slaughter and Rhoades, 2004; Washburn, 2005), but they generally neglect equity concerns.

I use equity to characterize a situation in which inequality in the distribution of resources or privilege is problematic from a normative point of view. As Sen (1992) points out, when discussing inequality normatively, the first question to ask is "inequality of what?" My answer to Sen's question is Rawlsian: "primary goods"—resources and capacities that individuals require to lead their own conception of the good life (Rawls, 1971). However, my position is only loosely Rawlsian, because I am concerned also with inequalities at the level of groups and organizations—although these institutions are arguably the conduit of primary goods for individuals. At the level of groups and organizations, equity concerns are better mapped onto economic resources and relative political power.

The three evaluative criteria—the pace of innovation, the independence of research, and the equitable distribution of the privileges and resources from university patenting—are interdependent. But for this very reason, the lack of explicit attention to the distributional outcomes requires greater attention. In the following chapters I seek to address this lacuna by taking a different approach to assess Bayh-Dole and view the problem from a different perspective. Before I explicate this approach and perspective, I would like to address two pressing questions: Why has the evaluation community shown so little interest in examining the distributive character of the Act, and why should we care about equity issues in this policy domain?

It is unexceptional for evaluators to focus on the hot issues of a policy debate and neglect other considerations that receive less public attention. In the Bayh-Dole debate, the impacts on the pace of innovation and on the non-commercial activities of universities have been brought into the limelight while equity problems have been relegated to backstage (NRC, 2010). This has happened largely because equity has no strong political advocate. The Congress that enacted Bayh-Dole had representatives and senators who had fought in the 1960s and 1970s to pass welfare, healthcare, and civil rights legislation. Subsequent generations of lawmakers have shown much less zeal for the cause of equity and have even rolled back welfare legislation (Bartels, 2008, Murray, 1994|1984). In addition, Bayh-Dole affects the distribution of resources via consumption of new products in the same way that patents do, with the difference that technology developers of academic research have the research part of R&D paid by the government. The problem resides in that consumers in general, and specifically the demand for new medical treatments and other

applications of public patents, are not politically organized and cannot counterbalance monopolies in the market or exert pressure on policymakers to redress abuses of excessive pricing or inventory-managed shortage. Moreover, equity issues are also related to allocation of licensing revenues across the implementers of Bayh-Dole—the universities—and they exhibit very little interest in adjusting the manner in which licensing revenue is divided. Still, lack of public attention to equity issues in Bayh-Dole does not mean these issues are not important.

The first and most obvious manner in which distribution of resources is important to Bayh-Dole is because it fashions itself as a mechanism to fulfill the promise of another distributive policy: the public funding of research. I use "distributive policy" (Lowi, 1972) because using general taxation to support the research enterprise is justified because the benefits of research are widespread. However, by transferring intellectual property rights (IPRs) from the public to the private domain, Bayh-Dole seems to be a rather counterintuitive mechanism to attain that goal, and it was counterintuitive to many policymakers before it was enacted. Since then, it has become an article of faith to believe that private enterprise requires IPRs to develop any technology, but this view was far from unanimous when Bayh-Dole was being debated and equity concerns were behind opposition to the Act. For this reason it is worthwhile to highlight some key events leading to Bayh-Dole.

1.2 The road to enact the Bayh-Dole Act.

In addition to evaluations of Bayh-Dole, scholars have given serious attention to its history. The leading accounts of how Bayh-Dole came to be law are told by Eisenberg (1996), Guston (2000, Chapter 5), Mowery et al. (2004, Chapter 5),

respectively from the legal, political, and economic perspectives. To these I may add Bermans' (2008) history of the institutionalization of the Act from the sociological perspective. Neither of these authors addresses equity issues explicitly, although Eisenberg and Guston recount in detail the objections in Congress which were motivated by equity concerns and Berman reminds us of the formation of the universities political support of the Act, which hints at the current distribution of political power in the university system; from the beginning, it was elite-universities that controlled the voice of the university system. The journalistic chronicles by Greenberg (2007), Washburn (2006) and Stevens (2004) highlight the work of a handful of individuals whose offices permitted the passing of Bayh-Dole, and whereas Mowery and colleagues (2004) emphasize the effects on innovation, Greenberg and Washburn focus on the effects of Bayh-Dole on academic science.

The debate about ownership of "public patents" —that is, patents originated from publicly funded research—dates back to the postwar debate on the institutional structure of U.S. research policy. Two prominent figures in that debate, Vannevar Bush, former director of the wartime Office of Scientific R&D, and Senator Harley Kilgore, are representative of the opposing views on the issue of patents. Bush recognized the inventors' rights to their inventions; Kilgore in turn contended that the public interest was best served when the government retained ownership (Guston, 2000; Hart, 1998; c.f. Smith, 1990). The debate for the postwar configuration of science policy started during World War II and extended beyond the war, and the institutionalization of public funding of research—through agencies such as the National Science Foundation—was not settled until the early 1950s. The standstill took longer to settle regarding intellectual property and only twice in the

next thirty years was government patent policy revisited. First, President Kennedy's memorandum of 1963 (36 F.R. 16889) explicitly asserted the government's rights to public-funded inventions but granted some latitude to federal agencies to transfer title to contractors or license government patents on an exclusive basis under special circumstances and on reasonable terms. Then, President Nixon's memorandum and policy statement of 1971 (28 F.R. 90343) reaffirmed the administrative discretion granted by his predecessor but denied that a "single presumption of ownership of patent rights to Government-sponsored inventions" was a "satisfactory basis" for government-wide patent policy. The conventional moral wisdom that public research should lead to patents held in the public domain prevailed, albeit reasonable exceptions were allowed, and federal agencies had as many as twenty-six different patent policies in force by the end of the 1970s (Eisenberg, 1996).

The then Department of Health, Education, and Welfare (HEW)—renamed in May 1980 as Department of Health and Human Services—was at the center of the Bayh-Dole story. After World War II, universities had been allowed to license to pharmaceutical firms chemical compounds developed in research programs funded by the National Institutes of Health (NIH), and occasionally the licenses were given on an exclusive basis. When the practice was denounced, HEW required in 1962 that firms screening such compounds commit to not pursue exclusive rights on them. HEW was later criticized in the Harbridge House report (1968) on patents' use and another report on patents for medicinal chemistry (General Accounting Office, 1968) for introducing such restrictions. In consideration to the parallel recommendations contained in both reports, HEW instituted in 1968 the Institutional Patent Agreements (IPAs) to grant ownership of discoveries emerging

from agency's research grants to universities that demonstrated technology transfer capabilities. The Department of Defense had a similar policy in place already and the National Science Foundation implemented IPAs in 1973. In 1977, HEW's own General Council Office observed that liberal policy on NIH patents could lead to excessive pricing of new treatments. In response, HEW secretary Joseph Califano moved to delay (withhold) 30 patent applications and three IPAs applications. The universities and the NIH then mobilized to reverse this move and found an ally in Senator Robert Dole who, in a press conference, criticized HEW for "stonewalling" university patenting. Senator Birch Bayh, already an advocate of university patenting, was then able to partner with Senator Dole to introduce to the Senate in September 13, 1978 a bill modeled after the IPAs.

It should be recalled that Representative Ray Thornton had introduced the previous year a bill to the House Subcommittee on Science, Research and Technology proposing to transfer rights to all research contractors. The bill died in committee but the proposal attracted the attention of opponents to the idea. Senator Gaylord Nelson held hearings and invited vocal detractors of transferring public patents to the private sector, notably Admiral Hyman Rickover who directed the development of the nuclear submarine, and Senator Russell Long—son of Senator Huey Long and a strong advocate of social policy—who saw in this bill yet another industry subsidy (U.S. Senate, 1980a).

The bill introduced in the 95th Congress had to be re-introduced in the following Congress after the midterm elections as S. 414 on February 9, 1979. The Senate's Committee on the Judiciary held hearings on May 16 and June 6, and reported favorably to the Senate on December 12, 1979. The bill was then debated in

the floor of the Senate on February 5 and 6 and passed on April 23, 1980. This was nevertheless not the bill eventually enacted because the House Committee on the Judiciary required the recoupment provision to be dropped—this provision would have had the government share in a portion of the incomes arising from licensing patents. Finally, the mirror bill introduced (with modifications) passed the House on November 17. At this point the sponsors of the bill numbered 54 and counted with ample support in Congress; and won the Senate vote 91 to 4 on November 20 (Berman, 2008). Being late in the year, there was a risk of a pocket veto. In a hurry, congressional advocates reached out for representatives of small businesses and universities to pressure the White House for a last minute signature (Stevens, 2004). In the end, President Carter signed Bayh-Dole into law on December 12.

This sweeping reversal of the long-standing government patent policy—allowing agency discretion—begs the question, what upset the political balance? One reason is the economic environment. The U.S. economy was shaken during the seventies as the effects of a cyclical recession (1973-1975) were compounded by the oil embargoes of 1973 and 1979. The economic and social turmoil of that period put in question the presumed robustness of the economy. General apprehension verged into histrionics when the surplus of the trade balance went into decline (albeit the first trade deficit did not occur until 1982). Particularly, visible sectors —such as automobiles, electronics, and textiles—started to lose their competitive edge in international markets and higher import penetration was suggestive of lassitude in the domestic market as well. The recessive economy and the symbolic loss of strength in the manufacturing sector were perceived as a widespread "competitiveness crisis", even though it was confined to a few economic sectors

(Papadakis, 1994). As I show later in Chapter 3, the competitiveness crisis became the main characterization of national economic problems and policy makers who capitalized on this rhetoric were in better position to advance their policies and programs casting them as responses to the crisis (see also Slaughter and Rhoades 1996). This strategy required the appeal to fresh ideas that buttressed the prescribed reforms, and by the end of the Carter Administration, many new ideas focused on small business and entrepreneurship; one of these was Bayh-Dole.

The political balance was also tilted in favor of reform because a central argument motivating Bayh-Dole had gained great currency in Congress. As I explain in Chapter 4, the argument is that government funded research was underutilized because, unable to gain title or exclusive license to an invention, firms were discouraged from taking the inherent risks of large developmental investments. The support of this argument relied primarily on one piece of evidence: only 5% of the 28,000 government-owned patents were under a licensing contract (Federal Council for Science and Technology, 1978). However, Eisenberg (1996) found that the majority of those patents, about two-thirds, belonged to the Department of Defense whose patent policy allowed contractors to take title; what is more, she found that 325 of the 28,000 belonged to HEW and 75 of them were licensed at the time the report was made. The fact that DoD contractors had not taken title suggests that those patents had little commercial value. Still, in 1980 the FCST data stood unchallenged and the belief that exclusive licenses were condition *sine qua non* for product development was cemented in policymakers' minds.

Creating a sense of political urgency and a convincing economic logic were not the only reasons for the legislative agreement achieved by Bayh-Dole. Enacting

the Act required the offices of skillful policy actors—including bureaucrats and congressional staffers (Washburn, 2005; Stevens, 2004)—capable of bringing universities into a coalition (Berman, 2008) and to push the bill through Congress by anticipating all opposing arguments. These arguments had been voiced when, a year earlier, Senator Nelson held the aforementioned hearings to counter the Thornton bill. The objections were mainly three: (i) that transferring rights to public patents was tantamount to a giveaway to corporations, (ii) that it would condone monopolistic practices, particularly in sectors such as healthcare, and (iii) that taxpayers were denied legitimate returns from research investments. In turn, the bill addressed each of these objections with specific provisions. Bayh-Dole, as originally enacted, is for the explicit benefit of small businesses and not-for-profit organizations, and exclusive licenses for large businesses are limited to five years. As mentioned above, the original bill included a recoupment provision. It also established two mechanisms for government intervention: the first allows federal agencies to limit or cancel rights to a patent but only under "exceptional circumstances" and the second mandates the agency to take up a paid-up non-exclusive license to use and practice a patent that is not being developed.

This brief history of the road to Bayh-Dole reveals that equity considerations were once important. The fact that the original bill sought to regulate the market incentives with safeguards of the public interest is an implicit recognition of the imperative of seeking the widest possible distribution of the fruits of research. However, as I show in the next following chapters, the normative counterweights to market values are faint at best. Still, for this very reason equity must be brought back into the debate again.

The historic context in which Bayh-Dole emerges is indeed useful to understand equity concerns in Bayh-Dole. Likewise, it should serve us well to locate it within the wider context of research and innovation policy in the U.S.

Not long ago, legal scholars Stuart M. Benjamin and Arti K. Rai (2009) called for the creation of a White House office of innovation policy. Their argument summarizes the received wisdom on innovation policy: that growth in productivity is key for long-term economic growth, that technological change fosters productivity gains, and that research is key in the new technologies. Bayh-Dole was conceived precisely as regulatory policy to strengthen the weakest link in that chain, that is, the transfer of knowledge from laboratory research to new technologies used in the factory floor. In that context Bayh-Dole bridges the domains of research policy or the public funding of scientific research, and innovation policy or the public incentives given to firms to produce gains in productivity.

Speaking of innovation, in the National Academics symposium on *Innovation Policies for the 21st Century*, economist Carl Dahlam (2006) stressed that variety of ingredients that support a thriving economy in the very long run. He suggested that the U.S. economy had benefited from:

- Very large, integrated domestic markets;
- An economic institutional framework facilititatind rapid deployment and restructuring to take advantage of new opportunities;
- Strong competition;
- A deep and flexible capital market (including risk capital);

- A deep and flexible labor market;
- Good rule of law;
- Very strong science and technology institutions; and
- Very flexible managerial organizational structures. (Dahlam, 2006, p. 48)

Consequently, it is important to remember that innovation policy is best seen in the context of the variety of institutional capacities that an economy must develop to foster growth in the long-run, and it is hardly the most important institution. What has fueled the rhetoric that innovation policy as the most important ingredient of economic wellbeing is perhaps the fact that policy on those other institutions is much more politically contested. Consider the contestation the laws on the flexibility of the labor market, or reform of the financial industry, or anti-trust law. Innovation makes for palatable political speech and thus it is often depicted in disproportion of its power for economic change. I do not argue here against the importance of innovation in economic prosperity, or the advancement of science and technology, or the creation of an adequate environment for entrepreneurship, but I want to stress that the received wisdom of innovation and growth, and the extolled role of Bayh-Dole in linking research and innovation has been overemphasized. The obverse side of this coin is that the distribution of income—that occurs simultaneously with growth—is deemphasized, and as I will show in the following chapters, in the Bayh-Dole debate, it is all but absent.

Sizing properly innovation policy, what type of policy is then Bayh-Dole? First of all, Bayh-Dole is a regulatory policy because it regulates IP rights and it does

not involve additional spending on the part of government or on the part of taxpayers. However, as I suggest in the first part of Chapter 4, it could be considered also industrial policy insofar insofar as it helps to increase the market power of established firms, it increases industry concentration in dynamic sectors (as opposed to competition), and by these means, it reduces the rotation of productive assets between new and old firm-cohorts in the transition to a new technological platform. Is is industrial policy also in the sense that Bayh-Dole is a "tax on technology development," when compared to a policy that gives patent rights free of charge; a tax that firms pay and universities collect (Eisenberg, 1996). Bayh-Dole could also be seen as a "tax on consumption" in the case of exclusive licenses that could be developed under competition; a tax that consumers pay as a portion of consumer surplus and the monopolist collects in profits. In addition, Bayh-Dole can also be understood as a distributive policy as I suggest in the second part of Chapter 4. It operates like a subsidy, because it reallocates the potential stream of incomes from the licensing of public patents: from government to the university. A bit more subtly, the Act could be seen as a subsidy for elite universities, because it increases the probability of producing a blockbuster patent for higher levels of financial resources while keeping it the same for lower levels of resources.

Equipped with this notes on the history and policy context of Bayh-Dole, I now turn to the approach and perspective that I will take in bringing equity back into the discussion of Bayh-Dole.

1.3 Approach, perspective, method and data.

The conventional approach to policy evaluation (Heckman, 2007; 2001; Weiss, 1998) is condensed in the idea of "comparative statics." This approach compares the effect of the policy in question as though nothing else but the policy changed. Bayh-Dole is a challenge for comparative statics because the outcomes are not well determined and because the policy has gradually changed by effect of amendments and models of implementation. Making the challenges worse, the effects of Bayh-Dole cannot be easily separated from those of patent policy as a whole and patent policy has undergone significant changes in two decades starting in 1979.

For those reasons, my approach examines instead the "policy drift," that is, the gradual shift in the way a policy is interpreted and implemented. This concept is derivative of the concepts of bureaucratic drift (McCubbins, Noll, and Weingast, 1987), legislative drift (Horn and Shepsle, 1989) and epistemic drift in policy (Shapiro and Guston, 2007) that refer, respectively, to tensions between administrative procedures and bureaucratic discretion, between political changes and institutionalization in the legislature, and between new knowledge and technical standards, and how these tensions shape policy. First, I trace the changes in the letter and implementation of Bayh-Dole to reforms in the patent system and even shifts in the macro political and economic environment. I do this to reveal external forces (discourse and institutions) to the Bayh-Dole debate that, to a significant extent, set the internal terms of that debate and the design of the policy itself. I use "policy design" to emphasize the fact that public policy is susceptible to amendments and

change and the fact that it is construed differently at multiple points in time (Schneider and Ingram, 1997).

While the comparative statics approach often treats policy in the same way as a treatment in a clinical trial—i.e., as a stable change in a regime—my approach instead takes it as an organic evolving institution. I show that Bayh-Dole's design has been heavily influenced by a doctrinal shift in U.S. policy-making driven by neoliberal conceptions of the proper management of the economy and government (Harvy, 2007, Turner, 2008, Mirowski, 2009). One tenet of this new doctrine is that unfettered markets are a necessary condition for economic prosperity; yet, unlike classical liberalism, not only competitive markets but also monopolistic structures are to be freed from regulation. Therefore, a strong patent system is a policy imperative, and so it is private ownership of all patent rights, including those patents that result from public R&D investments (Mirowski and Sent, 2007; Nedeva and Boden, 2010; Pestre, 2005; Slaughter and Rhoades, 2004).

Furthermore, for this new doctrine to hold sway in all domains of policy-making it needed to enlist a rationale that is perceived as neutral and objective and that is, at the same time, compatible with its normative commitment to free markets. It so happens that the standard of policy analysis, the market failure rationale, is predicated on the premise that public action is justified only when markets fail or do not exist (Bator, 1958; Samuelson, 1954). From this perspective, it can be fully expected that market failure assessments of Bayh-Dole further justify its basic logic of creating a market for public patents. For this reason, I introduce an alternative analysis to market failure to study Bayh-Dole, an analysis based on Public Value

Failure rationale (Bozeman, 2002). This emerging analytical rationale rejects the notion that only a market failure justifies public action; rather, it seeks to identify situations when public values of consensus are not served, even when markets work well. Considering public value failures reveals important dimensions to Bayh-Dole that most evaluations neglect. In particular, the tone of the debate has shifted from caution to eagerness in transferring public patent rights to private parties. Consequently, subsequent amendments to Bayh-Dole gradually removed all constraints on the profit motive, particularly constraints introduced for the sake of equity.

The study of the distributive character of Bayh-Dole creates the space for adding a new perspective to policy analysis. Schneider and Ingram (1997) show that policy stakeholders "construct" target populations across two dimensions: power and just deserts. When populations are deemed powerless, the methodology of evaluation can simply assume that effects flow from policy to populations, without feedback, or actualization. In the case of Bayh-Dole's distribution of resources, this perspective would consider the allocation of resources from consumption of new products developed from university patents, or would consider the asymmetry of rents perceived by universities. However, allocation matters and consumers and universities may organize politically to re-design Bayh-Dole if they perceived unfair distribution. While consumers of innovation are too dispersed to coalesce politically, universities have in fact professional organizations and even a technology managers' association (AUTM) that muster a degree of political clout. Hence, the perspective

that I add to evaluation examines the policy effects flowing also in the opposite direction, from target populations to policy design.

My analysis shows the mutual influence between policy and target populations by combining both perspectives. Bayh-Dole allowed a few universities to accrue significant revenues from licensing. Other universities sought to raise incomes in the same way and developed technology transfer capabilities, modifying in this way the organizational structure for the implementation of the Act (Mowery et al., 2001; Thursby and Thursby, 2002). As I show in Chapter 4, this increase of organizational capacity not only exacerbated the asymmetry of resources of the university system because many universities run technology transfer offices at an operative loss but also placed incentives for creative licensing practices that worsen the allocative effects of patents. Universities were publicly criticized for these creative practices (e.g., reach through clauses) when it became apparent that they maximized financial gain for the university at the expense of the public interest (Wadman, 2005; Eisenberg, 2003; Eisenberg and Rai, 2004). The organized response of universities was to commit publicly and voluntarily to a set of best practices that ostensibly protect the public interest, affecting *de facto* the implementation of Bayh-Dole. The declaration is entitled *In the Public Interest: Nine Points to Consider in Licensing University Technology* (Bienenstock, 2007) and has been endorsed by AUTM. Future *de jure* reforms to the Act are expected and it can be anticipated that these reforms will respond to the mutuality of policy and target populations made explicit by the double-perspective analysis offered here.

The research conducted here uses a multi-method approach involving quantitative and qualitative methods. The inquiry is primarily reliant on archival research and refers to primary sources from Congressional hearings, statutes, public speeches and declarations. Secondary sources are used extensively too since this work is concerned with evaluation studies. Statistical analysis used survey data on university patenting from the AUTM patenting survey (2010), R&D data of the federal government and the university system from the National Science Foundation (2010a; 2010b), and data on universities from the Carnegie Classification of Higher Education (2010) and on patents from the U.S. Trademark and Patent Office (2009). The details on the use of these data are clarified over the presentation of arguments, generally in footnotes.

1.4 Structure of the dissertation.

The following chapters elaborate four themes in the re-assessment of Bayh-Dole in relation to its distributive effects. Chapter 2 is a critical review of the evaluation literature of Bayh-Dole. This chapter surveys studies of the intended and unintended consequences of Bayh-Dole. The common approach of these studies is comparative statics; however, I also survey studies in the National Systems of Innovation tradition that examine the policy within its economic and institutional context. The multiple concerns attended to in this literature can be synthesized in two groups, one motivated by the effects of Bayh-Dole on the pace of innovation, and the second guided by the changes to the organization of science and particularly of university research.

It is worth noting here the parallels between my review and the recent report from the National Research Council, entitled *Managing University Intellectual Property in the Public Interest* (NRC, 2010). The NRC report organized its review along two themes, the influence of technology transfer on the university culture (p. 33) and the effectiveness and accountability of university technology transfer (p 49). The former overlaps perfectly with the theme I identified as threats to academic research and culture. The latter point in the NRC report has two parts. The first deals with effectiveness, and as Bozeman (2002) suggested in his review of technology transfer: effectiveness is a contingent concept. The various ways in which the NRC refers to effectiveness— level of disclosure, patenting, licensing, and fostering entrepreneurship—could be collapsed onto the pace of innovation. The explicit treatment of accountability is admittedly a difference with my own synthesis. However, the NRC treats it as derivative of effectiveness because it seeks to emphasize management practices and self-regulation of university patenting and licensing as well as shortcomings of government oversight (53-60). Chapter 3 and 4 delve into these accountability concerns in relation to the university's stewardship of the public interest and the university new business models of patent commercialization.

The two main concerns identified above are important but narrow. Consequently, in Chapter 3 I seek to expand the set of concerns by examining the policy drift in Bayh-Dole and probing this drift with the Public Value Failures rationale (Bozeman, 2002, 2007). There are two dimensions of this drift, the changes in the debate and in the design of the Act. It would seem an odd coincidence that

separate political bodies as the Executive, Congress, and the courts would become aligned in the direction given to patent policy reform since 1980. In fact, regulations and dispositions, new law, and court rulings have all strengthened patent protection, expanded the scope of patentable subject matter, made it easier to acquire patents and costlier to infringe them. Likewise, it appears coincidental that these bodies issued and enacted an array of policies to enhance incentives and protections for businesses without regard to their size or the market structure in which they operate—that is, monopolies are no longer treated with suspicion as it was the norm from the Progressive Era and up to the early 1970s. However, placing the Bayh-Dole debate in the larger discourse on policy in relation to the economic debacle of the 1970s and the political rhetoric that emerged, the seeming coincidences are rendered instead purposeful and systematic. I argue that the ascendancy of neoliberalism in policy making is implicated in shaping patent policy in the manner I just described.

What is more, Bayh-Dole itself was not immune to these changes in the policy environment. As I show in Chapter 3, it was successively amended to include large business (it originally limited the benefits for these) and regulated by the Department of Commerce such that the provisions that would allow agencies to intervene in the public interest were rendered impractical. To the light of the policy drift, I introduce an analysis of public values relevant to the Act within the framework of Public Values Failure as explained above and identify tensions inherent to values such as political equality and transparency in the implementation of the Act. The relevance of this analysis is highlighted by the threat of reforms that would remove altogether the built-in safeguards to the public interest.

Probing Bayh-Dole through the lenses of those values reveals an interesting aspect. As I discuss in Chapter 3, the degree in which opposing views were giving equal consideration at the time Bayh-Dole was passed, suggests that political equality is now in decline. Likewise, the analysis of other values reveals increasing inequality in the distribution of benefits from Bayh-Dole. For instance, the inability of the NIH to intervene and use the provisions of the Act that could control pricing excesses by companies that licenses their patents from universities; or the increasing secrecy necessary for offices of technology transfer to compete in an environment similar to that of a capital investment firm. From this analysis emerged a patterned array of considerations missed by other studies: lack of use of the mechanisms and authority in the Act to promote an equitable distribution of its benefits.

Chapter 4 probes more deeply the distributional effects of Bayh-Dole. Taking first the perspective of the university system, I discuss specific institutional arrangements that reinforce a very asymmetric distribution of political and economic resources among universities. It is well known that economic resources (research funds, endowments) are disproportionately allocated to elite universities, but it is sometimes overlooked the fact that elite universities also command the political voice of the system. As a result, smaller universities do not yield enough influence to promote federal policy that would curb resource allocation to their favor. In the specific case of technology transfer, most of these universities generate very little returns (generally operating tech-transfer offices at a loss); yet, spokespersons of the university system have given unqualified support to Bayh-Dole on behalf of all universities.

In this environment, and partly due to it, universities have sought new business models to increase the financial returns from technology transfer, and at the same time they have sought to hedge the reputational risks of engaging too aggressively in licensing activities. Among other alternatives such as patent pools (Winickoff, 2006) and socially responsible licensing (Mimura, 2007; 2010) a business model has emerged that seems to balance the financial needs and public mission of the university. This model, called here "nurturing start-ups," consists on providing business services, such as legal counsel and administrative asistance, to new companies established with intellectual property from the university's own faculty-inventors. The university will thus promote entrepreneurship while taking a stock interest in the firm that can be recouped if the firm is later acquired or offered in open financial markets (Feldman et al., 2002). I use this emerging business model as an example of an institutional arrangement with significant consequence on the distribution of benefits from innovation. When established firms can easily acquire new high-tech start-ups, new economic sectors are unlikely to emerge in a competitive environment. In that scenario, productive assets are not reshuffled across technological platforms and market concentration reallocates the benefits from consumers to monopolists.

A case in point is the emergence of the biotechnology industry. Early in the history of this industry, well-established pharmaceutical companies came to constitute its "core"; the rest either constituted the "supporting nexus" or failed in their attempt to join the core firms (Chandler, 2005). Of about one hundred promising start-ups in the early 1990s, all but two succumbed to the liquidity

pressures of establishing themselves independently; the rest either closed operations, merged, or were acquired by the big pharmaceutical companies in the industry's core. The prospects of success for the business model of nurturing start-ups, and the significant share of university patenting that goes into biotechnology, suggest that distributive benefits from public research and innovation risk being a significant and pervasive problem.

In discussing distribution of resources in relation to Bayh-Dole, I addressed too the set of standard assumptions as to how innovation comes to be widely distributed. For instance, research has been conceptualized as a public good or that innovation-driven economic growth creates new wealth atop of the economic ladder that eventually trickles down to all economic strata. I show that these assumptions are suspect at best, and inadequate in a wide variety of circumstances.

Is the neglect of equity issues specific to Bayh-Dole? It may seem that the problem is not endemic to this policy alone; rather, it is the entire domain of innovation policy that has neglected the problem of inequality—notable exceptions are Healey, Hagendijk, and Pereira (2009), and symposia discussed in Senker (2003) and Wetmore (2007). Still, if we suspend judgment about any systematic bias on the part of students and policy-makers of innovation, a usual suspect for the neglect of equity could be the methodology of evaluation itself.

In Chapter 5, I take issue with what seems to be a systematic neglect of important public values in conventional public evaluation. I examine the philosophical underpinnings of policy evaluation to see if there lies a source of the chronic neglect of values in evaluation. I argue that "instrumental reason" is the

primary if not the only logic guiding the practice of evaluation and that "consequentialism" has hegemonic control of the moral thinking in this discipline. This orientation precludes evaluators from asking deeper questions, as to "why do we care for such and such outcome?" or "why do we accept such and such law as legitimate?" While methodologically robust in measuring impacts—given that data are available and "well-behaved"—evaluation is too thin in valuing outcomes and the policy process itself, it relies too heavily on intuitive judgments. But then, when the normative questions are more complex and there are trade-offs between values that cannot be reduced to the same measure, intuitive judgments become inadequate. Policy evaluation thus needs to be complemented by a deontological perspective that formalizes the valuation of outcomes and the valuation of the policy process.

The task of formulating a theory that guides the formation of judgment in policy evaluation is a question that makes explicit the commitments of the discipline with democratic policy making. In Chapter 5 I critique not only the conventional conception of policy, at least from a methodological perspective, but also the related conventional notions of political representation. From that critique, I seek to formulate the basic conditions to be required from deontological evaluation. To this end, I draw from recent work in science and democracy (Brown, 2009) and the bureaucracy and democracy (Catlaw, 2007) to introduce a different conception of representation to policy evaluation. This conception relies on a different ontology of the sovereign (the people) that is distributed across an ecology of institutions of representation. Thus, the traditional epistemic and ontological unity in the representations of "popular will" breaks apart and is replaced by a descentralized system of representation that is at the same time more socially robust (in the sense of

enhancing of social cohesion and resilience) and fairer in terms of political power (because power is a function of the ability to claim one's representation is truthful). The challenge is surely to adapt this conception of representation to policy evaluation.

This is not a complicated way to say that politics is local and that a normative theory of policy evaluation should observe local sensibilities. Descentralization does not imply necessarily geography or other physical criteria of dispersion. Rather, it does imply a distribution along the spectrum of political power, along degrees of participation and marginalization. In fact, it seeks to elevate the voice of traditionally marginalized technical and political representations. It also implies that evaluation must not settle for single representations (such as that from polling) but rather cross-reference the various institutions of representation. It also implies that a deontological perspective in evaluation does not suppress value trade-offs or resolve them by projecting competing values onto a single unit of measurement; it implies instead the necessity to match values to institutions of representation.

Chapter 6 offers a summary of the main conclusions of the preceding chapters. I emphasize here what could be called and "epistemic conflict of interest" in policy evaluation. That is when the method of evaluation and the object of evaluation are normatively informed by the same theory, as it would be the case of making a market failure analysis to Bayh-Dole. In addition, I stress the relation of political resources and economic resources as they are distributed similarly among groups, as it was shown for the university system. When the problem cannot be cast as a zero-sum game, the economic disadvantaged cannot wield the political power

necessary to change external factors of their disadvantage.[2] Finally, in the very last section, I suggest an implication of this study to the theory of governance. By interpreting the evolution of Bayh-Dole to the light of the mutual influence between emerging technologies and the institutions that facilitate and regulate their emergence. Specifically, the emergence of biotechnology has been shaped by patent policy, and this in turn has been influenced by the advances and new entities brought about by this technology. I ask "how can this mutuality be managed?" and I draw from "anticipatory governance" (Barben et al., 2008) to conceive of Bayh-Dole as an "integrative" institution in the sense that it integrates tasks of innovation (research, commercialization) that are traditionally conceive as separate, and doing this it opens the possibility to shape the entire innovation process.

[2] University patenting is not a zero-sum game because the licensing of an elite university does not impede the licensing of a non-elite university, if the latter were to produce a blockbuster patent.

Chapter 2

CRITICAL ANALYSIS OF THE BAYH-DOLE EVALUATION LITERATURE

2.1 Introduction.

The body of work that evaluates the effects of the Bayh-Dole Act is a veritable library. In this essay, I synthesize that literature and offer a critical review.

From the outset, the university must be located within the system of innovation. For this reason I begin my survey taking the perspective of the *National Systems of Innovation (NSI)*, offering a brief exposition of the origins and tenets of the NSI approach in innovation studies and then examining studies in this genre that addressed the history of the university. The historic and systemic character of NSI analysis illuminates some important aspects that are only hinted in evaluation studies based on partial approaches; specifically, it refutes the traditional view of an insular U.S. university as the record shows a rather different picture. From inception, most universities were sensitive to the industrial needs of their geographic constituencies and had close links to industry, a relation that was only temporarily weakened in the postwar period.

Against this backdrop of the innovation system, I then discuss more specifically the Bayh-Dole Act. The economic logic that came to dominate the debate was codified in the text of the Act, namely, that the goal of Bayh-Dole was to accelerate the commercialization of federally funded research. This is my starting point and I discuss the studies that assessed the realization of that objective. Because

commercialization escapes easy measurement, proxy variables such as patent counts are used for inference. Looking at these data it becomes apparent that the growth of university patenting precedes Bayh-Dole. However, it also becomes clear that a number of reforms to the patent system introduced in the 1980s—taken together and not solely the Act—provided the institutional support for the sustained growth of patenting observed for more than two decades. The Act was neither the cause of the surge in university patent nor the only reform that supported it for more than two decades, but it was undoubtedly an important part of the institutional rearrangement of the patent system.

Having discussed the intended effect of the Act, I will turn my attention to its unanticipated consequences. I organize the literature here under three groups. The first is concerned with the effects of Bayh-Dole on the efficiency of the innovation system. The problems identified there include the following: the possible crowding-out of basic research by applied research, the emergence of "patent thickets" that might slow down innovations that draw from several previously patented inventions, the restricted licensing of research tools and limitations to the sharing of databases and materials, and other perverse incentives that create situations in which universities are caught in patenting and bargaining contests that restrict their own ability to do research. The second group deals with unintended organizational changes within the university that are traced back to Bayh-Dole. Studies of this group are concerned mainly with a rupture in academic tradition in terms of public dissemination of research results, faculty discretion in setting the curriculum and research agenda, and impartiality in the conduct and peer-review of research.

2.2 The University in the Innovation System.

2.2.1 Brief Introduction to National Systems of Innovation.

National Systems of Innovation (NSI) is a conceptual framework that arose from two main preoccupations. The first was a concern about the economy. The co-occurrence of an economic downturn during the 1970s, the emergence of Japan as a technological power, and a deteriorating trade balance in the U.S. (and many European countries), were both factors that fueled the idea of a competitiveness crisis.

The second concern was theoretical. The economics of innovation had grown as a sub-discipline enough to put neoclassical economic theory to the test, and several scholars of innovation found this theory wanting as a framework to explain innovation (see, prominently, Freeman, Lundvall, Nelson and Rosenberg; whose work is cited further below). The feeling among these scholars is that microeconomics oversimplified economic behavior by imposing the constricting assumption that economic agents have a well-determined objective function, and from there proceeding to aggregate individual behavior to deduct conditions of equilibria under various markets structures. This critique took issue with the modeling of innovation simply as a particular form of the production function or alternatively as a factor of production like labor or capital. It also took issue with the neglect of important aspects of innovation such as the role of "networks" and "tacit knowledge." Moreover, these scholars felt that the stylization of firm behavior and innovation made difficult the consideration of organizations whose behavior does not fit the inflexible assumption of profit-maximization; take, for instance, the university. The stylized market relations also ignored significant institutions whose

dynamics affect all aspects of innovation; institutions such as law and legal precedent, traditions of research and academic life, regimes of the governance of science and technology, and due process in the allocation of political authority. There was also a palpable sense that these institutions were configured differently in different countries, yet neoclassical analysis does not have any historic awareness because it tends to reduce the state of affairs to atemporal regularities of firm and consumer behavior (see a complete exposition of this critique in Nelson, 2005).

Christopher Freeman introduced the concept of *national systems of innovation* to the literature (Freeman, 1982; 1987[3]); he recalls to first have heard the phrase from Bengt-Åge Lundvall. Further work of Freeman (1994a), and team projects directed by Lundvall (1992) and Nelson (1993) gave body to the NSI framework and provided the basis for what came to be called "reasoned history" (Freeman and Louçã, 2001)—that is, a historical analysis of innovation that looks into five interdependent domains:

1. the generation of scientific knowledge;
2. the development, improvement, adoption of new artefacts and new techniques of productions (that is, the domain of technology);
3. the 'economic machine' which organizes the production and distribution of goods, services and incomes;
4. the political and legal structure; and finally,
5. the cultural domain-shaping values, norms and customs (Dosi, 2008, p. ix).

[3] Note that the subtitle of the 1987 NSI book, "Lessons from Japan" is testimony to Freeman's concern and curiosity for Japan's innovation feat.

NSI privileges the national level because, Freeman (1994) argues, only at this level is it possible to encounter sufficient independence of these domains to permit an analysis of their trajectory and interconnectedness, such that the effects of "techno-economic paradigms" on society are rendered discernable (Perez, 2002). I submit that this choice of level of analysis is somewhat a choice of convenience. For one, it is consistent with the received wisdom of state sovereignty; I may suggest as a possible explanation that the post-World War II stabilization of national borders created the illusion that nation-states are neatly demarcated across homogenous histories and cultures, and the electoral rhetoric of democratic states only reinforces this belief. Another convenient aspect is that data, when available, are generally collected at the national level, making nations the de-facto ideal unit of empirical analysis. Nevertheless, it should be noted that within the systems of innovation literature there have been attempts to define other levels of analysis: the regional system of innovation (Storper, 1995) and the sectoral technological system (Breschi and Malerb, 1997).

The NSI approach benefited from the parallel emergence of an evolutionary theory of innovation (Nelson and Winter, 1982). Directly confronting the assumptions of neoclassical economics, evolutionary economists do not see the firm as a maximizing agent but as an organism that seeks survival and adaptation. The market acts as the selective mechanism that rewards fitness with profit and bankrupts those unable to adapt. The elementary unit of firm behavior, the "routine," is both path-dependent and to some degree sensitive to changes in the external environment of the firm's own structure. The capability of adaptation of a firm resides in acquiring the set of routines that will allow it to innovate the

technologies used in production, the processes of supply, production and distribution, and the organization of the firm itself. Considering that this theory holds innovation as the critical function of firm evolution, and the routine as the empirical unit of analysis that links the productive system, it is not surprising that the systems of innovation approach rapidly incorporated evolutionary economics as its explanatory kernel (Dosi, 1988; and McKelvey, 1997).

This brief exposition of the basic concepts in the NSI will let me now turn to the literature, within this framework, that considers the effects of Bayh-Dole. As suggested above, these studies seek to understand the process of innovation from a historical perspective.

2.2.2 The role of the university in the innovation system.

Because Bayh-Dole is particularly relevant to universities, it is the historic role of the U.S. university in the innovation system that guides this review. Earlier, section 4.2 considered evaluations centered in the university that sacrificed a systemic perspective for the sake of a thick explanation. In contrast, the histories of the role of the university reviewed here emphasize the relationship of these organizations to the other actors of the innovation system.

The first significant aspect to be observed is that U.S. universities functioned, from inception, in a decentralized system—in contrast to other high-income countries. For instance, since the Napoleonic reform, France has a centralized administration of higher education. Universities in the U.S. were at the same time accountable to the geographical constituencies they served, tailoring their educational programs and research to the needs of these constituencies, but also were recipients of the beneficence of these constituencies (Mowery and Sampat, 2005a).

Sensitivity to industrial needs is evidenced by the rapid incorporation of educational programs in engineering, introduced as early as 1802 in West Point (when it was founded), and followed by Rensselaer Polytechnic Institute (1824), MIT (1865), and the School of Mines of Columbia (1864). The importance of state level support to state universities further deepens the incentives for universities to be attuned to local needs. This is epitomized by the emphasis on agricultural research at the land-grant colleges that were created by the endowments of the Morrill Act of 1862. Further support was provided by the Hatch Act of 1887, and the Adams Act of 1906 that complemented existing education and research in agriculture by establishing experimental stations (Rosenberg and Nelson, 1994). University support of local industry continued in the twentieth century, as Rosenberg (1998) pointed out, through the significant emergence of chemical engineering. Places like the University of Akron that became a critical supplier of skilled labor and research to the rubber industry exemplify this period. Furthermore, great research attention and resources were placed on the improvement of the yield of arable land. The investments took decades to pay off because output per acre remained flat in the first part of the twentieth century and the growth in the agriculture sector was merely "extensive;" but by 1940 university research in biology and chemistry applied to agriculture (e.g. hybrid seed corn) made a breakthrough and started to increase that output per acre several fold—primarily in cotton, wheat, oats, and corn (Parker, 1972).

The post-war period saw major shifts in the federal organization and funding of science in general and of the university in particular (Guston, 2000; Smith, 1990). In fact, the increase of federal funding of university research multiplied by a factor of

5 from mid 1935 to 1960, and again by a factor of 4 from 1960 to 1985 (going in 50 years from $0.4 bn to $8.5 bn in 1982 dollars). This increase led economic historians Mowery and Rosenberg to conclude that federal support "transformed major U.S universities into centers for the performance of scientific research", adding that this was "an unprecedented role" (Mowery and Rosenberg, 1993, p. 47). Far from allocating this increase solely to fundamental research, monies were allocated through federal agencies, each with its own goals and missions, and generally requiring an application in sight (Stokes, 1997).

The increasing willingness of the federal government to fund universities displaced, to some extent, industry funding of university research. That this retreat was justified because universities continued research with a practical orientation is not a completely invalid conjecture (Swann, 1988). In effect, the university research portfolio in the postwar period was rebalanced to accommodate ever larger shares of research relevant to the manufacturing sectors. At the same time, the stable corporate profits in the 1950s and 1960s permitted industry to fund sizeable operations in their own laboratories, both for fundamental research and product development (Mirowski and Sent, 2008). It should be stressed that prior to the war university-industry ties were close, with industrial barons chartering private universities and endowing schools at public universities.

The second significant aspect that emerges throughout the history of U.S. innovation is the cycles of industry-university partnership: a wax and wane that responds to institutional changes at the industrial and governmental levels. In fact, the significant changes triggered by World War II altered the relationship between government and science and, as noted earlier, increased the federal commitment to

research at universities and national laboratories. Also, the economic boom of the postwar period strengthened the position of corporations that expanded their in-house R&D operations; both events reinforced the industry withdrawal from funding university research. However, economic conditions shifted again in the 1970s. Increasing international commerce and capital flight made economies more interdependent, and this in itself led to a second wave of reforms in the governance of science around 1980. Notice that Bayh-Dole and the other patent reforms are really not seen here as the source of reform, contrasting with most studies discussed earlier (section 4.2). Rather, it is seen as part of systemic phenomena including (i) low productivity gains of the economy as a whole combined with a negative trade balance (Papadakis, 1994), (ii) increasing international trade and the emergence of strong exporting economies that took world leadership in some high-technology sectors (Freeman, 1994b), and (iii) easier technology transfer across international borders combined with deregulation of several sectors that led corporations to re-concentrate on their core products and refocus their R&D operations by gradually farming it out of the firm, through research consortia or closer ties to universities (Mowery and Rosenberg, 1993; Mirowski and Sent, 2008).

The increased breadth and depth of university-industry relations that is observed since the 1980s is not a new phenomenon; rather, it has a precedent in the organizational arrangements that dominated the interwar period. This relationship was perhaps weakened in the 1950s and 1960s, but after the macro-events of the 1970s and 1980s unfolded the relationship evolved with a wider array of channels specific to each industry. In this context, Bayh-Dole and the other patent reforms of the 1980s can be seen, now from a wider perspective, more as a catalyst than as

cause of the reconfiguration of university-industry relations. It is worth noting here that, compared to other high-income countries, the proportion of non-academic basic research performed in the U.S. by the government is relatively low, while that of industry remains relatively high (Mowery and Sampat, 2005a). It is possible that the proportion of university basic research that is of interest to industry increased since Bayh-Dole by effect of licensing contracts allowed in this regime (Mowery, et. al, 2004). It should be recalled nonetheless that industry does not see intellectual property to be a main mechanism to appropriate returns to R&D investments (with few exceptions, e.g. pharmaceuticals) and that informal channels of knowledge diffusion rank higher than licensing agreements (Levin et al., 1987; Cohen, Nelson, and Walsh, 2000; 2002).

Undoubtedly, the NIS approach expands the understanding of the effects of Bayh-Dole. Recapitulating, the two aspects that emerged from this historic and systemic view of the U.S. university are that from inception the university was sensitive to local industry needs and that this relationship has been punctuated by economic trends and the regimes of science governance. Both aspects relocate the debate on Bayh-Dole into a discussion of economic and trade policy; patent policy is still important but only in concert with other policy domains.

This vantage point allows us to identify drivers of policy reform that are not otherwise readily apparent. For instance, political pressure to increase patent protection may increase in recessive periods of the economic cycle or when facing emerging competition from a foreign exporting industry. Another example is the effect of international commerce agreements on national patent policy, and, in particular, the deleterious effect of the implementation of the Special 301 Report

(Haskins, 1998),[4] which includes incentives for other OECD countries to implement policies inspired by Bayh-Dole (Mowery and Sampat, 2005).

2.2.3 Limitation of the NSI framework.

For all its strengths, NSI analysis suffers from two types of limitations that become apparent when considering the role of the university in the innovation system. The first is the pervasive problem of determining the scope of the system. For instance, while studies thus far have adequately given innovation a historic perspective with respect to economic conditions and industrial organization, other domains, such as financial markets, remain confined to footnotes. In light of the events that unfolded since September 2008 (Greenspan, 2010), NSI studies will have to incorporate financial markets within the analysis or suffer the same under-determination and policy ambiguity as the economic analysis it aimed to replace (notable exceptions are Perez, 2002; and Coriat and Orsi, 2002).

The second limitation of NSI studies is perhaps deeper and more difficult to redress. The motivation of these studies seems too tightly aligned with the narrow concerns articulated in elite discourse. As such, innovation appears worth studying chiefly because of its effects on national "competitiveness" for high-income countries (see Cantwell, 2005), "catching-up" for middle and low-income countries (Kim, 1993; Alcorta and Peres, 1998), and a general concern for the "returns of R&D investments" for which measurements are developed (e.g. the Innovation "Oslo Manual," first produced in 1992; OECD, 2005). These are surely important issues as they relate to overall employment and economic growth. However, the

[4] Whereby the Trade Representative may suggest sanctions to U.S. trade partners who do not enforce IPRs under the World Trade Organization terms of the Uruguay Round (Trade-Related Aspects of Intellectual Property Rights or TRIPS).

alignment with the worries expressed by the press and policymakers has kept NSI scholarship from tackling other critical problems. In economic matters, for instance, very little has been said on the relation of income inequality with innovation, and, more specifically, with the role of the university and the intellectual property regime. The obsession with the pace of innovation seems to neglect the risks to the democratic order that come from the uncritical adoption of new technologies—an alarm raised from several angles of science and technology studies (see Jasanoff et al., 1995; Hackett et al., 2008). At the organizational level, the NSI approach has carefully codified the heterogeneity of industrial sectors but it has not carried over this nuanced analysis to the other actors of innovation. Universities are in fact a very uneven group and some policies may be to the advantage of only a few of them, which is precisely the case of Bayh-Dole. Likewise, governments rarely function consistently. Instead, Congress, the Executive branch, and the courts often transmit contradicting signals to the actors of the innovation system; bureaucracies implement policy sometimes with exclusive discretion; and state and national legislatures hardly operate with a single voice. Insofar as the NSI approach rejects over-stylizing institutions and rejects the heuristics of the linear model of innovation, it provides a useful conceptual framework for the analysis of innovation. But this is not always the case in NSI studies, particularly when universities or government are depicted as monolithic agents following consciously a logic or plan, or when the analytical value of easy dichotomies (basic-applied, research-development) goes unquestioned.

In the specific case of Bayh-Dole, NSI analysis has given new light to the role of university and intellectual property in the innovation system, but it has also

reaffirmed the widely held belief that the Act should be assessed ultimately by its impact on competitiveness.

2.3 Assessing the Intended Consequences of Bayh-Dole.

The Bayh-Dole Act was proposed justified by two premises, the first being that the U.S. economy confronted a competitiveness crisis and the second that fostering innovation was the long-term solution to that crisis (I discuss in more detail these premises in Chapter 3). The problem, thought the framers of Bayh-Dole, was that ambiguity of patent rights was a bottleneck in the innovation process—a bottleneck that impeded public R&D investments (turned into inventions) to flow swiftly from the laboratory to the market place. Accordingly, the proposed solution was simply assigning patent rights to the organizations performing the research to resolve the problematic ambiguity and to accelerate commercialization of public R&D.

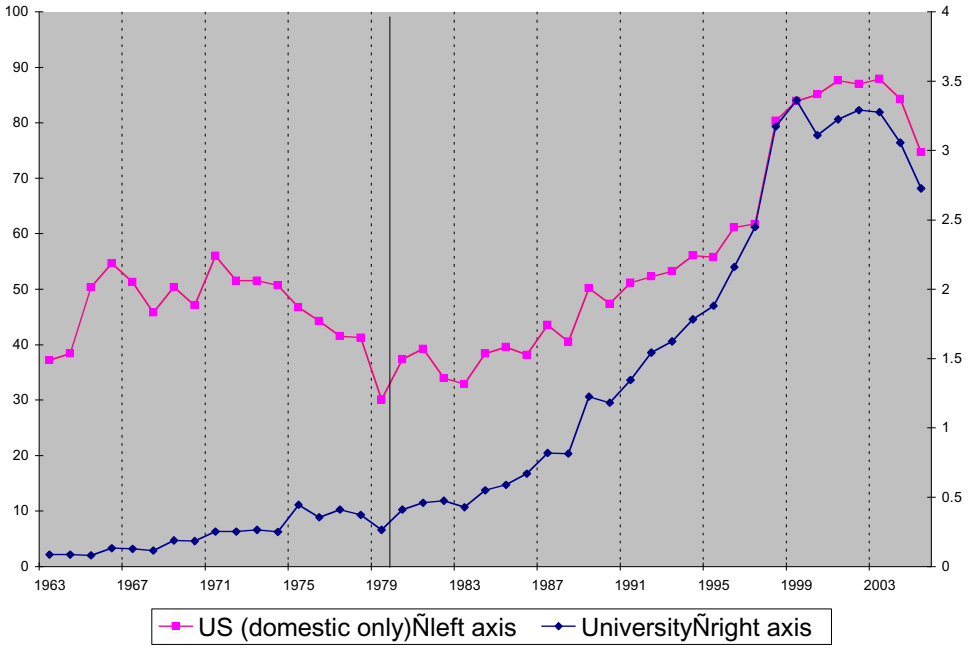
Such a goal poses a problem for evaluators who want to quantify "commercialization" because such a concept eludes easy measurement. The usual method for hard-to-measure concepts is to find proxy-measures that are conceptually related to the phenomena of interest. Provided that the Act was proposed on the presumption that patenting is a precondition for commercialization, university patenting has been the focal variable of evaluation studies of the Bayh-Dole.

Unsurprisingly, advocates of the Act are quick to point out to the rapid increase of university patenting following 1980 (CRS reports in Schatch, 2005; U.S.

GAO, 1987, 1991, 1998; AUTM, 1996, 1998). By implication, they attribute the growth in patenting to Bayh-Dole.

At least two reasons cast doubt on the adequacy of such an attribution. First, by the time the Act was enacted, universities were already patenting at increasing rates year after year. For instance, universities were granted 188 patent titles in 1969 and 264 in 1979. In fact, university patenting grew at an exponential rate for at least seventeen years before 1980 (Figure 1).

Figure 1. Patenting Activity, Universities and US System.

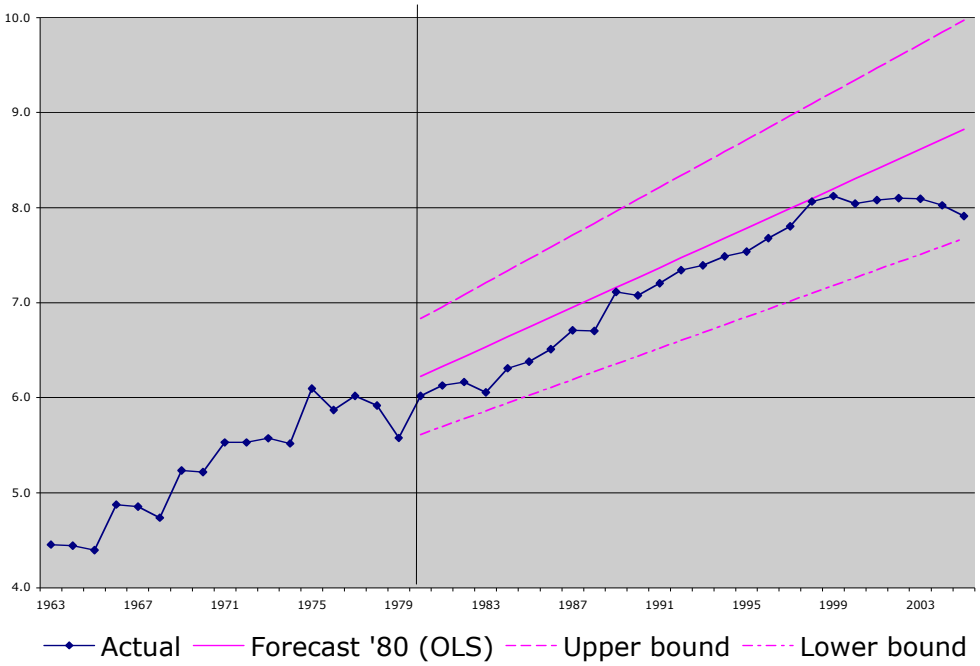


Data Source: USTPO (2009). Note: Scale in thousands of patents granted.

Second, before Bayh-Dole many research universities had already developed the administrative capacity for patenting and licensing. By 1980 nearly 76% of the "largest research universities" had signed an invention administration agreement with the Research Corporation, a non-profit organization founded in 1912 to be a third-party administrator of university patents (Mowery and Sampat, 2001a and 2001b). In

addition, a few state universities not contracting with the Research Corporation had set up their own offices of technology transfer following the steps of the Wisconsin Alumni Research Foundation (WARF) of the University of Wisconsin, founded in 1924. It should be recalled as well that universities that participated in the HEW's IPA program (and similar programs in other federal agencies) were required to demonstrate technology transfer capabilities.

Figure 2. Forecast 1980-2005 of Patenting Activity using 1963-1979 data.



Data Source: USTPO (2009).
OLS regression in Figure 2 is over time (no lags), and estimated slope statistically significant at p =.01.

Considering the rapid growth of university patenting observed from 1963 through 1979, as well as the organizational capacity for patenting prior to 1980, I have projected, using time series analysis, the growth of patenting based on those 17 years of data. The best fit is an exponential curve and it happens to be, with hindsight, surprisingly accurate 20 years forward (see Figure 2). Even before Bayh-

Dole, it would not have been unreasonable to expect a long period of exponential growth of university patenting. It should not be assumed, however, that fast growth was sustainable, at least not for two decades, without significant reforms to the patent system. Such reforms did take place through the 1980s, changing the use and scope of patents in the U.S. Starting with the Stevenson-Wydler Act (PL 96-480), enacted two months before Bayh-Dole, that created offices of research and technology application (ORTAs) inside federal laboratories. This act was later amended and expanded by the Federal Technology Transfer Act of 1986 (PL 99-502) that introduced economic incentives for federal researchers to seek technology transfer and for federal laboratories to enter into Cooperative Research and Development Agreements (CRADAs) with private parties (Guston, 2000; see Chapter 5). The incentives for universities (Bayh-Dole), federal laboratories (Stevenson-Wydler), and CRADAs (FTTA) mutually reinforced each other, and created a favorable environment for patenting and licensing to industry. The increasing patenting observed through the 1970s (Figure 1) stressed and strained the appellate courts that at the time were responsible for hearing appeals in patent infringement cases. To address this problem, Congress created in 1982 the CAFC or Court of Appeals for the Federal Circuit (PL 98-462) that centralized patent appeal decisions under a specialized court. The creation of CAFC intended to relieve the regional appellate courts from the flood of patent cases and to provide greater consistency across decisions. Greater consistency was in fact achieved; nevertheless, taken together and in comparison with the previous decentralized system, the decisions of the new court are skewed towards leniency in judging the validity of patents and towards severity in sanctioning patent infringement (Henry and Turner,

2006; Lunney, 2003). Further restrictions related to anti-trust legislation were relaxed under the National Co-operative Research Act of 1984 (PL 98-462) for patents under public-private research joint ventures (see Scott, 2008). Another protection, more specific to the pharmaceutical industry, was packaged in the Hatch-Waxman Act of 1984 (PL 98-417) that extended patent rights up to five years to compensate pharmaceutical companies for the lengthy approval process of a new drug (on average 7.5 years). Further protection to patenting in the biotechnology and software industries was given by two Supreme Court decisions, respectively: *Diamond v. Chakrabarty* (447 U.S. 303/1980) initiated the patenting of genetically engineered life forms and *Diamond v. Diehr* (450 U.S. 175/1981) paved the way for the patenting of software.[5] This overhaul of patent policy created a favorable environment for patenting, yet it is evident that this environment—of which Bayh-Dole is part—is not responsible for the growth in patenting activity anymore than a cold winter is the cause of a flu pandemic.[6]

What then was the cause of the growth of university patenting? Three possible explanations have been put forward. First, starting in the late 1960s, the U.S. government sought greater control of the research agenda and research output of universities (see Guston, 2000, pp. 77-85); while the total federal research budget did

[5] Following the precedent of *Diamond v. Chakrabarty*, the U.S. Trademark and Patent Office modified its guidelines declaring "non-naturally occurring non-human multicellular living organisms, including animals, to be patentable subject matter" (USTPO, 1987). *Diamond v. Diehr* allowed the patenting of a machine controlled by a computer creating an exception to the theretofore exclusion of mathematical algorithms as patentable subject matter, the scope of which was later expanded by various rulings of the CAFC and ultimately codified in the USTPO 1996 guidelines for computer-related claims (USTPO, 1996).

[6] Other relevant legislation includes the Orphan Drug Act of 1983 (PL 97-414) granting a seven year exclusive license of government patents related to drugs that target rare diseases (less than 200,000 patients diagnosed) and the U.S. Trade Representative's mandate known as "Special 301" used to monitor and sanction U.S. trade partners that fail to provide adequate IPR protection. For further reference see Coriat and Orsi (2002; Table 1, p. 1494).

not fall, the focus on some research programs (e.g. Research Applied to National Needs[7] and Nixon's War on Cancer) benefited some universities more than others, increasing pressure for those in the funding periphery to seek sources of income other than federal grants. The economic crisis on the 1970s may have accentuated this problem as state budgets for education shrank and university endowments contracted. Second, new technologies produced entire families of new patentable inventions. One such family of novelties is in the field of biotechnology that through the 1970s flourished into a well established discipline and industry (see the history of molecular biology in Judson, 1996|1979; and of bioengineering in Citron and Nerem, 2004). Another sector that expanded quickly in the 1980s is computer software, both personal computers and network servers. Looking at patent data, Kortum and Lerner (1998) show that from 1969 and 1991 biotechnology and software patents nearly doubled their weight in the total of patents (from 3% to 6% for biotechnology and from 4% to 7% in software). The third explanation for the increase in university patenting is a cultural change in the academic and business worlds about the role of patents. The attitudes of university administrators and even the disposition of some scientists towards patenting has turned from reluctance to euphoria in three decades, from setting their scruples aside and timidly patenting university inventions to actively seeking and promoting patenting (Greenberg, 2007—see specially Chapter 4; also Bok, 2003). Today, most research universities encourage (if not require) their faculty and staff to provide invention disclosures when appropriate, have all personnel sign patent release contracts, and they give

[7] The NSF started in 1971 the Research Applied to National Needs (RANN) program; expanding the previous short-lived Interdisciplinary Research on Problems Relevant to Our Society (IRPOS) program.

great latitude to their offices of technology transfer to maximize licensing profit, including sometimes undertaking aggressive litigation (Greenberg, 2007).

In summary, the ostensible goal of Bayh-Dole was to accelerate commercialization of public R&D. Consequently, evaluation studies seek to assess whether this goal was accomplished. Because commercialization itself is difficult to measure directly, evaluators focus on university patenting—deemed strongly related to commercialization. University patenting has grown significantly, yet this growth started before Bayh-Dole was enacted. In fact, the drivers of the explosion of university patenting—the coming to maturity of emerging fields of research, and institutional changes in university funding—are unrelated to the Act. Still, important reforms to the patent system that started in 1980 did create a favorable environment for patenting, and Bayh-Dole is undoubtedly an important part of these reforms. For this very reason, the Act should be seen more as a catalyst than as a driver of the growth in university patenting. What is more, due to the interconnectedness of these reforms, it is difficult and perhaps futile to try to separate the individual effect of the Act (Mowery et al., 2001; Mowery et al., 2004; and Mowery and Ziedonis, 2000; 2002).

It should be added that the effects of the Act have not been assessed only in reference to its goal of accelerating commercialization of university inventions. Other important effects have been discussed, mainly in relation to the quality of university patenting and the organization of university research. These are discussed next.

2.4 Assessing the Unanticipated Consequences of Bayh-Dole.

The unintended effects of Bayh-dole can be arranged in three groups: effects on the efficiency of the innovation system, effects on the internal organization and culture of science broadly and the university particularly, and effects on the distribution of costs and benefits of innovation. What follows in this chapter engages the former two groups because they have received serious attention in the literature. Because the latter has been generally neglected, Chapter 3 introduces my own analysis of distributional outcomes.

2.4.1 Effects on the efficiency of the innovation system.

The most common heuristic representation of innovation is referred to as the "linear model of innovation," as it evokes the image of an assembly line where the conveyor belt transports raw materials through different processes to convert them into a final product. This process originates in *basic research*, the findings of which are later used to solve specific problems through *applied research*, that feeds the stage of *development* for the mass production of final products (a canonical representation in Ziman, 1987). Although this representation has been charged with obscuring rather than illuminating how innovation takes place, it remains widely used in public discourse and to some extent in empirical evaluations of science policy, including evaluations of Bayh-Dole (for a history of the linear model as a discourse, see Godin, 2006).

National accounting of innovation is partly responsible for the pervasiveness of the linear model. For instance, the U.S. Office of Management and Budget under Circular A-11 (2009) requires federal agencies to account for R&D expenses under

the basic-applied-development template; what is more, agencies that account expenses in greater detail must fit their typology within the same template (see Fossum et al., 2000 for a comparison with the U.S. Department of Defense).[8] The result is that the main sources of data, such as the annual NSF report on national patterns of R&D (NSF, 2007), shape hypothesis formation in the cast of the linear model.

As a heuristic description, the linear model implies a parsimonious division of labor. In the case at hand, the division of labor among the organizations participating in innovation accords to the government the funding of research, to universities and national laboratories the performing of research, and to industry the development of research findings into products and their commercializing. It also implies a boundary between the public and private spheres of innovation, placing universities on the boundary of these two spheres. From this perspective, the problem, as Bayh-Dole conceived it, was very clear: resources flowed from government to universities and laboratories but the resulting inventions barely trickled to industry because of the ambiguity of patent rights. As said earlier, the Act sought to widen this bottleneck and various evaluations of Bayh-Dole are couched in this logic. In what follows, I will engage these studies in their own terms. Later, in Section 2.4, I will show the inadequacy of some of these studies from a different perspective.

Political discourse linked innovation to the public interest through economic growth and competitiveness (see Chapter 4). The currency of this normative link has

[8] The status of the "linear model of innovation" in innovation studies is comparable to that of the "linear policy process" in public policy studies.

nursed a consensus in innovation policy about targeting the pace of innovation.[9] It is plain that this was the ostensible goal of Bayh-Dole: to accelerate innovation by fostering commercialization of inventions. Consequently, evaluators have identified problematic effects where Bayh-Dole (and the other patent reforms) may be slowing down innovation, to wit: the crowding-out of basic research, inefficiencies in the Republic of Science,[10] and perverse incentives.

Crowding-out basic research.

The sequential logic of the linear model implies that undermining basic research is equivalent to thinning the stream of innovation at the headspring. Hence the concern for the absolute and relative size of basic research in the university research portfolio.

Measuring basic research is not straightforward, but empirical studies have suggested that some useful inferences are possible by examining patent data. There is in fact a long tradition of research that uses patent data to measure various aspects of innovation (for a review see Griliches, 1990). Two of these measures are patent *importance* and patent *generality*. In order to prove "novelty," a patent application must account for prior art including all existing patents relevant to the invention at hand. Between two patents, the one more often cited should be deemed relatively more important, because it leads to more novel inventions, all else being equal—i.e. given

[9] Generally, innovation policy seeks to affect the pace but also the direction of innovation. While there is broad consensus in policy aimed at accelerating innovation, some controversy exists for policy that seeks to direct innovation towards certain economic sectors. Bayh-Dole is considered a "neutral instrument" because, a priori, it does not benefit any specific sector at the expense of another.
[10] The phrase "Republic of Science" was introduced by Michael Polayni (1962) who argued that science is a social institution with such a political and economic structure that resemble that of a republic of its own.

that both patents were granted at the same time and in the same economic sector.[11] Moreover, between two patents of equal importance, the one less concentrated in a single sector is relatively more general, since its impact extends across more economic sectors.

Henderson, Jaffe, and Trajtenberg (1998) compared university patents against non-university patents (a 1% random sample) looking at patents issued from 1970 through 1988 and patent citations up to 1992. They observed that university patents were more important (between 1970 and 1983) and more general (between 1975 and 1983) than the comparison group. However, by the mid 1980s (between 1984 and 1988) no difference is discernible suggesting a drop in the quality of university patents.

Sampat, Mowery, and Ziedonis (2003), replicated the analysis of Henderson and colleagues adding seven more years of forward citations including data until 1999. Henderson et al. (1998) had anticipated a truncation bias, and indeed this was apparent when more years were considered. As it turns out, post Bayh-Dole university patents are as important as pre 1980 patents but the bulk of citations arrives at a later time, and that explains why Henderson and colleague observed a drop in quality. These "changes in the intertemporal distribution of citations", Sampat et al. (2003, p. 1373) found, are partly explained by a systematic increase in lag between application and granting of patents, but the question of the intertemporal effect remains open.

[11] Forward citations are admittedly an imperfect measure of patent use in productive activities, the latter being closer to the notion of patent importance.

The patent reforms of the 1980s led to a concern for technology transfer activities to displace basic research at university and government R&D laboratories (Rahm, Bozeman, and Crow, 1988). Along the same line, evaluators of Bayh-Dole (e.g. Foray and Kazancigil, 1999) worried that the Henderson et al. (1998) study suggested that applied research was crowding-out basic research. Such a conjecture depends on the assumption that basic research patents are more important than applied research patents and these last are not more important than non-university patents. However, when the Sampat et al. (2003) study refuted the lower quality thesis and suggested instead an intertemporal effect, the question was somewhat reversed. Under the assumption that basic research produces patents that take longer to be widely cited, Bayh-Dole could have either increased the relative production of new basic research patents or it could have opened up a stock of patentable inventions that was composed mostly of basic research findings. What is clear in this interpretation is that Bayh-Dole seems to have stimulated the patenting of inventions further upstream in the innovation process. Using survey data, Jensen and Thursby (2001) corroborate this impression showing that universities are licensing mostly patents for embryonic inventions: 77% of university patents are either proof of concept (48%) or prototypes available only at a laboratory scale (29%).[12]

If the hypothesis that Bayh-Dole led to a crowding-out of basic research is correct, then the effect should be observed in the historic composition of the portfolio. However, looking at the time series of university R&D expenditures,

[12] Survey data from 62 U.S. research universities reporting technology transfer operation from 1991 through 1995 (Jensen and Thursby, 2001).

Rafferty (2008) finds no "structural break" around 1980;[13] all trends—basic, applied, and development—remain unchanged. If instead the hypothesis that Bayh-Dole encouraged the patenting of existing inventions (the low-hanging fruit) and these were mostly basic research findings, the resulting wave of patenting should be observable in the graphed series (Figure 1) and detected in Rafferty's (2008) tests of structural changes. But no such wave is observed. The intertemporal effect of Bayh-Dole in the distribution of patents is perhaps not well explained by a model of innovation that explains the additional lag on university patents on a basic and applied dichotomy. A deeper insight into the nature of inventions that universities are patenting motivated case study research.

Responding to the Henderson et al. (1998) study, Mowery and Ziedonis (2000, 2002) examined the patenting of three major research universities, University of California (UC), Stanford University, and Columbia University; the former two had experience patenting before Bayh-Dole and the latter started only afterwards. They observed two important phenomena: First, biotechnology—dominated by applications in biomedicine—had increased its importance in the portfolio of disclosures, patents, licensed patents and income-yielding licenses of UC and Stanford, but this change had started about a decade before Bayh-Dole was enacted. Second, they observed no drop in importance and generality in the UC and Stanford patents, they observed too that these patents were of higher quality than the patents of the less experienced Columbia—experienced in patenting, that is—although Columbia's patents remain more important and general than non-academic patents.

[13] It should be added that Rafferty's (2008) analysis does find structural changes that occurred before Bayh-Dole, likely connected with the coming to maturity of the biotechnology and software industries that I described in the previous section.

The authors concluded that there is a learning curve in the business of university patenting; universities that had started to patent and license before Bayh-Dole were ahead of a learning curve while the others, like Columbia, trying to catch up had been a little less selective of the inventions they were patenting. Under this light, the change in the intertemporal distribution of citations of university patents discussed earlier could be attributed, as suspected by Henderson et al. (1998), to lower quality patents; albeit not necessarily to lower quality research. It was the inexperience of "entrepreneurial university administrators" (Thursby and Thursby, 2002) who, once Bayh-Dole passed, rushed to take title on batches of low quality patents. This accounts for the "transitory element" of the intertemporal effect, transitory because, at some point, universities become more selective of what they patent and learn the business of licensing (Mowery, Sampat, and Ziedonis, 2002). Moreover, to the extent that the intertemporal effect of Bayh-Dole has a "permanent element", this is attributable to the increasing number of biotechnology patents. Forward citations for patents in this field are likely to peak later than other patents because their prior art is more densely patented and they are more highly contested (see below "patent thickets").

An underlying concern of the crowding-out of basic research was that researchers themselves, by effect of the Act, had shifted their attention away from fundamental questions in pursuit of applications that led to royalty income. This culture change hypothesis is, as seen above, not supported by evidence, at least not strictly in terms of basic versus applied research (Mowery et al. 2001; Mowery et al. 2004; and Thursby and Thursby, 2002). It would seem more plausible to talk of a crowding-into of biotechnology, which has characteristics of both basic and applied

research; more specifically, in biotechnology the search for fundamental knowledge is not considered exclusive of the pursuit of practical applications which bear the prospect of royalty income. The greater currency of biotechnology and this field's own dynamics promoted greater tolerance and even at times eagerness among faculty to patent their research findings. More than a cultural change then, what took place was a change in attitudes towards patenting. Still, this change is not causally attributable to Bayh-Dole but it was certainly facilitated its endorsement of university patenting. What this change permitted, however, was the patenting and licensing of research findings (stocked and new) that previously had been placed in the public domain, and in many cases patent rights were asserted on inputs for further research as if they were no different from inputs for final products. Many evaluators of Bayh-Dole (see below) worry that this lack of discrimination in what is being patented should have an effect, too, in the organization of science.

Inefficiencies in the Republic of Science.

The linear model of innovation stresses the importance of science as the foundation of innovation. In this perspective, a division of labor is implied between laboratories (of universities and government) and firms, each performing a characteristic task (research and development) and a specific output (science and technology). Other models (e.g. the evolutionary approach of Nelson and Winter, 1982) do not readily accept that innovation follows a sequential process or that labor is divided so neatly, but they too stress the importance of science in innovation. Hence the widespread concern that Bayh-Dole disrupted the organization of science, and that a weakened science risks constricting and slowing down innovation (Merges and Nelson, 1990; and Heller and Eisenberg, 1998).

This concern presumes a demarcation of science and while the demarcation debate is inconclusive, it can be shown that most evaluators of Bayh-Dole seem to subscribe to (or their arguments are subsumed by) the characterization of the "new economics of science" (Dasgupta and David, 1994).[14] In contrast to the old economics of science (Nelson, 1959; Arrow, 1962), Dasgupta and David adopt a sociological perspective and discern between science and technology by looking at the different socio-political arrangements of the communities that produce science and technology. Previous theorized distinctions—ontological, epistemological, methodological, and financial[15]—are rendered in this view epiphenomenal to these socio-political arrangements and their respective incentive mechanisms. In the domain of science, the rewards (pecuniary and non-pecuniary) are allocated according to the "rule of priority" of discovery, and given that discovery must be demonstrable, this incentive encourages disclosure of findings, methods, and data into the public domain. Conversely, in the domain of technology the goal is to gain commercial advantage and the incentive encourages either secrecy or, when patent protection is reliable, patenting. A central point of this characterization is that disclosure of scientific findings into the public domain is not only a consequence of

[14] The new economics has been greatly influential because it synthesizes much of the economics and sociology of science of the post-war period with important exceptions being the French "Action Network Theory" and the Scottish sociology of the "Strong Program." It should be added that Dasgupta and David (1994) do not subscribe to the linear model of innovation although it could be considered a particular case of their framework.

[15] Ontological because as objects they were differentiated by their inherent attributes, such as appropriability or uncertainty—for instance, a central concept in the old economics was to construe science as a public good. Epistemological, in the philosophical quest for the demarcation of science from other forms of knowledge and thus rendering technology outside the province of science, albeit as a derivative of it. Methodological to the extent that scientists and engineers are presumed to follow different research strategy to acquire their knowledge. Financial, the source of funding for science (generally public) is often presumed distinct from that for technology (a mix of public and private).

the organization of science but also guarantees its rapid and robust advancement (Dasgupta and David, 1994; Nelson, 2002; Rai and Eisenberg, 2003).

The problem "arises when the domain of public science becomes entangled with the domain of proprietary product development." (Eisenberg and Nelson, 2002, p. 93) or put another way, the "narrowing of the conceptual gap between fundamental research and commercial application" (Rai and Eisenberg, 2003, p. 289). With the Supreme Court decisions that expanded the definition of patentable subject matter (referred to in Section 2.3) and the U.S. Patents and Trademark Office following suit, the entanglement has been inevitable and the profit motive has quickly advanced over what was traditionally governed by the rule of priority of discovery and public disclosure. Patented databases and materials force researches to take license before undertaking research paths that make use of these tools. In fact, in the field of biomedical research it has become a matter of regular business to sign and pay for patent licenses, material transfer agreements, and database access agreements. For instance, in the sequencing of the human genome, the publicly sponsored Human Genome Project (HGP) created the Genbank database in the public domain, but this has not prevented private firm Celera from establishing proprietary databases and selling access to research universities, hospitals and even the National Cancer Institute. Evidently, Celera's gene sequencing data and other capabilities in bioinformatics provide a service to research organizations beyond what they can freely acquire from Genbank, but this only highlights the fact that these universities now consider payment for research tools a normal course of business, even in genetics where a significant public investment regimented open disclosure of sequences.

Nelson and Eisenberg (2002) observe that the parallel development of public and private data may have actually complemented each other in a race to map the human genome thus making genetic biology more robust. Their concern is not this public-private complementarity, but that patenting research tools and licensing them on an exclusive basis is becoming "normal practice." A dramatic example in which this practice restricted further research and market competition is the case of research on the breast cancer genes called BRCA1 and BRCA 2. Parthasarathy (2007) has documented how the patenting of the BRCA genes weakened both the research program and the healthcare provided with these genes. The sequencing of BRCA1 involved significant public funding and was the joint effort of five organizations—University of Utah, McGill University and National Institute of Environmental Health Sciences (of the NIH), and firms Eli Lilly and Myriad Genetics—that involved 45 researchers in total. This was only one of several research programs that had zeroed in the BRCA genes and much of the knowledge and methods were common knowledge in the scientific community. In fact, Mike Stratton's team (not Myriad) is generally credited with uncovering BRCA2 and his priority was recognized with a patent in the UK. Nevertheless, Myriad was granted patents for BRCA1 and BRCA2 in the U.S. and this firm used them to set up a profitable testing service. What is more, at the time Myriad was awarded the testing for BRCA, genes were already being provided—specifically, University of Pennsylvania's Genetic Diagnostic Laboratory (GDL) and firm OncoMed (using the Stratton patent). Parthasarathy (2007) shows that these laboratories were not only more cost-effective for patients but provided higher standards of care than Myriad; particularly, GDL and OncoMed used to provide counseling of patients by genetic specialists following

the recommendation of several professional associations in light of the complexity underlying the interpretation of BRCA tests. Yet, Myriad bought the OncoMed patents for an undisclosed amount and then forced GDL to discontinue their testing services with the consequent constraint on their research program because GDL could no longer access new patients' genetic data.[16]

Another prominent example is that of the OncoMouse, a mouse bioengineered to carry an activated oncogene and thus a predisposition to cancer; it is therefore clear that the sole purpose of creating this mouse was to further research. Harvard University was granted a patent for the OncoMouse in 1988 that was subsequently licensed on exclusive basis to DuPont who, not without controversy, charged hefty fees and imposed a number of restrictions to sublicensing (Marshall, 2002; Hanahan, Wagner, and Palmiter, 2007). DuPont is also infamous for licensing with "reach through" provisions by means of which it retains a claim to royalties from products developed from research with the OncoMouse. This practice has extended to university licenses too. WARF, the patenting office of University of Wisconsin, has also included a reach through clause in licenses of its human embryos stem-cell (HES) patents derived from research funded partly by NIH. This decision triggered litigation and controversy that mounted pressure on WARF for renegotiating the licensing terms to research organizations. Because the research that led to the patents was partly funded by NIH, the agency could execute its rights under Bayh-Dole if it was able to demonstrate a failure on the part of WARF to practice the patent widely. This implicit threat enabled Public Health Services to

[16] On March 30, 2010, a Court ruled in favor of the plaintiff (and against Myriad) invalidating the patent on the basis that naturally occurring substances should not be patented. The case will be appealed in the Federal Circuit (Schwartz J., and Pollack A., 2010).

negotiate low licensing fees and a waiver to reach through licensing for research uses of the HES patents, albeit inter-laboratory sharing of materials was kept restricted. High fees and the reach through provision remained in effect for other licensees (Wadman, 2005; Eisenberg and Rai, 2004). Patenting of research tools has, in those instances, disrupted the organization of science and its incentives for public disclosure of findings.

These examples are just anecdotes. However, a more systematic threat to science is in the impetus for establishing those special tactics, including exclusive licensing, patent hoarding, and reach through provisions as "normal practices." If those practices are effectively normalized, the patent system risks inducing the formation of an "anticommons", that is, "a property regime in which multiple owners hold effective rights of exclusion in a scarce resource" (Heller, 1998, p. 668). To understand this problem, recall the "tragedy of the commons" that occurs when lack of property rights leads to overuse of a scarce resource (Hardin, 1968). Biotechnology, argue Heller and Eisenberg (1998), is a clear example of the "tragedy of the anticommons" because the building blocks of certain scientific puzzles are patented to different parties, and each party excludes others from using its own piece. The solution to the puzzle becomes eventually "common" knowledge in the scientific community and yet it cannot be used to advance the science of that puzzle. Heller and Henderson (1998) illustrate this point with the patenting of receptors (cells that react to stimuli). New drug development involves testing it against all known receptors in the relevant families of receptors, but if these are patented to multiple companies every new drug would required the impossible task of collecting all relevant patents; developers are slowed down by a "patent thicket" (Shapiro,

2000). Specifically, when Heller and Eisenberg (1998, p. 699) searched the term "adrenergic receptor" in an index of patents, they found it in more than 100 patents. Seide and MacLeod (1998) claim that only a small portion of these patents would be required for any given application, but the point remains that research in said receptor, if not already an anticommons problem, it is at serious risk of becoming one.

In a study commissioned by the National Research Council, Walsh, Arora, and Cohen (2006) concede that much, but stress that the emergence of anticommons should not be exaggerated. They argue that the preconditions for anticommons are latent; yet, patents on research tools "do not yet pose the threat to research projects" (p. 322). This, suggest Walsh and colleagues, is in part due to countervailing actions taken by federal agencies—as in the case of the Public Health Service that negotiated differentiated treatment for research with HES patents—and some isolated efforts from the biomedical industry. In some niches of drug development the risk of anticommons has given way to the promotion of public disclosure of findings or alternatively the use of patent pools. Examples are, respectively, the Wellcome Trust (associated with the HGP) that set up a public database of single nucleotide polymorphisms (SNP, base-points of individual variation in the DNA) and the Public Intellectual Property Resources for Agriculture (PRIPRA) that organizes bundling and pooling of patents in agribusiness (see Winickoff, Saha, and Graff, 2009).

It is not clear yet the extent to which this countercurrent can reinforce itself and eventually provide sufficient resistance to the increasing use of research-tool patents. What is clear is that it will depend on future patent policy, judicial precedent,

and particularly the organizational capabilities that universities develop to manage the tensions between public and private domains of intellectual property.

Perverse incentives.

When a university engages in patenting and licensing, two of its critical functions, securing self-sustenance and fulfilling its service mission, are set in conflict. However, the office that manages the university's intellectual property, the office of technology transfer (OTT), is not commonly structured to balance this tension. Jensen and Thursby (2001) surveyed 62 OTTs and asked them the following question: What are the most important outcomes of their operations? Respondents were given a three-item scale of importance (extreme, moderate, not very, plus the fourth item not applicable) to apply over five broad categories: revenue generation, invention commercialized, licenses executed, attracting sponsored research, and patents generation. Revenue generation ranked above all other categories with 71% of respondents thinking it was extremely important. The other four categories were also extremely important by decreasing proportions of respondents (61%, 49%, 35%, and 17% respectively). It is reasonable to expect that responses of OTT officials might have deflated the revenue motive and inflated the other categories to project an image of themselves as entrepreneurs motivated by a balanced mix of goals rather than the unidimensional bottom line. Under this light, the candor of OTT officers is surprising; they could not conceal that revenue generation commanded their professional efforts much more than commercialization itself. Moreover, Jensen and Thursby (2001) asked the same question to university administrators about the outcomes of their OTTs. In this case, the administrators were speaking of a third party, the OTT, and thus felt perhaps less pressure for offering an answer

conforming to social expectations. Among administrators, about the same proportion (70%) thought that revenue generation was extremely important, but far less thought the other four categories were also extremely important.

In a similar study, Rahm and Hansen (2002) surveyed 121 OTT managers about their understanding of the costs and benefits of technology transfer and found great consensus in their definitions, with "money for research" the dominant definition of benefit. This is surprising given that few universities do actually profit from technology transfer. The answer suggests an organizational culture within OTTs that values revenue generation above all else. Consider now, from the same study, the responses of 759 industry-linked academic researchers, i.e. "PhD-level researchers who have interacted with businesses in an effort to transfer knowledge, know-how, or a technology" (Rahm and Hansen, 2002, p. 60). Rahm and Hansen (2002) inquired about the researchers' definition of success in university-industry technology transfer. When they analyzed the answers to their open-ended questions they found that 85% of respondents understood success of technology transfer operations as benefit for the firm, the researcher, or both and only 2% thought success was characterized by benefit for society.

It is clear that OTTs aim to maximize revenues. Their operation may be compared to venture capitalists, because OTTs often keep oversight on legal aspects and the business strategy of the firms to which they license, taking even, in some cases, a stakeholder interest in those firms (about 10.3% of the time based on my tabulation with data from AUTM, 2008).

Furthermore, OTTs are insulated as much as possible from the university structure and in some cases they are even chartered as independent legal vehicles.

This insulation allows the OTT a degree of independence to manage its operations and thus to be assessed simply on revenue generation. At the same time it allows university administrators to distance themselves from practices that, however normal in the venture capital business, might be considered unbecoming of a not-for-profit organization.

Among these questioned practices, the most prevalent is unnecessary exclusive licensing. Exclusive licenses are justified in several circumstances, especially when only one start-up firm has the capacity for developing a patent or when significant costs, such as those of new drug development, would prevent development under a competitive market structure (Mazzoleni and Nelson, 1998). Other times, however, non-exclusive licenses suffice for widespread use and development of a patent, the Cohen-Boyer patents being a good example. Yet, even in cases where non-exclusive terms are good enough, the pressure for revenue generation will lead OTTs to seek high-yielding exclusive contracts, as in the case of the OncoMouse.

It seems that not all patents under Bayh-Dole are licensed on exclusive basis. This begs the question: are exclusive licenses pervasive?

AUTM reports that U.S. universities and hospitals in 2007 licensed 36% of all executed licenses on exclusive terms. Furthermore, of all active licenses that year, 48% yielded some income (Figure 3). The AUTM survey does not offer a breakdown of income data by exclusive and non-exclusive licenses; nevertheless, a rough approximation can be made because, between 1996 and 2007, on average, universities executed 45% of their licenses on a exclusive basis, and of all their active licenses only 43% yielded income. Add to this the fact that exclusive licenses

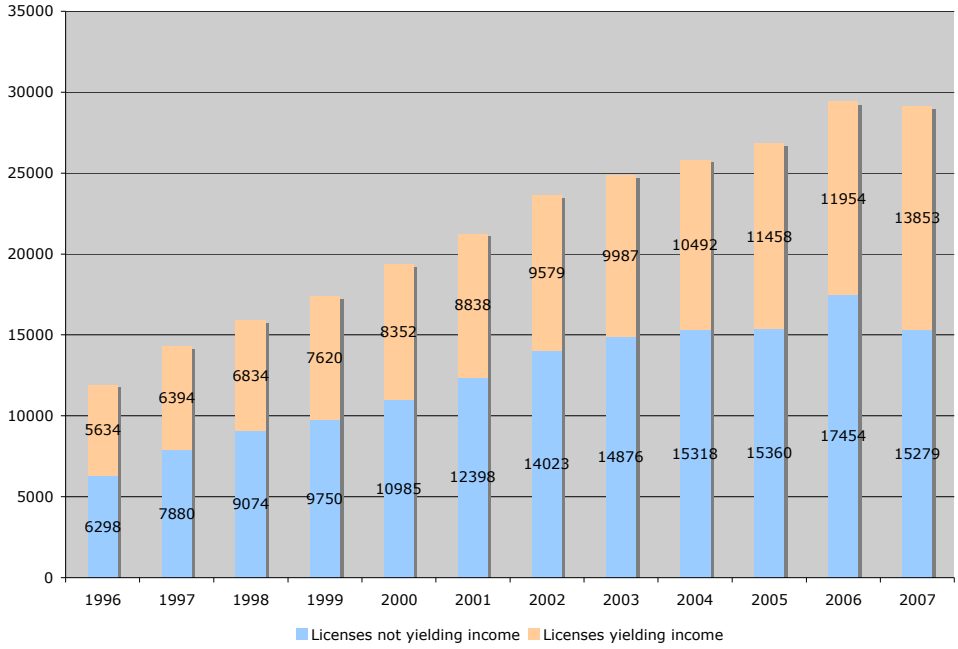
generally yield higher income than non-exclusive ones and it can be safely conjectured that the bulk of licensing income has historically come from exclusive licenses.

Moreover, the observed declining trend in the proportion of exclusive to total licenses (Figure 4) need not imply a decline in the proportion of revenue that exclusive licenses yield; exclusive licenses will not fall into disuse nor will they cease driving licensing revenues in so far as they remain unregulated. On the obverse side of the coin, 64% of all licenses in 2007 were non-exclusive contracts. Considering that exclusive rights pay higher royalties, the large proportion of patent licenses without exclusivity may be in part due to a low demand for those patents and in part due to the universities making a conscious effort to balance their own financial interest with the needs of various users of those patents, as it was the case with the aforementioned Cohen-Boyer and Axel patents.

Furthermore, the profit motive led legal teams at OTTs to come up with creative provisions, such as reach-through royalties, and some universities have permitted their OTTs to pursue even more aggressive tactics. The most visible example of this has been the case of the Axel co-transformation patents, a significant discovery in biomedicine that enables researchers to induce production of specific proteins in mammalian cells by inserting genes. Colaianni and Cook-Deegan (2009) described how Columbia University not only aggressively litigated the infringement of the Axel patents—and won in the case against Roche Diagnostics—but also

sought to extend the expiration of these patents by filing successive *divisional* and *continuation* applications until 1995.[17]

Figure 3. Cumulative Total of Active Licenses.

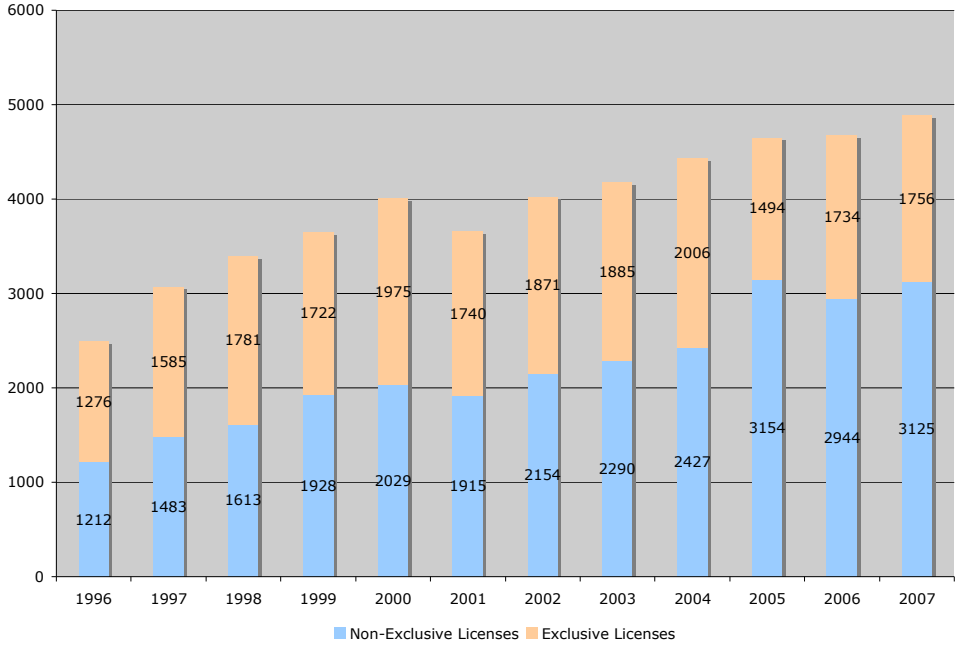


Year	Active Licenses	Yielding revenue (%)
1996	11,932	47
1997	14,274	45
1998	15,908	43
1999	17,370	44
2000	19,337	43
2001	21,236	42
2002	23,602	41
2003	24,863	40
2004	25,810	41
2005	26,818	43
2006	29,408	41
2007	29,132	48

Source: My own tabulation with data from AUTM (2008).

[17] It used to be that patents in the U.S. protected rights of use for 17 years from the "date of issue". Since June 8, 1995, rights are extended for 20 years counting from "date of application", not date of issue anymore. Divisional applications are filed in response to the patent office objection that the application encompassed more than one invention. Continuation applications are filed to revise a claim. These applications retained the original priority date and until the aforementioned reform, effectively extended the issue date as the patent office had to review the applications anew.

Figure 4. Licenses Executed (per year).



Year	Licenses Executed (per year)	Exclusive Licenses (%)
1996	2,488	51
1997	3,068	52
1998	3,394	52
1999	3,650	47
2000	4,004	49
2001	3,655	48
2002	4,025	46
2003	4,175	45
2004	4,433	45
2005	4,648	32
2006	4,678	37
2007	4,881	36

Source: My own tabulation with data from AUTM (2008).

Columbia went as far as to lobbying Congress to extend the protection of these patents, albeit its efforts were unsuccessful. Still, when this attempt was made public, the university was heavily criticized. The scandal cast such a large shadow on the university that much of the criticism ignored the fact that monopolistic pharmaceutical companies stood to gain from the expiration of the patents

(Colaianni and Cook Degan, 2009)—the costs for these firms dropped by the amount of the license fees and royalties, yet their prices on co-transformation related products did not fall proportionally.

In addition to a preference for exclusive licenses and the other licensing practices, universities have, in fact, become more aggressive asserting their patent rights in the courts (Moore, 2001; Bessen and Meurer, 2008, c.f. Leaf, 2005). The normalization of these practices sends a clear signal that the universities have a clear economic interest in patent protection. This was the opinion of the Court of Appeals of the Federal Circuit in *Madey v. Duke* (307 F.3d 1351/Fed. Cir. 2002). Physicist John Madey had sued his former employer, Duke University, for infringement of his patent, and while a trial court granted summary judgment for Duke based on the "experimental use doctrine,"[18] the Federal Circuit ruled in favor of Madey, noting that "Duke… like other major research institutions of higher learning, is not shy in pursuing an aggressive patent licensing program from which it derives a not insubstantial revenue stream" (307 F.3d 1351). Eisenberg (2003) observes that this decision did "not extinguish the experiment use defense entirely, [but] it eviscerated it to the point that it is essentially useless to research universities" (p. 1019). Undoubtedly, universities are now forced to spend money and time negotiating licenses that before the Madey ruling did not seem necessary, and both firms and universities are growing more suspicious of each other and entering into lengthier negotiations to cover all possible liabilities of licensing contracts (Thursby and Thursby, 2006). Whereas Bayh-Dole sought to "lubricate" the transactions between

[18] The doctrine dates back to 1813 when the Supreme Court ruled on the *Whittemore v. Cutter* case. Justice Story added to the court's opinion a *dicta legalese* (a statement without binding authority) to the effect that the legislature could not have intended to prohibit mere experimental use of inventions.

university and industry, the profit incentive seem to have had the perverse effect of increasing "friction" in that relationship.

But the problem is larger than that of the OTTs, for, however insulated, universities cannot fully disown these units and their practices. What is more, the profit incentive introduced by Bayh-Dole and the other reforms possibly exerted influence also in other units and domains of university activity.

2.4.2 Effects on the internal organization of the university.

In the previous section I showed that a dominant normative concern in evaluations of Bayh-Dole is the efficiency of the innovation system. Efficiency is, however, not the only measuring rod; neither science nor the university are important to society just because they contribute to innovation and economic growth. For this reason, many evaluators of patent policy have displaced efficiency from the normative center of attention (although rarely excluded it completely) and assessed instead Bayh-Dole's effect on other values that they ascribe to science and universities. These evaluation studies follow the Weberian strategy of crafting an "ideal type" for both institutions (on this strategy see Palumbo and Nachmias, 1983) and comparing what is observed against that image.

Robert Merton's characterization of the "ethos of science" (1973; originally published in 1942) is the most influential *ideal type science*. The scientist, proposed Merton, is guided by four norms in performing science, to wit: communism, universalism, disinterestedness, and organized skepticism. The scientist feels part of a communitarian enterprise that seeks universal understanding of nature, i.e. knowledge should transcend social and cultural contexts. A conventional reading of

Merton takes his famous article to be a descriptive sketch of the organization of scientific activity; I would instead submit that he describes the common aspirations and beliefs shared by scientists about how science "should" be organized; this reading can be supported if we accept that the famous sociologist knew full well that these norms are not uniformly observed.

In contrast, the *ideal type university* has not been codified to a set of norms the way Merton did for science; however, "academic freedom" is widely endorsed as a key normative principle in the organization of the university. The defense of academic freedom is part and parcel of two doctrines. The first is the autonomy of science; a characteristically modern view, popularized by Michael Polanyi as the Republic of Science (1962), asserts that the efficient operation of science is only possible if no external institution, such as government or the market, attempts to guide or steer it.[19] The second doctrine, in a pre-modern fashion, argues that a liberal education is intrinsically valuable because it is constitutive of the "good life" (Nussbaum, 1997), and in its modern version reasserts critical thinking as indispensable to democratic order (Menand, 2010). By implication, academic freedom becomes a precondition for both: the autonomy of science in academia, and the preservation of a liberal arts curriculum.

Each discourse, the ethos of science and academic freedom, accrued gravitas in their respective spheres of influence since the beginning of the twentieth century and especially the interwar period, but their organizational aspirations only came to fruition in the aftermath of the war. The autonomy of science came to be received by

[19] It should be noted that the defense of the autonomy of science is never a case for the autarchy of science; quite the contrary, it is an argument to shield public spending for science from political cycles.

the political establishment as an article of faith, ironically, when the perils of the Cold War elevated scientific research to an imperative for the preservation of democracy (Smith, 1990; Hart, 1998). At the same time, U.S. universities were finally able to legitimize their dual claim to self-government and government financial support, in no small measure, due to their visible contributions to the war campaign (Jencks and Reisman, 1969). This claim encompassed the consolidation of the tenure system (hitherto unevenly applied for five decades) and faculty discretion over curricula and the research agenda (Fuchs, 1963; Hofstadter and Metzger, 1955).[20]

It was the accident of war that synchronized these organizational changes in science and the university, but their co-occurrence has too often been taken to be a single phenomenon. Historiographies that blend the two into one usually attach this particular normative conception of science, i.e. Merton's norms, to university practices and behaviors adopted in the name of academic freedom. In other words, the normative ideal type of science is conflated with a set of specific university practices.

This "traditional type" university is thus vested with all the virtues of Mertonian science and becomes the point of reference evaluating any putative departure from the virtuous traditional type. The Weberian evaluations to which I have been referring are fashioned accordingly as they all point to a discontinuity or inflection point in the trajectory of the university, locating it generally in between the mid 1970s and 1980s. Authors in this canon include Slaughter and Leslie (1997) who denounce the onset of "academic capitalism" as a process of transformation of the

[20] For further reference see van den Haag (1963) and the special issue on academic freedom in Law and Contemporary Problems in which it appears.

university into a for-profit organization; a process epitomized by the commercial success of University of Phoenix. Likewise, Etzkowitz and Webster (1998) suggest that the university underwent a second revolution in the 1980s by extending the range and depth of its transactions with industry—the first revolution, noted Jencks and Reiman (1969), took place in the aftermath of World War II. Calhoun (2006) locates the rupture more squarely on Bayh-Dole and the patent reforms of the 1980s, buttressing his argument with the collection of incidents reported in Washburn (2005). This book shows case after case where commercial interests compromised the integrity of university researchers (also on this, see Judson, 2004), where the protected domains of the ivory tower—course curriculum, faculty promotions, and mentoring of graduate students—were seriously constrained by university-industry agreements, and even cases where entrepreneurial administrators committed future research of entire departments to industrial sponsors (in the same vein, see Greenberg, 2007). Further discontinuities in the trajectory of the traditional university are observed not only in research commercialization but also in its educational mission, from the provision of undergraduate degrees (Slaughter and Rhoades, 2004) to medical schools (Angell, 2004).

These studies differ in their identification of the inflection and its causes, but for all their differences, a remarkable agreement surfaces in their characterization of the traditional type university along three organizational attitudes: (A1) public disclosure of research findings, (A2) faculty discretion in setting the research agenda and teaching curricula, and (A3) impartiality in the conduct and peer-review of research.

It should be plain that the history of transgressions to these attitudes is as long as the history of the attitudes themselves, albeit the literature cited above seems to suggest that transgressions are on the rise. This is precisely the significance of the evaluation studies mentioned above, which collectively justify a point of inflection, generally around Bayh-Dole, and with respect to it demonstrate that the transgressions in the succeeding period greatly surpass those in the preceding one. Great is the temptation to accept the premises and diagnostics of these studies, particularly when one is ready to accept the traditional ideal type as characterized by A1, A2, and A3. However, to the extent to which their vantage point is located within the university, the analysis is endogenous to a university system in equilibrium, and Bayh-Dole (and the other reforms) appears either as an exogenous disruptive force, or, when it is linked to the university lobby, all explanatory dynamics remain corralled inside the university campus. This endogenous perspective lends at times narrative depth to these studies. However, it does so often at the expense of analytical breadth, for it neglects important factors outside the universities that drove organizational change in the university as well as Bayh-Dole and the other reforms.

Two other shortcomings in these studies are important to note as well. The first is the presumed stability of the traditional type. However conservative is the university as an organization, its culture, practices and attitudes are in constant flux; taking a representation of university attitudes as frozen in time to produce convenient evaluative standards, presumes a stability that those attitudes never really exhibited. It becomes apparent in Hofstadter's (1952) history of higher education in the U.S. that colleges and universities have been sensitive to the national political and economic circumstances since inception. Likewise, economic histories such as

Rosenberg and Nelson (1994), Mowery and Rosenberg (1993), and Mowery et al. (2004) recount the significant influence that industry and government exerted over research universities throughout their entire history. Consequently, the purity of university autonomy and the absence of secrecy and patenting as depicted in the traditional type simply cannot be reconciled with the history of the U.S. university. The second shortcoming of these evaluation studies is their docile subordination to the specific normative theory contained in the ethos of science—the conflation of ideal and traditional types that I pointed out earlier. Admittedly, such a normative perspective is still the most influential compass for the organization of science in the political establishment—recall for instance, the inaugural address of President Obama (2009) exhorting to "restore science to its rightful place". For this very reason, these critical studies, at least in a normative sense, amount to little more than specious apologies for the establishment. A establishment, should be added, whose inadequacies have become increasingly apparent by the very success it has had promoting unbridled technological development (Hilgartner, 2010).

Earlier (Sections 2.4 and 2.4.1) I made the case that Bayh-Dole alone could not be considered the cause for the increase in patenting and commercialization, and this casts doubt on the claims that the Act caused the institutional discontinuity in the recent history of the university. Perhaps not even the set of reforms to the patent system taken together marks the inflection because rushing into such a conclusion may neglect other important forces, external to the university but exerting important influence on it, ranging from increasing international trade, transformation of industrial organization and research, and new political priorities arising from the end of the Cold War.

It would be incorrect to suggest that the studies mentioned above dismiss those forces; quite the contrary, they often provide an insight into the operation of such forces. Where these evaluations come short, however, is in assembling all the explanatory threads into a coherent structure and integrating them with the history of the university. Considering the trajectory of the university, and any discontinuity in this trajectory, from a higher vantage point than the simple story of a single explanatory thread, and rather integrating the several explanations inevitably expands the character of policy evaluation into the realms of historic and political analysis as well as political economy. More robust studies of the university and the commercialization of its functions could be found, for instance, in the analyses of former Harvard University president Derek Bok (2003), political scientist David Guston (2000), and economic historians Philip Mirowski and Miriam Sent (2008). Bok (2003) is worth noting for its historic perspective on university politics and the tensions between certain traditional institutions and reforms of commercial bent. This study shows that, rather than any major inflection point, it is the gradual concession to commercial interests, sometimes born of necessity, that determines the trajectory of the university. Bok offers the example of the commercialization of varsity sports where every concession given to their establishment in campus becomes an irrevocable right of constituencies (popularity hungry administrators, alumni association, student bodies) and irreparable damage to others (student athletes). In turn, Guston (2000) takes a historic perspective of the entire governing system of science policy in the postwar period and integrates the explanatory threads with the theories of principal-agent relations and boundary organizations; in this account Bayh-Dole is recognized as an important policy reform but within the larger

transformation of the U.S. science policy system. Likewise, Mirowski and Sent (2008) acknowledge the science policy regime change, but integrate this to the historical transformation of large corporations, and particularly the corporate laboratory, to explain the changes in the university—drawing from the Chandlerian perspective on the rise of the U.S. corporation, its growth and diversification and later restructuring and concentration (Chandler, 1977).

These studies dissect the problem from different angles but they all keep a systemic perspective of the whole and seek to integrate extant explanatory threads. The aspiration of this more robust type of analysis led a group of innovation scholars to propose a systems approach to study innovation.

2.5 Conclusion.

This survey offers important insights into the significance of Bayh-Dole in the U.S. innovation system. First, the oft-repeated claim that the Act initiated an era of research commercialization misrepresents the role of this policy. University patenting and licensing has a long history and it started to expand more than a decade before the Act. Second, Bayh-Dole is best understood as part of an orchestra of policy reforms that together in concert lent institutional support to the rapid expansion of university patenting and the establishment of offices of technology transfer. Third, the greater the distance between these offices and the university, the more these offices become unencumbered by the public mission of the university, sometimes engaging in practices that to some extent threaten the research performance of the universities themselves. Fourth, the organizational changes of the university and its relationship with industry respond to larger transformations of

the economy and corporate governance and this linkage must be kept in mind when considering the institutional design of technology transfer.

The glaring absence of studies examining the distributional consequences of Bayh-Dole as well as other public values immanent to the Act motivate the subsequent chapters.

Chapter 3

PUBLIC VALUE FAILURE IN THE BAYH-DOLE REGIME

3.1 Introduction.

The foregoing survey of evaluation studies of the Bayh-Dole Act showed that they are generally concerned with the pace of innovation or the transgressions to the independence of research. While these concerns are important, I propose here to expand the range of public values considered in assessing Bayh-Dole and formulating future reforms. To this end, I first examine the changes in the terms of the Bayh-Dole debate and the drift in its design. I find that the neoliberal ideas have had a definitive influence on U.S. innovation policy for the last thirty years, including legislation to strengthen patent protection. I also find that the neoliberal policy agenda is articulated and justified in the interest of "competitiveness." The inherent vagueness of the term helps actors to conflate the public interest with economic growth. Against that backdrop, I use Public Value Failure criteria to show that values such as political equality, transparency, and fairness in the distribution of the benefits of innovation, are worth considering to counter the "policy drift" of Bayh-Dole.

In the last three years, Congress has intensified scrutiny of the Bayh-Dole Act (P.L. 96-517) holding hearings to assess the first 25 years of this policy (U.S. House of Rep., July 17, 2007), to revise a rarely used provision[21] (U.S. Senate, October 24, 2007), and more recently, to consider the possibilities for improving the technology transfer regime (U.S. House of Rep., June 10, 2010). In the most recent

[21] This provision requires government-owned-contractor-operated facilities to pay the government a 75% of any portion of net operating licensing income (i.e. net of related expenses) that exceeds 5% of the facility's operating budget (35 U.S.C. §202-C-7-E-i).

hearing, Rep. Daniel Lipinski (Dem.-IL), chair of the Technology and Innovation Subcommittee, announced that the intention of the subcommittee is "to carry out a comprehensive review of the Bayh-Dole and Stevenson-Wydler Technology Innovation Acts later this year." Anticipating that Congress may eventually muster the political will to amend Bayh-Dole, the National Research Council (NRC) commissioned a consensus report on university management of intellectual property that was recently published (NRC, 2010). Because that report synthesizes the voluminous literature that assesses Bayh-Dole, this chapter could be read as a companion study that points out lacunae in the literature.

The vast majority of evaluation studies of the Bayh-Dole Act (the "Act") are either concerned with its effects on the pace of innovation or concerned with the culture and organization of academic research. Studies of the first type examine, for example, the possible loss of quality in university research (e.g. Henderson, Jaffe, and Trajtenberg, 1998; Jensen and Thursby, 2001; Mowery et al., 2004; Mowery and Ziedonis, 2002; Rafferty, 2008; Sampat, Mowery and Ziedonis, 2003), the threats to basic research from the "enclosure" of the scientific commons (Heller, 1998; Heller and Eisenberg, 1998; Shapiro, 2000; cf. Walsh, Arora, and Cohen, 2003), and the friction brought about by aggressive bargainers of intellectual property (Jaffe and Lerner, 2004; Thursby and Thursby, 2006). These are presented as problems because they risk slowing down innovation. Studies of the second type believe in an ideal set of norms for academic research, an "academic ethos" that encompasses norms such as the public dissemination of research, impartiality in peer-review, and faculty discretion over the curricula and the research agenda. These authors argue that since Bayh-Dole was enacted, the transgressions to these norms have become more

frequent and pervasive (Greenberg, 2007; Judson, 2004; Slaughter and Leslie, 1997; Slaughter and Rhoades, 2004; Washburn, 2005). While both concerns must to be taken in consideration to understand the Bayh-Dole regime, I argue in this chapter that limiting our attention to them narrows the scope of analysis and misses other important values. For instance, "distributive equity" or "political equality" are much more adequate values for evaluating outcomes such as affordability of new medical treatments or processes such as bureaucratic regulation of patent-based monopolistic practices.

To redress this narrowness in conventional evaluations of Bayh-Dole, I take a different approach to evaluation. This approach, called Public Value Mapping (Bozeman, 2002; 2007), allows me to explicitly consider public values other than the pace of innovation or transgressions to the academic ethos. In order to expand the scope of values considered it is necessary to understand the public values that currently dominate the institutions and discourses of the Bayh-Dole regime. It is necessary as well to examine how the balance between those dominant values shifted in time, transforming in turn the terms in which Bayh-Dole was debated and implemented. The examination of this dual drift problem—the simultaneous "drift" in the policy design and the policy debate—is integral to my analysis.

Before discussing the dual drift problem, I want to briefly describe what is the Public Value Mapping (PVM) approach and why it is suitable for the evaluation of Bayh-Dole. Considering that public values are latent in all facets of policy, from the formation of expectations to the evaluation of outcomes, PVM is an approach to examine policy through the lenses of the intervening public values. PVM redirects attention in policy analysis from cause-and-effect relations to the articulation-and-

realization of public values in the making of policy. Why is PVM useful to examine Bayh-Dole? The answer follows from two premises. First, the predominant criteria of policy evaluation, the Market Failure Criteria (MFC), are also common rationales for policy: government is justified to intervene in the economy only to correct noise in the price mechanism. Second, Bayh-Dole is a canonical policy solution to a market failure problem. The alleged problem is that firms are reluctant to invest in product-development if they cannot appropriate the potential returns of their investment, in this case, by keeping exclusive rights to the patents of those products. The Bayh-Dole solution consists in creating a market for those patents: government transfers its patent rights to universities, and universities can lease those patents to firms. It follows from these premises that, evaluation studies that use the Market Failure Criteria will conclude that the Act has been an unqualified success because it did in fact create a market for public patents. If evaluators disagree, it will be only about the degree of success—as measured by the effectiveness of the appropriation mechanism, or how much development and commercialization were really streamlined, or whether the incentives introduced have perverse effects. However, market failure studies cannot assess the other half of Bayh-Dole on its own merits because they must apply the same evaluation standard to all provisions; under that light, the provisions to keep a check on the profit motive are bound to be considered unnecessary. PVM in turn is normatively more flexible than market failure. It starts by identifying the public values that motivated those provisions and then examines whether those values were realized in the evolution and implementation of Bayh-Dole. The normative criteria of PVM are concerned with the realization of core public values in the policy making process without necessarily privileging the

operation of the markets. In Section 4, I probe Bayh-Dole with the Public Value Failure Criteria.

I should make at this point a conceptual digression to explain my use of "policy design." I use this term in the sense of Schneider and Ingram (1997) to refer to the "substance of public policy;" that is, the "blueprints, architecture, discourses, and aesthetics of policy." (p.2). The use of policy design underlines my stance in policy analysis that conceives of policy as a fluid institution rather than a crystallized rule, and deals with policy making as an ongoing political negotiation rather than a multi-stage linear process that commences in formulation and ends in implementation. As Schneider and Ingram (1997) point out, the letter of the law is fixed but only until the law is amended or modified by other statutes, and more pervasively, the letter of the law it always subject to different interpretations and those interpretations are subject to contestation.

Returning to the dual drift problem, I argue that the systematic changes in both the Bayh-Dole debate and the policy design can be traced to the ascendancy of neoliberalism over U.S. policymaking and to the reforms to the patent system (including the amendments to the Bayh-Dole statute). I treat these factors as two analytical threads recognizing that they are entwined and interdependent.

The influence of neoliberal ideas over social and economic policy, over the last three decades and on both sides of the Atlantic, cannot be underestimated. Neoliberalism is hard to catalogue; it has been variously defined as a doctrine of political economy (Harvy, 2007), an ideology (Turner, 2008), and a "thought collective" (Mirowski, 2009). For all its internal plurality, its adherents share a fundamental commitment to private property, free markets, and a strong state to

enforce the law. The neoliberal defense of free markets acquires a political dimension when it equates freedom with free markets, adding a moral imperative to the classical justification of markets as the most efficient mechanism for the allocation of resources. Furthermore, the neoliberal state ought to be small but strong enough to effectively enforce the law, property rights, and secure the untroubled operation of markets. The dual prescription of unfettered markets and an assertive state have pervaded all policy domains, and in the case at hand, their decisive influence on the Bayh-Dole regime has been amply noted (Mirowski and Sent, 2007; Nedeva and Boden, 2006; Pestre, 2005; Slaughter and Rhoades, 2004). In Section 2, I bring these arguments to bear and discuss the centrality of "competitiveness," as a key public value and a rhetoric trope, to the terms of the Bayh-Dole debate.

The second factor driving the policy drift in Bayh-Dole can be decomposed into two components, "bureaucratic drift" (McCubbins, Noll, and Weingast, 1987) and "legislative drift" (Horn and Shepsle, 1989). Bureaucratic drift—that is, changes to the policy by administrative discretion—resulted from the failure of the enacting coalition to establish administrative procedures that would effectively constrain the profit motive, particularly with respect to exclusive licenses and the emergence of "creative" licensing practices (e.g. reach-through clauses). Legislative drift—that is, subsequent statutory amendments to the law that alter its mechanisms and aims—was the consequence of not providing for institutional mechanisms to replicate the political pressures of the enacting coalition, particularly with respect to limited benefits for large firms and sufficient authority for federal agencies to safeguard the public interest. To understand why the enacting coalition arrived at a compromise with respect to checks on the profit motive, limitations on large firms, and

administrative regulatory discretion, I review in Section 3 the terms of the compromise achieved by the enacting coalition and account for the drift in terms of amendments to Bayh-Dole, and other changes in the patent law and the patent system, including the creation of the Court of Appeals of the Federal Circuit and key Supreme Court rulings on patentable subject matter.

The next two sections will engage respectively with the drift in the debate and the drift in the design setting the stage for the analysis of public value failure in the subsequent section. The last section draws some conclusions from this analysis.

3.2 The changing terms of the Bayh-Dole debate.

The impetus for legislative reform does not come as a surprise when one considers that the Bayh-Dole debate has carried on for three decades and that critics of the Act have redoubled efforts to reform it, lately, opening a new front of attack. Whereas past critics of the Act worried that the incentives to accelerate the commercialization of public research had a perverse effects on the performance of research itself (Heller and Eisenberg, 1998; Heller, 1998; Henderson, Jaffe, and Trajtenberg, 1998; Merges and Nelson, 1990; Mowery et al., 2004; Shapiro, 2000), a new generation of critics now worries that Bayh-Dole does not facilitate research commercialization sufficiently well (Litan, Mitchell, and Reedy, 2007; Kenney and Patton, 2009). This latter group, led by researchers of the Ewing Marion Kauffman Foundation—a steward of entrepreneurship—proposed to amend Bayh-Dole so that inventors retain title to their inventions and be given full discretion over those titles, instead of assigning those rights to their employers, the universities. They claim that the university is a bottleneck in the commercialization of research and that in order

to avert a slowing down of innovation, scientists should be free to choose a partner to negotiate the development of their research (Litan, Mitchell, and Reedy, 2007). In response, former senator Birch Bayh—one of the Act's sponsors and its staunchest defender—rebuked the Kauffman Foundation proposal, arguing that the university was an essential partner in the commercialization of public-funded research, and stressed that it was widely believed that Bayh-Dole promoted research commercialization and injected dynamism in the U.S. innovation system (Bayh, Allen, and Bremer 2009). Still, the Kauffman Foundation proposal was welcomed in the business community and endorsed by the influential Harvard Business Review (2010), and what is more, Lesa Mitchell, one of its authors and a vice-president at that foundation, was invited as a witness to the most recent congressional hearing on Bayh-Dole.

If we remember that the 96th Congress would not have even considered Bayh-Dole in 1980 had the proposed bill not included the university in the equation (see Stevens, 2004; Washburn, 2005, pp. 63-69), we cannot help to wonder: How did we get here? How can a proposal to exclude the university from technology transfer be given serious consideration? The answer lies in the changing terms of the Bayh-Dole debate, particularly the importance that government officials ascribe to patent protection and an increasingly liberal attitude of universities administrators towards patenting and licensing. Regarding patent protection, with few exceptions (particularly chemical and pharmaceutical industries) firms have not used patents as the primary strategy to secure the returns of their R&D investments (Levin et al., 1987; Cohen, Nelson, and Walsh, 2000; 2002). Still, during the last thirty years, all three powers of the U.S. government have strengthened patent protection (Scherer,

2009) and even coerced U.S. trade partners to enforce IP law (Haskins, 1998). It may seem that these changes to patent policy were driven more by a doctrinaire view of patents than the actual needs of industry.

Regarding the university in the Bayh-Dole regime, the change is visible in the attitudes of university administrators towards generating revenue from licensing intellectual property. While university patenting was increasing before 1980, the prevailing attitude at that time was that patenting was justified only in the public interest, and the public interest was thought best served by promoting wide diffusion of inventions through affordable non-exclusive licenses—this was precisely the case of the famous Cohen-Boyer patents. Today, university administrators are much more interested in supporting regional (or national) economic growth than in promoting the diffusion of inventions. Because they understand that growth is driven by industrial innovation and entrepreneurship, they feel the public interest is best served when universities contribute to the creation of new companies. They also know that the ultimate measure of entrepreneurial success is the firm's market capitalization (its market value in financial markets). In the case of high-tech start-ups, market capitalization depends on intangible assets, and more specifically, on whether the firm has exclusive rights to key patents. For this reason, university offices of technology transfer have fewer qualms about licensing on exclusive basis than they did thirty years ago; the public interest is still guides their actions, only now the public interest is conflated with the university financial need and the financial value of the firms taking licenses. Again, this change in the way university administrators construe the public interest seems guided by a doctrinaire view that privileges economic growth over diffusion of innovation—which is a form of economic

distribution. Let me stress that these attitudinal changes are not arbitrary; rather, they seem to systematically favor property rights and profit maximizing behavior. This doctrinaire character of the changes is part and parcel of a larger political project of neoliberalism. To understand the drift in the Bayh-Dole debate it is thus necessary to account for the influence of neoliberal ideas on innovation and the patent system.

Let me start by giving some context to the emergence of neoliberal ideas in the U.S. By the time Bayh-Dole was enacted, in 1980, the thin political consensus in the U.S. on the welfare state was wearing thinner. The electoral contest of that year brought a direct attack on big government and the institutions that represented, particularly in economic and social policy, the growth of governmental power. The economic debacle of the 1970s was the perfect excuse to declare the failure of any and all government intervention in the economy, including regulatory and redistributive policies. The discourse went beyond simply an electoral platform for it drew from the neoliberal project, a philosophical and political project that by that time had been in the making for nearly four decades. Neoliberalism has been given content by various schools on both sides of the Atlantic and across various disciplines—notably in economics, political philosophy, and law—as it is perhaps best understood as a thought collective rather than single coherent ideology (Mirowski, 2009; cf. Harvey, 2007; Turner, 2008). The greatest affinity among its adherents is their shared desire to propose a practical alternative the dominant Western traditions of social order: "laissez-faire classical liberalism, social welfare liberalism, and socialism" (Mirowski, 2009, p. 431). The variety of intellectual programs and significant personalities (and egos) that conformed the neoliberal thought collective never allowed to enunciate a manifesto or even a statement of

founding principles; however, most members share a fundamental belief in unfettered markets, private property, and a minimal but strong state; strong because it must be able to adjudicate property disputes between powerful interests (Plehwe and Walber, 2006; Turner, 2008). What is more, neoliberals dispute the notion that monopolies are antithetical to free markets on the grounds that the prospect of monopolistic profits creates the incentive for firms to invest in R&D; monopolies are thus necessary for innovation.

Although the word neoliberalism is not of common use in the U.S.,[22] the most important economic, trade, and regulatory policies introduced by every Administration since Reagan are canonical examples of neoliberal policymaking (Meeropol, 1998; Pollin, 2003; Van Horn and Mirowski, 2009), for instance, deregulation (and later re-regulation), devolution, the 1995 welfare reform, and NAFTA. In the specific case of innovation policy, Slaughter and Rhoades (1996) observed the formation of a political coalition that successfully advanced a neoliberal agenda under the banner of promoting "competitiveness." The previous political force of innovation policy, the Cold War coalition, underlined the transformative character of basic research as the source of U.S. leadership over the Soviet Union. They believed that the autonomy of science was a necessary condition to unleash the creative forces of basic research and gradually expanded funding for the scientific establishment. The new coalition was formed in response to the emergence of Japan as an economic power and the seeming loss of competitiveness of the U.S. economy.

[22] Neoliberalism, in U.S. political parlance, is more closely aligned with conservatism than it is to liberalism. This is due to the curious reversal of meanings that dates back to President Roosevelt campaigning for the New Deal reforms and describing them as truly liberal reforms. He did this with such success that his political opponents eventually surrendered the word and adopted the label conservative for themselves (see Lowi, 1995, p. 87).

They attributed the economic success of Japan to strong research in engineering and applied programs as well as the adoption of more efficient models of production and commercialization. Consequently, they sought to redirect government resources to support industrial R&D and business interests. Slaughter and Rhoades (1996) are careful not to draw easy distinctions between these coalitions as they recognize that the emergence of the competitiveness coalition did not fully displace the Cold War coalition. However, these authors stress the increasing power of the new coalition in enacting key legislation such as the Bayh-Dole Act itself and its later amendments (see Section 3), the creation of the Court of Appeals of the Federal Circuit (P.L. 98-462), the subsidies to private sector R&D through the Small Business Innovation Development Act (P.L. 97-219), the tax-credits for clinical trials of the Orphan Drug Act (P.L. 97-414), and dispensations on anti-trust law including a seven year market exclusivity for developers of "orphan drugs" and a exempt status for R&D joint ventures under the National Cooperative Research Act (P.L. 98-462). Admittedly, a policy agenda for stronger patent protection, subsidies and tax-credits for industrial R&D, and softer anti-trust legislation, looks distinctly neoliberal.[23]

The encroachment of neoliberal values in the organization of innovation extended beyond the competitiveness coalition; in fact, it reached the very regime of knowledge production including researchers themselves (Nedeva and Bolden, 2006; Pestre, 2003; 2005). The transition to the new mode of knowledge production, or "Mode 2," is characterized by greater attention to the context of application (Gibbons et al., 1994; Nowotny, Scott, and Gibbons, 2001). This is not the

[23] Compare with Bruno (2009) who discusses "competitiveness" in the context of the European governance of innovation.

application of theoretical or experimental knowledge typical of Mode 1, but the context of application "describes the total environment in which scientific problems arise, methodologies are developed, outcomes are disseminated, and uses are defined." (Nowotny, Scott, and Gibbons, 2003, p. 186). In a Mode 2 research environment the researcher has professional incentives to produce use-inspired research, and these will be reinforced by the financial incentives attached to those "useful" research findings; to the extend that Mode 2 has not replaced Mode 1, the Bayh-Dole regime is a catalyst of the transition to Mode 2. Consequently, it could be expected a "normalization" of the research culture stylized by the Mode 2 description including a legitimation of profit-seeking behavior in university patenting.

The drift in the Bayh-Dole debate is thus only a reflection of neoliberal ideas taking hold of policymaking in the U.S. At the legislative level, the competitiveness coalition reformed R&D and patent law. At the university administration level, it became more acceptable to engage in patenting and maximizing licensing income. Even at the level of academic research, the uptake of the market values of the Bayh-Dole regime was reinforced by the emergence of fields like information technologies and molecular biology. The changing values at all these levels required a new lexicon to be communicated, and as Slaughter Rhoades (1996) suggest, the primary rhetorical trope has been "competitiveness." For this reason, I now turn my attention to this term.

Competitiveness entered elite discourse with force about the same time Bayh-Dole was passed.[24] The three foremost voices of elite discourse—political leaders, journalists, and scholars—quickly took up the term. Politicians adopted competitiveness because it transcends party-ideology given that the term fits well with what McCloskey and Zaller (1984) call "the American ethos": the bipartisan agreement on public values such as personal freedom, self-help, and merit-based organization. In turn, mass communication media is in constant search for words that convey meaning, at once, intuitively and forcefully. Using LexisNexis Academic to track wires of the Associate Press and the print edition of the New York Times, I found that the term was used in the postwar period until 1980 a total of 117 and 201 times respectively; the use exploded in the 1980s to 3442 and 2373, stabilized in the 1990s with 3432 and 2817, and is like to remain at that level during this last decade, with the count at 3401 and 1448 on July 2009. No less important for the pervasiveness of competitiveness was the host of academic new ideas—in economic theory, public management, corporate culture, and industrial policy—where the term came to symbolize new paradigms. For instance, the efforts to conceptualize competitiveness in economics led to revisions in the theory of "comparative advantage" (for instance, Fagerberg, 1988) "conditional convergence" (for a theoretical and empirical synthesis see Baumol, Nelson, and Wolff, 1994). In public administration competitiveness was central to the emergence of the "new public management" school (Hood, 1991, surveys in Pollit and Bouckaert, 2000, and Hood

[24] I use elite discourse in its standard definition in political science. That is "stereotypes, frames of reference, and elite leadership cues that enable citizens to form conceptions of and, more importantly, opinions about events that are beyond their full personal understanding." (Zaller, 1992, p. 14)

and Peters, 2004). Corporate culture and industrial policy were influenced by the notion of "competitive advantage" pioneered by Porter (1980, 1990).

More than any specific meaning or definition, the pervasiveness of the term in elite discourse impressed on the public imagination the notion that competitiveness is a public value of consensus, similar in its unqualified virtue to justice or freedom. At that point, a whole array of social problems could begin to be articulated in terms of their deleterious effects on competitiveness: A deficient educational system creates less competitive workers; poor public health reduces the productivity of the labor force; higher taxes and welfare benefits undermine the incentives for getting ahead in life; government intervention creates frictions in otherwise competitive markets. Competitiveness became, in the words of Paul Krugman (1994), an obsession that bore the serious risk of lowering the quality of policy discussion: "If top government officials are committed to a particular economic doctrine, inevitably that sets the tone for policy-making on all issues, even those which may seem to have nothing to do with that doctrine" (p. 42).

Competitiveness became an all-purpose goal (if not an obsession) in policy discussions and it was elevated to be a public value of consensus in the public imagination. Unsurprisingly, Bayh-Dole and its subsequent amendments have been justified in terms of promoting competitiveness; Senator Bayh himself offered this reasoning during the hearings in 1980:

> One of the greatest threats to our economic (and ultimately political) well-being is the recent slump in American innovation and productivity… American industry is simply not keeping up with its international competition

in too many fields. While Government patent policy is by no means the only cause of this problem, it is certainly a contributing factor. (U.S. Senate, 1980).

The popularity of competitiveness however does not logically link patent policy and this value. There was indeed a more formal explanation that linked patent rights to competitiveness. First, economists usually define competitiveness in terms of national productivity—measured usually as national product per hour of labor. More precisely, competitiveness is the relative position of an economy in terms of productivity (Hatsoupolus, Krugman, and Summers, 1988; see also Klein, 1988). Second, economic theory since the 1960s has re-invigorated the old notion that innovation is the driver of long-term productivity gains, and consequently, of sustained economic growth. While the fluctuations of the business cycle are explained by the fluctuations in employment of the factors of production, in the long run, the size of the economy is capped by its productive capacity at full employment. Hence, only technological innovation can expand the frontier of production possibilities by making labor, capital, and land increasingly more productive. Third, that other old notion that patents introduce an incentive for innovation is also alive and well— although it had suffered some setbacks from the Progressive Era through the 1960s as policy makers and the courts had favored, in some instances, anti-trust arguments over industrial patent rights. Fourth, and in relation to the previous point, it was believed that patent rights to public research (i.e. federally-funded research) were not clearly assigned because, unless prior agreement existed between research contractor and federal agencies, the government retained rights to those patents. I will elaborate on the latter point further in the next section, but here it is sufficient to stress that it was thought necessary to clearly assign patent rights to public research

for the private sector to invest in the development and commercialization of that research. This linear causal relation—from public support of research, to assignation of patents for private exploitation, to innovation, to productivity gains, to national competitiveness—linked Bayh-Dole to competitiveness and made of it a national cause.

I have argued thus far that the ascendancy of neoliberal ideas over policymaking and particularly over the innovation system were the primary source of drift in the Bayh-Dole debate, and that competitiveness is a good point of reference to identify neoliberal justifications of the Act and posterior reforms to its design. It is to that aspect that I now turn my attention, the drift in the design of Bayh-Dole.

3.3 Changes in the design of Bayh-Dole.

Bayh-Dole is today a very different policy than it was when enacted. The Act ended the policy ambivalence and achieved uniformity in patent policy across most federal agencies[25] but it did not close the Bush-Kilgore discord. By the late 1970s, many lawmakers—particularly those who fought the legislative battles for expanding the welfare state in the 1960s—would have scoffed at the idea of transferring government patent rights directly to industrial interests. The enacting coalition of Bayh-Dole had to overcome serious objections and in doing so it equipped it with provisions to balance the various intervening interests.[26]

[25] Bayh-Dole exempts research programs directly tied to national security, especially at the Department of Defense.

[26] In addition to the Congressional wrangling, see Stevens (2004) and Washburn (2005, Ch. 5) for accounts of the closed-door negotiations leading to the legislative agreement on Bayh-Dole.

The objections were mainly three. If the Act was enacted, it was feared that granting rights on profitable patents would be seen as a government giveaway to large industrial interests, that unrestricted exclusive licenses would promote non-competitive practices such as excessive pricing and the stifling of potential competitors, and that taxpayers would be denied their fair share of returns on research investments that yielded profitable patents.

The balancing mechanisms were inscribed in the proposed bill (S. 414, introduced on February 9, 1979) and they were successful in preempting the aforementioned objections. To neutralize accusations that this policy was a giveaway to corporations, the Act explicitly states its aim "to encourage maximum participation of small business firms in federally supported research" (35 U.S.C. §200), requires that small businesses be given preference when granting a license (35 U.S.C. §202-c-7-D) and, when enacted in 1980, it limited the time length of exclusive licenses for large businesses to five years. To forestall allegations that the taxpayer's investments in research would never yield monetary return, the text of the Act—as originally introduced to the Senate—included a provision for the government to recoup a portion of the licensing income. Finally, and as the cornerstone of all safeguards against the lack-of-use, misuse, or abuse of titles or licenses, the Act established two mechanisms for government intervention before and after rights to title are granted. The first of these mechanisms allows funding agencies to limit or cancel the rights to an invention "in exceptional circumstances when it is determined by the agency that restriction or elimination of the right to retain title to any subject invention will better promote the policy and objectives of the Act" (35 U.S.C. §202-a-ii), namely, that inventions "are used in a manner to promote free competition and

enterprise without unduly encumbering future research and discovery" (35 U.S.C. §200). The second provision has two elements. First, it requires contractors that take title to inventions to grant, in favor of the funding agency, a "nonexclusive, nontransferable, irrevocable, paid-up license" (35 U.S.C. §202-c-4). Second, it confers the respective federal agency "march-in rights." These rights are legal authority for the agency to practice such a royalty-free license under certain circumstances, primarily when "the contractor or assignee has not taken, or is not expected to take within a reasonable time, effective steps to achieve practical application" and when "action is necessary to alleviate health or safety needs which are not reasonably satisfied by the contractor, assignee, or their licensees" (35 U.S.C. §203).

It would not be an exaggeration to say that, in 1980, not even the few skeptics of Bayh-Dole could imagine how weak and impractical were those safeguard provisions. The first blow to the safeguards was inflicted even before the bill was passed: the final text of the Act did not include the recoupment provision. The second strike to the safeguards came with President Reagan's memorandum of 1983 that eased the restrictions for large companies to benefit from Bayh-Dole.[27] Congress later amended the Act according to this memorandum, further striking down the five-year limitation on exclusive licensing for large companies in the Trademark Clarification Act of 1984 (PL 98-620). Furthermore, the provision for agency intervention was by design impractical given that its application requires meeting the high threshold of "exceptional circumstances." In fact, the sole place where this

[27] See Woolley and Peters, 2009a, for Memorandum on Government Patent Policy of February 18, 1983.

provision has been used is a solicitation for molecular target laboratories by the National Cancer Institute (2000).

Likewise, regarding the march-in rights provision, Admiral Hyman Rickover, famous for directing the development of the nuclear submarine, warned during the hearings that it was impractical for the government to supervise the development of technology sufficiently to justify the use of march-in rights. The admiral thought of it as simply a cosmetic provision crafted to placate objectors to the Act. In time, his fears proved warranted. As this provision was regulated (37 CFR 401.6), agencies considered exercising the rights only upon petition of a disaffected third party, and under the Trademark Clarification Act of 1984, any march-in determination is held in abeyance until the appeals process is exhausted (P.L. 98-620; §V-9). It is thus not surprising that only three petitions have been presented, and all were found unjustified by the National Institutes of Health (NIH) (see details in the next section).

Asserting that the changes to the terms of the Bayh-Dole debate and the changes to its design reflect the ascendancy of neoliberal ideas in US policy making, is not sufficient to evaluate these changes. If we think that the value of the technology transfer regime resides in its ability to streamline commercialization of pubic research, the current terms of the debate would not be a concern at all. If instead we see technology transfer policy as serving various public values other than those related to commercialization, we should assess how well the Act is performing with respect to those values. To this end, the next section will introduce the evaluation approach called "public value failure" and deploy it on Bayh-Dole.

3.4 Public Value Failure in the Bayh-Dole regime.

The most influential rationale for policy evaluation is known as Market Failure Criteria. This is a normative theory for public action that justifies government intervention in the economy when markets fail to behave as perfectly competitive markets (Bator, 1958; Samuelson, 1954). The notion of perfect competition is an ideal state of frictionless markets where consumers and producers transact with complete and perfect information such that prices convey all the relevant information about the goods transacted. The fundamental assumption of market failure is that perfectly competitive markets allocate resources efficiently in a Pareto optimal sense, that is, no person can be made better off without making another worse off.

This specific definition of efficiency, that means all markets clear at current prices, is silent about the pattern of distribution of resources. This point can be sufficiently illustrated by a stylized economy of two individuals who must divide a loaf of bread. An efficient allocation, in the Pareto optimal sense, is any allocation that exhausts the loaf; for instance, each person gets half, or one person gets the entire loaf while the other nothing. Perfect competition guarantees an efficient allocation in this specific sense (no bread is wasted), but it should be noted too that perfect competition supports any allocation of resources, however intolerable or unjust is such an allocation.

Notwithstanding this inadequacy dealing with issues of distribution, market failure became enormously influential in policy analysis and policy making circles in the U.S. partly because it was vested with all the scientific authority that economic theory could muster—general equilibrium theory—and partly because it provided

the Cold War generation with a rationale for government intervention that did not betray their commitment to the market system, quite the contrary: it celebrated markets. Such is the sway of market failure, that its method par excellence, cost-benefit analysis, was instituted as the norm when assessing prospectively federal regulatory initiatives—following President Reagan's E.O. 12291 of 1981 and President Clinton's E.O. 12866 of 1994.[28]

In spite of its popularity, market failure has a fundamental problem because social groups do not always value efficiency or the freedom of markets as a superordinate goal. Rather, societies often balance the free markets against other values like security or justice, and as a consequence, governments may be fully justified to take action even when markets do not fail. Consider the case of basic necessities such as housing, food, or medicine. At any price level—even at the marginal cost of production, that is, the price of perfect competition—there will be a segment of the population unable to afford those prices. If social values were such that the provision of basic necessities to all citizens overrides the value of free markets; then, the government would have reasons to secure the provision of those goods for the entire population.

To escape this fundamental narrowness of market failure, Bozeman (2002) proposed an alternative rationale, called Public Value Failure Criteria, that expands the analysis to non-market values. Whereas market failure prescribes public action only to restore perfect competition, public value failure prescribes action when any of several discrete "core public values" go underserved or neglected. This begs the

[28] It should be noted that President Reagan executive order introduced cost-benefit analysis as part of the Regulatory Impact Analysis. The RIA also mandates the assessment of distributive and fairness impacts, although these are not formalized in a method in the same way as cost-benefit analysis.

question of which public values exactly? In answering this question Bozeman produced a canonical set of public values that reflects well-established convictions about the rule of law and democratic policy making (e.g. transparency, inclusiveness) but that are also distilled from a pragmatic theory of the public interest in democracy in the tradition of Dewey's *The Public and It's Problems* (Dewey 1927; the theory in Bozeman, 2007: Ch. 5). This canonical set of public values is referred to as "public value failure criteria" (Bozeman, 2002) or as "public value mapping criteria" (PVM-C) when embedded in the public value mapping method (see Bozeman and Sarewitz in this issue).

Note that assessing policy with the pubic failure criteria is a "negative test," in the sense that it helps to identify failures to serve the public interest rather than to positively affirm whether a given policy is in fact furthering the common good. Bozeman formulated his criteria—the core set of public values—in such a way that it symmetrically counterposes the market failure criteria. Taking this symmetry in consideration, I have adapted Bozeman's criteria to the particular purpose of evaluating Bayh-Dole.

Table 1 below summarizes Bozeman's public value failure criteria (first column), transposes it to the Bayh-Dole problem (second column), and summarizes the main public value failures (third column) that are described in detail next.

Table 1. Summary assessment of Bayh-Dole with PVM criteria.		
Public failure criteria. In parenthesis, the market failure analog.	**Equivalent criteria for evaluation of Bayh-Dole.**	**Brief description of the failure.**
Interest aggregation and articulation (general failures of the price system)	Equal voice and equal consideration.	Opposition to Bayh-Dole was neutralized by ill-designed safeguards that were easily defused and struck down.
Legitimate monopolies (monopolies and non-competitive market structures)	Legal attributions of government.	Failure to enforce march-in rights for controlling excesses of monopolistic pricing. Failure to support universities balancing organizational needs and the public interest.
Imperfect public information (asymmetric information).	Transparency.	No formal channels for holding implementation agents (OTTs) accountable.
Distribution of Benefits (benefit hoarding and rent-seeking).	Preclusion of benefit hoarding	Lack of institutional mechanisms to determine "imperatives" for exclusive licensing.
Provider availability (monopsonies and non-competitive chains of supply).	Provision of public goods and services.	Exclusion of firms willing to develop applications in a competitive environment.

Equal voice and equal consideration.

A failure of aggregation of interests, occurs, explains Bozeman (2002), when "core public values are skirted because of flaws in the policy-making processes" (p. 151). These failures could be attributed to ill-designed institutions governing the policy process, or the failures could be procedural when they are due to a willful or heedless deviation from due process. Procedural flaws could be uncovered by process audits and are commonly attributed to negligence or corruption. Failures of design are harder to detect because the system may work by-the-book. Bozeman (2002, 2007) offers an example of structural problems facilitated by the seemingly

reasonable rule of seniority for the chairmanship of Congressional committees; the problem was that this rule enabled tenured Southern congressmen to impede civil rights reforms for decades until the mid 1960s. Likewise, analyzing US science policy, Bozeman and Sarewitz (2005) characterize another structural flaw arguing that the science policy system of the US does not have a mechanism to involve lay citizens in crucial policy decisions such as the portfolio allocation of federal research funds. In both cases, policy-making institutions work according to design and still, widely held public values (such as equal rights or social returns on public investments) fail to be articulated and the resulting policy aggregates the competing values unduly privileging some stakeholders over others.

The swift passage of Bayh-Dole suggests bipartisan cooperation, a success of aggregation of interests. Nevertheless, it should be remembered that the sponsors of the Act had anticipated opposition and crafted provisions to address each major objection. This tactic effectively neutralized opposition.

The degree to which the policy drifted from the seeming compromise of its first statutory version may not have been suspected by the sponsors of the bill, and surely, it was not forsawn by the opposition that was placated with the safeguard provisions. In retrospect, one is left wondering if the safeguards were mainly introduced to deflect objections rather than give objections due consideration. Were the voices of dissent given due consideration or were they simply assuaged under the pretense of safeguard provisions and the urgency of implementing solutions to the competitiveness crisis? The hearings of Bayh-Dole cannot be charged for failing to give equal voice to proponents and objectors; it is doubtful however that all voices have been given equal consideration.

Legal attributions of government.

A public value failure occurs when private individuals or institutions exercise rights that are the exclusive privilege of government, such as speaking on behalf of the whole of society or making law and regulations to protect the public interest. For instance, foreign policy and the prevention of a flu pandemic, argue Bozeman (2002) and Feeney and Bozeman (2007) respectively, are both responsibilities and attributions of the government that no individual or organization can take upon itself to provide. Likewise, Bozeman and Sarewitz (2005) warn of public value failure when little or no governmental authority is executed to protect the physical and mental integrity of human subjects participating in clinical trials. When researchers conducting those studies have an economic interest in the companies producing the drugs, a public value failure ensues if the researcher's conflict of interest is not fully disclosed to participants because it cannot be assumed that subjects who consented to participate were fully informed of the benefits and risks of their participation.

Likewise, the enforcement of march-in rights in the face of excessive pricing and other monopolistic practices is a statutory attribution of government, and the failure to enforce has been indeed a public value failure. Three cases were brought to a federal agency petitioning the use of march-in rights, and all three were dismissed. In the first case, CellPro, Inc. had intended to license patents granted to competitor Baxter by John Hopkins University (developed with NIH grants). NIH found that Baxter was actively practicing the patent seeking FDA approval on a device with those patents; provided that Bayh-Dole requires only reasonable effort to practice the patent, the NIH rejected the petition (NIH, 1997). The other two cases regarding drugs Norvir, an HIV/AIDS treatment, and Xalatan, a treatment for glaucoma,

merited a similar conclusion from the NIH (see resolutions in NIH, 2004a; 2004b). In both cases the petitioners had complained of excessive pricing and requested the government to exercise its royalty-free license with respect to titles held by Abbott Laboratories and Pfizer respectively. However, NIH stressed that, under Bayh-Dole, the exercise of march-in rights was limited to circumstances where the patents in question were not practiced or to alleviate health and safety needs, neither of which applied to Norvir and Xalatan that were already commercial products. The NIH concluded that "the extraordinary remedy of march-in is not an appropriate means of controlling prices" (NIH, 2004b). This interpretation is nevertheless controversial; for instance, legal scholars Arno and Davis (2001, p. 662) find "countless references in the legislative record to the need to maintain competitive market conditions through the exercise of march-in rights," including the control of profits and prices.

The neglect to affirm march-in rights is as much a public value failure in patent policy as it would be laxity in enforcing informed consent in the regulation of human subject in research. The weakening of the safeguards built-in the Act partly explains the observed government tolerance of monopolistic practices but it does not justify the three-decade neglect of regulatory support to universities in dealing with the tensions of revenue-seeking licensing activities and their public service mission. It is worthwhile to stress that government-backed institutions would greatly assist universities in their efforts for good governance and self-regulation.

Transparency.

The citizens' ability to exercise oversight over the policy process, from design to implementation, is often considered a public value of consensus. Bozeman (2007) argues that lack of transparency in the policy process inhibits this ability resulting in a

public value failure. The canonical examples are closed-door executive meetings such as the Clinton task force for health care reform (Hacker, 1997) or the Cheney talks on energy policy (Bozeman, 2007); various concerned publics interpreted the lack of transparency as a threat to the public interest even when they did not think that the First Lady or the Vice President were transgressing due process.[29]

In contrast to these examples of public value failure, the passing of the Bayh-Dole, while swift, was indeed subject to customary hearings and debate. It may not be easy to challenge the fact that the Act was enacted in a public and transparent fashion. Its implementation, on the other hand, is not so obviously transparent. Admittedly, the implementation of the core logic of the Act is straightforward: the government confers rights of intellectual ownership to research contractors (e.g. universities, hospitals, etc.) and demands minimal reporting requirements from them. Nevertheless, the implementation of the Act's safeguards of the public interests is much less transparent. Granting of rights to research contractors should also be construed as a delegation of the government's fiduciary duty to society with respect to publicly funded innovation. At the same time, university offices of technology transfer are constituted with the clear mission to profitably commercialize university inventions. Seeking to find a market for those inventions is as much a business as real estate or venture capital. Whether the OTT is constituted inside the organization (as a division or department) or outside (as an independent legal vehicle) its performance will primarily be assessed by revenue generation. Revenue is derived from licensing patents in two modalities, cash or stock options in the licensee firms.

[29] *Ex post facto*, the Supreme Court found the First Lady in violation of Federal Advisory Committee Act for not being a federal employee.

Hence, many of the companies licensing from the university will be start-ups founded by faculty members working on a particular invention and will partner with the OTT that provides them with the resources and legal expertise to develop their high-technology products. In this partnership the OTT is constituted across two spheres, the university and the industry. It is crucial for the firm to keep private information secret if the firm is to successfully position itself in the marketplace—information that includes technical aspects of the product under development, the configuration of the supply chain, and the marketing and business strategy of the firm. The OTT is the most important partner for the firm at this early stage and must be committed to secrecy if is to be a valuable partner; consequently, the OTT cannot be expected to function adequately if it is open to pubic scrutiny. This is a public value failure by design: the burden of implementation of Bayh-Dole befalls on organizations that straddle the public and the private and therefore cannot be entirely transparent. In fact, the OTT by design sits astride the public spheres of knowledge creation and the private spheres of profit making and is therefore ill equipped to internalize the ensuing tensions because the delegation of Bayh-Dole is much more clear about implementing the profit incentive than it is delegating the government's fiduciary duty.

Preclusion of benefit hoarding.

The best example of this public value failure concerns precisely technology transfer policy. Bozeman and Sarewitz (2005) explain how the Federal Technology Transfer Act of 1986 (15 U.S.C. §3701-3714) that instituted cooperative agreements (CRADAs) between federal laboratories and industry resulted in one visible case in the commercialization of a technology design to hoard the benefits of improved

varieties of seeds. Seed-sterilizing technology, also called the terminator-gene, was developed under a CRADA between the Department of Agriculture and Delta and Pine Land Co., as a complex bioengineered procedure that prevents farmers from producing second-generation seeds from first-generation crops, thus enforcing intellectual property rights on new varieties of seed. Small farmers, including subsistence farmers in the developing world, explained these authors, "continually seek better plant varieties for local growing conditions, through careful selection of kept seed, as well as purchase of new varieties from both public and private seed distributors" (Bozeman and Sarewitz, 2005 p. 131). Seed-sterilizing technology prevents such practices and deprives vulnerable farmers from free riding the new seed varieties. However, the purpose of government for funding research to improve agricultural methods including the engineering of seeds for better crop varieties is to improve stability and sufficiency of the food supply by means of improving the productivity of arable land, irrigation, and crops. Seed-sterilizing technology does not serve that purpose or the values that inspire it.

It would be a mistake to blame the CRADAs mechanism for the development of seed-sterilizing technology. Rather, the cause for this public value failure is the lack of institutional safeguards of the public interest that upon discovery of the terminator-gene did not prevent a firm from obtaining rights to the patents of such a technology. This lesson resonates with the implementation of Bayh-Dole because the problem in this case is not the profit incentive but the assumption that monopolistic profits are the only level of incentive that will bring about the development and commercialization of research. Exclusive licensing is hardly warranted when fundamental discoveries or research tools are in question or when

the application is nearly contained in the patent. In the former, the collective efforts of a research community could be throttled; in the latter, a competitive environment would better serve the wide dissemination of the technology. Thus, unless there is only one company willing to develop an application with a public-research patent, exclusive licensing of such a patent is a form benefit hoarding.

Provision of Public Goods and Services.

Even when private initiative is motivated by public values, as is the case of charity, the entrepreneur may decide the time, quality, and form of the service, and may even decide to discontinue its provision, at his discretion. When the government provides a service motivated by public values, any changes in the service level and quality should a priori reflect a change of values or a shift in the way public values organize public priorities. However, when the government delegates to a contractor the provision of a given service, private discretion over the provision may not represent a change in public values as much as it will be a change in the determinants of the bottom-line of the contractor. Bozeman (2007) declares that a public value failure will occur in a situation where the government, having delegated a given service in the past, finds itself in a situation where the need emerges to provide that service with urgency, yet neither it can avail itself of contractors nor it has the capacity to provide the needed service anymore.

As it was discussed earlier, Bayh-Dole solved a two-sided problem by providing simultaneously an incentive for demand and supply of R&D by motivating a greater concern for mission-oriented research and by granting legal protection to developmental investors respectively. In this sense Bayh-Dole provides two public goods of great value: more socially sensitive research and lesser risk for technology

developers. Was there a shortage of these services before the Act? Research is not conclusive on this respect but one thing is certain, the abrupt increase of transferring activity since 1980 must have reduced any shortage or even perhaps turned it into a surplus. Yet, not every exclusive license granted is justified. To the extent that research tools are licensed exclusively, Bayh-Dole is reducing the availability of technological applications that would exist if those tools would be licensed on non-exclusive basis (Mazzeloni and Nelson, 1998; Colyvas et al., 2002). Likewise, the cases where there is at least one company willing to take a non-exclusive license and develop a technology in a competitive environment (typical of some industries such as software and mobile telephony), an exclusive license is actually curtailing other firms from providing new products at competitive prices. In the absence of institutional mechanisms that restrain monopolistic excesses, the Act has two edges, one that expands the demand and supply of economically valuable R&D and another that cuts the number of potential providers. Again, appropriate institutional mechanisms could keep the incentives of the Act in place and at the same time maximize the number of research programs and developers willing to compete with each other in a race that promotes the public interest.

3.5 Conclusion.

The direction of the Bayh-Dole debate was influenced by the new political and economic context in which it unfolded. Neoliberal conceptions of the economy, innovation, and property rights came to dominate the political discourse since the 1980s and the Bayh-Dole debate became dominated by the banners of the imperative of innovation and specially "competitiveness." This situation and the attrition of

countervailing forces in the enacting coalition allowed for a legislative drift of the Act and a rollback of safeguards introduced to protect economic opportunity and access, increasing in this way the authority of markets.

In terms of public value failures, it could be said that with the passing of time, voice and consideration is less and less equal in the Bayh-Dole debate, that the legitimate attributions of government are in retreat, and that the ambiguity of the delegation of the fiduciary role is condoning an environment of business secrecy. The enthusiasm for a hands-off government has resulted in a vacuum of institutional safeguards of economic opportunity; a vacuum manifested in the NIH inability to exercise march-in rights due to its narrow interpretation of that provision, and manifested too in the lack of government support for universities that were left to their own resources to countervail the force of financial need with the more tenuous commitment to public service.

Chapter 4

EVALUATION OF DISTRIBUTIONAL OUTCOMES

4.1. Introduction.

In the previous chapter I sought to expand the discussion of Bayh-Dole beyond the regular concerns with the pace of innovation (and its rhetorical surrogate: competitiveness) and with the erosion of traditional academic values. In this chapter, I take the analysis deeper into the distributive character of the Act.

All public policy, in one way or another, allocates resources, rights, or privileges (Rae,1979; 1981, Stone, 2002|1988). Equity is thus a central public value in policy analysis and it is often discussed in relation to the distribution of economic resources or access to resources. It is also important to consider however, equity in the distribution of political power. I use equity as a public value that motivates a fair distribution of influence and resources in society and I do not assume that all forms of inequality are unjust ("fair" in a Rawlsian sense; see Introduction). In fact, below I make explicit the normative framework in which I anchor the problematization of the inequalities examined in this chapter.[30]

The formal relationship between the distribution of influence and the distribution of economic resources has been long recognized in policy analysis and evaluation (Lasswell, 1936), and more recently has received attention in the literature of science, technology and innovation (STI) policy (Healey, Hagendijk, Pereira, 2009;

[30] I emphasize equity as a "public value" to separate its use to judge a social state of affairs from its use to judge individual behavior. This distinction is necessary to avoid wrongly imputing the inequity of certain social arrangements that we discuss here onto the values of citizens themselves. My use of equity and inequality is not too different than Cozzens (2007) who reserves "inequality" for descriptive purposes and "inequity" for normative assessment.

Senker, 2003; Wetmore, 2007).[31] In the domain of STI, evidence from case studies suggests that inequality of resources follows from political inequality (Rayner and Malone, 2001),[32] and in turn political inequality (defined by forms of representation and accountability) follows from structural inequalities (defined by patterns of ownership of productive assets, social hierarchy, and political culture), and completing the cycle, these last follow from long-term patterns of resource allocation (Cozzens et al., 2008). These authors have spearheaded the study of the conditions that determine whether the cycle reinforces or mitigates inequality.

To discuss equity in relation to Bayh-Dole we must locate problematic inequalities across the relevant actors and through the relevant processes where this policy intervenes. Let's begin by identifying the main actors according to their level of participation. By design, Bayh-Dole directly affects government research contractors. Here I will focus on universities because of their relative importance among research contractors—60% of government obligations for basic research ($ 27.7bn) were allocated to universities in 2008 (NSF, 2009).[33] Users of university patents who enter in licensing contracts with universities are the second level of actors. These may be technology development companies that pursue the commercial application of university patents or other research organizations in the

[31] The Healy et al. is a final report of the ResIST project, a large multi-country team who researched specifically inequality and science and technology in large and emerging economies. The Senker and Wemore pieces are introductions to symposiums on inequality and science policy published respectively in the journals *Science Technology and Human Values* and *Science and Public Policy*.

[32] Rayner and Malone push the argument further, an suggest that "poverty cannot be understood in terms of lack of goods or income, or even basic needs, but must rather be understood in terms of people's ability to participate in the social discourse that shapes their lives" (p. 176).

[33] This figure includes allocations to universities (51%) and allocations to university-based federally funded research and development centers, better known by their acronym FFRDCs (9%). While universities take 60% of government obligations for basic research, they take 40% in applied research and only 6% in development; universities total share in government R&D obligations is thus 27% in 2008.

case of patents on research tools. Individual and organized groups of citizens are the next level of participating actors. Citizens are relevant not only as consumers or prospect consumers, but also as taxpayers who are entitled to have a say in what new technologies are introduced in their common living space. Consequently, adding the equity dimension to the evaluation of Bayh-Dole requires a look into the distribution of economic and political resources among these actors.

Let's now identify the relevant processes affected by Bayh-Dole. In the domain of STI policy, technology transfer occupies a special place because it links two processes traditionally separated in policy studies: research and innovation. Research involves knowledge creation by the scientific establishment, and innovation encompasses the creation of economic-value by private enterprise from new scientific and technical knowledge (in the form of commercialized applications). To the extent that the scientific establishment and private enterprise are separate institutions, the research-innovation distinction is tenable (David and Dasgupta, 1994). However, as discussed in the previous chapters, this institutional distinction was blurred with the wave of reforms to the patent system of which Bayh-Dole is an integral part. Therefore, equity considerations on Bayh-Dole must take into consideration this hybridization of the organizations of research and innovation and their underlying distributive mechanisms.

Before proceeding with the analysis of relevant inequalities I want to make explicit the normative framework that will guide my discussion of equity in the design and implementation of Bayh-Dole: the "democratization of science" can be understood as the aspiration of introducing decision checks and balances into the processes of research and innovation. Advocates of the democratization of science

think that these checks and balances ought to be modeled after other democratic institutions that have successfully precluded the centralization of political power in a single office, organization, or political body (see for instance Guston, 2004; 2005, Kitcher, 2001; Kleinman, 2000; Maasen and Weingart, 2005)—hence, my use of democratizing innovation is not quite in the vein of consumer-driven innovation (von Hippel, 2005). One way to characterize democratization is as the aspiration for striking the right balance between expediency and political equality in collective decision-making. It is obviously impractical to expect all collective decisions to be decided in the widest political forum, but it is not unreasonable to expect that decisions of great import to the social order be more broadly and critically deliberated and citizens participate more in the making of such decisions (see Dryzek and Dunleavey, 2009; on political equality see Dahl, 2006).

The need to democratize decision-making when decisions affect the very structure of society acquires new urgency when we suspect that the construction of new knowledge and social order take place simultaneously. I will call this the "co-production thesis" (Latour, 1987; Jasanoff, 2004) and include not only the production of knowledge but also the emergence of new technologies as forces that conjointly shape the social order (e.g. Jasanoff, 2005; Parthasarathy, 2007).[34]

Considering that research and innovation are advancing at a fast pace, it remains an open question the extent to which fundamental social institutions are

[34] A survey of the field of science and technology studies (STS), where the co-production thesis was elaborated can be found in Jasanoff, et al. (1995) and Hackett, et al. (2008). For the unfamiliar reader, a pedestrian illustration may help form an intuition about the co-production thesis: as mobile-texting usage continues to increase (soon it will surpass mobile-voice usage), the new language that is emerging is shaping the tool (SMS neologisms, abbreviations, etiquette, etc.) and is also shaping the terms of our interpersonal relationships; for instance, developing a cultural preference for brevity in communication may at the same time reduce our tolerance for elaborated articulations of complex thoughts and emotions.

simultaneously changing, and how much of these changes threaten democratic values. Taking this question seriously in the domain of STI implies normatively that an effort should be made to appraise *ex ante* the impacts of research or innovation decisions, where affected publics are identified and then given channels to have a say in those decisions. It also implies the necessity of reinforcing (or creating) institutional mechanisms that legitimize the decision-making process. In the sub-domain of technology transfer, a clear normative implication is to seek a more equitable distribution of voice and vote in the design of patent licensing contracts. I propose therefore to examine Bayh-Dole under this normative framework, that is, the extent to which this policy assists in the democratization of research and innovation, particularly the extent to which it facilitates (or impedes) the participation of the stakeholders of technology transfer decisions.

The aspiration to democratize research and innovation is not free of criticism. The first objection comes from the view that the current system for collective decision-making not only upholds democratic values but also that it works just fine—the early work of Robert Dahl (2005|1961) may give the impression that a "pluralist democracy" was just that system (compare with the later Dahl, 1983; 1989). A second objection may arise, even accepting that the current system has room for improvement, and that is taking issue with the co-production thesis. In fact, this thesis is far from a consensus outside the field of science and technology studies; and it is even received with acrimony in some quarters (as in the "science wars;" for a discussion see Hacking, 1999). Nevertheless, the critics of co-production are likely to fashion their views in line with the "technological determinism thesis," that affirms

causal effects from science and technology to the social structure.[35] Under this view, it is still possible to observe that contemporary technologies (biotechnology, nanotechnology) have the potential to produce significant social change, even altering the social compact, and this awareness implies the need for greater democratic checks on the emergence of these technologies. The need to rein in the emergence of technologies might be recognized under both theses, but the prescriptions will vary greatly. Technological determinism assumes a clear institutional separation between the production of knowledge and the maintenance of social order and thus their advocates may prefer to regulate production rather than to democratize it. To the extent that the preference for regulation is widely accepted, my normative framework emphasizing democratization will have, admittedly, limited sway in policymaking. However, I will show that examining Bayh-Dole as an instrument of democratization may in some instances be reconciled with the view of this policy as an instrument of regulation.

My argument in this chapter moves across the two dimensions introduced above—actors and processes. I begin by looking transversally through the levels of actors, first probing the distributive dynamics in universities and pursuing the implications of these dynamics into the industrial organization of high-tech development firms, and these into the effects on citizens as economic and political agents. Then in the second part, I revisit the standard arguments for the distribution

[35] Insofar as the process-effect (science and technology) is kept analytically separated from the process-cause (social order), the transformative power of science and technology throughout history seems hard to contest. However, co-production unearths the simultaneity of both processes and it does so to such a fundamental level that it subverts their analytical difference, as though the analysis would be of a single thing (a single network of actors). This analytical strategy presents a challenge to co-production because practical observers may find themselves hard pressed to translate the lessons of co-production into plain language and to accommodate the standard preconceptions of policy makers.

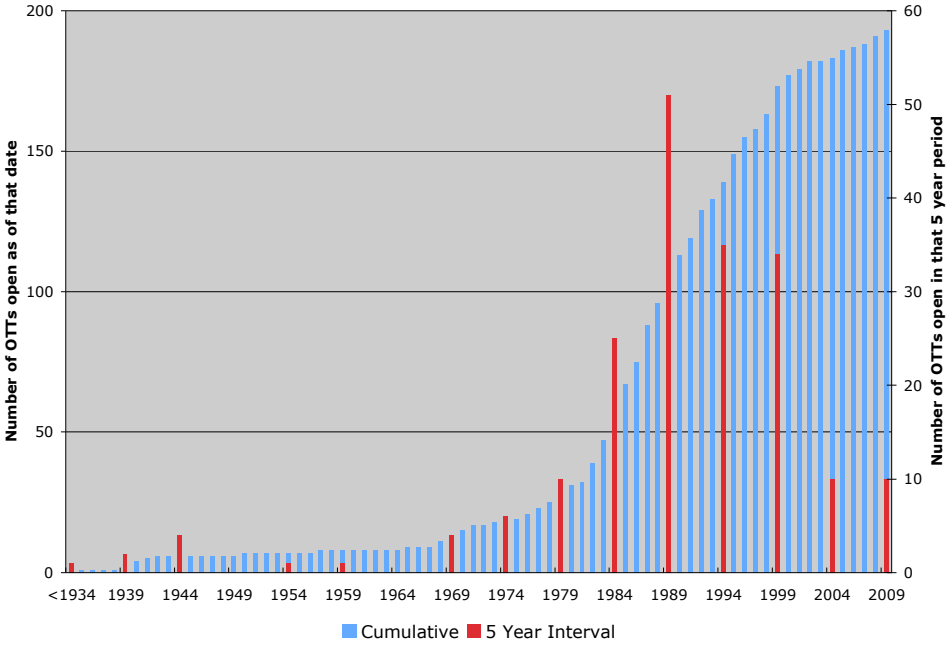
of benefits from research and innovation and engage them in light of the hybridization of their institutions.

4.2 From asymmetries in licensing income to a new OTT business model.

After Bayh-Dole was enacted universities created the organizational capacities for managing their intellectual property, opening and staffing offices of technology transfer (OTTs) in a great hurry. The Association of University Technology Managers (AUTM) reports that by 1979, only 30 universities had an OTT but in two decades this number went up to 174 in 1999. The annual growth of OTT openings is exponential through the 1980s and 1990s, and now that most research universities are in business, the yearly increment is only marginal; by 2009 the total was 194 (See Figure 5). The 2010 Carnegie Classification of Higher Education counts 206 U.S. universities with very high or high research activity; all of them have OTTs.

While universities rushed to open OTTs, only a few have raised significant income from licensing their patents under Bayh-Dole. Figure 6 shows the great asymmetry in the distribution of licensing gross income, an asymmetry that seems consistent for 2009 when compared to the average of the last three years and the average of the last decade. In all cases, an exponential trend is the best fit to that distribution (results of regression analysis were not included in the figure). In 2009, a year very much in line with the decade's average, the top 5% of earners (8 universities) took 50% of the total licensing income of the university system; and the top 10% (15 universities) took 72%, nearly three-quarters of the system's income.

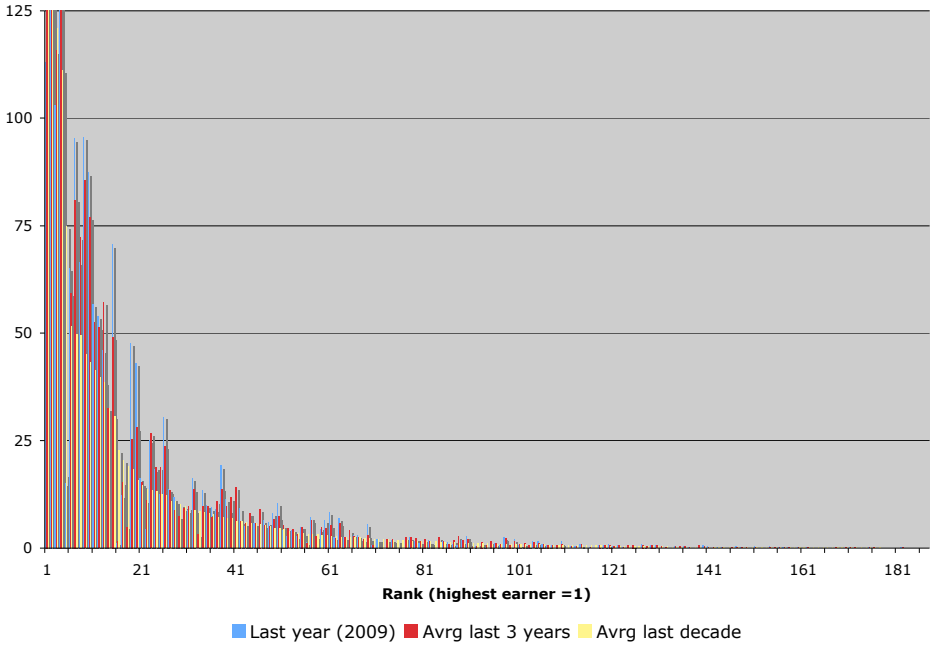
Figure 5. Growth of University OTTs.



Five Year Period	Number of OTTs Open	Cummulative
1925-1929	1	1
1930-1934	0	1
1935-1939	2	3
1940-1944	4	7
1945-1949	0	7
1950-1954	1	8
1955-1959	1	9
1960-1964	0	9
1965-1969	4	13
1970-1974	6	19
1975-1979	10	29
1980-1984	25	54
1985-1989	51	105
1990-1994	35	140
1995-1999	34	174
2000-2004	10	184
2004-2009	10	194

Source: AUTM (2010)

Figure 6. Distribution of Licensing Gross Income by University.



Percentile	Total income of percentile (in $mm)	Percentile share of overall income	Nbr. of universities in percentile
Year: 2009			
99	316	18	2
95	881	50	8
90	1259	72	15
85	1417	81	22
50	1719	98	71
0	1759	100	142
Average of last 3 years (2007-09)			
99	693	33	2
95	1326	62	9
90	1648	78	17
85	1785	84	25
50	2083	98	81
0	2122	100	162
Average of last decade (2000-09)			
99	307	20	2
95	853	57	10
90	1116	74	19
85	1233	82	28
50	1479	98	93
0	1509	100	186

Source: AUTM (2010)

Taking the top 20 earners each year individually for the last decade, I found a rather stable club of 40 leading research universities in the U.S. (listed in Table 2). Moreover, during the last three years the composition of the top 20 universities that controls 75% of the total licensing market has changed very little, and new entrants are actually long time members of the academic elite, namely, University of Michigan, University of Georgia, and Duke University.

Table 2. Top earners of licensing gross income 2000-2009.

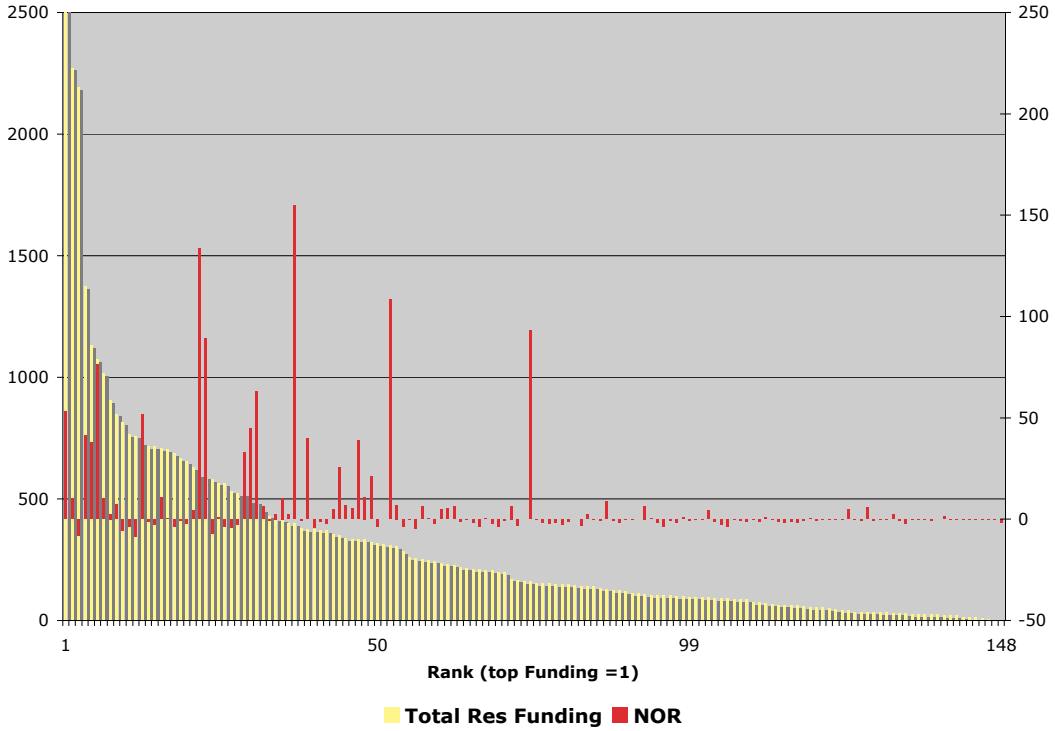
University	Rank by Decade Average	University	Rank by Decade Average	University	Rank by Decade Average
New York Univ.	1	Univ. of Massachusetts	15	U of TX Southw. Med Center	29
Columbia Univ.	2	Florida State Univ.	16	Washington Univ. St. Louis	30
Univ. of CA System	3	Harvard Univ.	17	Baylor College of Medicine	31
Northwestern Univ.	4	Michigan State Univ.	18	Dartmouth College	33
Emory Univ.	5	Cal Tech	19	Univ. of IL—Ch and U&C	34
Stanford Univ.	6	Univ. of Iowa Res. Found.	20	Tulane Univ.	36
Univ. of Minnesota	7	Res. Foundation of SUNY	21	Duke Univ.	38
MIT	8	Univ. of Colorado	22	Vanderbilt Univ.	39
Wake Forest Univ.	9	Mount Sinai Sch Med NYU	23	Iowa State Univ.	40
Univ. of WA Res. Found.	10	Univ. of Michigan	24	Wayne State Univ.	41
WARF	11	Univ. of Utah	25	Georgetown Univ.	42
Univ. of Florida	12	Univ. of Georgia	26	Cornell Research Fdn. Inc.	43
Univ. of Rochester	13	Johns Hopkins Univ.	27	Eastern Virginia Med Sch	56
University of Texas System	14	Univ. of Pennsilvanya	28		

Source: AUTM (2010)

It is hardly a surprise that the distribution of incomes from technology transfer is highly asymmetric. After all, it is a well-known fact that the U.S. university

system is characterized by elitism, where resources (endowments, public and private funding or research, tuition fees) are widely asymmetrical (see Figures 7 and 8). For instance, AUTM (2010) reports for 2009 that the 50 universities with the largest research budgets controlled 78% of the system's research funds and 99% of the licensing net operative revenue (NOR)—defined as gross income minus operating costs.[36] Moreover, our top-40 elite commanded 71% of the funding and 79% of licensing NOR.

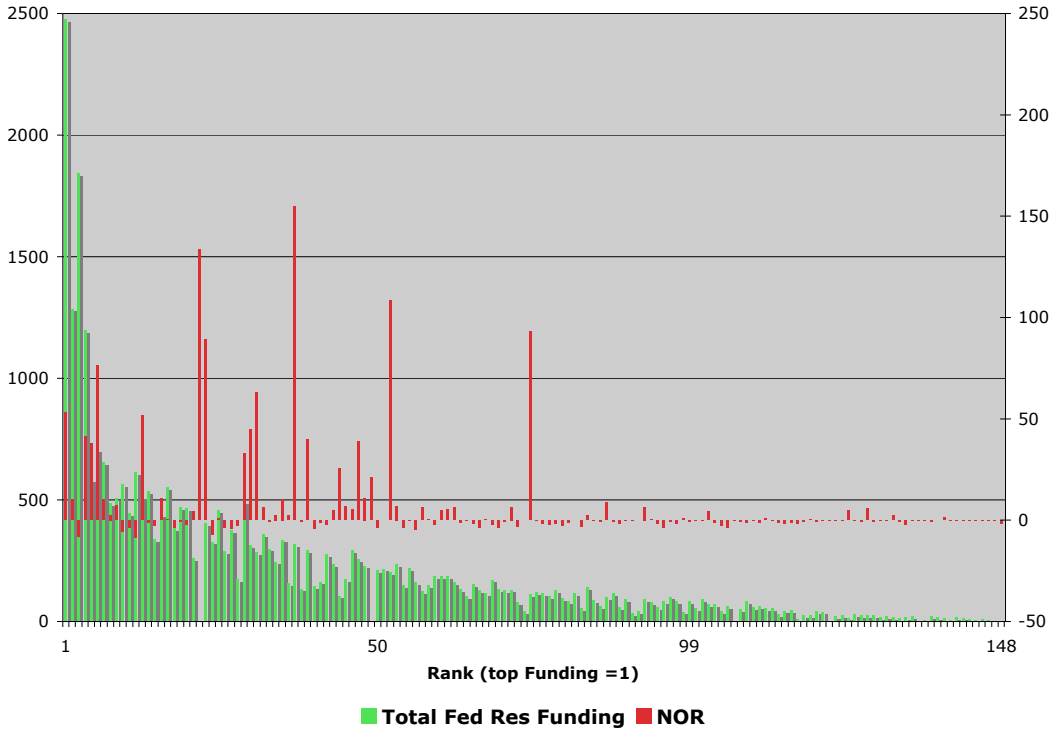
Figure 7. Total research funds and licensing NOR.



Source: My own tabulation with data from AUTM (2010).

[36] My calculations are based on the AUTM 2009 survey (AUTM, 2010). The estimated net operative revenues is calculated here as the Total License Revenue (LIRECD) minus Non-reimbursed Legal Fees (EXPLGF-REIMLG) minus Estimated Operational Expenses. This last variable is a conservative estimate of operational expenses assuming only $100k per full time employee (LICFTE) $75K for other FTE (OTHFTE) and $30k per patent application (NPTAPP). Acronyms in small-capitals are the variables in the AUTM survey database.

Figure 8. Federal research funds and licensing NOR.



Source: My own tabulation with data from AUTM (2010).

To put in perspective the asymmetry in the distribution of university resources, and particularly licensing income, I calculated Gini coefficients—a standard measure of unequal distribution with a value-range from 0 to 1, where 0 is a perfectly even distribution and 1 is absolute inequality. Household income in the U.S. had a Gini of 0.47 in 2008 (Census Bureau, 2009). The U.S. is known to be a highly asymmetric country when compared with other rich economies. The United Nations' Human Development Report ranks the U.S. 77 in income equality that compares poorly against the more egalitarian Scandinavian countries that have Gini values around 0.25 (specifically, Denmark, Sweden, and Norway; UNDP, 2009). Universities are indeed very asymmetric, with Gini indices for research budgets at 0.58, federal research budgets at 0.60, and a very unequal distribution of licensing

income at 0.88. These distributions compare with household income of some the poorest countries in the world, specifically South Africa with a Gini of 0.58 and Haiti with 0.60 (ranked 134 and 138 among 141 for which Gini is available) (UNDP, 2009).

The distribution of licensing revenues is skewed to such an extent that most universities outside of the elite are functioning at an operational loss. Using information on legal expenses and employees from the AUTM survey (2010), I estimated net operating revenue (NOR) as defined above. As many as 61% of universities did not generate enough licensing income in 2009 to cover the wages of their technology transfer staff and the legal costs for the patents they filed. On average, 62% of OTTs have lost money each year since 1993, just to keep the office open.

One interpretation for the low licensing income (and negative NOR) of the majority of universities is that they give most licenses at minimal or at no charge to the developing firms; thus promoting not only innovation but also equity. There is, however, some evidence that universities that began patenting after Bayh-Dole was enacted, did so a bit too eagerly without discriminating carefully between high and low quality patents (Mowery, Sampat, Ziedonis, 2002) while more experienced universities patented only high quality inventions. Accordingly, low incomes correspond to low quality patents because they have little if any commercial value.

Still, even having high quality patents, some universities may have a culture of philanthropy and license them free of charge (or at cost). But there are indications that firms rely increasingly on patents even in sectors not traditionally reliant of them (Hall and Ziodenis, 2001), and as discussed in Chapter 2, OTTs are primarily

concerned with generating revenues (Thursby and Thursby, 2002). This systematic behavior across the board of OTTs resides in organizational isomorphism, which itself is explained by the fast diffusion of practices and attitudes towards patenting within the community of technology transfer professionals—for which AUTM is to be given credit. It is thus plausible to assume that a majority of universities invest resources in technology transfer activities, but cannot derive significant revenues from them.

In fact, of the 149 universities who responded to the AUTM 2009 survey (AUTM, 2010), 91 could not even cover operational costs and another 20 did not generate enough licensing income to recover as little as 1% of their research budget for that year, only 38 generated income above 1%, 20 above 5%, and as few as 10 made more than 10% of their total research expenditures. This picture speaks to the well-known fact that licensing revenue is significant only in the exceptional circumstance of landing a discovery of tremendous commercial value; what in the jargon of the field is referred to as a "blockbuster" patent.

Emblematic of these exceptional patents are the gene splicing method of the Cohen-Boyer patents—that yielded near $255 million for Stanford University and UCSF during the life of the patent—and the Axel patents for co-transformation, a method to insert DNA into eukaryotic cells, from which Columbia University collected $790 million in licensing fees (Colaianni and Cook-Deegan, 2009). Further examples include the cancer treatments Taxol (Florida State U.) and Cisplatin (Michigan State U.), the vaccine for Hepatitis-B (UCSF), the antiretroviral Zerit (Yale U.), and the treatments for glaucoma Xalatan (Columbia U.) and Trusopt (Michigan State U.). The lucky universities that owned these patents derived significant

revenues for their universities, between $15 and $45 millions per year—and the products rendered handsome profits for the firms that commercialized them, namely, Merck, Bristol-Myers Squibb, Pharmacia & Upjohn—now GE Healthcare (Eisenstein and Resnick, 2001). So rare are these kind of patents that university administrators must feel like winning a lottery when their faculty discover such a commercial invention.

Going a little further with the simile that research is like a lottery and a blockbuster patent like the jackpot, one would be tempted to say that all universities play but only elite universities get to win. I estimated the probability of such a lottery modeling that success in discovering a blockbuster as a function of research funds, and found that indeed the chances drop dramatically beyond the top ten universities in research funding, at the total and federal levels. While the tenth university has a 26% chance of landing a blockbuster patent in a given year (not bad for a lottery), the 40th has 13%, and the 100th just 8% (see Table 3).[37]

Spite the probability of a blockbuster being disproportionately high for elite universities, small universities still have a reasonable chance of winning (the 149th in resources has more than 6.2% chance). If this research-as-lottery simile is actually used by universities to calculate their engagement in technology transfer, many of them would indeed be willing to invest in the necessary administrative capacity.

[37] In this model, each annual draw is an independent lottery from previous years, hence the probability does not compound year after year. A more sophisticated model could involve a stochastic process where landing a blockbuster patent is an certain event in the future and each year of failure increases the probability year after year, or where the probability is actualized by licensing incomes of the previous year added to a stable stream of research funds, and thus the probability falls every year a blockbuster patent is not discovered.

Table 3. Probability of blockbuster patent as a function of Research Funds.

Rank According to Research Funds	Probablity of NOR≥10m: As a function of total research funds (TRF)	As a function of federal research funds (FRF)
3	48.0%	56.4%
10	25.7%	24.6%
20	20.4%	20.7%
30	15.9%	15.2%
40	12.9%	10.6%
50	11.7%	12.3%
100	7.7%	8.5%
149	6.2%	7.4%

Estimated using a PROBIT model: Regression on success/failure of blockbuster patent (NOR≥$10m) over TRF (intercept -1.534409, slope 0.001079) and over FRF (intercept -1.444591, slope 0.001340); all estimated coefficients are statistically significant at p=.05. Data Source: AUTM, 2010.

Still, research is not quite like a lottery, and although some element of good fortune attends to a momentous discovery, a university administration may be able to influence its chances by directing its research efforts, laboratories, faculty, and students to the pursuit of lucrative patents. A university may adjust the composition of its research portfolio as some fields are more likely to produce a blockbuster patent than others (particularly biotechnology); it may enter into agreements with large companies interested in outsourcing their R&D in exchange for rights to the resulting IP; and a university may also introduce organizational incentives for faculty by attaching patenting to promotion and compensation. Such agreement and reforms, whenever adopted, have met resistance from university faculty members, student movements, and other advocates of humanitarian causes (Winickoff, 2010). The organizational changes, particularly regarding incentives, may reasonably be expected to change the culture and orientation of researchers. However, as reviewed in Chapter 2, the evidence of such changes is yet to be observed. University grant-

for-IP, deals which are increasingly common particularly at elite universities, have also come under scrutiny and criticism (see examples in Greenberg, 2007; Mirowski and Sent, 2002; Washburn, 2005). Committing future IP in the bargain is specially controversial (NRC, 2010), as exemplified by the controversy around the $500 million deal between UC Berkeley and BP (Dalton, 2007).

Universities are adapting to this threat to their reputation and have developed alternative strategies to manage their IP without attracting strong resistance to commercial activities and university-industry partnerships (Debackere and Veugelers, 2005). As I pointed out in Chapter 3 (discussing transparency), the offices of technology transfer that are placed at a distance from the central university organization— established as affiliate units or even as separate legal entities—can be managed more like businesses than academic units. With more room to maneuver, OTTs can be more than simply licensing agents, and can now provide a wider array of services to the firms taking licenses. Because university patents are generally prototypes that need much work and investment to become commercial applications (Jensen and Thursby, 2001), it is likely that only a small group of people, including the inventor, will understand the potential uses and applications of the patents. It is there where OTTs have spotted a business opportunity because they can provide services to faculty-inventors who want to pursue their ideas into commercial products but have little experience in starting up a firm. By "nurturing start-ups," OTT's can add the most economic value to an invention disclosure.

The scope of services that an OTT may provide can be as broad as to juxtapose with services typically associated with firm incubators (Mian, 1994; 1996; Phillips, 2002). For a start, in addition to the traditional legal council in patent

application, the OTT will provide legal assistance in building and managing the company's IP portfolio, arranging for licenses from owners of prior patented art. Also, the OTT may advise in the legal constitution of the firm, particularly regarding the terms of use of university facilities (such as leasing of equipment) and the terms of employment for faculty-inventors. Partnering with the university incubator, if this exists, the OTT may assist in hiring the managerial team for the firm, and for an initial period it may provide for office space and administrative support. Another service will be networking, as a university may connect start-up firm executives with private investors, institutional investors, market analysts, marketing consultants, and the networks of entrepreneurial support. Likewise, an experienced technology transfer team may help the start-ups in attracting and negotiating capital influxes, first with angel capitalists, and later with corporate officers, venture capitalists and investment bankers.

There are advantages and disadvantages from the nurturing start-ups model over the model of simply licensing the university's IP. One is that the energies of the OTT will not be spent finding a market for the university patent portfolio, its own start-ups are ready to take up licenses; in turn, considerable efforts will be directed to finding a buyer of the start-up firm. In addition, inflow of incomes is deferred for the university—because instead of cash fees it takes stock in the new company (or stock options)—while the costs of nurturing a start-up are immediate, which may impact the cash flow of the university unless a portion of revenues is provisioned to finance these operations.

Still, the costs for the OTT will not be significant compared to "angel capitalist"—private investors that may include family and friends of the inventors—

who bear the brunt of financing initial operations. Another advantage for the university is that this strategy is likely to be perceived by its constituencies as a positive effort to foster entrepreneurship, to attract high-tech industries to the university's region, and to contribute to economic growth and job creation. These favorable perceptions stand in stark contrast with the perceived excesses in university licensing—excesses related to aggressive negotiation and "creative clauses" (the reach-through provisions discussed in Chapter 2). The strategy of nurturing start-ups poses a greater financial risk to the university compared to a more traditional licensing-only business model, but it also lessens the reputational risk associated with commercial activities of the university. At the same time, the university can expect higher returns from its shares and options in a successful start-up and it retains a degree of control over that outcome.

Considering these arguments, many universities will find that advantages outweigh the disadvantages, and those universities will surely adopt the nurturing start-ups model. It is too early to test weather this model will be successful for all universities—for instance, data from the AUTM survey on stock and options goes back only as far as 2000 (AUTM, 2010)—but it is not unrealistic to expect that it will become increasingly popular among OTTs. The potential of the nurturing start-ups model to expand the scope of university technology transfer is sufficient reason to consider its distributive consequences.

4.3 From industrial organization to university politics.

Here my argument moves to the second level of actors, the firms that apply and develop university patents. The link in the argument is the proposition that the

new business model of university technology transfer, the nurturing start-ups model, will have an impact on the industrial organization of high-tech companies and this, in turn, is an important determinant of the distribution of the economic benefits from innovation.

To demonstrate this proposition I will enlist the Schumpeterian notion of "creative destruction" that explains both the long-term growth of productivity and the distribution of rents in capitalist economies (Schumpeter,1989|1939; 1994|1954; a review in Metcalfe, 1998). Economic history, observed Schumpeter (1994|1954), is marked by long waves of acceleration and deceleration of economic activity (cycles longer than regular business cycles) due to shifts in the technological platform of the productive system, such as the electric dynamo or the microprocessor. While emerging economic sectors harness the new technology they begin to displace the old sector in economic importance; during the transition the overall productivity of the economy falls because the productive factors must be retrained (labor) and retooled (physical capital) to fit the new technological platform. Productivity picks up only after a critical mass of adopters begin to exploit economies of scale of the new technology (see complete formulations in Hall and Rosenberg, 2010 and Magnusson, 1993).

Two aspects of creative destruction are relevant here. The first is the role of destruction in the creative process of innovation; destruction is observed in every cycle of innovation as a new cohort of firms rise and an old cohort, unable to adapt to the new technological platform, perish. The second aspect follows from the first; innovation works also as a mechanism for reallocation of income and wealth. As new cohorts of firms wrestle markets from old cohorts, productive assets change hands,

and with the control of assets, rents and wealth change hands too. Innovation gives the edge that new firms need to succeed in competition with old firms, and by means of competition, the distribution of income and wealth is reshuffled, at least across firm cohorts. Creative destruction may also have an immediate effect on distribution by promoting competition not only across firm-cohorts but also within them, as competition drives prices down in final and intermediate product markets. The longer-term effect on distribution is ambiguous, because the new economic structure may inject dynamism into marginal economic sectors, or conversely, the new technological platform may exclude some economic groups—if it were to emerge localized within a geographic area or favoring a type of factor of production. In fact, a standard hypothesis for the growing income inequality is that technical change brought about by information and communication technologies has been skill-biased (see Acemoglu, 1998; and Saint-Paul 2008).

These two considerations make it clear that creative destruction relies on competition, and that without competition there is no destruction of old firms. Conceivably, innovation may take place without competition—if incumbent firms could block new entrants by investing themselves in R&D or buying out firms that threaten their market power—but the distributive effect of innovation is lost. Innovation without competition is creative destruction without destruction. Historian Alfred Chandler (2001; 2005) has shown that for important technological revolutions—including the chemical industry, electric power, and more recently, information and communication technologies—the stylized characterization of Schumpeter has only partially being realized, for new firms do emerge in the lead of new industry but they do not fully displace the old industries; rather, they just carve

in a space for themselves in the economy. Schumpetrian destruction does happen but is never complete; as leading firms consolidate their position at the core and firms in a nexus of support consolidate in the periphery, the structure of the new industry becomes stabilized in very long-run (Chandler, 1990). The history told by Chandler is all the more relevant to the Schumpeterian explanation because it demonstrates that each new technological platform does not fully reshuffle the ownership of productive assets and thus explains the secular trend in the concentration of economic power; every technological revolution adds only a few hands at the top. Innovation is indeed suspect for the rising income inequality of the last three decades (Acemoglu, 1998; Acemoglu, Aghion and Violante, 2001; Autor, Katz, and Krueger. 1998). Furthermore, detractors of creative destruction, mainly from neoclassical economics, use the assumption that monopolistic profits are the source of R&D investments and explain innovation as phenomena endogenous to the economic system (for a review see Valdivia, 2010). These models however have failed to explain the accompanying rise in income and wealth inequality, precisely because the explanation of inequality resides in what they omit, the concentration of economic power.

I revisited creative destruction in order to justify my claim that the manner in which high-tech start-ups emerge had consequences on the distributional character of innovation. Reiterating the central relationships: if start-ups emerged to compete in markets against established firms, creative destruction takes place, successful new firms displace old firms, and economic resources change hands. Conversely, if start-ups are acquired by established firms as soon as they show commercial promise, competition is stymied and with it the reallocative effect of innovation.

There is indeed some evidence supporting this logic. Surveying 118 start-up firms, Gans, Hsu, and Stern (2000) found that "while venture financing is certainly associated with certain 'instances' of creative destruction, the focus by venture capitalists on profit maximization and their ability to reduce the costs of identifying potential partners increases the relative attractiveness of cooperation with more established firms" (p. 31).

To the extent that the OTT model of nurturing start-ups is aligned with the venture capital model, that is, both aim at maximizing the value of the firm, universities are likely to encourage start-ups to accept tender offers from established firms as opposed to seeking independence and consolidating their position as competitors. Furthermore, in markets where incumbents have raised barriers to entry—agreements with suppliers, productive capacity, distribution and marketing networks, or a brand-name—Gans and Stern (2003) show that strong patent protection leads start-ups to collude with established firms. In addition, the prospect of a protracted market battle against an established firm may seem impractical for a cash-starved start-up firm. Passing on a serious offer from an incumbent firm may be very hard indeed for a start-up valued largely by its intangible assets (including its intellectual property).

Aside from the evidence offered by Gans, Hsu and Stern (2000), one may wonder if there is evidence that directly connects Bayh-Dole with the manner in which high-tech start-ups emerged (competing vs. colluding) and with the resulting industrial organization of that new economic sector. In fact, there is such historical evidence in the biotechnology industry, which has benefited greatly from university patenting.

While the biotechnology industry took-off before Bayh-Dole was enacted, it benefit greatly from the liberalization of university patenting in 1980. Biomedical patents have consistently increased their share of total university patents and usually have yielded the highest licensing incomes. For instance, Mowery and Ziedonis (2000, 2002) looked at data from the University of California System and Stanford University where biomedical patents issued to those universities came to represent 60% of their portfolio in the 1984-1988 period. They also found that biomedical patents amount for nearly all the top-5-earners' income for 1990 and 1995, and for a substantial portion of their licensing income—66% in the UC System, 83% in Stanford University, and 85% in Columbia University.

It is commonly believed that start-up firms championed the emergence of the biotechnology industry and while young companies had an important role, the role of big established firms in the pharmaceutical industry should not be underplayed. Chandler (2005) chronicles how pharmaceutical giants Eli Lilly, Merck, Schering-Plough, and Ciba-Geigy led entry and key initial investments in biotechnology. Chandler documents a hundred start-ups that developed the "nexus" of support for the companies at the "core" of the industry, but among those with ambitions to operate at the core, only two succeeded independently (Amgen and Genzyme), while the vast majority eventually surrendered control to incumbents. Among the notable cases, Genentech and Chiron, while technically successful needed the financial assistance that came from their acquisition by Roche and Ciba-Geigy respectively. Likewise, Genetics Institute and Immunex were acquired by American Home Products, Centocor by Eli Lilly, and Biogen entered into partnership with Merck.

Bayh-Dole did facilitate the emergence of biotechnology, and a consequence of this policy is the large number of start-up firms that sought to establish themselves as independent players in this industry. However, the story takes the turn predicted by Gans and Stern (2003), as nearly all those start-ups ended up reinforcing the position of established firms in the industry as opposed to presenting real competition.

I should clarify that I am not attributing to Bayh-Dole the current market structure of the biotechnology industry. Rather, I have recalled the history of this industry to illustrate the potential for Bayh-Dole to curb distributional outcomes from innovation. Universities and the standard licensing model of the last three decades facilitated the emergence of biotech start-ups and these new firms eventually reinforced the market power of core companies in the pharmaceutical industry. If the new model of nurturing start-ups takes hold, OTTs will push start-ups further into that direction; that is, in the direction of colluding to established firms rather than standing up to compete. Bayh-Dole cannot be made responsible for the industrial organization of the new economic sectors, but to the light of this analysis future amendments to this policy should consider how best to foster competition. With greater competition, the ownership of productive assets in the economy would be reorganized to some extent and this should increase the distribution of economic benefits from innovation.

I suggested in the introduction to make Bayh-Dole an instrument for the democratization of technology transfer, and this implies not only to rethink this policy in terms of the allocation of economic resources (as I just did) but also with respect to the allocation of political resources. I want to add this dimension, if only

briefly, because it complements the foregoing discussion. A caveat is in order here. I focus on the political organization of university interests because they are the implementers of Bayh-Dole. The political dynamics that involve the other relevant actors, firms and citizens, often involve political forces and relations in which patent policy and technology transfer is but a modest concern. However, of the broad range of industrial interests represented in political action, the ones that speak directly to Bayh-Dole lie precisely in their negotiation of agreements and patent licenses with universities. Likewise, citizens as consumers lack organized political representation, and as political persons they delegate much of the decisions about new technologies to private enterprise; but they do take political action relevant to Bayh-Dole as various constituencies of the university. Consequently, focusing on the political dynamics of the university system is indirectly relevant to firms and citizens as well.

I showed above that the gains from technology transfer that universities derive are strongly related to their economic resources, and that the distribution of these resources is consistent with the well-known fact that the university system is elitist. It would seem, then, reasonable to expect that the majority of universities with modest research funding take an interest in shaping Bayh-Dole such that the incomes from licensing are not distributed as unequally as federal research funds. However, universities as a group have lent support to the Act and have not even hinted at reforms to increase participation of small universities in technology patents.

Is this owed to the fact that elite universities control political representation of the university system? That may be the case to some extent. Consider for instance the Association of American Universities (AAU), arguably the most influential of all university associations: Founded in 1900, AAU is an invitation-only association

composed by 61 of the wealthiest universities. Presidents of the AAU are regularly invited to Congressional hearings to represent the view and interests of the university system; unmistakably, they show strong support of Bayh-Dole (Slaughter, 1993)—even at times suggesting that no reforms are necessary to the law but only to practices and coordination. However, the solid support of the university system cannot be attributed entirely to the fact that the voices of elite universities are the ones policymakers are listening to more often. Other organizations, such as the American Council of Education, are much more plural in their composition, but have equally portrayed the position of universities as unanimously favorable towards Bayh-Dole (Slaughter, 1993; Slaughter and Rhoades, 2004). This may suggest two forces at play. One, that the leadership of university associations follows the lead of the elite echoing its influential voice, and the second, that it may cast the interests of its political base in the language and values that are prevalent in policy circles (Slaughter, 1990). For instance, as I discussed in Chapter 3, the ascendancy of neoliberalism may require universities to articulate their interests in terms of support for stronger patent protection and deregulation of monopolies.

Also, Berman (2008) shows that universities were organized to support the passing of Bayh-Dole in Congress, and the organizer's views became *de facto* the group's discourse. In the 1970s the organizers were government officials and bureaucrats (Berman, 2008; Stevens, 2004), but the organization that was founded then, the Association of University Technology Managers (AUTM), is today the one that coalesces university support for Bayh-Dole. This association promotes the role of technology transfer professionals and informs various constituencies—policy makers, technology entrepreneurs, policy analysts—about the positive impacts of

university technology transfer. The leadership of AUTM is generally composed of executives from profitable OTTs; and once again, the views of the leadership is portrayed as the views of all universities.

Consequently, the political dynamics of the university system allocate voice unequally among its members, and this is particularly true in the advocacy of Bayh-Dole. Most small universities do not want to dismantle the Act, but they may want to amend it to create more opportunity for all universities to benefit from it, not only the elite. Their cause has a slim chance to surface in university political discourse. The internal dynamics of the university system will unlikely lead to forging a consensus on reforms to democratize technology transfer; instead, the dynamics will give way to other organic forms of reform—such as the emergence of the nurturing start-ups model—that may not necessarily benefit equally all universities and that carry the larger consequences on the distributive effects of innovation that I described above.

I have discussed thus far the dynamics of allocation of political and economic recourses in the university system in relation to Bayh-Dole. I have also invoked creative destruction as an explanatory device to relate the new business model of OTTs with industrial organization and this with the distributive character of innovation. I have done all that self-consciously taking the university system as my focal point. However, if the focal point is more general, such as the economy as a whole, the discussion of distribution in technology transfer will invoke more general arguments on the distributive effects of the research and innovation processes as a whole. To complement my university-centered explanation, I now turn my attention to those more general arguments.

4.4 The distributive myths of research and innovation.

I would like to be explicit about my aims in this section. At first glance, Bayh-Dole reallocates resources in the same fashion as a subsidy, transferring monies from general taxation to universities, or taking a longer view, from taxation to technology developers.[38]

I will probe this intuition more formally by testing if the policy fits the concept of distributive policy.[39] Second, the Act was intended to streamline innovation by privatizing public patents and was built to connect government funding of research (research policy) and patent protection (innovation policy). To understand the distributive character of Bayh-Dole it is then necessary to review the standard arguments that justify public support of research and innovation, in the distributive sense. In the process of reviewing those arguments I tackle some regular myths about the distributive character of research and innovation.

My argument in this section is highly deductive. In contrast with the foregoing discussion, there is not much empirical evidence to draw from and relational hypotheses are consequently much harder to suggest. This is because (i) the relevant empirically observable effects cannot be attributed directly to Bayh-Dole, but to a host of reforms including court rulings, and (ii) in two of the three mechanisms of distribution that I identified (spillovers and wealth creation),

[38] The transfer of monies has two elements. The traditional effective cash-flow—the current period funds granted to government research contractors—and an additional element of future cash-flows—the yet unrealized licensing incomes or profits that the government would have kept had it kept rights to its patents and negotiated similar licensing terms.

[39] Distributive and redistributive policies reallocate resources, but the former does target a group as in the case of a subsidy or a tariff, and the latter targets the entire population as in the case of monetary policy or the income tax. This distinction was standardized by Lowi's *Four systems of policy* paper (1972).

empirical hypotheses concern primarily how innovation creates growth and how growth trickles down, and both concerns are outside the scope of this study.

4.4.1 Research funding and patent protection as distributive policies.

Public funding of research reallocates resources between groups, specifically from taxpayers to research contractors. Why should taxpayers support the livelihood of researchers and their expensive activities? The traditional response is that investments in research, given sufficient time, have been a boon for society.

The argument for public support for research, at least since the famous *Endless Frontier* report (Bush, 1945) is that free markets would not provide a level of research activity, particularly of basic research, that meets social expectations of economic growth, national security, public health, etc. This leads to the first myth in the distribution of benefits from research:

P1. Research produces a public good: new knowledge. Once new scientific knowledge is placed in the public domain it is evenly distributed among all who are able and willing to use it. The open use of new scientific knowledge is the driver of economic growth, and is critical to national security, public health and overall quality of life.

The public good argument is at best suspect. Callon and Bowker (1994) have persuasively argued that scientific knowledge is not a public good. One reason is in the significant costs of learning new knowledge already produced. Compare highly technical knowledge with national security, the canonical example of a pure public good. One of the characteristics of national security is that the enjoyment of the protection that a single citizen receives from the state does not require that individual

to pay additional costs in proportion of its consumption (additional to having paid taxes)—in economic lingo, the marginal cost is zero. In contrast, the individual who wants to understand advanced technical knowledge must invest enormous effort in time and resources to do so. And going from learning to application of technical knowledge only raises the costs. Application demands from firms "absorptive capacity," (Cohen and Levinthal, 1990) or the productive capacity and the knowledge base to adapt an invention effectively into an existing production process.

Patent protection is also distributive, because when it creates a monopoly from an invention, it reallocates resources between groups, specifically from the consumers to the monopolist. To understand the distributive effect of patents, a good starting point is to recall the allocative distortions of monopolies. Compared to competitive markets, monopolies sell less and at higher prices because their market power allows them to capture profit from the consumer surplus of those consumers willing to pay the monopolist price. What is more, monopolies also create deadweight loss, which is the vanishing surplus (for consumer and producer) at prices below the monopolist price (a review in Housman, 1981).

The distributive character of patent protection is perhaps less obvious than that of public funding of research, but the reallocation of resources it produces is generally justified by two other myths:

P2. Patents are a necessary incentive for innovation. That patents are a necessity for firms to take the risks of large investments in technology development (see Mazzeloni and Nelson, 1998—third patent theory) may be true for some firms and in some circumstances, but it is hardly an unqualified truth. In fact, two influential studies on the role of patents in U.S. manufactures—known as the Yale

survey (Levin et al., 1987) and the Carnegie Mellon survey (Cohen, Nelson, and Walsh, 2000; 2002)—have found that firms in most manufacturing sectors do not consider patents as an important instrument to secure returns for their R&D investments. Given that those surveys focused on established firms, it remains possible that patents are truly important for start-up firms, because, without that protection, large firms could more easily copy the new products and force emerging firms out of business. The point remains inconclusive, but this seems unproblematic to a good many policy-makers who hold as an article of faith that patents are necessary for innovation.

P3. The benefits of innovation trickle down to all social strata. This premise is explained in a number of ways. One way is by consumption: the wealthiest constantly upgrade their consumption to the highest quality available, that is they buy today's innovations, pushing down yesterday's innovations to the next level in the economic latter. Insofar as new products keep appearing a top, everyone will keep upgrading their consumption. A second way to explain the trickle down effect is in reference to "wealth creation," that is, new industries induce economic dynamism to old industries resulting in growth of the aggregate economy. Recall the discussion in the previous chapter—political discourse of innovation links in a logical chain innovation to economic growth to competitiveness—as a result innovation is generally taken as a social goal of consensus. Yet believing that new wealth is necessarily distributed fairly betrays a conviction in "trickle down economics" which, as an economic theory, is far from consensual (Thornton, Agnello and Link, 1978; Arndt, 1983, c.f. Aghion and Bolton, 1997). Still, a third common explanation for the trickle is related to "spillover effects." Innovation spawns further innovation in the

input and intermediate goods sector, particularly in labor (see review in Feldman, 1999). The successful introduction of a new product into the market also creates incentives for further innovation, in the processes of production at scale, commercialization, and distribution. Furthermore, patent protection forces potential competition to try alternative technical avenues. Also, patents enable profits, and these allow firms to re-invest profits in further R&D.

Because the distributional power of spillovers resides in the multiplication of innovation itself, and innovation as a source of wealth creation explains better how the economic pie is made larger than how the pie is divided, the first mechanism—distribution by consumption—seems to capture more aptly the immediate distributive effect of patents. This effect, as explained above is a reallocation from consumer's surplus to monopolist's profit.

Yet, this reallocation is believed to be temporary because patent protection lapses in 20 years from the date of filing. This notion follows from a fourth myth:

P4. The expiration of the patent opens the relevant market to competition.

There are reasons to doubt the generality of this premise because, as I explain later in more detail, the profitability of a firm depends on its ability to retain market power, and a successful firm will use the initial advantage of a patent to develop capabilities that work as barriers to entry beyond the patent expiration.

These four premises (summarized in Table 4) have been the basis for standard argumentation to justify funding of research and patent protection from a distributive perspective. Yet, how exactly does Bayh-Dole bring together the distributive elements of these policies?

Table 4. Four premises: distribution of benefits from research and patents protection.
P1. Research produces a public good: new knowledge P2. Patents are a necessary incentive for innovation P3. The benefits of innovation trickle down to all social strata P4. The expiration of the patent opens the market to competition.

4.4.2 Bayh-Dole as a distributive policy.

The architects of Bayh-Dole thought that public research was underutilized and that the public investment in research was not realizing its promise. It was believed at that time that patents owned by the government (public patents) remained undeveloped by the private sector due to the lack of economic incentives for development. The Bayh-Dole solution was simple; it "privatized" public patents. In doing so, however, Bayh-Dole restructured the distributive mechanisms of public research and exacerbated those of patent protection.

Before the Act, universities patenting was much less frequent and this lent some credence to the belief that university research was in fact a public good (Dasgupta and David, 1994). Since Bayh-Dole however, it was not only permitted but also encouraged to turn new knowledge into a private good, particularly when it has a potential application. Bayh-Dole thus forced an analytical distinction between the activity of research and the product of research, in order to keep the former (the activity) conceptualized as a public good (P1) supported by government, and to be able to convert the latter (the output) into a private good, a patent.

The privatized patents are expected to accelerate innovation (P2) and innovation is expected, at the macro-level, to create new wealth that trickles down the economy (P3). In turn, at the micro level, it will work by creating monopolies in markets for new products that are based on public patents. Studying how new wealth spreads is outside the scope of this study. Rather, to shed some light into the distributive character of Bayh-Dole I prefer to focus on the distributive effects of monopolies that can be traced back to privatized public patents: the distributive effect of reallocating consumer benefits into profits.[40] The reasoning is straightforward: the concentration of consumption benefits (consumer surplus) is the highest in a monopolistic market structure. If a patent could be developed in a competitive environment, that is, if an exclusive license is not a necessary incentive for innovation, Bayh-Dole artificially creates a monopoly. The reallocation of resources, inherent to patents, is exacerbated by Bayh-Dole's liberal policy on exclusive licenses because patent-based monopolies reap the fruits of labor that are not uniquely theirs, since they are using publicly funded seed.[41] From this perspective, Bayh-Dole effectively subsidizes entrepreneurs with general taxation.

To put this point in perspective, consider the equivalent of Bayh-Dole in venture capital markets. For a start-up firm, the period between the first influx of

[40] The macro and spillover effects of Bayh-Dole are best understood in the context of all other reforms to the innovation system in the period (1980s and 1990s). Recall, Bayh-Dole was only one piece in a set of reforms to patent policy (Chapter 2), and patent reform was only a province of the institutional change motivated by a neoliberal policy agenda (Chapter 3).

[41] This line of reasoning could be pursued further. Does a patent solve the allocative problem of remunerating fairly all parties whose effort resulted in a useful invention? There is surely an unaccounted and non-negligible amount of effort that society puts into every invention, by means of creating and maintaining institutions that preserve knowledge, to educate the inventor, and to enable him to do his work. It is a genuine question to ask whether patents are remunerating inventors in excess of their value-added, or to ask what other practical mechanism might remunerate, inventor and society, more fairly.

capital (aimed at developing the business concept) and the second influx of capital (aimed at financing growth) is called the "valley of death" because the company may be imperiled by lack of liquidity before it becomes eligible for the second influx. The valley of death occurs because of the asymmetry of information about the project: regardless of the entrepreneurs' optimism, venture capitalists cannot yet determine if the investment is likely profitable. Until the firm is able to produce minimum evidence of future profitability, venture capitalists will be reluctant to assume the financial risk. The same has been said in the Bayh-Dole debates, that firms would be reluctant to assume the financial risk of development without exclusive rights to patents. Bayh-Dole is in this perspective the equivalent of setting up a government fund to help start-ups across the valley of death; it works as a subsidy to reduce the financial risk for entrepreneurs. It should be noted that the Small Business Administration announced, in February 2011, that it will set aside two billion dollars to set up two such funds, one for early stage companies and the other for companies in underserved communities.

The argument that Bayh-Dole works as a subsidy because it allows exclusive licenses and thus sanctions patent-based monopolies must contend with the counterargument that, at the expiration of the patent, the monopoly effectively ends. At that time, competition should more widely distribute the benefits of innovation. I want to take issue with this counterargument because it does not hold in a wide variety of circumstances, and is particularly misleading in the markets being created with university patents.

4.4.3 Monopolies' enduring market power.

Monopolies seek to extend their market power well beyond the life of the patents they own. Market power is the ability of a firm to charge a price above its marginal cost and hence make profit. Market power is divvied up among the firms controlling the market; a monopolist holds complete power, an oligopoly shares less of it, and market power is all but diluted in the case of a fully competitive market. Profits are thus proportional to market power.

The literature of first-mover advantages can help explain how a patent-based monopoly can retain market power in the long run. Firms derive first-mover advantages from pursuing three strategies: leading innovation, appropriation of scarce resources, and costumer switching costs (Lieberman and Montgomery, 1988).[42]

The strategy of investing in innovation has two basic mechanisms, one related to the industry's learning curve and the other through R&D or patent-races. When learning and experience in the production and commercialization of a new product leads to drops in the unit cost as production expands, early investments in acquiring that experience may function as barriers to entry, to the extent that such learning is appropriable and leadership in market share can be maintained. Likewise, when the size of R&D investments or the priority in acquiring a patent can give an advantage, pursuing such strategies is a source of advantage. This is not the case for most industries, because competition finds a way to "invent around" patents (Mansfield, Schwarts, and Wagner, 1981); however, it does apply to the pharmaceutical industry (Levin et al., 1987; Cohen, Nelson, and Walsh, 2000).

[42] This section draws heavily from Lieberman and Montgomery (1988; 1998).

The strategy of appropriating scarce resources is highly applicable in extractive industries, as rights of exploration and exploitation are tied to geography. Retailers may also find it advantageous to set up shop in specific locations ahead of the competition. Also, and particularly relevant to Bayh-Dole, Robinson and Fornell (1985) found that pioneers may appropriate the perception of quality and are thus able to differentiate their product from emerging rival substitutes.

The third strategy refers to the additional costs for competitors of convincing buyers to switch to their product. In the case of low-cost products, costumers who find the first brand satisfactory may have little incentive to re-consider their decision in subsequent purchases. Consumers who acquire expertise on a given product (e.g. MS Office) may find it hard to switch to better alternatives even if those are less expensive (e.g. Open Office). Firms may also attach additional benefits, such as loyalty reward programs, that discourage the use of alternative products. Wernerfelt and Karnani (1987) suggest that switching costs may provide the opportunity to create a reputation for quality of a brand that is then used for a variety of other products. Social psychologists have discussed the common judgment biases that influence the formation of preferences. For instance, Carpenter and Nakamoto (1989) found that consumer preferences may be skewed in favor of products that enter the market first. This is particularly relevant to pharmaceuticals because generics are regularly sold at lower prices and struggle to gain a significant market share.

The four myths described above have dominated justifications of public support of research and innovation on distributive grounds. However, it must not be forgotten that research and innovation policy have been mainly argued in terms of its

impact on productivity, growth and competitiveness (see Chapter 3), and the distribution of economic resources that results form it carries very little weight in the policy debate, much less the distribution of political resources. Not surprisingly, the myths of distribution to have gone largely unchallenged, and I sought in this last section to start the discussion of them.

4.5. Conclusion.

If the aim is to foster innovation and competition at the same time, it could be argued that Bayh-Dole is better suited for industries where an exclusive license is necessary for developing a new product, as is the case of the pharmaceutical industry, and more specifically, biotechnology. At the same time, as I explained above, the advantages that first-movers can derive from exclusive licenses are enduring and will effectively raise barriers to entry and competition. Reforms to Bayh-Dole could then work in these two fronts: by regulating exclusive licenses in order to allow them only when demonstrably necessary, and restricting the tenor of exclusivity in order to allow competition to more quickly position itself in the market fray.

I would like to further emphasize two points I made in this chapter. First, in an important sense Bayh-Dole can be analyzed as a distributive policy because it subsidizes high-technology entrepreneurs, reducing their financial risk and enhancing their first-mover advantages. Moreover, the Act creates the incentive for OTTs to maximize the firm value of start-ups, possibly enhancing the market power of existing monopolies or oligopolies.

Second, the asymmetry of resources allocated to universities seems to reflect the balance of power in university politics. In fact, university associations are

represented by those who stand to gain the most from Bayh-Dole, and consequently, they speak for the entire university system as though each an every member offer unconditional support to the *status quo*.

Both findings could be useful to organize stakeholders that currently lack representation in the Bayh-Dole debate. On the one hand, organizing consumers in the markets based on public patents may increase pressure for monopolies to relinquish some of their market power, expanding in this way the benefits of innovation through consumption. On the other, non-elite universities could use their good standing among their peers to institutionalize cooperation. I am not only referring to research collaborations between elite and non-elite research universities, but also to other forms of cooperation such as sharing materials and databases. Take for instance Agbio that has had a measure of success forming a patent pool for biotechnology patents for agriculture; in fact, patent pools are a promising way to foster collaboration and competition and future reforms to Bayh-Dole should consider enabling and facilitating them (see Winickoff, 2006). Under collaboration agreements, non-elite universities would acquire access to some of the resources of elite universities, while mutually benefiting from the collaboration. Under such university collaborations, not only a better allocation of resources will be achieved, but also synergies in research may be experienced.

Chapter 5

IMPLICATIONS FOR POLICY EVALUATION

5. 1 Introduction.

The preceding chapters exposed a blind spot in the evaluation studies of Bayh-Dole; to wit, the systematic neglect of several important public values. Chapter 3 described some of those values left out of the analysis and Chapter 4 dealt in more detail with equity. In this chapter I ask: Why is the neglect systematic? I have thus far chronicled some of the circumstances for such an oversight in the evaluation of Bayh-Dole; namely, the ascendancy of neoliberal ideas in U.S. policy-making and the structural asymmetry of political power in the university system. I now turn to a more general reason, one located in the philosophical underpinnings of policy evaluation as a methodology and as a set of practices.

The following discussion is motivated by a practical problem: the decline of public trust in government. Political scientists have identified this problem since the early 1970s using half a century of electoral survey data that included the question: "How much of the time do you think you can trust the government in Washington to do what is right?"[43] (Alford, 2001; Citrin, 1974; Lipset and Schneier 1983, 1987; Miller, 1974; Nye, Zelikow, and King, 1997). The many putative causes for the public's decline of confidence include heightened social tensions (e.g. around civil rights), domestic economic problems (e.g. unemployment, unmanageable fiscal

[43] This question is from the American National Election Studies (ANES) produced by the Center for Political Studies and distributed by the Inter-University Consortium for Political and Social Research at the University of Michigan. Other questions in ANES are also used to compute the American Political Trust Index which does not differ from the specific question on trust mentioned above.

deficits, and competitiveness crisis), widening of economic disadvantage (Bartels, 2008), or eroding national prestige (e.g. the apparent loss of U.S. clout in international affairs) (Nye, 2004a; 2004b, 2010), as well as incidents of political scandal (Watergate marked the beginning of the decline) and publicized failures of leadership and responsiveness (e.g. mismanagement of natural disasters like Katrina, or threats to national security). These disappointing realities are not by themselves the source of distrust because disillusion results from our perception of reality falling short of our normative expectations. The lack of trust in government is thus born from contrasting those perceived realities against notions of what government ought to be doing; which is why people in both ideological positions of U.S. politics are loosing their confidence, the government does either too much or not enough (see Figure 2.8 in Alford, 2001). It is then important to recognize that the problem of public trust in government depends on the ways in which people form normative views of government, and the extent to which they causally attribute specific aspects of their perceived reality to government. Therefore, not only contemporary events of political and social life have driven the citizens' confidence in government down, but also the ways in which normative expectations about government are formed, ways that in many respects are governed by a "consequentialism morality" and guided by "instrumental reason."

This is the first link between the motivation and the problem of this inquiry. Instrumental reason is implicated as much in the decline of the public trust in government as it is in the foibles of conventional policy evaluation. The former point has been argued famously by Max Horkheimer (2004|1974) and elaborated further by the Frankfurt School to what amounts to a critique of "consequentialism"

(Horkheimer and Adorno, 1972; Marcuse, 1968; and second generation Habermas 1975, 1984, 1987). My goal here is to argue the latter point, that is, to examine deductively the limitations imposed by instrumental reason on the discipline of evaluation in light of the democratic commitments of this discipline. My formulation takes issue with the moral theory of consequentialism which is enabled by instrumental reason.

A second manner in which the parallel problems of trust in government and incomplete policy evaluation are connected is the citizenry's exclusion from the policy making process. Over the last four decades we have seen a public confidence in government drop, but we have also seen increasing civic mobilization and activisms to include the lay public input in policy decisions (Inglehart, 2001), including areas traditionally insular from lay opinion such as those involving highly technical expertise. Notable examples are nuclear power (Kasperson et al. 2008), ecological degradation (Hajer, 1995), and biotechnology in the food supply (Winickoff et al., 2005) where groups of organized citizens have increasingly demanded greater inclusion in bureaucratic regulation and legislative policy-making. In response to this situation, government has sought to increase spaces for wider participation in the policy making process (Kettl, 2000; Pollit and Bouckaert, 2004) and scholars have turned more eyes to public participation and engagement (Skocpol and Fiorina, 2000; Verba, Schlozman, and Brady, 1995; see reviews in Carpini, Cook, and Jacobs, 2004 and Lowndes, Pratchett, and Stoker 2001a; 2001b). Policy evaluation has not been impervious to this evolution in political relations. In fact, evaluators have begun to see their role in organizational learning as derivative from their principal concern with organizational outcomes (Fleischer and Christie, 2009)

which may in part be a response to previous calls for involving stakeholders early and often in the evaluation process (e.g. Reineke, 1991). Nevertheless, I argue that these efforts will not be sufficient to correct the neglect of key public values in evaluation if the discipline does not revisit its own commitments to democracy. The problem resides in conceiving of policy analysis as an extra-political enterprise. When politics is brought back into our conception of policy analysis, the questions of political representation and legitimacy re-appear. To address these questions I draw from two theorists (Brown, 2009; Catlaw, 2007) who reformulate representation and legitimacy in relation to democracy, expertise, and the bureaucracy, and deploy their proposals to the case of policy evaluation.

My argument proceeds in the following manner. In a deductive fashion, I first elucidate the problem of policy evaluation in relation to consequentialism. Then I introduce specific formulations of "representation" and "legitimacy" to re-conceive the methodology of policy evaluation.

5.2 Consequentialism and policy evaluation.

Policy evaluation, for all its sophistication, remains underdeveloped in important areas. Conventional evaluation provides tools to measure the impacts of public programs and policies but it does not give any criteria to evaluate the value of those impacts. Short of the latter, policy evaluation is only a dull scale that tells us if we have more or less, but not if collectively we are better or worse. My aim with the observations that follow is to make a case for expanding the scope of policy evaluation and pathway for developing the necessary methodology.

The so-called "evaluation problem" is the problem of measuring policy impacts. The policy impact is the effect a policy treatment has on a social unit or entity such as a nation-state, an organization, an individual, etc. However, no entity can experience two states, treatment and no treatment, at the same time; hence, the problem is to infer its counterfactual state.[44] Policy evaluation methods have focused therefore on the production of counterfactuals and the attending problems, including the unit-homogeneity assumption necessary for statistical inference, the ceteris paribus assumption needed to preclude misattribution of causality, and the effect-stability assumption that informs future public action (for reviews see Heckman, 2007; 2001; Weiss, 1998).

It is tautological to say that consequences matter; hence, the methodological focus of policy evaluation on consequences is self-evident and justified. However, it is also tautological that evaluation encompasses the assessment of value of the consequences of policies. In general, evaluations have taken two strategies to deal with the latter normative question: either they leave the reader to judge whether the direction and size of the impacts are desirable or they incorporate, in the evaluation methodology, an implicit normative theory of value. "Let the facts speak for themselves" say evaluators who think hardly anyone could argue with the value they attribute to the impacts they just inferred, or because they are confident that the moral system underlying their technical approach is fair. This is of course not altogether objectionable. For instance, if the impact of policy is fewer dead people,

[44] Traditionally, counterfactual is used in the context of time series analysis, for extrapolations of trends that prevailed before treatment. I will use it here a bit more expansively, to include the control group in an experimental/quasi-experimental evaluation design, because this group is used to see what happens if the "fact" of treatment did not occurred on an identical individual, that is to say, the state "counter the fact."

hardly anyone will deny that such an outcome is desirable. In contrast, when the impact is less well determined, for instance the value of a program to create jobs may depend on many factors including whether the new source of employment is sustainable and if it is not displacing other more sustainable sources of employment. This is one area where evaluation methodology needs further development, so that we can move away from an intuitive valuation towards a more systematic appraisal of the value of outcomes.

The attention to consequences is not disingenuous. To start, there is a tradition in policy analysis going back to Dahl (1963)[45] and Gamson (1968) that prescribes considering those outcomes that can be tied to the intentions that motivated the policy, generally the program's stated goals. That is a convenient strategy from a methodological and a political point of view. Confining attention to a well-defined set of effects determines the space of outcomes to be examined, which in turn determines, per force of convention, the space of causal relations.[46] Otherwise, unabridged evaluation leaves the problem open to indiscriminate inclusion of effects and ad hoc causal relations. Exclusive attention to stated goals could also give a political advantage; it justifies a narrow focus of evaluation on the presumption that those goals emerged from a democratically legitimate policy process. Likewise, a public official may claim the same to fend off criticism on other less salutary consequences of the same policy. But criticisms cannot be dismissed too easily when ingenious evaluators uncover unintended consequences of clear and urgent concern.

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[45] Dahl's *Modern Political Analysis* (1963) is now in its 6th edition.

[46] It is of course possible to conceive infinite putative causal relations for a single effect. Nonetheless, disciplinary tradition and convention often allows but a few causal relations to be deemed plausible.

Whether intended or unintended consequences, the measurement of outcomes, and the sizing of impacts have dominated the methodological efforts of policy evaluation. Evidently there is an underlying commitment to consequentialism. Elizabeth Anderson defines it as a theory of moral action satisfying the following conditions:

> "First, it gives people the sole ultimate aim of maximizing intrinsic value. Second, it holds the fundamental object of intrinsic value to be the state of affairs. It assesses the value of a state of affairs independent of the values of persons, actions, motives, norms, practices, states of character, or anything else. Third, it assesses the values of these other sorts of things, or at least actions, rules, or practices, solely in terms of their consequences, broadly construed–that is, in terms of how effectively they bring about or embody the best states of affair... [F]ourth: that all values are 'agent–neutral'. A value is agent-neutral if it gives everyone a reason to value it. A value is agent–relative if it gives only some people a reason to value it" (Anderson, 1993, pp. 30-31).[47]

Consequentialist normative theories such as utilitarianism and welfarism (Sen, 1979) have in fact lent policy evaluation a normative core. A case in point is cost-benefit analysis that combines methodological individualism with a normative theory of value such that individual valuation is mapped onto a single scalar measure of value (willingness to pay) rendering, in this way, individual values additive and social value measurable. Cost-benefit evaluation provides a straightforward

[47] In her own analysis, Anderson's (1993) does not presume "agent-neutral evaluative consequentialism" and therefore, does not use the fourth condition.

representation of consequences—that is, of the policy impact—as a welfare gain or loss (formally consumer and producer surplus). At the same time, the change in welfare represents the social valuation and thus social value of the policy. The linchpin of this methodology is evidently the premise that individual valuation can be mapped onto a single scale of measure.

I should clarify why I link cost-benefit analysis and "willingness to pay" because much of standard practice in cost-benefit does not seem to derive common costs or benefits from willingness to pay. The unifying method of cost-benefit analysis is to transpose every consideration of analysis onto a single scale, which is often expressed in a monetary unit (at a given point in time), so that a net calculation of pros and cons can be performed (and time-preference accounted for). Take for example, the regular cost-benefit analysis practice of monetizing the cost of a social program, not measuring willingness to pay but taking the realistic approach of adding all public expenditures associated to such a program. This is surely an acceptable approach. Still, the cost of different levels of service may not be appropriately estimated simply at the unit cost of the level actually observed. It is not unusual that the marginal cost or cost of one additional unit of service may come at a cost higher than the last unit serviced, as is the case of a traditionally upward sloped supply curve. How are those other levels of service—in the vicinity of the observed level—estimated? The answer is given by approximating the public expenditure of the marginal unit via willingness to pay. The same may happen for the demand side, as the last consumer may be the last one willing to pay that high a price for the service. This is hard to imagine when the public service is, for instance, a toll-road simply because the price is flat for any level of demand. But imagine the auction of public

land where the buyer of the last plot may indeed be the last one willing to pay such a price-point per acre. Again, the demand in the vicinity of the observed consumption level cannot in all cases be assumed singled-priced. Willingness to pay is not needed, nor used, for a cost benefit analyses when price and cost are observable and it is plausible to assume that either the marginal cost or the demand are flat. But if it is perceived a high sensitivity of cost or price to the service level, they are needed.

Boiling down all consideration to a single scale is open to criticism on both its normative and methodological implications. On the normative charge, economic individualism is not a precondition for methodological individualism, yet cost-benefit imposes self-interest as the sole driver of individual valuation in order to produce a social aggregate of welfare.[48] Moreover, the choice of a discount rate is a normative choice because it represents the opportunity cost of the stream of net gains, which implicitly is a preference ranking of alternative states of affairs. On that methodological charge, willingness to pay misrepresents individual valuations when the presumed process that elicits valuation–utility maximization–is rendered internally inconsistent in the most common circumstances. Consider for instance, the case of preference-orders susceptible to price changes (as it happens often on eBay or Infomercials) or the case when the total of item-valuations of a basket exceed the budget constraint (evidenced by the sizable outstanding balance in most credit card holders).

[48] The methodological strategy of studying social phenomena as the aggregation of individual actions does not imply any specific assumption on individual motivation such as self-interest or rational egoism. Recall Weber's (1922|1978) admonition: "It is a tremendous misunderstanding to think that a 'individualistic' *method* should involve what is in any conceivable sense an individualistic system of *value*" (p. 18).

Therefore, it is likely that the methodology of policy evaluation will benefit from addressing two weaknesses. First, the commitment to consequentialism seems to unduly constrict evaluation because public action is never exclusively motivated by the desire to achieve certain ends, but also because the act itself of making policy is congruent with certain principles and duties that we hold dear. Considering this *duality of motive*, an evaluation of motivations of public action complements the assessment of policy impacts. A subtle form of this duality is observed in political discourse. A coalition or a public official cannot garner political support for a policy proposal sounding half-hearted about it. Political promises are often tempered by the degree of uncertainty born in all predictions of policy impacts; when discourse cannot credibly assure results the uncertainty-gap is filled with a commitment to popular principles. As a result, policy advocates knit political discourse with two rhetorical threads: one alluding to the desirability of the likely outcomes; the second, declaring the principles upheld by the policy itself and the congruence of its likely outcomes with those principles and other core values. The point is that one important reason for policy is the act itself of enacting it; there is a symbolic value in making policy.

There is no need to impose the assumption that all public action is done to advance some democratic principle because modern democracies have formal institutions that regulate the possibilities of public action justifying their character in reference to specific principles. While defining in strict terms what principle means is cumbersome, it is not difficult to recognize that social groups share a few stable precepts—such as the rule of law or free speech and religious freedom—and in the

liberal democratic tradition, these precepts are often deemed to be categorical and universal.

Suggesting that policy may be in itself valuable is committing to a deontological theory of evaluation. Philosophers contrast consequentialist and deontological theories and it is worth clarifying our position in this respect. Evaluative consequentialism is teleological because according to it the moral value of an act is derived from the value of its purpose, of its *raison d'être*. Depending on the theory of moral value adopted, consequentialism can be utilitarian when hedonism commands valuation, or welfarist when a measure of welfare determines valuation. In contrast, in non-teleological theories, or deontological, both the act and its consequences are judged by their congruence with a value system. Different deontological theories of moral value will produce different sets of criteria to assess value of policy consequences. Let us stress this point: deontological theories are not "views that characterize the rightness of institutions and acts independently from their consequences"; as Rawls explained, "ethical doctrines worth our attention take consequences into account in judging rightness." (1971, p. 30). The logic of arguing in favor of a shift from consequentialism to a deontological normative theory of policy evaluation is a logic with which we are all intuitively familiar. Our behavior is often purposive but desired consequences are never our only motivation. We often check the meaning of the act itself against our values and sometimes conclude that restraint is warranted even when the consequences were socially valued. The theoretical challenge is then to characterize such a "value system" or set of criteria well enough to inform policy evaluation.

The second underdeveloped area of policy evaluation is the reconciliation of any normative assessment of policy consequences with democratic values. A common strategy of evaluation is to uncover policy impacts that are at all lights worrisome, even alarming. These normative assessments could be called "front-page headlines" because they are akin to the type investigative journalism that unearths rotten problems. This strategy comes short for the wide majority of policy problems where problems are more subtle and complex and can only be assessed across multiple dimensions that do not boil down to a single shocking fact. Another common strategy is to use an evaluation method containing a packaged normative theory.

A case in point is cost-benefit analysis that has utilitarianism built-in its method. Let me be more explicit about this, the cost-benefit approach admittedly is a clever contraption; it lets individuals reveal their valuations and indexes them as a price they are willing to pay. By having a common unit the different individual valuations can then be added to a grand social total, just as Bentham envisioned his felicificus calculus. Nonetheless, the normative theory that undergirds the cost-benefit approach is suspect to be at odds with at least one aspect of democratic rule; that of political equality, or more precisely, equal consideration of interests. Specifically, if policy evaluation is to guide policy decisions, the interests of the constituency served by the policy ought to be given equal consideration, but in cost-benefit evaluation individual interests are given asymmetric consideration by construction. Given that: (i) welfare is defined as total surplus equal to consumer plus producer surplus, (ii) that consumer surplus is the summation of individual surplus of all individuals willing and able to purchase the good, and (iii) given that

individual surplus is the difference between two prices–the would-pay price and the actual market price–; then, different levels of individual surplus mean that different individuals have different weights as measured by consumer surplus. Furthermore, given that: (iv) the would-pay price is nothing more than the demand schedule, and (v) that the demand schedule is derived from a utility maximization constrained to a budget; then, for any two equal preference profiles, a larger budget will result in greater willingness to pay. As a consequence, policy decisions guided by cost-benefit analysis seem to accord voice in proportion to purchasing power. What is more, those who cannot afford to pay are not given any consideration, regardless of their preferences or needs. Furthermore, units of producer surplus are the same as units of consumer surplus; implicitly then, cost-benefit analysis grants equal consideration to the producer. Evidently, that too is inconsistent with political equality; particularly, when production is concentrated in a few firms, where each top executive of those firms would be given disproportionately more political consideration than each consumer.

Both stances, the built-in normativity in the method of analysis and the assumed normativity of certain troubling outcomes, hides in the background the normative frame of reference. In the next section I suggest a few conditions for the formulation of such a normative framework.

5.3 Towards a normative framework for deontological policy evaluation.

The first question in assessing the value of a policy outcome or the policy itself is value for whom? If evaluation is put to the service of democracy, it must provide a democratic answer to that question. I will concern myself with the case of

a "representative democracy" because that is the general structure of contemporary democratic nation-states. Those who reject the possibility of representation, usually perched on the participatory democracy tree, will surely object. However, it will become apparent that there are elements in my argument that may actually be reconciled with their views.

From the outset I must clarify that formulating a normative framework for evaluation is not an effort to propose a closed-ended theory of value for policy; this has been precisely the shortfall that I am seeking to redress. Assuming that a plausible or popular theory of value is universally adequate, as it happens with consequentialism, subverts the notion that democracy can accommodate a plurality of values, and in the specific case of consequentialism I have argued that it misses entirely the duality of motive in policy making.

A first approximation could be the formulation of a set of minimum standards that policy outcomes and process should satisfy if they are to be considered legitimate. This is precisely the strategy of Public Value Failure analysis (Bozeman, 2002; 2007) that I used in chapter 3 to examine the neglected public values of Bayh-Dole. For other examples see Bozeman and Sarewitz (2005), Fenney and Bozeman (2008), and the case studies discussed in Bozeman and Sarewitz (2011).

After demarcating the outer terrain in which a policy is situated, a second approximation to the normative frameworks that we seek to sketch could be in narrowing the preferable set of values and map them onto the practical aims of policy. Such an approach was proposed by Frank Fischer who proposed a "critical policy evaluation" (1988, 2003). This project is certainly coterminous to the

deontological evaluation proposed here; however, Fischer sought to establish such a mapping distilling social values from the political philosophy of the Frankfurt critical theory. In the actual practice of policy making these value-set could meet resistance from critics of critical theory who find it hyperbolic in its characterization of contemporary problems withing democracies—my critique of "instrumental reason" and "consequentialism" is, of course, exposed to the same attacks. Alternative mappings in the same fashion could be done on liberal theories that are more accommodating of current political arrangements. For instance, the values from the political philosophy of Rawls (1971, 2005|1990) as condensed in the "difference principle" and "overlapping consensus" may lead to an evaluation of policy in regards to "primary goods"—resources and opportunity that citizens deploy and use in pursuing their conception of the good life. Also within the liberal tradition the mapping could be done against the enunciated capabilities of Nussbaum's "capabilities approach" that refined Rawlsian (Nussbaum, 2000). A possible weak link in Fischer's approach lies in that mapping a well-defined set of values onto policy goals may inadvertently validate some of the justifications of such goals. For instance, assessing developmental policies (that rely heavily on innovation) as a vehicle to alleviate poverty using Nussbaum's approach—which incidentally is done by official UN assessment of the Millennium Development Goals—implicitly validates the view that poverty is something that can be solved with innovation. Those people called poor may instead see poverty as derived from their historical political marginalization, but those values are invisible to developmental policies center on mosquito webs and water filters.

Consequently, a third approximation to our normative framework for deontological evaluation ought to take seriously the values of the publics impacted by policy. The legitimate representation and aggregation of those values is precisely the historic challenge that various forms of representative democracy have tried to resolve. This means that two critical issues are at stake, how to understand representation, and how government derives legitimacy for its authority.

To respond to the first question I draw directly from the discussion of representation in Mark Brown's *Science and Democracy* (2009). Brown begins by critiquing the "theories of correspondence" that have characterized representation. Not only political but also scientific representation too, commonly thought to be different kinds of representation, have actually been conflated by the liberal democratic project. When no specific mechanism (like voting) can project the image of the "will of the people" to scale, as an architect's design, neither view of government as a delegate or as a trustee are adequate—this is a parallel argument to the seminal work of Pitkin on representation (1967). Brown conceptualizes representation as a dynamic process that results from the functioning of a whole ecology of institutions of representation, each of which satisfies one or more of several critical functions, namely: "authorization, accountability, participation, deliberation, and resemblance" (Brown, 2009, p. 206). The thickness and heterogeneity of this ecological space, extending the natural analogy, determines the resilience of democratic representation.

To respond to the question of government legitimacy, I enlist some concepts from Thomas Catlaw's *Fabricating the People* (2007) who tackles the problem in the arm of government where legitimacy has being contested the most: the bureaucracy.

Like Brown, Catlaw rejects the theories of correspondence, but locates the culprit for the misconception in the ontology of the sovereign of democracy, the people. The liberal democratic project has been ultimately a project of creating a political identity in the sense that representation of the sovereign as one person, one will, succeeds only insofar as the sovereign is believed to exist and is given its coercive authority by every citizen. Moreover, this is only possible if the political self-concept of every citizen can accommodate such an entity. The inevitable consequence of the construction of this political national identity is the demarcation of its contours; that is, the construction of its negative which is the act of political exclusion. Exclusion is thus as fundamentally democratic as is representation. The contemporary crisis of administrative legitimacy is brought about by the fracture of the political identity. Once the national identity is fractured, exclusion is equivocal, almost capricious, and thus it slips into further fractious conflict. The current legitimacy crisis may then explained, at least in part, by the social tensions that became apparent since the 1960s (one could imagine that a similar and perhaps deeper fracture led to the Civil War). I would hazard to add that it has been also co-produced by the rise of information technologies (c.f. Castells, 1996). Catlaw concludes that government and the bureaucracy will only undermine further their legitimacy if they insist in fabricating that "*unum"* of *e pluribus unum*. Government and policymakers that admit the defeat of the national political identity project must anchor their legitimacy in a multiplicity of institutions that have retain their legitimacy independently, or in Brown's terms, must anchor policy in the ecology of democratic institutions of representation.

The political philosophy of Brown keeps the term representation but redefines it, Catlaw prefers to vanish it, but both rely on a robust and heterogeneous ecology of institutions to preserve democratic life.[49] I submit then, that deontological evaluation would sharpen the examination of values relevant to policy by mapping them onto the institutions of representation and characterizing their dynamics. This is indeed similar to the policy analysis method that Bozeman named *Public Value Mapping* (2003) with the caveat that, to the light of the foregoing considerations, the characterization of values must be careful to discern values that emanate from theories of correspondence in representation and those that re-fabricate the people as a national political identity. For instance, deontological evaluation would distrust deriving values form polls and surveys given that they systematically boil down heterogeneous identities to a single menu of responses.

5.4 Conclusion.

The foundations of deontological evaluation should not be confused with the now popular characterizing of politics as local and its derivative prescription for evaluation to be sensitive to local and contextual needs. Nor should they be construed as negating such a prescription. Rather, I am submitting a challenge for evaluation to be reconceived more amply in its considerations of political power of the publics affected. Deontological evaluation must elevate the voice of traditionally marginalized technical and political representations, such as equity in the Bayh-Dole

[49] I will not answer here the question of what are these institutions and how can we tell which are to be nurtured and which to be stunned. I might suggest that the design of those institutions may benefit from the work on the stabilization of social boundaries, called "boundary work" (Gieryn, 1990, Jasanoff, 1990) and "boundary organizations" (Guston, 2000, 2001).

debate. What is original of this proposition, the mapping of values into the various institutions of representation, could benefit from the methods of institutional analysis that have thus far been developed into a robust toolkit of analysis (Ostrom, 2005).

This project starts with a strong critique of the epistemological and ethical gaps that have grown within the discipline of evaluation, and I would add, gaps that have grown in despite of the increasing sophistication of its methods and techniques. Nonetheless, I should stress that, like Fischer's "critical policy evaluation" (1988), and Schneider and Ingram's (1997) "policy design," deontological evaluation does not discard the conventional practices of evaluation; rather, it seeks to complement them, and ultimately, it seeks to assist a wide arrange of other democratic institutions in restoring legitimacy and trust to government.

Chapter 6

CONCLUSIONS

6.1 Evading co-optation of prescriptions.

My analysis of Public Value Failures in Bayh-Dole implies the need to counterbalance the forces of neoliberal discourse (Chapter 3) by strengthening the safeguards of the public interest (e.g. relax exceptional circumstances threshold, interpret pricing excesses within march-in rights) and assisting universities in balancing their financial need with their public mission. In turn, my emphasis on managing—instead of arresting—the emergence of the OTT business model of "nurturing start-ups" may seem to be rather accommodating to the neoliberal policy agenda (Chapter 4). It is worth clarifying my position in this regard.

The neoliberal defense of free markets is a defense of markets left free from government intervention. Free markets are defined simply as free from regulation; no longer they are synonym of "competitive markets" and "monopolistic free-markets" is not an oxymoron. Therefore, the emergence of the nurturing start-ups model among OTTs, and its possible effect on industrial firm concentration (i.e due to monopolistic markets) is not seen as problematic from the neoliberal perspective.

However, from the perspective of an equitable distribution of the benefits of innovation, industry concentration and the unregulated monopolies are problematic. If that is so, why not propose policy to stifle the nurturing start-ups model? Why instead, do I propose a sort of "cultivation" of the nurturing model? My main reasons are that (i) the nurturing model is poised to become a standard in university technology transfer, (ii) that there is little opposition to it from the constituencies of

the university, and that (iii) it seems unlikely that future amendments to Bayh-Dole will proscribe the practice because the reforms are being debated in terms of liberalization not regulation of the market of technology transfer services. But even if these reasons do not suffice to elevate the nurturing model to the primary strategy of OTTs, the policy implication of adjusting and calibrating this business model, such that it fosters industrial competition and not concentration, remains valid. Other models such as patent pools (Winickoff, 2006) or socially responsible licensing (Mimura, 2010) may emerge as equally important—and should thus be encouraged to emerge—still, the nurturing of start-ups could play a role in widening the base of beneficiaries of innovation.

What is more, Chandler's (2005) account of the emergence of biotechnology as a highly concentrated industry would suggest that even before the nurturing start-ups model is standardized, concentration in new industries was a likely outcome. That is why my policy recommendation is valid running the argument in reverse, that is, by adjusting this particular business model to reverse the propensity of emerging industries towards firm-concentration.

6.2 Lessons and policy implications.

The first lesson to remark from the analysis of Bayh-Dole is that the policy design is shaped as much by what is omitted in the debate as by what is said. The omissions in the Bayh-Dole debate included the transparency in its implementation, the failure of the NIH to interpret march-in rights too narrowly, and particularly considerations about equity.

The emphasis on the pace of innovation led to subsequent amendments to the law lifting licensing restrictions to large companies and establishing inadequate oversight in the Department of Commerce (the use of iEdison, the electronic reporting tool for Bayh-Dole, is not mandatory and is not available for public view). In turn, the emphasis on traditional academic values has led to other non-statutory changes in licensing practices. A few universities have proactively and voluntarily started to adopt practices in the public interest to counter accusations of mismanagement in the licensing of its IP. The changes include for instance, the *Nine Points* declaration (Bienenstock, 2007) enthusiastically embraced by AUTM and programs of "socially responsible licensing" established at University of Washington and University of California Berkeley (Mimura, 2007; 2010).

The lack of discussion of equity issues has also led to changes, in this case by permitting certain practices to become commonplace. In particular, what I called "creative" licensing practices, such as reach-through provisions, would likely not have been adopted if the public discourse kept equity on the table. Of greater consequence even is the emergence of a new business model for offices of technology transfer—the nurturing start-ups model—that is poised to become the standard of service among offices of technology transfer. For all its advantages including a stronger commitment on the part of the university to entrepreneurship, this model may unfortunately contribute to the concentration of economic power in high-tech industries by leading start-ups to accept acquisition offers early in their development.

It is not hard to imagine slight modifications to the nurturing start-ups model that would increase rather than curtail competition in technology markets. For

instance, the university may partner with venture capital funds and investment managers to establish long-term funding commitments for start-ups, as an added incentive for them to remain independent until they become attractive for an IPO—initial public offering, which is the first sale of shares in the open financial market. The incentives for entrepreneurship would remain, the return for the university would increase even further (although after an extended period of stress in its cash-flow), and this strategy would actually contribute to make new industries more competitive. This type of alternative development is unlikely to happen if equity is kept as an afterthought in the debate on technology transfer.

Another way to understand this lesson is using the concept of "policy drift" (Chapter 3). McCubbins, Noll, and Weingast (1987) are inclined to advocate a preservation of the policy design, because they propose to use administrative procedures to reproduce the political tensions that characterize the making of law throughout the implementation of the law, and keep administrative discretion in check by preventing what they call "bureaucratic drift." Horn and Shepsle (1989) are of the same mind with respect to "legislative drift," and they would prefer the institutionalization within the designated supervisory committees of Congress to keep the political tensions that prevailed when law was enacted. In their views, there is an implicit recognition of the legitimacy of the act of enacting law, a recognition embodied in the judicial tradition of observance of the letter and the spirit of the law. In the case of Bayh-Dole, the lack of administrative procedures (that would have come as an specific mandate for universities) and congressional institutionalization of the 1980 political tensions (the ascent of a different generation of members of Congress) allowed a drift that privileged the profit motive over other views of the

public interest. The drift, form this perspective, could thus be attributed to the lack of voices advocating more equitable distribution of the benefits from Bayh-Dole. The retreat of this kind of argument, and the ascendancy of voices concerned with the pace of innovation and academic values, permitted an "epistemic drift" (Shapiro and Guston, 2006) in the way this policy was conceived. What is omitted in the body of evaluation studies of any given policy domain does seem to shape the design such a policy.

If equity was neglected, the second lesson to draw from this study is the need to bring back equity consideration into the policy debate. The central approach offered in the preceding chapters is by expanding the scope of evaluation, and by beginning to examine why is a given outcome important, not just assuming its value. I can offer a brief example of how to go about examining the value of outcomes from the now familiar case of Bayh-Dole.

Why is the pace of innovation important? Among many reasons, because it leads to economic growth, because that leads to greater wealth, and because that leads to a higher standard of living. At that point it becomes evident that we cannot aspire as a society to higher standards of living for only the few already comfortable. When we push the question of the pace of innovation hard enough, then we may realize that it involves distributive justice. Deontological policy evaluation may harness social theory to canvass the social choices confronting us. Chapter 4 made it clear that there is no single pathway for innovation; innovation can occur in a competitive environment or it can take place free of competition; the former leads to reshuffling the ownership of productive assets at every wave of innovation, the latter leads to the concentration of economic power in a few hands. Deontological

evaluation could then bring about a systematic understanding of the values that support each route for innovation and technology transfer.

Why do traditional academic values matter? Among the various ways in which they matter, academic values matter because they constitute the university as an institution vital to democracy. The public mission of universities could be interpreted as providing citizens with the means to education and social mobility. The public mission could also be interpreted correctly as the provision of services to the productive sector by way of training the labor force and generating innovative ideas. Another correct interpretation is that the university offers society with a source of critical thinking, and a forum for deliberation of capital ideas for society. Pushing the question of academic values, in this case, leads us to recognize the diversity of services that the university my offer and design the management of technology transfer such that it recognizes the various needs and the trade-offs between those values. Deontological evaluation would help to balance those values when in conflict and would help to identify the specific ways in which they are to be served in the management of university IP. Deontological evaluation expands the scope of values considered in governance and management.

A third lesson, this time from deontological evaluation, is to consider the political arrangements behind the outcomes examined by consequentialist evaluation. I showed that while universities benefit financially from Bayh-Dole in a rather asymmetric fashion, their associations voice, on behalf of all universities, an unqualified support of the Act and even the *status quo*. It is unlikely that those spokespersons really speak for those universities who keep an OTT open at an

operational loss, or that represent the sentiment of the whole university system given that a majority of research universities loose money in technology transfer activities. What happens is that patenting is not a zero-sum game and this is an important reason for the inaction of non-elite universities; they cannot cry foul play because no resources were taken away from them. But if non-elite universities would put themselves at a disadvantage by politically confronting elite universities, their best strategy is to invite cooperation. Cooperation does not need to mean political advocacy to reform Bayh-Dole, but arrangements like multi-campus collaborations or OTT consortia may go a long way democratizing technology transfer.

A fourth lesson is related to the impartiality of an analytical rationale (e.g. market failure) is compromised if the policy evaluated (e.g. Bayh-Dole) is inspired by the same normative doctrine that inspired that rationale. Normatively, both market failure and Bayh-Dole rely on the "virtue" of the markets to justify themselves; hence in a market failure analysis of Bayh-Dole, the analyst becomes plaintiff, judge, and jury in the trial of policy. Could this be called an epistemic conflict of interest?

If the norms that inspire the policy are the norms that set the evaluative criteria, then evaluation is not impartial. At the same time, if the norms behind evaluative criteria are irreconcilable with the norms of policy, evaluation is not impartial either. The question of a possible epistemic conflict of interest is really a question as to whether evaluation is always under-critical or over-critical, depending on the normative frame of reference. If epistemic conflict of interest is an apt term for this phenomenon, addressing this problem may benefit from a regular solution to conflicts of interest: full disclosure. A rule of thumb for the practice of evaluation

could then be for the evaluator to reveal its normative framework explicitly. Perhaps impartiality is to the evaluator what the new clothes were for Andersen's emperor, no one dares to point out it is not there. The possibility of impartiality being pervasive does not mean that evaluation cannot be honest. Intellectual honesty requires evaluators to be explicit about their normative commitments and they can apply consistently their value-laden definitions and methods to the problem at hand.

In addition to the foregoing lessons, Table 5 highlights some key points discussed in the preceding chapters.

At the practical level, the dissertation reveals the importance of affirming the role of the university in managing the intellectual property that results from public research. Research universities are chartered as not-for-profit organizations and have a strong history of public service, and for that reason are the most adequate organizations to manage the commercialization of public research and to keep the profit motive in check with other social needs. This conclusion stands in stark contrast to other analysts (Kenney and Patton, 2009; Litan, Mitchell, and Reedy, 2007) who have proposed to assign patent rights directly to inventors, and the contrast can be appreciated when one contrast their aims (to expedite development and commercialization of patents) with my aims (democratize technology transfer). Surprisingly, my prescriptions could be reconciled with theirs. Litan and colleagues are particularly concerned with the bureaucratization of patent filing and licensing negotiation because they see this to be detrimental to entrepreneurship. In their proposal, faculty-inventors keep the right to their patents, and mobilize much faster their inventions from the lab to the shelves. Inventors would scan and choose the best transfer agent in the market, no necessarily the OTT from their own university.

In this way they envision the creation of a market of transfer agents, where understaffed and inexperienced OTTs would shut down. Admittedly, there is efficiency to be gained from reducing the number of OTTs and clustering university patent portfolios under the most effective transfer teams may be beneficial to universities, entrepreneurs, and investment capital—incidentally, during decades before Bayh-Dole the Research Corporation played the role of one such consortia of OTTs (Mowery et al., 2004). This is not contrary to my own prescription of greater university cooperation in technology transfer as I would advocate too OTT consortia. However, I would insist in my prescription to consider the eventuality that the nurturing start-ups model becomes the dominant OTT business strategy. In that case, the design of OTT consortia is best given two conditions, first, that each consortia is formed from a mix of elite and non-elite universities, and second, to strive to make these consortia search and find financing for start-ups to cover liquidity gaps through the "valley of death", in order to increase the chance that they emerge as stand alone firms.

Furthermore, this study revealed areas that future reforms to Bayh-Dole should consider. Namely:

(i) Providing federal assistance and incentives for universities to enter in partnerships that mix elite and non-elite institutions. The NSF and NIH have a history of positive experiences funding large research programs with teams constituted by faculty from several universities. Likewise, cooperation agreements could be modeled after professional and master's programs that

combine faculty from two universities or more or offer education in two locations.

(ii) Introducing incentives for start-up firms to prefer IPOs over the acquisition by established firms in the industry. For instance, a tax credits could be made to expire if a firm is acquired. Liquidity funds could also attach no-acquisition conditions for the receiving firms.

(iii) Empowering federal agencies to enforce regulation of monopolistic practices related to Bayh-Dole licenses. This should include broadening the authority and discretion of agencies to use march-in rights, particularly to prevent pricing excesses in connection to university patents.

(iv) Modifying the statute to allow agencies to include conditions in giving research grants that grantees must meet when managing their intellectual property. For instance, a grant in the development of cancer treatment may require the grantees to favor non-exclusive licensing when feasible or to apply fee-waivers for social, humanitarian, and research uses of the patents.

Table 5. Key points from the analysis.

- The commercialization of academic research began long before Bayh-Dole was enacted. Therefore, it is no more than a myth that it originated with this policy.
- The exponential growth of university patenting was supported by whole array of reforms to the patent system, including Bayh-Dole and other statues, court rulings, new institutional infrastructure (such as the Court of Appeals of the Federal Circuit), and advances in research fields amenable to patenting, particularly the emergence of molecular biology.
- A systemic approach is preferred over an atomistic approach in evaluating Bayh-Dole. The effects of Bayh-Dole are best understood when this policy is studied in the context in which it operates, as part of the patent system, as part of the partnership between universities and technology development firms, and as part of the innovation system.
- Institutional changes to economic and industrial policy as well as changes in corporate governance have a significant influence on the university organization and the way universities implement Bayh- Dole.
- The ideological ascendancy of neoliberalism has transformed the U.S. policy agenda in the same period Bayh-Dole has been in effect, changing too the terms of the debate on this policy.
- In the Bayh-Dole debate, proponents have consistently argued for the positive effects of this policy on the pace of innovation, while detractors have shifted from equity concerns to concerns with the loss of independence in academic research. In the last three decades, the influence in the Bayh-Dole debate has shifted greatly in favor of its advocates.
- The policy design has drifted in the same direction as the policy debate. University administrators implement Bayh-Dole following strategies of the venture capital industry, validated by the conviction that it is the most expedite way to justify economic growth. There is nevertheless an emerging movement that is retaking some aspects of an implementation of Bayh-Dole with strategies to more broadly distribute the benefits of innovation.
- While universities collect the benefits of patenting very unevenly, as a group, they actively support Bayh-Dole. This exposes "representational inequalities" in the organization of university associations.
- Given that tax dollars fund university research and universities and technology development firms profit from patenting that research, Bayh- Dole can be assessed in the same way as a subsidy.
- Given the current trend in licensing practices and OTT business models, Bayh-Dole may facilitate the concentration of economic power in a few large firms that will acquire start-ups
- Following from the previous point, it is worrisome that the main research field that emerged from universities in the last four decades, biotechnology, has fortified the oligopolistic structure of the global pharmaceutical industry. Bayh-Dole has been a catalyst of such a process.
- The evaluation of the values realized by a policy (deontological evaluation) is at least as valuable as that of consequences (conventional evaluation). The case of Bayh-Dole illuminate values

obscured or relegated by ideology and intellectual fads.

6.3 Future directions: from a deontological evaluation of Bayh-Dole to anticipatory governance.

I would like to return to the discussion of Chapter 4 where I contrasted the co-production thesis with the technological determinism thesis. I said that co-production emphasizes the simultaneity of the production of new knowledge or the design of new gadgets, and the configuration of the institutions that order society. When these phenomena takes place in an interconnected network, the analytical separation required for the determinism thesis is no longer possible; ideas, things, discourses, policies are meshed in a complex network and the challenge of the analysis shift to determine the extent of the network where attention will be directed.

There is a comforting simplicity in technological determinism particular when one thinks of the practical implication of such an analysis. Painted with a very thick brush: if such technology leads to such an outcome, and the outcome ranges from the felicitous to the perilous, the challenges for governance are to improve prediction of likely outcomes and improve control over the technology (cause) thus control the outcome. These are the two most common dispositions in the governance of technology, prediction and control.

Conversely, the co-production thesis complicates matters. First, it trumps neat narratives that organize understanding in chains of case-effect relations between science and society (Latour, 1987), technology and the economy (see essays in Callon, 1998), technoscience and the social fabric, (Haraway, 1997), operating programs and codes of conduct. Second, it demands a different governance

approach. Prediction becomes a trivial problem—in a substantive not methodologically way—because predictable things are of little importance in the analysis of co-production. For instance, the size of the network (which is arbitrary in the first place) or the number of actors, are trivial matters in comparison to showing how intimate or interconnected actors are, and these non-trivial substantive attributes of our understanding are elusive to measurement. Likewise, the aspiration of controlling causes (specifically technoscience) becomes impossible because there is not clear distinction between cause and effect; any discretionary inclusion of actors in a group of causes cannot be understood properly as such because they are at once cause and effect of the excluded actors. The general disposition of governance under the co-production thesis must be instead organizational and integrative. The challenge becomes that or organization of actors, the configuration of the networks in which they interact, the integration of functions. The challenge becomes the management of the mutuality in the evolution of technology and the very institutions that facilitate and regulate their emergence.

Cultural institutions such as scientists' preferences for research questions are influenced by the hot topics in their fields and the feasibility of answering those questions with the available data and methods. Business models of venture capital are tailored to the needs of technologies in financially viable industries. Even the meaning and application of the institutions that regulate political voice (interpretation of the first amendment) must accommodate to the structure where the voice is uttered and disseminated—see Hindman's (2006) concept of *googlearchy*. In the same fashion, the allocation of pubic funds for research depends, to a large extent, of what technical programs appear to be promising. Patent policy, as specific

to jurisprudence or economics as it seems, has also been wrought in important ways by the emergence of biotechnology, which in turn, has emerged along the paths permitted by the patent system.

How can this mutuality of institutions and technology be managed? The theory of anticipatory governance proposes to create sites that are manageable by design, that are compatible with democratic values, and that are able to internalize that mutuality. The case of Bayh-Dole offers the possibility of studying how the mutuality between patent policy and biotechnology can be internalized within specific sites. Three are the core functions of anticipatory governance: foresight, engagement, and integration (Barben et al., 2008) and I would like to elaborate further on the function of integration from an institutional perspective.

One of the aims of anticipatory governance, through integration, is to make individual decisions about innovation more socially robust. This implies minimally two things: that decision-making is more widely distributed among stakeholders (a goal shared with engagement), and that more considerations are involved in the decisions that those inherent to the decision (a goal shared with foresight). At an organizational level, this is achieved by promoting dialogue and interaction between innovation actors that do not have organizational incentives to interact. For instance, under a socio-technical integration project, humanists are embedded in laboratories to ignite well-structured discussions with biologists about the implications of their research beyond the merely technical (Fisher and Mahajan, 2006). In the same vein, organizational integration could take place by adding ethicists to the staff of congressional committees, including sociologists in agency advisory committees,

enlisting anthropologists in venture capital firms, or having natural scientists co-author the next books on the politics of science or the bureaucracy of innovation.

Anticipatory integration is more than bringing communities into dialogue. Integration is the creation of sites where the different logics that govern the innovation process can coexist and complement each other. In the example above, socio-technical integration in the laboratory combines curiosity and purposefulness.

The "logics" of the innovation process are generally ascribed to the "tasks" of innovation, traditionally understood as research, development, commercialization, and more recently, reflexivity too.[50] In despite of the history of iteration, interaction, and even simultaneity of these tasks, it remains common in some quarters—particularly policy makers, administrators of research organizations, and scientists—to insist that they are separated and that they operate under different logics. A stylistic representation of these logics would have research governed by curiosity and the prospects of priority of discovery, development structured by technical possibilities of application and scale, commercialization organized by the prospects of profit, and reflexivity guided by the critical understanding of the broader implications of innovation. That this division of labor has been refuted and falsified does not imply that it has not served, flawed as it is, to organize and coordinate resources in the innovation system. Hence, whenever a group involved in innovation

[50] Here I take a narrow conception of reflexivity meaning simply the efforts to critically understand innovation as it takes place and from a historic perspective. At first, one may think that observing the object does not necessarily change the object. When the object is innovation, I argue that it does, perhaps as much as any other task. At a visible layer of analysis, innovation studies change the individual behavior of entrepreneurs, scientists, and policy-makers. A layer deeper, innovation studies change the terms of policy debate, shifting interest groups' positions or reconfiguring these groups with respect to government policy, bureaucratic regulation, or even markets. Further, lessons from innovation studies percolate into society at large as "narratives of innovation" that weave new threads in the ideological tapestry and shape cultural conceptions of progress.

characterizes its work under this task-typology and the respective logic, the integration of logics can indeed be effected.

Connecting the disjointed actors of innovation is an effective way to create integrative sites. Another way is to configure the institutions of innovation to promote, maintain, and regulate those sites. Institutional integration consists of configuring structures within which an innovation task (or various tasks) can no longer be performed as though a single logic would command it (see def. of "tasks" below). A good example is indeed Bayh-Dole. While university patenting was increasingly common in the 1970s, this statute sanctioned the ability of universities to take title to public patents and thus benefit financially from licensing these patents. This institution mixed the logics attending research and commercialization in the work of university scientists. Another example is the National Nanotechnology Initiative (NNI) that allocated resources for reflexivity and thus created voices in the innovation community that insisted on discussing the broader societal implications of the emergence of nanotechnology. As a result, scientists, policy makers, agency regulators and businessmen must consider these new voices in their deliberations.

Taking this dissertation as a point of departure, the notion of "institutional integration" in the context of anticipatory governance could be further developed to identify the blurring of boundaries between the traditional "tasks" and "logics" of innovation and introduce practices to foster socially robust innovation.

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APPENDIX A.

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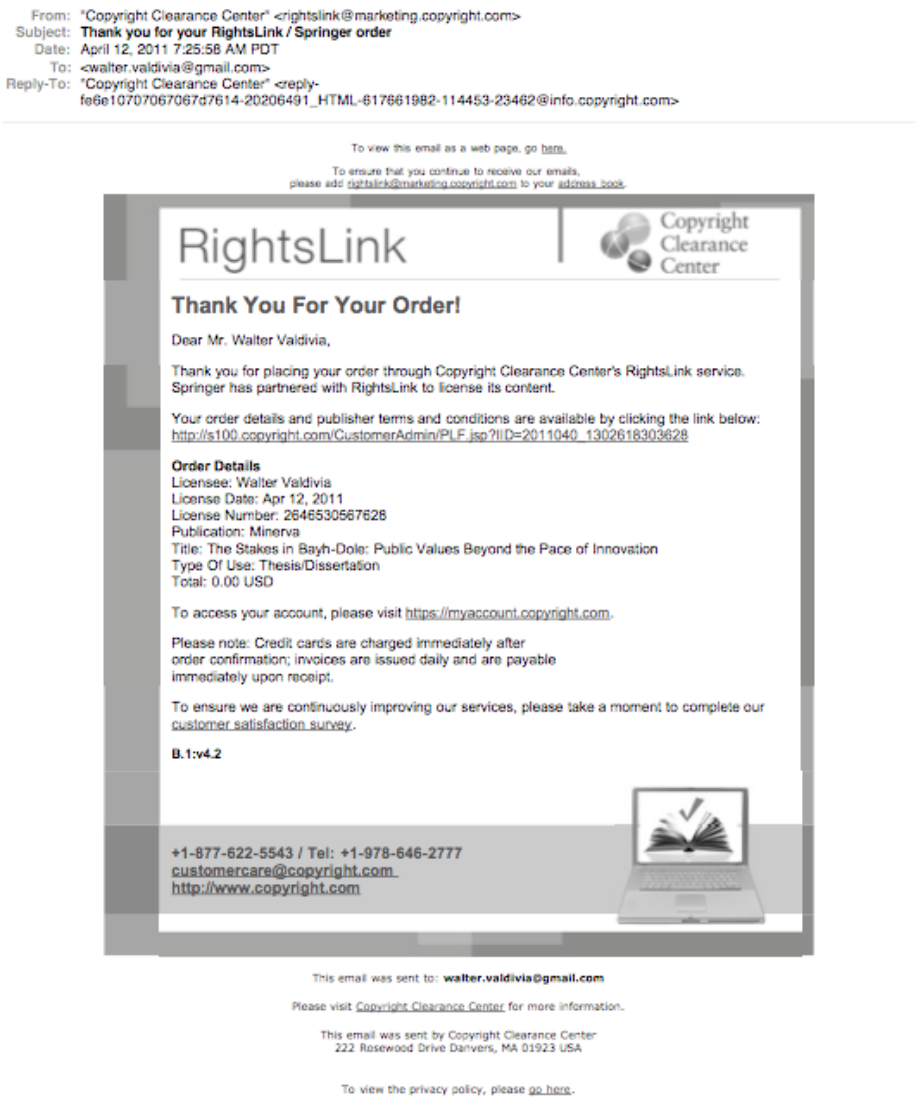

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