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The Globalization of the Bayh–Dole Act

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Annals of Science and Technology Policy

Published, sold and distributed by:
now Publishers Inc.
PO Box 1024
Hanover, MA 02339
United States
Tel. +1-781-985-4510
www.nowpublishers.com
sales@nowpublishers.com

Outside North America:
now Publishers Inc.
PO Box 179
2600 AD Delft
The Netherlands
Tel. +31-6-51115274

The preferred citation for this publication is

T. Gores and A. N. Link. *The Globalization of the Bayh–Dole Act*. Annals of Science and Technology Policy, vol. 5, no. 1, pp. 1–90, 2021.

ISBN: 978-1-68083-755-1

Annals of Science and Technology Policy
Volume 5, Issue 1, 2021

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Annals of Science and Technology Policy, 2021, Volume 5, 4 issues. ISSN paper version 2475-1820. ISSN online version 2475-1812. Also available as a combined paper and online subscription.

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The Globalization of the Bayh–Dole Act

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ABSTRACT

Our thesis in this monograph is that an overlooked metric associated with the impact of the Bayh–Dole Act is its effect on influencing university-based technology transfer policies in other countries. We refer to this phenomenon by the phrase *The Globalization of the Bayh–Dole Act*. To substantiate this thesis, Bayh–Dole like university technology transfer policies in 20 other countries are reviewed. In an effort toward an assessment of these Bayh–Dole like policies, we explore in each country higher education expenditures on research and development (R&D) before and after the Bayh–Dole like policies were adopted. We conclude, in terms of this metric, that in some countries the Bayh–Dole like policies have been more effective than in others.

Keywords: Bayh–Dole Act; technology transfer; policy evaluation; R&D.

Thorsten Gores and Albert N. Link (2021), "The Globalization of the Bayh–Dole Act", Annals of Science and Technology Policy: Vol. 5, No. 1, pp 1–90. DOI: 10.1561/110.00000018.

1

Introduction

Possibly the most inspired piece of legislation to be enacted in American over the past half-century was the Bayh–Dole Act of 1980

—*The Economist*

1.1 Setting the Stage

On December 12, 1980, President Jimmy Carter signed Public Law 96-517, Amendments to the Patent and Trademark Laws Act.[1] This act is formally known as the University and Small Business Patent Procedure Act of 1980, and it is informally or commonly known as the Bayh–Dole Act of 1980.

The legislative process which led to the passage of the Bayh–Dole Act began on March 26, 1980 as H.R. 6933.[2] The Act was introduced in the aftermath of productivity slowdowns in various sectors of the U.S. economy. *The Economist*, from which the epigraph above came, referred

[1] This Public Law amends the Patent Act of 1790, the Patent Act of 1836, the Patent Act of 1922, and the Patent Act of 1952.

[2] A legislative history of H.R. 6933 is available at 20 House Report No. 96-1307, 96th Cong., 2d Sess. (1980).

to this period of time before the passage of the Act as the period of "technological malaise that befell America in the late 1970s."

Figure 1.1 illustrates the Multifactor Productivity (MFP) index for the years 1965 through 1985 for the Private Business Sector in the United States.[3] MFP, or as many economists refer to it as total factor productivity (TFP), is widely regarded as an index of technological advancement.[4] This figure clearly shows the decline in MFP in the early 1970s and then again in the late 1970s and early 1980s.[5]

Figure 1.2 shows, over the same time period of 1965 through 1985, the annual percentage change in MFP for the private business sector. Figure 1.3 shows, over the same time period, the MFP index for the non-farm business sector.[6] And, Figure 1.4 shows, again over the same time period, the annual percentage change in MFP for the non-farm business sector. Figures 1.1 through 1.4 tell the same story; technological advancement slowed in the United States in the early 1970s and then again in the late 1970s and early 1980s. It was these periods of productivity slowdown or "technological malaise" that initiated several new and responsive technology policies in the United States. That policy story began during the Administration of President Jimmy Carter.

President Jimmy Carter's policy prescriptions for reversing this productivity decline were set forth, at least in part, in what has become

[3]Publications related to the documentation of the measurement of multifactor productivity by the U.S. Bureau of Labor Statistics is at: https://www.bls.gov/mfp/home.htm#technotes.

[4]This interpretation of TFP arguably dates to Solow (1957).

[5]These are the periods of decline referred to in *The Economist* article as "technological malaise." An excellent academic history of the Bayh–Dole Act is in Stevens (2004).

[6]The private business sector of the United States is a subset of the U.S. domestic economy and it excludes the economic activities of the following: general government, private households, and nonprofit organizations serving individuals. The non-farm business sector is a subset of the U.S. domestic economy and excludes the economic activities of the following: general government, private households, nonprofit organizations serving individuals, and farms. The two pairs of figures are almost identical as might be expected because the farm sector is relatively small. See: https://www.bls.gov/bls/glossary.htm#B.

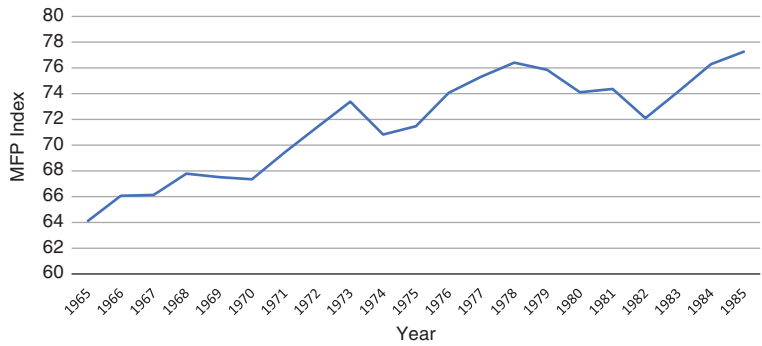

Figure 1.1: Annual multifactor productivity index for the private business sector in the United States, 1965–1985 (2012 = 100).

Source: Bureau of Labor Statistics, Historical Multifactor Productivity Measures.

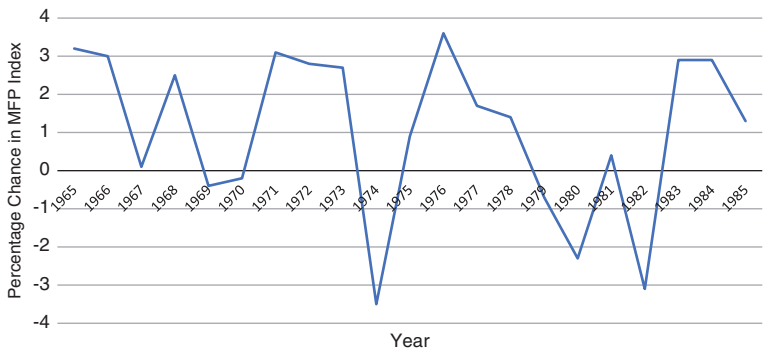

Figure 1.2: Annual multifactor productivity percentage change for the private business sector in the United States, 1965–1985.

Source: Bureau of Labor Statistics, Historical Multifactor Productivity Measures.

known as his Domestic Policy Review (1979).[7] Therein the President's remarks are:

> I will also support the retention of patent ownership by *small business* and *universities* [our emphasis added], the prime thrust of legislation now in Congress, in recognition of their special place in our society.

[7] James (Jimmy) Earl Carter Jr. served as the 39th president of the United States from 1977 to 1981.

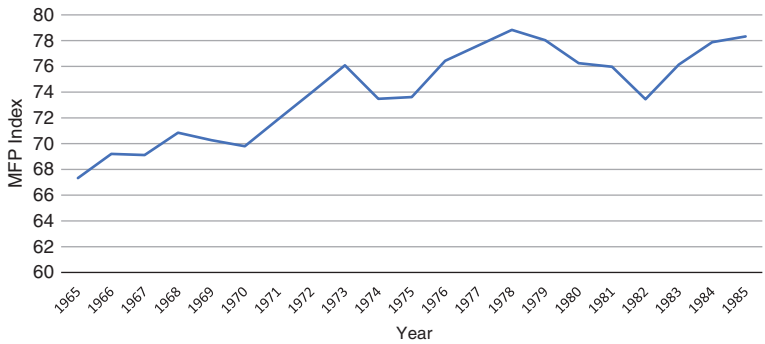

Figure 1.3: Annual multifactor productivity index for the non-farm business sector in the United States, 1965–1985 (2012 = 100).

Source: Bureau of Labor Statistics, Historical Multifactor Productivity Measures.

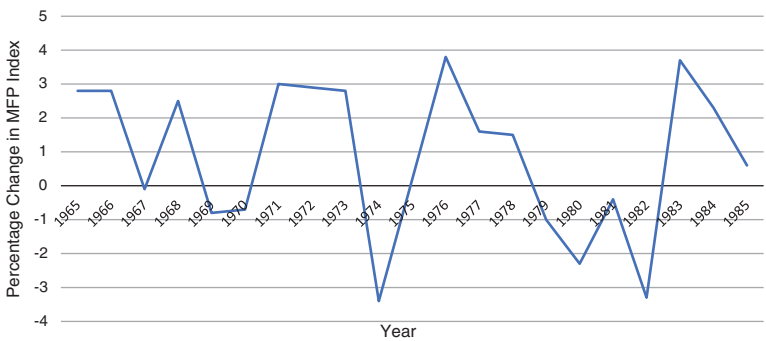

Figure 1.4: Annual multifactor productivity percentage change for the non-farm business sector in the United States, 1965–1985.

Source: Bureau of Labor Statistics, Historical Multifactor Productivity Measures.

The Bayh–Dole Act, with our emphasis again added in italics, states:

> It is the policy and objective of the Congress to use the patent system to promote the utilization of inventions arising from federally supported research or development; to encourage maximum participation of *small business firms* in federally supported research and development efforts; to promote collaboration between commercial concerns and *nonprofit organizations*, including *universities*; to ensure

> that inventions made by nonprofit organizations and small business firms are used in a manner to promote free competition and enterprise; to promote the commercialization and public availability of inventions made in the United States by United States industry and labor; to ensure that the Government obtains sufficient rights in federally supported inventions to meet the needs of the Government and protect the public against nonuse or unreasonable use of inventions; and to minimize the costs of administering policies in this area.

The Bayh–Dole Act was one of several reasoned policy responses to the productivity slowdown that plagued the private sector of the United States.[8] Again, this productivity slowdown was what *The Economist* article had referred to as the period of U.S. "technological malaise."

As the title of this monograph suggests, the Bayh–Dole Act has been embraced (i.e., imitated) globally. This apparent influence of the Act raises questions about how one should view the Act. Specifically: Was the Bayh–Dole Act simply a timely piece of legislation that serendipitously captured global attention at a time when productivity growth was slowing down in many industrialized nations? Or: Was the Act something else? Did the Bayh–Dole Act represent a new way of viewing technology

[8] Although the focus of this monograph is on the Bayh–Dole Act, we would be remiss if we did not also mention other U.S. technology policies that were and were not mentioned in President Carter's Domestic Policy Review. These included the Stevenson-Wydler Act of 1980, the R&E tax credit of 1981, the Small Business Innovation Development Act of 1982, and the National Cooperative Research Act of 1984. Clearly, using national data, it would be difficulty to isolate the impact of any one particular legislative initiative on a measure of technological advancement. Thus, Bozeman and Link (2015) examined the ratio of R&D investments to value added in the United States over the period 1953 through 2011. Their estimate of statistical fixed effects policy models (2014, pp. 373–374): "suggest that the technology and innovation policies under study in this monograph—and these are the policies that shaped the post productivity slowdown legislative response—did indeed have a measurable impact on the relative level of industrial investments in R&D, but that impact has waned."

policy—that is, a new lens through which to view technology policy—within the United States and in other countries?[9]

Leyden and Link (2015) and Hayter *et al.* (2019) have offered such a new lens through which to view not only the Bayh–Dole Act of 1980 but also the other technology policies that were promulgated in the United States in the early 1980s. Perhaps this public sector entrepreneurship lens has a broader appeal to understanding the adoption of technology policy initiatives than simply saying that a country imitated a particular U.S. technology policy initiative.[10]

Many scholars have offered definitions about who an entrepreneur is and what he/she does. Accordingly, a so-called *entrepreneurial lens* merits a definition, from a public sector perspective, of what makes such a lens or perspective entrepreneurial.[11]

1.2 A Public Sector Entrepreneurship Lens

Leyden and Link (2015, p. 46) define the concept of public sector entrepreneurship in the following way:[12]

> Public sector entrepreneurship . . . refers to innovative public policy initiatives that generate greater economic prosperity by transforming a status quo economic environment into

[9]It should not go unnoticed that the first formal U.S. technology policy statement is dated as 1990: *U.S. Technology Policy* (Executive Office of the President, Office of Science and Technology Policy, 1990). Some might take issue with our claim that this is the first formal technology statement, and they might argue that Bush's *Science—the Endless Frontier* (1945) is the foundation for U.S. technology policy. There are clearly elements of *Endless Frontier* in *U.S. Technology Policy*, as Leyden and Link (2015) point out, and those elements can meaningfully be characterized as having aspects of public sector entrepreneurial intensions.

[10]For examples, see Hayter *et al.* (2019). They make the argument that the entrepreneurial lens is also applicable for viewing the genesis of and consequences from global grand challenge programs.

[11]See, Hébert and Link (2006, 2009) for an intellectual history of the concept of entrepreneurship.

[12]Subsequently, Hayter *et al.* (2019, p. 682) modify this definition of public sector entrepreneurship as: "Public-sector entrepreneurship refers to the formation of innovative public-sector initiatives that transform a status quo social and economic environment into one that is more conducive to creative change in the face of uncertainty."

Table 1.1: Dimensions of the Bayh–Dole Act as an example of public sector entrepreneurship

Initiating party of the Act	U.S. Congress
Targeted party of the Act	Universities and private sector firms
Direct versus indirect nature of the Act	Indirect option to universities; effects are indirect based on research success
Innovative nature of the Act	Transferring technology from universities creates new production possibilities for firms
Status quo economic environment transformed by the Act	Advancement of knowledge within firms, which enhances economic growth.
Dimensions of uncertainty	Adopting technology from universities is outside of the routine and thus has uncertain outcomes

Source: Based on Hayter *et al.* (2019).

> one that is more conducive to economic units engaging in creative activities in the face of uncertainty.

Leyden and Link (2015) go on to make a case that the passage of the Bayh–Dole Act is an example of public sector entrepreneurship.[13] The Act redirects property rights that brings about the transfer of existing knowledge from a university to the private sector for commercial exploitation. Hayter *et al.* (2019) elaborate on the fact that the Bayh–Dole Act is an example of public sector entrepreneurship by characterizing the Act through various entrepreneurial dimensions as we have summarized in Table 1.1.

One aspect of the Leyden and Link (2015) definition of the concept of public sector entrepreneurship as a lens through which to view public policies to be emphasized in the case of the Bayh–Dole Act is their phrase "engaging in creative activities in the face of uncertainty." As shown in Table 1.2, data from the European Commission show that, even at the time of the publication of these data in 2017, many universities

[13]The relevant literature on public sector entrepreneurship is reviewed in Leyden and Link (2015), and that review is expanded in Hayter *et al.* (2019).

Table 1.2: Industry collaboration with universities in the area of university R&D results (selected countries)

Do You, As a University, Collaborate with Industry in the Commercialization of R&D Results (e.g., Licensing/Patenting)?	
Country	**Percent of University and Higher Education Institution Representatives Responding "Not at All"**
Spain (1983)	83.1
United Kingdom (1985)	80.2
Denmark (1999)	70.2
France (1999)	78.9
Italy (2001)	90.1
Austria (2002)	48.4
Germany (2002)	56.4
Norway (2003)	80.3
Finland (2007)	66.4

Source: European Commission (2017).
Note: The year that a country adopted a Bayh–Dole like university technology policy is shown in parentheses. This table includes all of the countries that adopted a Bayh–Dole like policy that are described in the European Commission (2017) report.

infrequently collaborate with industry in the commercialization of their R&D results, where collaboration refers to licensing activity or patenting activity.

As will be discussed below, Spain was the first country to adopt a Bayh–Dole like university technology policy, and that occurred in 1983. As of the European Commission's (2017) publication, 83.1 percent of the Spanish academic and higher education institution (HEI) representatives surveyed by the Commission responded that they have *no* [our emphasis] such collaboration with industry. Austria, at the other end of the distribution with the highest collaboration rate among the countries surveyed, is characterized by 48.4 percent of the respondents having no licensing or patenting activity collaboration with industry. Austria adopted a Bayh–Dole like university technology policy in 2007, as we will also discuss below.

Table 1.3: Percentage of firms reporting partners with which they co-operate in innovation, 2014 (selected countries)

Country	Universities or Other Higher Education Institutions	Government or Public Research Institutes
Spain (1983)	7.3	9.7
United Kingdom (1985)	4.7	2.5
China (1994)	–	–
Denmark (1999)	14.5	10.5
France (1999)	13.2	10.8
Japan (1999)	15.7	14.4
South Korea (2000)	10.0	12.8
Italy (2001)	5.3	2.2
Austria (2002)	24.7	11.6
Germany (2002)	17.1	8.1
Indonesia (2002)	8.4	4.9
Mexico (2002)	7.0	6.1
Norway (2003)	14.3	18.1
Russia (2003)	9.1	15.6
Brazil (2004)	6.3	–
Finland (2007)	33.8	24.8
India (2008)	–	–
South Africa (2008)	16.2	16.2
Malaysia (2009)	20.7	17.4
Philippines (2009)	47.1	50.0

Source: UNESCO (2015).
Note: The year that a country adopted a Bayh–Dole like university technology policy is shown in parentheses. India is listed in italics because legislation was proposed in 2008 that would affect university-based technology transfer, but it was tabled in 2014.

There is, of course, a market for licensable or patentable technology from a university.[14] Table 1.2 describes participation in this market from the perspective of the university. Table 1.3 presents, to the best of our knowledge, a complete list of countries that have adopted Bayh–Dole like university technology transfer legislation. The data in the table approximate, or so we contend, participation in this market from the perspective of the firm. In the table are the percentage of firms that cooperate in innovation (a concept that UNESCO, 2015 did not clearly

[14]See Bradley *et al.* (2013) for a discussion of technology transfer at universities.

define) with universities and HEI as well as with government or public research institutes. Across the countries listed, the mean percentage of firms that cooperate with universities and HEIs is 15.3, the mean percentage of firms that cooperate with government or public research institutes is 13.9.

As a final across-country example of the "uncertainty" (a public sector entrepreneurship characteristic; see Table 1.1) about the effectiveness of Bayh–Dole like legislation, consider the data in Table 1.4. Across countries, universities, HEIs, or government or public research

Table 1.4: Percentage of firms reporting an information source as being "highly important," 2014 (selected countries)

Country	Universities or Other Higher Education Institutions	Government or Public Research Institutes
Spain (1983)	5.0	7.7
United Kingdom (1985)	–	–
China (1994)	8.9	24.7
Denmark (1999)	–	–
France (1999)	3.4	3.1
Japan (1999)	5.1	4.8
South Korea (2000)	3.9	6.1
Italy (2001)	3.7	1.0
Austria (2002)	–	–
Germany (2002)	–	–
Indonesia (2002)	0.4	0.4
Mexico (2002)	26.4	23.6
Norway (2003)	7.2	10.5
Russia (2003)	1.9	–
Brazil (2004)	7.0	–
Finland (2007)	4.5	2.8
India (2008)	7.9	11.0
South Africa (2008)	3.1	2.3
Malaysia (2009)	9.5	16.7
Philippines (2009)	10.1	7.1

Source: UNESCO (2015).
Note: The year that a country adopted a Bayh–Dole like university technology policy is shown in parentheses. India is listed in italics because legislation was proposed in 2008 that would affect university-based technology transfer, but it was tabled in 2014.

institutes are not noted to be "highly important" sources of information for firms.

The legislators in the countries listed in Tables 1.3 and 1.4 must have perceived or recognized an opportunity for "transforming a status quo economic environment" (see Table 1.1) as evidenced by the passage of Bayh–Dole like legislation in the face of uncertainty.

1.2.1 Research Related to the Bayh–Dole Act

Perhaps the most frequently asked question about the Bayh–Dole Act has been: How did the Bayh–Dole Act affect university patenting? Many scholars have carefully investigated this question—and it is indeed an important question in the relevant academic research literature from a policy evaluation perspective—as evidenced through the application of various econometric models by various researchers from different disciplines. Specifically, scholars have estimated time series of patent application data either at a specific university, or among selected universities, or in the aggregate using a dichotomous variable to define the year when the Bayh–Dole Act became active (either in 1980 or in 1981 to account for a lag). Drawing on individual publications as well as on the excellent syntheses of this literature by, among others, Berman (2008, 2012) and Grimaldi *et al.* (2011), the empirical evidence about the patenting effect of the Bayh–Dole Act remains mixed.

Few scholars doubt that after the passage of the Bayh–Dole Act, university patenting increased, and it increased substantially at some universities, but many scholars also note that there were other events occurring just before and just after the passage of the Act that are also covariates with an increase in university patenting. We have summarized a portion of this important body of literature in Appendix A to provide background context for the remaining sections in this monograph.[15]

The most recent, and perhaps a more salient, argument about the economic impact of the Bayh–Dole Act has been offered by Link and van

[15]The literature review is based on the excellent graduate research assistance of Kelsi Hobbs. Our omission of scholarly work from Appendix A is unintentional.

Hasselt (2019).[16] They argue, and they show empirically, that the Bayh–Dole Act had a measurable impact on universities forming and opening technology transfer offices (TTOs), which are a prerequisite infrastructure for university in-house patent applications. More specifically, Link and van Hasselt (2019, p. 478) conclude:

> Whereas the literature has focused on university patenting activity as the relevant metric for assessing the technology impact of the Act, we suggest that the establishment date of TTOs relative to the passage of the Act is also an appropriate metric, and in fact it might be a more appropriate one. Our argument is that formal university patenting generally begins after the establishment of a TTO. . . . [Our empirical findings give] support for the argument that the Act provided an incentive for universities to establish a TTO and thus to position themselves for formally transferring faculty inventions through patent licensing.

Perhaps the effect of the Bayh–Dole Act on the institutionalization of university research is what was meant in *The Economist* article by the statement:[17] "More than anything, this single policy measure [known as the Bayh–Dole Act] helped to reverse American's precipitous slide into industrial irrelevance."

We suggest that one would be hard pressed to argue against the point of view that the establishment of TTO infrastructure at U.S. universities did transform a status quo academic as well as economic environment into one that is more conducive for dealing with the uncertainty of research and that transformation can eventually lead to economic growth and social wellbeing.

[16] See also Coupé (2003).

[17] Bozeman and Link (2015) argue that it is difficult, if not impossible, to disentangle one post-productivity slowdown policy for another when explaining the subsequent increase in industrial R&D investments.

1.3 Overview of the Monograph

Our thesis in this monograph is that, in addition to the formation of university technology transfer offices and the university patent applications that followed, an overlooked metric associated with the Bayh–Dole Act is its effect on influencing university-based technology transfer policies in other countries; we refer to this phenomenon by the phrase *The Globalization of the Bayh–Dole Act* (which is also the title of this monograph).[18]

To substantiate this thesis, we review related university technology transfer policies in 20 other countries in Section 2 of this monograph. Of course, the scope of these related policies varies from country to country, but one cannot help but notice that there are seeds from the Bayh–Dole Act present in all of them. We discuss these country policies below in chronological order based on the year of the initiating legislation.

We conclude this monograph in Section 3 with summary remarks and suggestions for future policy related research. Our attempted tone throughout this monograph is descriptive, that is we have attempted to report in a non-assessing or non-evaluative manner the pattern of globalization of the Bayh–Dole Act.[19] However, we do note in Section 3 some correlative patterns. We do so to help to motivate our proffered research agenda.

[18] Graff (2007) uses the phrase *Echoes of Bayh–Dole*. See also, Hemel and Ouellette (2017).

[19] As Link and Scott (2011) have written, many use the terms *assessment* and *evaluation* interchangeably, especially with reference to public sector activities. Program or legislation assessment is based primarily on the criterion of effectiveness: Has the program or legislation met its stated goals and objectives; have its designated outputs been achieved? Program or legislation evaluation is based on the criterion of efficiency: How do the social benefits or outcomes associated with the program or legislation compare to the social costs?

References

Agapitova, N., L. Holm-Nielsen, and G. Vukmirovic (2002). "Science and technology in Colombia: Status and perspectives". In: *LCSHD (Latin America and Caribbean Social and Human Development) Paper Series*. Washington, DC: Banco Mundial.

Asmoro, P. K. (2017). "Technology transfer in Indonesian state universities: Do IPRS play a significant role?" *Indonesian Law Review*. 1: 49–78.

Audretsch, D. B., A. N. Link, and M. Wright (2019). "Disciplinary perspectives on innovation". *Foundations and Trends in Entrepreneurship*. 15: 1–172.

Azagra-Caro, J. M. (2011). "Do public research organisations own most patents invented by their staff?" *Science and Public Policy*. 38: 237–250.

Baldini, N. (2009). "Implementing Bayh-Dole-like laws: Faculty problems and their impact on university patenting activity". *Research Policy*. 38: 1217–1224.

Baldini, N., R. Fini, and R. Grimaldi (2015). "The transition towards entrepreneurial universities: An assessment of academic entrepreneurship in Italy". In: *The Chicago Handbook of University Technology Transfer and Academic Entrepreneurship*. Ed. by A. N. Link, D. S. Siegel, and M. Wright. Chicago: University of Chicago Press. 218–244.

Baldini, N., R. Grimaldi, and M. Sobrero (2006). "Institutional changes and the commercialization of academic knowledge: A study of Italian universities' patenting activities between 1965 and 2002". *Research Policy*. 35: 518–532.

BayhDole25, Inc. (2006). *The Bayh-Dole Act at 25*. New York, NY: BayhDole25, Inc.

Berman, E. P. (2008). "Why did universities start patenting?" *Social Studies of Science*. 38: 835–871.

Berman, E. P. (2012). *Creating the Market University: How Academic Science Became an Economic Engine*. Princeton: Princeton University Press.

Bozeman, B. and A. N. Link (2015). "Toward an assessment of impacts from US technology and innovation policies". *Science and Public Policy*. 42: 369–376.

Bradley, S. R., C. S. Hayter, and A. N. Link (2013). "Models and methods of university technology transfer". *Foundations and Trends in Entrepreneurship*. 9: 571–650.

Bush, V. (1945). *Science—The Endless Frontier*. Washington, DC: United States Government Printing Office.

Calderón-Martínez, M. G. and J. Garca-Quevedo (2013). "Knowledge transfer and university patents in Mexico". *Academia Revista Latinoamericana de Administración*. 26: 33–60.

Castro Peñarrieta, L. and G. Canavire-Bacarreza (2019). "Can intellectual property rights affect multinational enterprises' entry modes? The Chilean case". *International Journal of the Economics of Business*. 26: 177–198. URL: https://www.tandfonline.com/doi/pdf/10.1080/13571516.2019.1553656?needAccess=true.

Coupé, T. (2003). "Science is golden: Academic R&D and university patents". *Journal of Technology Transfer*. 28: 31–46.

Cunningham, J. A., E. E. Lehmann, M. Menter, and N. Seitz (2019). "The impact of university focused technology transfer policies on regional innovation and entrepreneurship". *Journal of Technology Transfer*. 44: 1451–1475.

Dai, Y., D. Popp, and S. Bretschneider (2005). "Institutions and intellectual property: The influence of institutional forces on university patenting". *Journal of Policy Analysis and Management*. 24: 579–598.

Della Malva, A., F. Lissoni, and P. Llerena (2013). "Institutional change and academic patenting: French universities and the innovation act of 1999". *Journal of Evolutionary Economics*. 23(1): 211–239.

Domestic Policy Review (1979). "Joint hearing before the committee on commerce, science, and transportation and the select committee on small business of the united states senate, committee on science and technology, and the committee on small business of the U.S house of representatives". *96th Congress*, Serial No. 96-68, October 31.

Eom, B.-Y. and K. Lee (2010). "Determinants of industry-academy linkages and their impacts on firm performance: The case of Korea as a latecomer in knowledge industrialization". *Research Policy*. 39: 625–639.

European Commission (2017). State of University-Business Cooperation in Europe: Country Reports. URL: https://www.ub-cooperation.eu/index/reports.

Executive Office of the President, Office of Science and Technology Policy (1990). *U.S. Technology Policy*. Washington, DC: Executive Office of the President.

Gallochat, A. (2003). "French technology transfer and policies". In: *Turning Science into Business: Patenting and Licensing at Public Research Organizations*. Paris: OECD. 139–151.

García, C. E. and L. S. Menéndez (2002). "From research to patents within Spanish public research organisations". Unpublished monograph.

Geroski, P. A. (2000). "Models of technology diffusion". *Research Policy*. 29: 603–625.

Geuna, A. and F. Rossi (2011). "Changes to university IPR regulations in Europe and the impact on academic patenting". *Research Policy*. 40: 1068–1076.

Graff, G. D. (2007). "Echoes of Bayh-Dole? A survey of IP and technology transfer policies in emerging and developing economies". In: *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices*. Ed. by A. Krattiger, R. T. Mahoney, L. Nelsen, J. A. Thomson, A. B. Bennett, K. Satyanarayana, G. D. Graff, C. Fernandez, and S. P. Kowalski. Oxford, UK: MIHR. 169–195.

Grimaldi, R., M. Kenney, D. S. Siegel, and M. Wright (2011). "30 years after Bayh-Dole: Reassessing academic entrepreneurship". *Research Policy*. 40: 1045–1057.

Guerrero, M. and D. Urbano (2017). "The impact of Triple Helix agents on entrepreneurial innovations' performance: An inside look at enterprises located in an emerging economy". *Technological Forecasting and Social Change*. 119: 294–309.

Guo, H. (2007). "IP management at Chinese universities". In: *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices*. Ed. by A. Krattiger, R. T. Mahoney, L. Nelsen, J. A. Thomson, A. B. Bennett, K. Satyanarayana, G. D. Graff, C. Fernandez, and S. P. Kowalski. Oxford, UK: MIHR. 1673–1682.

Harvey, K. (1992). "Managing the exploitation of intellectual property: An analysis of policy and practice in nine UK universities". Doctor of Philosophy thesis at the University of Stirling, UK.

Hayter, C. S. (2016). "A social responsibility view of the patent-centric linear model of university technology transfer". *Duquesne Law Review*. 54: 7–52.

Hayter, C. S., A. N. Link, and J. T. Scott (2019). "Public-sector entrepreneurship". *Oxford Review of Economic Policy*. 34: 676–694.

Hébert, R. F. and A. N. Link (2006). "Historical perspectives on the entrepreneur". *Foundations and Trends in Entrepreneurship*. 2: 261–408.

Hébert, R. F. and A. N. Link (2009). *A History of Entrepreneurship*. London: Routledge.

Hemel, D. J. and L. L. Ouellette (2017). "Bayh–Dole beyond borders". *Journal of Law and Biosciences*. 4: 282–310.

Henderson, R., A. B. Jaffe, and M. Trajtenberg (1998). "Universities as a source of commercial technology: A detailed analysis of university patenting, 1965–1988". *The Review of Economics and Statistics*. 80: 119–127.

Hernandez-Mondragon, A. C., L. Herrera-Estrella, and W. Kuri-Harcuch (2016). "Legislative environment and other factors that inhibit transfer of Mexican publicly funded research into commercial ventures". *Technology in Society*. 46: 100–108.

Hvide, H. K. and B. F. Jones (2018). "University innovation and the professor's privilege". *American Economic Review*. 108: 1860–1898.

Iversen, E. J., M. Gulbrandsen, and A. Klitkou (2007). "A baseline for the impact of academic patenting legislation in Norway". *Scientometrics*. 70: 393–414.

Jamal, E., Istriningsih, and V. W. Hanifah (2016). "Model of technology commercialization from government research institutions in Indonesia". In: *Paper Presented at the International Workshop on "Effective IP Protection and Commercialization Strategies for Agricultural Innovation",* October 18–20, MARDI Headquarters, Serdang, Selangor, Malaysia.

Kauppinen, I. (2014). "A moral economy of patents: Case of Finnish research universities' patent policies". *Studies in Higher Education*. 39: 1732–1749.

Kesselheim, A. S. (2011). "An empirical review of major legislation affecting drug development: Past experiences, effects, and unintended consequences". *The Milbank Quarterly*. 89: 450–502.

Kilger, C. and K. Bartenbach (2002). "New rules for German professors". *Science*. 298: 1173–1175.

Kneller, R. (2003). "University-industry cooperation and technology transfer in Japan compared with the United States: Another reason for Japan's economic malaise". *University of Pennsylvania Journal of International Economic Law*. 24: 329–450.

Kochupillai, M. (2010). "The protection and utilization of public funded intellectual property bill, 2008: A critique in the light of India's innovation environment". *Journal of Intellectual Property Rights*. 15: 19–34.

Lambert, R. (2003). "Lambert review of business-university collaboration". *University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship*.

Leyden, D. P. and A. N. Link (2015). *Public Sector Entrepreneurship: U.S. Technology and Innovation Policy*. New York: Oxford University Press.

Leydesdorff, L. and M. Meyer (2010). "The decline of university patenting and the end of the Bayh-Dole effect". *Scientometrics*. 83: 355–362.

Link, A. N. (2019). "Technology transfer at the US National Institute of Standards and Technology". *Science and Public Policy*. DOI: 10.1093/scipol/scz038.

Link, A. N. and Z. T. Oliver (2020). *Technology Transfer and U.S. Public Sector Innovation*. Northampton, MA: Edward Elgar.

Link, A. N. and J. T. Scott (2011). *Public Goods, Public Gains: Calculating the Social Benefits of Public R&D*. New York: Oxford University Press.

Link, A. N., D. S. Siegel, and D. D. van Fleet (2011). "Public science and public innovation: Assessing the relationship between patenting at U.S. national laboratories and the Bayh-Dole Act". *Research Policy*. 40: 1094–1099.

Link, A. N. and M. van Hasselt (2019). "On the transfer of technology from universities: The impact of the Bayh–Dole Act of 1980 on the institutionalization of university research". *European Economic Review*. 119: 472–481.

Lissoni, F. (2012). "Academic patenting in Europe: An overview of recent research and new perspectives". *World Patent Information*. 34: 197–205.

Lissoni, F. and F. Montobbio (2015). "The ownership of academic patents and their impact: Evidence from five European countries". *Revue Economique*. 66: 143–171.

Loise, V. and A. J. Stevens (2010). "The Bayh-Dole Act turns 30". *Science Translational Medicine*. 2: 185–194.

Macdonald, S. (2009). "Seducing the goose: Patenting by UK universities". University of Sheffield unpublished manuscript.

Martin, B. C. (2009). "The American models of technology transfer: Contextualized emulation by developing countries?" *Buffalo Intellectual Property Law Journal*. 6: 104–132.

Mazzoleni, R. (2011). "Before Bayh–Dole: Public research funding, patents, and pharmaceutical innovation (1945–1965)". *Industrial and Corporate Change*. 20: 721–749.

Milthers, S. (2003). "Changing IPR regulations for researchers in Denmark". In: *Turning Science into Business: Patenting and Licensing at Public Research Organizations*. Paris: OECD. 129–138.

Ministry of Science, Technology and Innovation (MOSTI) (2009). "Intellectual property commercialisation policy for Research and Development (R&D) projects funded by the Government of Malaysia". Government of Malaysia.

Motohashi, K. and S. Muramatsu (2011). "Examining the university industry collaboration policy in Japan: Patent analysis". In: *RIETI Discussion Monograph Series*. 11-E-008.

Mowery, D. C. (2005). "The Bayh-Dole Act and high technology entrepreneurship in U.S. universities: Chicken, egg, or something else?" In: *University Entrepreneurship and Technology Transfer: Process, Design, and Intellectual Property*. Ed. by G. D. Libecap. Bingley, UK: Emerald Publishers. 39–68.

Mowery, D. C. (2011). "Learning from one another? International policy 'emulation' and university–industry technology transfer". *Industrial and Corporate Change*. 20: 1827–1853.

Mowery, D. C., R. R. Nelson, B. N. Sampat, and A. A. Ziedonis (2001). "The growth of patenting and licensing by U.S. universities: An assessment of the effect of the Bayh-Dole Act of 1980". *Research Policy*. 30: 99–119.

Mowery, D. C. and B. N. Sampat (2001). "University patents and patent policy debates in the USA, 1925–1980". *Industrial and Corporate Change*. 10: 781–814.

Mowery, D. C. and B. N. Sampat (2005). "The Bayh-Dole Act of 1980 and university–industry technology transfer: A model for other OECD governments?" *Journal of Technology Transfer*. 30: 115–127.

Mowery, D. C., B. N. Sampat, and A. A. Ziedonis (2002). "Learning to patent: Institutional experience, learning, and the characteristics of U.S. university patents after the Bayh-Dole Act, 1981–1992". *Management Science*. 48: 73–89.

Mowery, D. C. and A. A. Ziedonis (2000). "Numbers, quality, and entry: How has the Bayh-Dole Act affected U.S. university patenting and licensing?" *Innovation Policy and the Economy*. 1: 187–220.

Mowery, D. C. and A. A. Ziedonis (2002). "Academic patent quality and quantity before and after the Bayh-Dole Act in the United States". *Research Policy*. 31: 399–418.

Oba, J. (2005). "The incorporation of national universities in Japan: Initial reactions of the new national university corporations". *Higher Education Management and Policy*. 17: 105–125.

Payumo, J. G., P. Arasu, A. M. Fauzi, I. Z. Siregar, and D. Noviana (2014). "An entrepreneurial, research-based university model focused on intellectual property management for economic development in emerging economies: The case of Bogor agricultural university, Indonesia". *World Patent Information*. 36: 22–31.

Pojo, S. D., V. S. Vidal, A. C. Zen, and H. M. Barros (2013). "Management of intellectual property in Brazilian universities: A multiple case study". Working Monograph of Insper.

Pratt, W. H. (2010). "The collaborative research house that Bayh-Dole built: Perfectly constructed or in need of repairs?" *Nouvelles-Journal of the Licensing Executives Society*. 45: 195.

Pulsinelli, G. (2006). "Share and share alike: Increasing access to government-funded inventions under the Bayh-Dole Act". *Minnesota Journal of Law, Science and Technology*. 7: 393–482.

Rafferty, M. (2008). "The Bayh–Dole Act and university research and development". *Research Policy*. 37: 29–40.

Reichelt, K. M. (2007). "University technology transfer and national innovation policy: Success stories from Brazil, Colombia and South Africa". International Intellectual Property Institute. URL: http://iipi.org/wp-content/uploads/2010/07/UniversityTechTransfer_072507.pdf.

Rogers, E. M. (1962). *Diffusion of Innovations*. New York: Free Press.

Sampat, B. N. (2006). "Patenting and US academic research in the 20th century: The world before and after Bayh-Dole". *Research Policy*. 35: 772–789.

Sampat, B. N. (2010). "Lessons from Bayh–Dole". *Nature*. 468: 755–756.

Sampat, B. N., D. C. Mowery, and A. A. Ziedonis (2003). "Changes in university patent quality after the Bayh–Dole Act: A re-examination". *International Journal of Industrial Organization*. 21: 1371–1390.

Scotchmer, S. (2013). "Patents in the university: Priming the pump and crowding out". *The Journal of Industrial Economics*. 61: 817–844.

Shadlen, K. C. (2010). "The puzzling politics of patents and innovation policy in Mexico". *Law and Business Review of the Americas*. 16: 823–838.

Shane, S. (2004). "Encouraging university entrepreneurship? The effect of the Bayh-Dole Act on university patenting in the United States". *Journal of Business Venturing*. 19: 127–151.

Siepmann, T. J. (2004). "The global exportation of the U.S. Bayh-Dole Act". *University of Dayton Law Review*. 30: 209–243.

Sinaga, V. S. (2013). "Intellectual property law in Indonesia after 2001". *Jurnal Mimbar Hukum*. 25: 151–162.

So, A. D., B. N. Sampat, A. K. Rai, R. Cook-Deegan, J. H. Reichman, R. Weissman, and A. Kapczynski (2008). "Is Bayh-Dole good for developing countries? Lessons from the U.S. experience". *Public Library of Science Biology*. 6: 2078–2084.

Solow, R. F. (1957). "Technical change and the aggregate production function". *The Review of Economics and Statistics*. 39: 312–320.

Stevens, A. J. (2004). "The enactment of Bayh–Dole". *Journal of Technology Transfer*. 29: 93–99.

Sweeney, M. (2012). "Correcting Bayh-Dole's inefficiencies for the taxpayer". *Northwestern Journal of Technology and Intellectual Property*. 10: 295–311.

Tahvanainen, A. (2009). "Finnish university technology transfer in a whirl of changes: A brief summary". ETLA Discussion Monographs, No. 1188, The Research Institute of the Finnish Economy (ETLA), Helsinki.

Takenaka, T. (2005). "Technology licensing and university research in Japan". *International Journal of Intellectual Property Law, Economy and Management*. 1: 27–36.

Tassey, G. (2017). "The roles and impacts of technical standards on economic growth and implications for innovation policy". *Annals of Science and Technology Policy*. 1: 215–316.

Thursby, J. G., A. W. Fuller, and M. C. Thursby (2009). "US faculty patenting: Inside and outside the university". *Research Policy*. 38: 14–25.

Thursby, J. G. and M. C. Thursby (2011). "Has the Bayh-Dole Act compromised basic research?" *Research Policy*. 40: 1077–1083.

Trippl, M., H. L. Smith, and T. Sinozic (2012). "The 'third mission' of universities and the region: Comparing the UK, Sweden and Austria". In: *52nd Congress of the European Regional Science Association: Regions in Motion – Breaking the Path*. August 21–25. Bratislava, Slovakia: European Regional Science Association (ERSA), Louvain-la-Neuve.

Tseng, A. A. and M. Raudensky (2014). "Assessments of technology transfer activities of US universities and associated impact of Bayh–Dole Act". *Scientometrics*. 101: 1851–1869.

Tyler III, J. E. (2013). "Redeploying Bayh-Dole: Beyond merely doing good to optimizing the potential in results of taxpayer-funded research". *Journal of Technology Transfer*. 38: 911–929.

UNESCO (United National Educational, Scientific and Cultural Organization) (2015). *UNESCO Science Report: Towards 2030*. Paris: UNESCO Publishing.

Valdivia, W. D. (2011). "The stakes in Bayh-Dole: Public values beyond the pace of innovation". *Minerva*. 49: 25–46.

Valoir, T. (2000). "Government funded inventions: The Bayh-Dole Act and the Hopkins v. Cellpro march-in rights controversy". *Texas Intellectual Property Law Journal*. 8: 211–240.

Zolotykh, N. (2003). "Legal regulation of protection and commercialization of intellectual property created by Russian public research organizations". In: *Turning Science into Business: Patenting and Licensing at Public Research Organizations*. Paris: OECD. 153–166.

Zuniga, P. (2011). "The State of patenting at research institutions in developing countries: Policy approaches and practices". Working Monograph of the World Intellectual Property Organization.