The Government Patent Register: A New Lens on Historical U.S. Government-Funded Patenting[1]

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Abstract: This paper introduces the Register of Government Interest in Patents ("Government Patent Register") as a new administrative data source for measuring U.S. government-funded invention which has been maintained by the USPTO since 1944. We provide an open-source, digitized version of the historical register, which identifies patents resulting from government-funded R&D, the funding agency, and the government's legal interest (title or license). The dataset contains patents to the beginning of the twentieth century—including a large number of patents to which the government had license but not title (assignment), and which cannot be identified from patent text or other sources. Though the physical Register ended in the 1990s, we explain how government-interest patents can be identified in modern administrative data. We use these data to (i) document long-run patterns in government-funded patents and government patent policy, (ii) make comparisons to existing data sources, (iii) describe how these data can be used in research on a wide range of questions, including the determinants and impacts of public R&D and the effects of government patent policy, and (iv) discuss limitations of the data and suggest how those limitations might be overcome in the future.

1. Introduction

Since World War II, the U.S. federal government has been the world's largest funder of research and development. In 2022, the U.S. government spent nearly $200 billion on R&D, and in each year over the postwar era federal R&D expenditures have accounted for between 0.5 and 2 percent of U.S. GDP. Social scientists and policymakers have long sought ways to assess the impacts of federal R&D investments on innovation, jobs, health, security, regional development, and other outcomes. There is significant variation over time in the level and composition of federal R&D funding, including large shocks like the Space Race or the War on Cancer, that could be a source of evidence to inform R&D policy. However, a shortage of granular data linking federal R&D investments to specific outcomes over long horizons has posed challenges for harnessing these opportunities, and data availability has often constrained research to the recent past (the era of electronic records), limiting what has been learned.

In this paper, we introduce a new, long-run, administrative data source on government-funded invention: the Register of Government Interest in Patents (henceforth the "Government Patent Register", "Government Register", or simply "Register"). The Government Register is an official USPTO record identifying patents resulting from government funding, as well as the funding agency and the government's legal interest (title vs. license). Although patents are imperfect proxies for government R&D investment (for reasons we will discuss), they include precise

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information on the timing, geography, and topics of invention, and provide a versatile lens on federal R&D investments across space and time. The value of these data is in enabling research connecting government R&D investments to innovation and other outcomes, within and across technologies, regions, firms, diseases, and more.

The Register data measure more government-funded patents in the pre- and post-World War II eras, and more features of these patents, than can elsewhere be publicly observed. Previous efforts to measure government-funded invention have relied on information in patent text, such as government assignees and government interest statements (e.g., Fleming et al. 2019, de Rassenfosse et al. 2019). However, there are two reasons why this approach may produce an undercount, especially in the mid-twentieth century[2]—an era when federal R&D was growing rapidly and (according to qualitative accounts) was particularly impactful. The first is that prior to the Bayh-Dole Act (1981), different agencies followed different patent policies. Whereas some agencies adopted patent terms under which the government would receive title to inventions resulting from government-funded research, several major R&D funding agencies (including the largest R&D funding agency, the Department of Defense) allowed contractors and grantees to have title, subject to an irrevocable, royalty-free license for government use. The second is that government interest statements (i.e., short text in patent descriptions identifying a government interest in the invention) were not widely required or consistently used in this era.[3] As a result, though government-assigned patents capture inventions funded by "title policy" agencies (where the government retained title), they may miss many of the patents funded by "license policy" agencies (where contractors retained title), and these are not elsewhere consistently observed. The Register overcomes these obstacles with administrative data.

The Register itself traces back to a World War II-era effort to track patented inventions in which the government held legal interest. The Government Register was created in 1944 by President Franklin Roosevelt's Executive Order 9424 ("Establishing in the United States Patent Office a Register of Government Interests in Patents and Applications for Patents"). From the 1940s to the 1990s, the Assignment Branch of the USPTO maintained a physical card index where government-interest patents were recorded, with information on the patent (patent number and issue date, serial number and filing date, title), the inventor and assignor, the funding agency, and the legal interest (title vs. license). As part of recent work on the long-run effects of World War II on U.S. innovation and patenting (Gross and Sampat 2023a), we located these records at the U.S. National Archives (NARA) and digitized their contents, obtaining data on >110,000 unique, issued utility patents with a government interest from >125,000 index cards, including patents as far back as the 1890s. Around 1990, USPTO's Assignment Branch transitioned to electronic records, after which government interests can be measured in the USPTO's Patent Assignment Dataset (Graham et al. 2018). Though our focus in this paper is on the historical record, near the end of the paper we will describe a "Modern" Government Patent Register

[2] Watson and Holman (1964) highlight this point, showing that as of their writing, for every government-funded patent a researcher could observe in assignee data, there were two others which were produced with government funding, most whose government support was not publicly reported—resulting in a significant under-accounting.
[3] Government interest statements are haphazardly reported even today (Rai and Sampat 2012).

which we have compiled from the Patent Assignment Dataset, which can be appended to the “Historical” Register and we include in our accompanying data repository.

The data this paper introduces can be used to analyze a range of questions. Beyond questions around the impacts of federal R&D investment, a complete record of federally-funded patents resulting from both "title" and "license" agencies may also facilitate evaluation of these patent policies themselves. Since World War II, the question of whether the public (i.e. the government) or contractors should hold title to publicly-funded patents has been contended. Although the 1981 Bayh-Dole Act created a uniform federal patent policy shifting all agencies to "license" policies, this continues to be controversial. Historical data on government-funded patenting and innovation under different intellectual property policy regimes, which require a resource like the Register, can help inform these ongoing debates as well.

We proceed as follows. In Section 2, we provide historical background on the Register and on government policy regarding federally-funded patenting since World War II. In Section 3, we discuss the contents of the Register, and the value it adds to existing measures of government-funded patents. In Section 4, we document basic descriptive patterns in the data. In Section 5, we show how the Register data can be combined with modern datasets to create an up-to-date, nearly century-long record of government-funded patents, and providing code and the resulting data. We conclude in Section 6 by discussing potential uses of the data. We also discuss known limitations and gaps in both historical and contemporary data on government-funded patenting, including our own. The online data repository accompanying this paper provides annotated datasets of (i) the historical Government Patent Register (including the funding agency and patent policy) and (ii) more recent government-interest patents.

2. Historical Background

Origins of the Register

Five days after Pearl Harbor, President Roosevelt established a “National Patent Planning Commission” (NPPC) to study various aspects of the patent system—at the time, before the wartime expansion of government R&D funding, “the only provision of the government for the promotion of invention and discovery” (NPPC 1941, p. 7). Among the issues considered was the question of patents the government had rights in—not through extramural research funding, but rather inventions produced by Government employees. The NPPC considered and opined on various questions that would become prominent during and after the war, including whether government-owned patents were desirable at all (or whether publication better promoted the public interest), and the costs and benefits of exclusive licensing of these patents. But it also noted a paucity of information on exactly how many patents the government had rights in to begin with. To that end, it recommended the creation of a “central source” of information on patents where the government held a legal interest.

Among the recommendations of the NPPC was thus that the USPTO compile a list of such patents. Following the NPPC's recommendation, President Roosevelt's Executive Order 9424 (February 18, 1944) created the Government Patent Register:

> WHEREAS there exists among the several executive departments and agencies a need for a more adequate source of information with respect to patent rights and interests owned or controlled by the United States Government; and
>
> WHEREAS the establishment in the United States Patent Office, Department of Commerce, of a separate register for the recording of such patent rights and interests would meet this need and would be in the public interest
>
> …
>
> The Secretary of Commerce shall cause to be established in the United States Patent Office a separate register for the recording of all rights and interests of the Government in or under patents and applications for patents.

Roosevelt's Executive Order also instructed government departments and agencies to forward to the Commissioner of Patents information on any patents (or applications) where the government had rights, including not just those where the government agency was an assignee, but also those that were government-funded but held by grantees or contractors. The Register was to be maintained by the Assignment Branch of the USPTO. Though the Executive Order was issued in 1944, the Assignment Branch also made efforts to backfill the information (Watson and Holman 1964), such that the Register (and the data we collect from it) included patents issued in the 1920s and 1930s, and as far back as 1890.

The Evolution of Government Patent Policy

With the explosion of federal R&D during World War II, most through contracts to universities, research organizations, and private firms, questions over who should own patents resulting from publicly-funded research grew in both importance and prominence.[4] The wartime R&D effort was coordinated through the Office of Scientific Research and Development (OSRD). OSRD funded extramural research at levels unimaginable prior to the war, which often resulted in patentable inventions, and necessitated a policy on patent rights.

The patent terms which OSRD initially wrote into R&D contracts held that the U.S. government would retain title to any patents that resulted from public funding, reflecting a presumption that the fruits of publicly-funded research should belong to the public. However, after concerns that this policy disincentivized participation in wartime research, and reluctance of some firms to engage in OSRD-funded work due to patent rights (see Stewart 1948 or Gross and Sampat 2023b), in 1941 OSRD adopted what became called the "long form" patent clause, which

[4] The last section of the NPPC report discussed this, rejecting any uniform policy, but instead considered "in each situation in accordance with applicable circumstances" (NPPC 1941, p. 24).

allowed its contractors to retain title to patents, provided the government received a royalty-free license for wartime use. Letting contractors keep title to patents, as long as the government had a license for its own use—to prosecute the war—was viewed as a necessary balance. However, for some contracts where the "public interest" required government ownership, a simpler “short form” clause was used, which gave the government presumptive title. This was used in cases where there were no existing capabilities in the private sector (such that the government was funding the creation of new ones), for contracts to academic researchers, and for much of the funding by OSRD’s Committee on Medical Research, in view of its value to public health (Bush letter to NPPC, January 20, 1944). Of the OSRD contracts for which the patent terms are known (88% of all contracts, representing 95% of total obligations), about 67% of these contracts (34% of obligations) were written with the long-form patent clause.

Given the success of the wartime research effort, it was widely recognized that the federal government would continue to be a significant funder of extramural research after the war ended. How, and in what form, was a point of legislative contention. So was patent policy: OSRD’s choices had been controversial, with critics objecting that the long-form clause gave away the fruits of publicly-funded research (Sampat 2020).

Most major legislation for postwar research funding contemplated one major research funder (called the National Research Foundation in some bills, the National Science Foundation in others). While these proposals were mired in Congressional debates over the details—including who should get title to the patents resulting from publicly-funded research—other government agencies absorbed the wartime portfolio. The Public Health Service (PHS) picked up wartime medical research (through the National Institutes of Health, or NIH); the Department of Defense (DoD), military research (e.g., radar); and the Atomic Energy Commission (AEC), research on nuclear fission. The postwar R&D system was thus fragmented, with a large number of research funding agencies, and by the time the National Science Foundation (NSF) was created in 1950, it was a “puny partner” in the overall enterprise (Kevles 1977).

One consequence of this splintering is that each agency evolved its own patent policy “without any central guidance or overall coordination” (FCST 1976, p. 1). As Rebecca Eisenberg (1996) recounts, DoD and NSF had “license” policies similar to OSRD’s long-form clause, where contractors and grantees could retain rights but the government received a royalty-free license. Other agencies, including the AEC (later subsumed by the Department of Energy, or DOE), the Department of Agriculture (USDA), the Department of the Interior (DOI), and the Department of Health, Education, and Welfare (HEW, which included the NIH) had “title” policies under which the government retained title, like the OSRD short-form policy. The National Aeronautics and Space Administration (NASA), founded in 1958, initially had a title policy, but in 1963 shifted to a license policy for most of its patents.[5] Some agencies had no formal policy, and instead “simply ignored the issue … which in effect permitted contractors to retain all rights to inventions” (FCST

[5] In some cases, title policy agencies could be petitioned by contractors for title to patents on a case-by-case basis (or beginning in the 1960s, through Institutional Patent Agreements between funding recipients and agencies). Conversely, inventions from “license” agencies could revert to government assignment if the grantee/contractor chose not to pursue patent protection.

1976, p. 1). One implication is that the Government Register became an essential resource for keeping track of which patents the federal government controlled or had a legal right to use.

Table 1 provides an overview of patent policy by agency over the 1950-1980 period. Debates about title versus license policies continued during this time, similar to the short-form" vs. "long-form" debates in World War II. There were various unsuccessful attempts to create a "uniform" patent policy across agencies, including through President Kennedy's Memorandum on Government Patent Policy in 1963, President Nixon's memorandum in 1971, and through several associated pieces of legislation and executive regulations.

[Table 1 Here]

Uniformity was finally achieved by the 1981 Bayh-Dole Act, which created a uniform "license" policy under which grantees and contractors would own inventions created in the course of publicly-funded research, with the government retaining a license for its own use. Originally limited to universities and small businesses—reflecting persistent concerns about giving away government-funded inventions to large firms—the Act was extended to all recipients of federal R&D funding in 1983 through an Executive Order from President Reagan. Bayh-Dole also required grantees/contractors to include "government interest statements" in the text of patents, which was not uniform (or even common) practice beforehand, and even since then suffers from significant non-compliance (Rai and Sampat 2012).

The history of government patent policy suggests that simply looking at patents assigned to a government agency would miss a large number of government-funded patents, as would searching for government-interest statements in the patent text. In Section 4 we verify this empirically, using information from the Register.

3. The Government Patent Register

Though a few contemporary studies of the Government Register were produced in the 1960s—including several Congressional reports in the 1960s on patenting practices at DoD, AEC, and NASA which consulted the Register to examine patent policy[6]—it has largely been overlooked since. As far as we know, the only previous empirical work using the Register was a series of papers by economists Mary Holman and Donald Watson in this era (Watson and Holman 1964, 1966, 1967), who introduced the Register as "a valuable data source hitherto unexploited" (Watson and Holman 1964), observing that it may contain even more information than what is reported to funders—especially for agencies with "license policies."

These studies, in tandem with Executive Order 9424, revealed to us the Register's existence, and suggested where we might find it: at the USPTO. As Watson and Holman (1964) explain, the Register was maintained by the Assignment Branch of the USPTO, in three sets of index

[6] See, for example, reports of the Joint Committee on Atomic Energy (1959), the Senate Judiciary Committee's Subcommittee on Patents, Trademarks, and Copyrights (1959, 1961), and the House of Representatives' Committee on Science and Astronautics (1966).

cards recording government-interest patents, each with different sequencing (to facilitate manual searching). Though these records were then available at USPTO for public inspection (Crocker 1954), in our research we discovered this is no longer the case. We eventually located these records at NARA, where they were accessioned to its collection of records from USPTO (Group 241, "Records of the Patent and Trademark Office"), in a 174-box set (mis)titled "Index to Patent Assignments by Government Licensees, 1/1/1890-12/31/1955".[7] Appendix Figure A.1 provides the box list. Inspection of the records confirmed that they were the Register, included both government-assigned and -licensed patents, and extended into the 1990s (despite the title claiming 1955). As Appendix Figure A.1 shows, it indeed consisted of three sets of index cards, each with different index sequencing: one in alphabetical order by assignor, one by funding agency, and one by patent number. We picked one of these sets (the first set, by assignor), and digitized its complete contents, with a total of 127,852 index cards.

Figure 1 provides examples from these records, with patents: (i) from the 1940s, 1950s, 1960s, and 1980s; (ii) funded by OSRD, the Army, the Navy, the Air Force, and NASA; and (iii) where the government interest took the form of a title or license on extramural invention, and title to intramural (employee) invention (the latter denoted as "Act of 1883" or "U.S.C. 266"— i.e., 35 U.S. Code Section 266—which were legal statutes which determined government rights in employee inventions).[8] Each index card provides a range of information, including the patent number, filing and issue date, and title; the inventor and assignor (e.g., the grantee or contractor filing the patent); and the specific government interest (title/license).

[Figure 1 about here]

We scanned and transcribed the index cards, and then cleaned and regularized these data, including by: hand-checking the values of numeric fields with non-numeric characters, correcting errors in transcription as well as on the original cards; confirming that all identifying information is internally consistent, and manually resolving inconsistencies; and harmonizing government agency names and spellings, aggregating them up to modern cabinet-level departments where possible (e.g., Army, Navy, Air Force, War Department, National Security Agency all become DoD; AEC becomes DOE; HEW, PHS, NIH all become the modern Department of Health and Human Services (HHS); etc.). In the course of cleaning we drop index cards recording patent applications which were later abandoned, government interest patents at foreign patent offices, design patents, reissues, and a handful of index cards which identified firms that gave the U.S.

[7] The records can be found in the NARA online catalog at https://catalog.archives.gov/id/159071266.
[8] Government rights in employee inventions were first established by legislation in 1883 (P.L. 47-103, 22 Stat. 603, referenced by the Register as "Act of 1883") and amended by legislation in 1928 (P.L. 70-325, 45 Stat. 467), which was written into the U.S. Code at 35 U.S.C. § 266 ("USC 266"). The text of USC 266 stipulated that the U.S. Government would obtain title to all inventions made by Government employees where the invention was made using government resources or resulted from the inventor's official duties. However, the statute also provided exceptions when "the contribution of the Government" was insufficient to justify assignment, or when the Government was deemed to have insufficient interest in the invention. In these cases, title was given to the employee, subject to the provision of a "non-exclusive, irrevocable, royalty-free license" to the Government. Under this framework, the U.S. government could have title or license in employee inventions—explaining why we see both in the Register.

government license to all of their patents for the duration of World War II only, which we think represents public service but not a contractual legal interest. These excluded special cases comprise only a small fraction (3%) of index cards in the Register. We provide both the raw transcribed data and the cleaned data in the accompanying repository.

The first patent in the final working data is U.S. patent number 432,692 ("Ship's Binnacle", issued July 22, 1890 to two inventors in the U.S. Navy), and the last is 5,596,331 ("Real-time Control Sequencer with State Matrix Logic", issued January 21, 1997 to Lockheed Martin), which has no interest statement in the patent text but which the Register indicates is a license patent (to DoD). The associated index cards are shown in Figure 2.

[Figure 2 about here]

The final data we construct from the historical Register include 110,656 unique patents, and identify patents funded by the following agencies (ordered alphabetically by acronym): the Departments of Commerce (DOC), Defense (DoD), Energy (DOE), Interior (DOI), Justice (DOJ), and Transportation (DOT); Environmental Protection Agency (EPA); Department of Health and Human Services (HHS); National Aeronautics and Space Administration (NASA); National Science Foundation (NSF); Department of the Treasury (TREAS); Department of Agriculture (USDA); and Veterans Administration (VA). Some patents are associated with multiple agencies, either because multiple agencies were printed on the card, or (more often) because they had multiple associated index cards with different agencies printed. Of 110,656 patents in the final data, 109,638 (99.3%) have one associated funding agency, 630 (0.6%) have 2+ associated agencies, and 188 (0.2%) have no (or unknown) associated agency.

Table 2 lists the share of patents associated with each agency.

[Table 2 about here]

The data also indicate whether the patent was marked in the Register as a title patent, license patent, employee invention, or unknown (unmarked) interest. Some patents had multiple cards in the index with different recorded interests, or multiple interests recorded on the same card. Table 3 shows the distribution of interests listed for these patents, including all combinations. Patents where both title and license are indicated are ambiguous, and in our analysis below we treat these cases as having an unknown government interest.

[Table 3 about here]

4. Characteristics of Register patents

Patterns in Government-funded Patenting

The Register reveals several hitherto unseen characteristics of government-funded patents. In this section, we share several high-level patterns in the data, noting those which we think raise

or may be useful in studying new research questions. Because the analysis we undertake here provides only a partial lens into the Register, which is rich in variation, at the end of this section we suggest other cuts of the data which might yield intriguing findings.

Our starting point is to use the Register to evaluate the frequency of government-funded patenting. Figure 3(A) shows the share of annual U.S. patent filings from 1930 to 1990 which the Register identifies as government-supported. Contrary to the perception that government-funded technological innovation peaked in the Space Race (1960s), the federal government's share of invention was in fact much higher in World War II, at roughly 11% of USPTO patent filings (see Gross and Sampat 2023). It remained elevated through the early years of the Cold War (1950s) at 5-6%, but has since steadily fallen and by 1990 was under 1.5%—down nearly 80% since the Cold War and 90% since its World War II peak.

[Figure 3 about here]

Figure 3(B) breaks this patenting out by the funding agency. It is immediately apparent that defense technology comprises the vast majority of government-funded patents over this period. DoD-funded patents comprised 75-90% of government-funded patents in every year from 1930 to 1960, but subsequently began to decline (as other agencies, most notably DOE and NASA, and later HHS, began to grow). NASA had its peak share of government-funded patents in 1969 (15%), but was even then only a quarter as large as DoD's share.

One advantage of patent counts (a measure of innovation outputs) at the agency level is that they can be compared to agencies' R&D spending (the inputs), which are available from 1949 onwards.[9] This then allows us to calculate and examine how efficiently (or at what intensity) each agency converts R&D into patented inventions. Though this is inevitably an imperfect metric—not all public R&D yields inventions, patentable inventions, or patentable inventions that patents are taken out on—it can reveal differences and trends. Figure 4(A) shows that in the 1950s, government-funded research produced 4 patents for every $10 million in R&D (in 1990 USD). By the mid-1960s, this patent efficiency had declined to roughly 0.5 patents per $10 million, and by 1990 under 0.25 patents per $10 million. Figure 4(B) shows that whereas DoD, DOE, and HHS were relatively efficient at turning R&D into patents in the 1950s and 1960s, they subsequently converged to the (in)efficiency of other agencies like NASA, NSF, and USDA. One reason may be that these agencies' research programs grew more basic in nature—though we think this unlikely, as defense R&D (as one example) is generally fairly applied, and responsive to mission needs. To us, the evidence in Figure 4 raises questions around what was different in the immediate postwar era and what can be learned from it today.

[Figure 4 about here]

Patterns in Government Patent Policy

[9] See, for example, historical tables accompanying the President's FY2024 budget plan (especially "Table 9.8—Composition of Outlays for the Conduct of Research and Development: 1949–2024"). Available at https://www.whitehouse.gov/omb/budget/historical-tables/.

We can also use the Register to measure the incidence of government assignment and license, both overall and at each agency. Figure 5 does so—building on the work of Watson and Holman (1964), who similarly used the Register (in its state at that time) to document, by hand, patents of title- and license-policy agencies. Figure 5(A) shows that between 1930 and 1960, a plurality (if not outright majority) of government-funded patents were licensed to (rather than owned by) the U.S. government. The title share rises throughout this period, however, and passes 50% in the 1960s, before declining against in the 1980s. After the Bayh-Dole Act was expanded to all federally-funded invention in 1983, patents on which the U.S. government held title were limited to inventions by government employees and to patents which contractors and grantees chose not to file, but the government subsequently did (after first refusal).

Figure 5(B) shows that these patterns are driven by changes in patent policies on DoD-funded patents (an expected result, given their large share of the Register)—to which title and license policies were both applied. Figures 5(C) to 5(E) illustrate the patent policies of DOE, HHS, and USDA, highlighting cross-agency variation. Here we can visibly see DOE and HHS transitioning from title to license, and USDA holding title to most patents it funded throughout the twentieth century, in part because it performed much of its R&D intramurally.

[Figure 5 about here]

Comparisons to Previous Measures

As we discussed in Section 1, previous efforts to measure government-funded patenting have used the text of published patents to do so, via assignees and interest statements (e.g., Fleming et al 2019, de Rassenfosse et al. 2019, USPTO 2023). In examining the Register and what new information it may (or may not) offer, we found it useful to compare against existing measures. In principle, administrative data like the Register may provide more complete, and more precise, measurement than observational approaches which rely on voluntary disclosure or compliance (both of which are incomplete, especially historically) and which are subject to error (both over- and under-classification) in algorithmic approaches to measurement.

We focus our comparisons to the data provided by Fleming et al. (2019), who have produced the longest time-series to date (extending to 1926, using freshly-OCRed patent text, whereas other datasets begin in 1976, when the electronic record begins). To do so, we downloaded the replication data made available by the authors on Harvard's Dataverse, focusing on two files.[10] The first is "uspto.govt.reliance.category.tab", which the documentation describes as "a list of … patents that are reliant on government-supported science," with columns indicating "whether the patent is owned by the government [or] directly acknowledges government support," where the latter is measured via interest statements algorithmically detected in OCRed patent text. The second file is "uspto.govt.reliance.metadata.tsv", which reports patent assignees (obtained by OCR for pre-1976 patents and from PatentsView post-1976; see USPTO 2023), along with several other patent characteristics such as the assignee type (firm, government, individual,

[10] These data files can be found at https://doi.org/10.7910/DVN/DKESRC.

etc.) and likely associated agency (if government-interest), all measured or inferred from patent text. We found several assignee strings in the metadata file indicating additional government assigned patents which were not measured as such in the "category" file—most likely because the text was garbled by OCR, and though (subtly) visible with manual inspection, it was thus not easily detected via algorithmic entity recognition.[11] We identify an additional 3,468 government-assigned patents in this way, adding to the 69,630 already measured. We note that these do not materially change the results of Fleming et al. (2019), but may still be useful in our attempt to improve and extend on historical (and modern) measurement.

We then count government-interest patents in the Register, in the Fleming et al. (2019) data, and in both sources over the 1930-1990 period. We do so for all patents and separately for title and license patents, interpreting the Fleming et al. (2019) measures as indicating title if the patent is government-owned (i.e., has a government assignee), and as license if acknowledging government support (i.e., has an interest statement). We treat patents in each source as title patents if both title and license are indicated, which occurs rarely in the Register (95% of title patents only have title indicated), and frequently in the Fleming et al. data (50% of government-assigned patents are indicated as also having an interest statement).[12]

Figure 6 shows how these sources compare. In short, the administrative data in the Register fill significant gaps in other sources. This is especially the case in the mid-century (through roughly 1970; see Panel A). Panels (B) and (C) reveal why: though the Register and the Fleming et al. data largely overlap in their measures of government-assigned patents, the Register measures many more patents which were contractor-owned and government-licensed. The differences are economically significant: in some years, the Register measures up to 15 times as many license patents as can be measured through patent text alone (i.e., Fleming et al.'s approach)—most likely because interest statements weren't widely used at the time. Casual inspection of a few patents with divergent measures reinforces this interpretation.

[Figure 6 about here]

There are several implications of this very large increase in known government-funded patents in the mid-century. Prior to the collection of these data, the government footprint in technology, for example, was significantly underestimated. These data present more opportunities to study what technology was being developed with public support in this time, and what impacts that has had since—including up until today. Patent productivity of public R&D (e.g., Figure 4) would be significantly underestimated for this period using measures derived from assignments and interest statements alone, and indeed, in separate analysis we have found that it would look quite similar to patent productivity of public R&D today—but with the Register in hand, we can see differences, which raise the questions around what has changed.

[11] For example, the assignee string "assignors to the tjiiited states of a,-,i-,y- ica as represented -@y the united stat,@s atomic ei2er,-y" indicates the AEC, but is not easily algorithmically detected. Assignees such as "henry a wallace secretary of a" also indicate government-owned patents (Henry A. Wallace was Secretary of Agriculture and later Vice President) but are not easily detected.

[12] Interest statements are sometimes found in title patents, explaining that "The invention described herein was made by an employee of the U.S. Government" (or variants thereof).

Though it appears to materially build on existing data sources, the Register likely also has gaps and limits. In particular, the quality of the data depends on adherence to reporting requirements under E.O. 9424 (see Section 1). Our reading of the history, and the data, is that the Register is relatively complete in the mid-century, but its completeness may have begun to decline in the late 1980s and into the 1990s, as evidenced by the rising share of government-interest patents identified by Fleming et al. (2019) not in the Register (Figure 6). Though Fleming et al.'s data could include some false positives, we think these gaps in the later years of the Register are likely real, and in part reflect the Assignment Branch's transition to electronic records—a change we return to in Section 6, where we discuss how the historical Register data can be extended with more recent data. Notwithstanding these potential limitations, we think the administrative accounting and detailed measurement of the Register open up a number of new opportunities for research. We next offer examples of what these might be.

5. Extending the Register with Recent Data

Given that the physical Register peters out in the 1990s (declining from 1,650 patents in 1980, to 870 in 1990, to 264 in 1995) and ends in 1997, a natural question is where it went—how the requirements of E.O. 9424 were met after it ended. If the Register migrated to electronic data, and those data are available, a complete, administrative series of government-funded patents could be constructed from the early twentieth century to the present.

The closest thing to a modern Register is incorporated into the USPTO Patent Assignment Dataset (UPAD). The UPAD is a database derived from records of the USPTO Assignment Branch and provides a researcher-friendly record of "transactions that convey U.S. patents or patent applications between parties" (Graham et al. 2018).[13] In addition to assignments, the UPAD provides records of other transfers of ownership interests, including licenses. For each transaction, these records include the assignor(s), the recipient, and the interest conveyed. The dataset provides both the conveyance text and a "conveyance type" coded by the authors—one of which takes the value "govern" and represents the conveyance of a government interest (title or license). Examining the conveyance text directly, we see many instances of "EXECUTIVE ORDER 9424, CONFIRMATORY LICENSE" and variants thereon, consistent with Graham et al. (2018), who explain that "Assignments … affecting legal title or otherwise pertaining to a patent … required to be filed by Executive Order 9424 are recorded in the Office's assignment records and, with some exceptions, will appear in the UPAD" (p. 348).

[13] Although Graham et al. (2018) note that patent holders are not required to notify USPTO of all transactions, and the UPAD may thus be incomplete, they also note that "parties to a patent conveyance face certain legal incentives to record the transaction at the USPTO"— of which E.O. 9424 is one. Our understanding is that the Executive Order remains in effect, and the records of the Assignment Branch that enter the UPAD are where government interest patents, and the applicable legal interest, would be reported. Despite this, we are not fully confident that the UPAD provides a complete accounting, but we think it is likely to be additive to measures of government-interest patents obtained from patent text, such as those of Fleming et al. (2019). We test this question explicitly in this section.

When recorded in UPAD, government-license patents will generally be identified by this or similar conveyance text. Government-assigned patents will instead have traditional assignment text seen for other transactions (including between private parties), such as “ASSIGNMENT OF ASSIGNORS INTEREST”. Because we seek to build a “modern Register” of title and license patents, we would like to measure both. We began by identifying all assignees (i.e., interest recipients) of conveyances with the text “Executive Order 9424” or “Confirmatory License”, or which Graham et al. (2018) identified as government-interest. We then evaluated this list to specifically identify government assignees in the UPAD, by name, and to associate them to cabinet-level agencies as we did with the historical Register in Section 3. We subsequently retrieved the conveyance text of all conveyances to these entities (including assignments—not just confirmatory licenses), and manually categorized these conveyances as title or license. Putting these pieces together, we are able to classify transactions as (i) conveying interest to a government entity, and (ii) whether that interest is title or license.

This, in short, is our approach to deducing a “modern Register” from the UPAD. We provide our code and output for doing so in the online repository. Though this may seem like a prima facie intuitive approach, and we think the resulting data are precisely measured, there are several reasons why they may not be complete. The most important one is that the sample we produce is limited to entities (e.g., agencies) that had at least one confirmatory license in the assignment dataset: it is only for these entities that we go looking for title patents. We may thus be missing assignees that are not in this sample. However, there are two reasons why we don’t think this is likely to be very limiting: first, a large majority of government-interest patents today are license patents (given the scale of extramural, publicly-funded research and the requirements of the Bayh-Dole Act); second, major/common assignee strings will be picked up in the confirmatory license sample that provides us our starting point. Other reasons why our UPAD-based sample of government-interest patents may be incomplete include the possibility that we (and Graham et al. 2018) have overlooked some government-interest conveyances, as well the (inevitable) possibility of underreporting. Taken in full view, however, we think the approach above will find most of the government-interest patents that are measurable in the UPAD, and it provides us a way to identify title (intramural) and license (extramural) patents.

In Appendix B we provide counterpart figures to Figures 3 to 6 extended to 2014, combining the historical Register with the UPAD-derived modern Register. Appendix Figure B.1 shows the share of annual patent filings which the combined register identifies as government-supported, extending Figure 3; Appendix Figure B.2 shows patents per $10 million in R&D, extending Figure 4; Appendix Figure B.3 shows annual title and license shares of government interest patents, extending Figure 5; and Appendix Figure B.4 compares the Register-based measures against text-based measures of Fleming et al. (2019), extending Figure 6.

Many of the trends in Figures 3 to 6 continue to 2014. There are, however, some exceptions which strike us as interesting and may merit more attention—such as the uptick in DOE and NSF patents per R&D dollar post-1990, or the increase (rather than decrease) in the share of title patents at DoD, when in the post Bayh-Dole era, title shares at other agencies with large extramural research programs dropped to zero (e.g., DOE and HHS).

Juxtaposed against the Fleming et al. (2019) measures, the UPAD-derived modern Register appears to be less complete than the historical Register. This is particularly the case for patents in which the U.S. government has license but not title—reflecting patents in which confirmatory license was not reported to or recorded by the USPTO Assignment Branch but which Fleming et al. identify as having an interest statement in the patent text—and increasingly the case from the 1980s onwards. A third data source, in the form of a PatentsView-produced list of post-1976 patents with government interest statements, reinforces this view.[14] PatentsView's government interest patent list overlaps nearly one-for-one with the Fleming et al. (2019) list of patents that acknowledge government support (indicating that the PatentsView data may be the basis for Fleming et al.'s post-1976 measures). However, only 55% of these patents are present in the extended Register data, and only 50% post-1990. Conversely, too, only 80% of the extended Register's license patents are in the Fleming et al./PatentsView data.

Given their differences, combining these sources (the historical Register, the UPAD-derived modern Register, Fleming et al. 2018, and PatentsView) may enable a more complete account of government-funded patenting than either provides alone, and we think the combined record provides a functional approximation of the universe of government-funded patents which can be used in empirical research going forward. To facilitate future research, we have provided in the online repository a list of all issued U.S. patents with indicators for whether they are present in the historical Register, in the UPAD-derived modern Register, and in the Fleming et al. (2019) data, along with indicators for whether they are observed as title or license patents (in the Register sources) or government-owned or -acknowledging patents (for the Fleming et al. data), as well as the associated funding agencies (where observed). Researchers using these data should cite Fleming et al. (2019) if/when their measures are invoked.

6. Use Cases, Caveats, and Concluding Remarks

The Government Register opens up new opportunities for research on the development and impacts of R&D policy on the U.S. innovation system. A historical lens can not only help us understand the evolution of U.S. innovation: it can also be a source of natural experiments that can inform current practice. There are relatively few sources of longitudinal data on U.S. public R&D investments, beyond broad aggregate data, such as that provided in the NSF's annual "Federal Funds for Research and Development" volume. Moreover, despite recurring debates around government patent policy, and tensions between incentives for firms and scientists to engage in publicly-funded R&D vs. policy goals of securing the benefits of publicly-funded research for the public, the impacts of government patent policy have not been systematically evaluated with government-wide data or examining the rich policy variation in the postwar era. While the downsides of patent data are well-known (among them are that not all patents are inventions, not all inventions are patents, and the propensity to patent can vary across fields and agencies, and over time), patent documents provide rich sources of information on inventive activity. Beyond standard "front page" information (e.g., assignee, class, citations) the

[14] See Jones and Madhavan (2020) for documentation on how the PatentsView data on government interest statements were produced and validated in 2016, and reassessed in 2020.

rich text in patent documents (in-text citations, topics), now extractable through computational advances, may make the Register data even more valuable.

These data could be used to study a range of questions. For example, the Register could be used in research examining the determinants of government R&D investment, or in evaluating its effects on regional or industrial development and its commercial spillovers. Changes in patent policy can also be related to participation in the federal R&D enterprise, the technological fruits of federally-funded research (in the spirit of de Rassenfosse et al. 2019), or commercialization of federally-funded invention. Register data can also be used as a control: in our own previous research examining the long-run effects of World War II research on the U.S. innovation system (Gross and Sampat 2023a), we used Register data to control for patterns of postwar publicly-funded R&D activity by technology class and region. Similarly, the Register may be useful for other historical exercises assessing specific R&D shocks. They are particularly useful in contexts where DoD research activity is the focus, or is a potential confounder: as discussed, standard patent assignment data would severely undercount DoD-financed patenting in the 1950s and 1960s.

The Register data may also be useful in descriptive and/or causal analyses examining how government funded inventions percolate through the innovation system, and the division of labor between the public and private sectors in U.S. innovation. For example, what topics does the government specialize in versus the private sector? How commonly are government-funded inventions novel or disruptive, relative to private sector inventions? How do shocks to agency funding affect government-funded patenting, and what are the effects of these patents on private patenting on similar topics or adjacent regions?

Other important questions relate to the determinants of knowledge diffusion from the public to private sector. The Register is uniquely useful for assessing how patent policies may influence diffusion, since it covers the era (before Bayh-Dole) when there was cross-agency variation in policy. In addition, it tracks both “title” and “license” patents within agencies, which is useful since there were sometimes exceptions to, and procedures to get waivers around, some agencies’ nominal patent policies (Eisenberg 1996). Of course, measuring diffusion, commercialization, and impact is difficult, but new advances in patent data along other dimensions—in particular, access to the full text of patent documents and modern natural language processing tools—may help facilitate such analyses (e.g., Masclans et al. 2023).

Like all patent data, the Register has its limits. Most importantly, it captures patents, not government R&D spending (the input) or inventions (an output of R&D, and input to patents). In addition to the well-known fact that not all inventions are patentable (Griliches 1990), there is likely significant variation in the propensity to patent across agencies and fields and over time. For example, there were historically strong norms against patenting publicly funded medical research, so the Register may provide a distorted lens on NIH investment patterns. In addition, just as there appears to be significant underreporting in government-interest statements today (Rai and Sampat 2012) and even in the “modern” Register data (Graham et al. 2018), there was likely under-compliance with Executive Order 9424 as well. The magnitude of compliance is

unknown historically; for modern Register data it is possible to triangulate information across multiple sources, including government interest statements, assignment data, and disclosure to funding agencies (Rai and Sampat 2012; Graham et al. 2018). Better understanding gaps in compliance with reporting requirements remains an important task for research using modern as well as historical data on government interest in U.S. patents.

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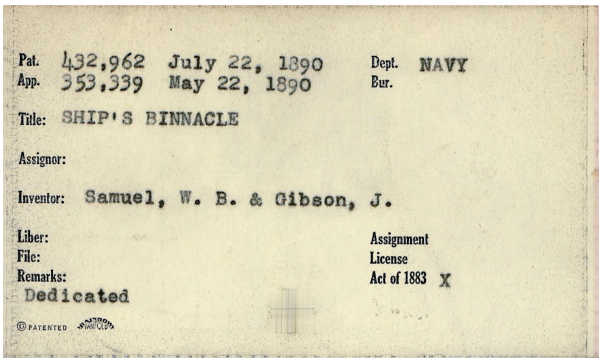
Figures and Tables

Figure 1: Example Government Register index cards

Figure 2: First and last patents in the Register



Pat. 432,962 July 22, 1890 Dept. NAVY
App. 353,339 May 22, 1890 Bur.

Title: SHIP'S BINNACLE

Assignor:

Inventor: Samuel, W. B. & Gibson, J.

Liber: Assignment
File: License
Remarks: Act of 1883 X
Dedicated

© PATENTED

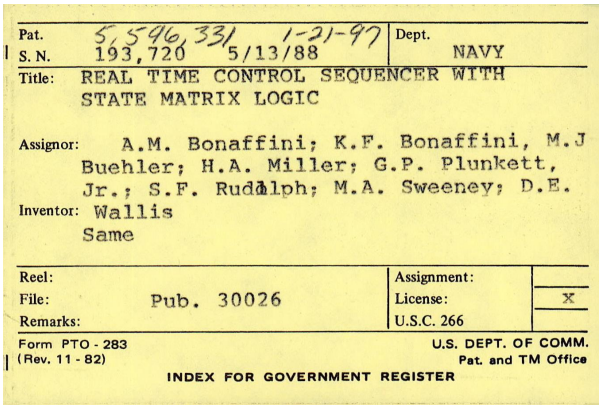
UNITED STATES PATENT OFFICE.

SAMUEL W. B. DIEHL AND JOHN GIBSON, OF THE UNITED STATES NAVY.

SHIP'S BINNACLE.

SPECIFICATION forming part of Letters Patent No. 432,962, dated July 22, 1890.

Application filed May 27, 1890. Serial No. 353,339. (No model.)



Pat. 5,596,331 1-21-97
S. N. 193,720 5/13/88 Dept. NAVY

Title: REAL TIME CONTROL SEQUENCER WITH STATE MATRIX LOGIC

Assignor: A.M. Bonaffini; K.F. Bonaffini, M.J Buehler; H.A. Miller; G.P. Plunkett, Jr.; S.F. Rudolph; M.A. Sweeney; D.E.

Inventor: Wallis
Same

Reel: Assignment:
File: Pub. 30026 License: X
Remarks: U.S.C. 266

Form PTO - 283 (Rev. 11 - 82)

U.S. DEPT. OF COMM.
Pat. and TM Office

INDEX FOR GOVERNMENT REGISTER

United States Patent [19]

Bonaffini et al.

[11] **Patent Number: 5,596,331**

[45] **Date of Patent: Jan. 21, 1997**

[54] **REAL-TIME CONTROL SEQUENCER WITH STATE MATRIX LOGIC**

[75] Inventors: **Andrew M. Bonaffini**; **Kathleen F. Bonaffini**, both of Warrenton; **Michael J. Buehler**; **Hubert A. Miller**, both of Manassas; **Galen Plunkett, Jr.**, Burke; **Sidney F. Rudolph**, Warrenton; **Michael A. Sweeney**, Manassas, all of Va.; **Donald E. Wallis**, Marblehead, Mass.

[73] Assignee: **Lockheed Martin Corporation**, Bethesda, Md.

4,538,239	8/1985	Magar	364/754
4,591,972	5/1986	Guyer et al.	364/200
4,631,666	12/1986	Harris et al.	364/200
4,635,277	1/1987	Blake et al.	375/20
4,639,921	1/1987	Gang et al.	364/900
4,658,253	4/1987	Johnson	340/825.83
4,674,089	6/1987	Poret et al.	364/200
4,677,586	6/1987	Magar et al.	364/900

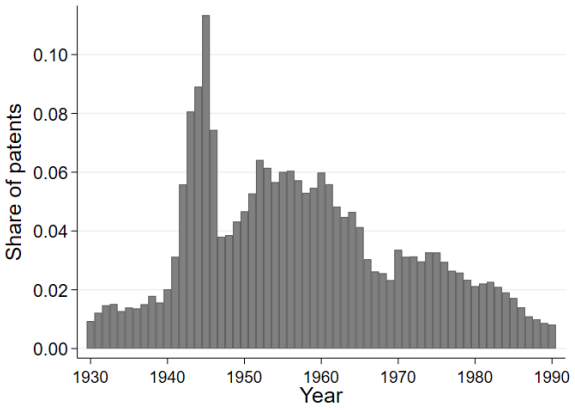
Primary Examiner—Salvatore Cangialosi
Attorney, Agent, or Firm—John E. Hoel; Mark A. Wurm

[57] **ABSTRACT**

A high performance, real-time control sequencer is disclosed which incorporates a unique state matrix logic. This real-

Figure 3: Share of U.S. patents produced with government funding, overall and by agency

Panel (A): Overall



Panel (B): By agency

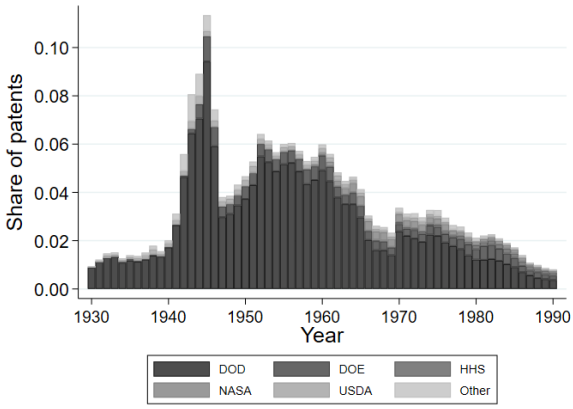
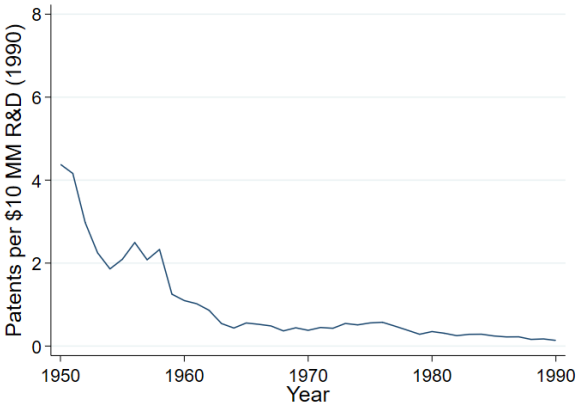


Figure 4: Share of patents and patents per R&D dollar, overall and by agency

Panel (A): Overall



Panel (B): By agency

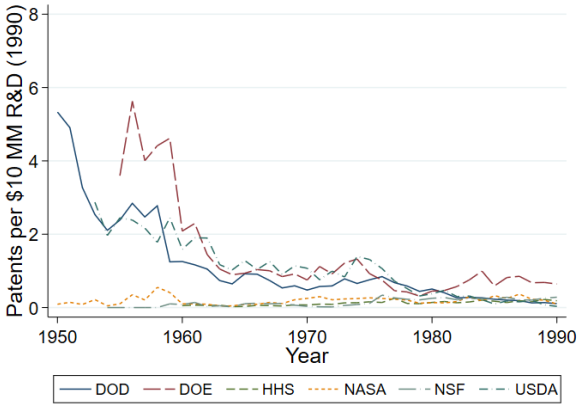
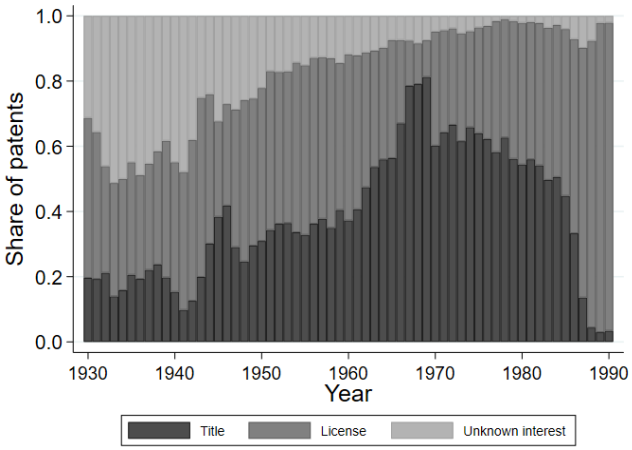
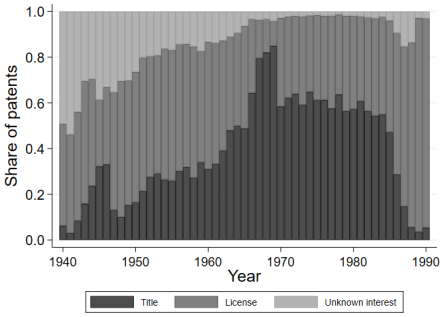


Figure 5: Title vs. license shares

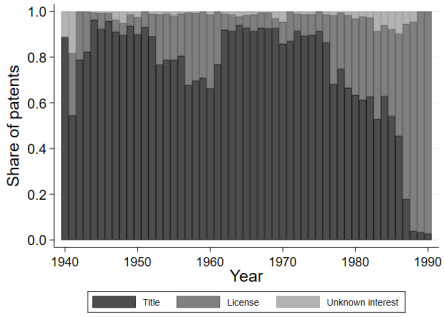
Panel (A): All agencies



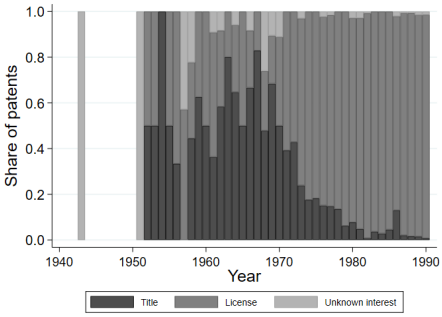
Panel (B): Dept. of Defense



Panel (C): Dept. of Energy



Panel (D): Dept. of Health & Human Serv.



Panel (E): Dept. of Agriculture

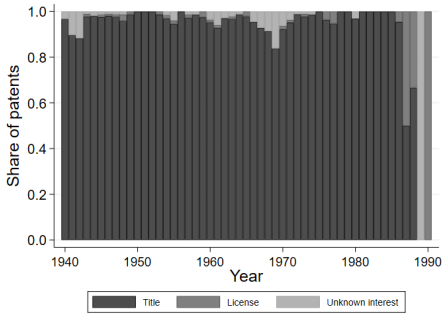
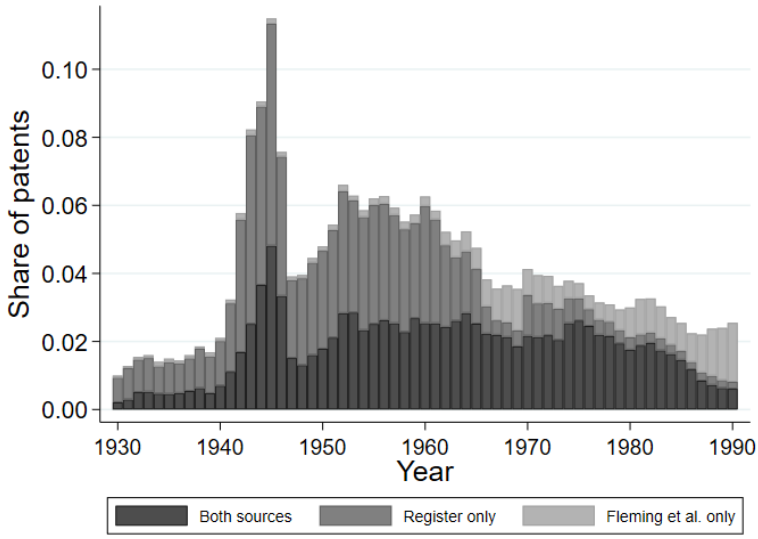
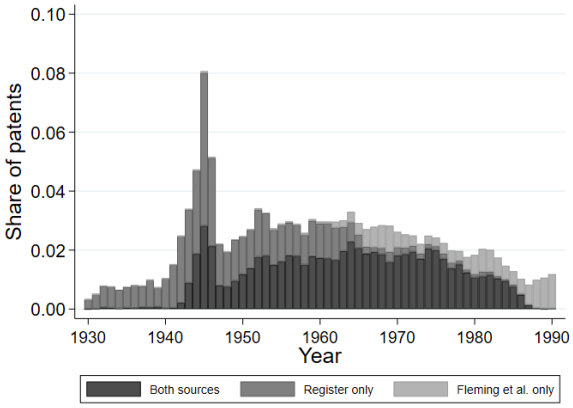


Figure 6: Comparison to Fleming et al. (2019)

Panel (A): All interests (title + license)



Panel (B): Title patents



Panel (C): License patents

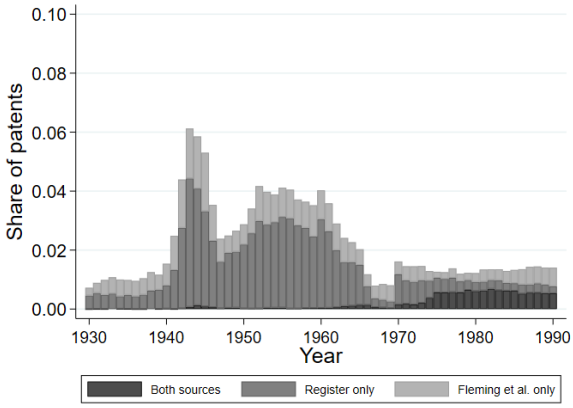


Table 2: Agency shares of Register patents

DOC	DoD	DOE	DOI	DOJ	DOT	EPA
0.7%	74.2%	11.0%	1.2%	0.8%	0.1%	0.1%

HHS	NASA	NSF	TREAS	USDA	VA	Unknown
2.3%	4.3%	0.7%	0.1%	3.7%	0.1%	1.4%

Notes: Agency acronyms are defined as follows. DOC: Department of Commerce. DoD: Department of Defense. DOE: Department of Energy. DOI: Department of the Interior. DOJ: Department of Justice. DOT: Department of Transportation. EPA: Environmental Protection Agency. HHS: Department of Health and Human Services. NASA: National Aeronautics and Space Administration. NSF: National Science Foundation. TREAS: Department of the Treasury. USDA: Department of Agriculture. VA: Veterans Administration. A small fraction of Register patents were associated with other independent agencies, such as the General Services Administration (GSA), Federal Communications Commission (FCC), Federal Maritime Commission (FMC), or the U.S. Postal Service (USPS). Percentages add to slightly over 100% due to a few patents being associated with multiple agencies.

Table 3: Distribution of reported government interest

	All years	Years: 1945-1965			Years: 1965-1985
	Total	Extramural	Intramural	Total	Total
Title (only)	40.2%	22.8%	15.9%	38.7%	61.6%
License (only)	52.9%	43.7%	13.3%	57.0%	33.8%
Both	2.2%	1.1%	1.6%	2.7%	1.8%
Neither	4.7%	0.9%	0.7%	1.6%	2.8%
Total	100%	68.5%	31.5%	100%	100%

Notes: Intramural patents defined as those marked as Act of 1883 or U.S.C. 266 (statutes which assign the government rights to employee inventions).

Supplementary Material

A. Historical Appendix

Appendix Figure A.1: Box List for Register records at the U.S. National Archives

TR-0241-2017-0042 - Patent Assignment - Government Licensees

ACCESSION #: TR-0241-2017-0042		
Patent Assignments Government Licensees (CY1890 thru CY1955) - 174 boxes		
Box #	**First Name or Serial Number**	**Last Name or Serial Number**
Box 1 of 174	A	AK
Box 2 of 174	AL	AN
Box 3 of 174	AP	AZ
Box 4 of 174	B	BEK
Box 5 of 174	BEL	BJ
Box 6 of 174	BL	BRI
Box 7 of 174	BRO	BZ
Box 8 of 174	C	CD
Box 9 of 174	CE	CL
Box 10 of 174	CM	CO
Box 11 of 174	CR	CZ
Box 12 of 174	D	DIE
Box 13 of 174	DIF	DZ
Box 14 of 174	E	EE
Box 15 of 174	EF	EZ
Box 16 of 174	F	FG
Box 17 of 174	FI	FZ
Box 18 of 174	G	GE
Box 19 of 174	GE	GH
Box 20 of 174	GI	GO
Box 21 of 174	GR	GZ
Box 22 of 174	H	HARD
Box 23 of 174	HARE	HE
Box 24 of 174	HI	HS
Box 25 of 174	HU	HZ
Box 26 of 174	I	I
Box 27 of 174	J	J
Box 28 of 174	K	KH
Box 29 of 174	KI	KZ
Box 30 of 174	L	LA
Box 31 of 174	LE	LL
Box 32 of 174	LO	LZ
Box 33 of 174	M	MAR
Box 34 of 174	MAS	McC
Box 35 of 174	McD	MG
Box 36 of 174	MI	ML
Box 37 of 174	MO	MZ
Box 38 of 174	N	NG
Box 39 of 174	NI	NZ
Box 40 of 174	O	O
Box 41 of 174	P	PH
Box 42 of 174	PI	PZ
Box 43 of 174	R	RAL

1

Appendix Figure A.1: Box List for Register records at the U.S. National Archives (cont'd)

TR-0241-2017-0042 - Patent Assignment - Government Licensees

Box 44 of 174	RAM	REE
Box 45 of 174	REF	RI
Box 46 of 174	RO	RZ
Box 47 of 174	S	SC
Box 48 of 174	SE	SL
Box 49 of 174	SM	SP
Box 50 of 174	SQ	STO
Box 51 of 174	STR	SZ
Box 52 of 174	T	TH
Box 53 of 174	TI	UNITED - R
Box 54 of 174	UNITED - S	V
Box 55 of 174	W	WAL
Box 56 of 174	WAM	WER
Box 57 of 174	WES	WESTH
Box 58 of 174	WESTI	WEY
Box 59 of 174	WH	WZ
Box 60 of 174	X - Y - Z	Z
Box 61 of 174	DESIGN FOREIGN-REISSUE	PLANT & HOLDING
Box 62 of 174	ABANDONED	APPLICATIONS
Box 63 of 174	1948	SER
Box 64 of 174	ABANDONED (CONT)	DEDICATED, PLANT etc.
Box 65 of 174	ERDA-ASSIGNMENTS	2,000,000 - 2,999,999
Box 66 of 174	ERDA-ASSIGNMENTS	3,000,000 - 3,599,999
Box 67 of 174	ERDA-ASSIGNMENTS	3,600,000 - S.N. 802,400
Box 68 of 174	ERDA - LICENSES	1,900,000 - S.N. 293,862
Box 69 of 174	AGRICULTURE-USDA-ASSIGN	1,300,000 - S.N. 809,803
Box 70 of 174	AGRICULTURE-USDA-LICENSES	3,600,000 - APP. 419,326
Box 71 of 174	AIR FORCE-ASSIGNMENTS	2,400,000 - 3,699,999
Box 72 of 174	AIR FORCE-ASSIGNMENTS	3,700,000 - S.N. 7/669,256
Box 73 of 174	AIR FORCE - LICENSES	1,500,000 - 2,699,999
Box 74 of 174	AIR FORCE - LICENSES	2,700,000 - 2,899,999
Box 75 of 174	AIR FORCE - LICENSES	2,900,000 - 3,049,999
Box 76 of 174	AIR FORCE - LICENSES	3,050,000 - 3,299,999
Box 77 of 174	AIR FORCE - LICENSES	3,300,000 - 4,199,999
Box 78 of 174	AIR FORCE - LICENSES	4,200,000 - S.N. 08/072,605
Box 79 of 174	ARMY - ASSIGNMENTS	1,300,000 - 2,699,999
Box 80 of 174	ARMY - ASSIGNMENTS	2,700,000 - 3,167,999
Box 81 of 174	ARMY - ASSIGNMENTS	3,168,000 - 3,699,999
Box 82 of 174	ARMY - ASSIGNMENTS	3,700,000 - 4,299,999
Box 83 of 174	ARMY - ASSIGNMENTS	4,300,000 - S.N. 606,742
Box 84 of 174	ARMY - LICENSES	980,000 - 1,899,999
Box 85 of 174	ARMY - LICENSES	1,900,000 - 2,149,999
Box 86 of 174	ARMY - LICENSES	2,150,000 - 2,329,999
Box 87 of 174	ARMY - LICENSES	2,330,000 - 2,411,999
Box 88 of 174	ARMY - LICENSES	2,412,000 - 2,499,999
Box 89 of 174	ARMY - LICENSES	2,500,000 - 2,699,999
Box 90 of 174	ARMY - LICENSES	2,700,000 - 2,999,999

2

Appendix Figure A.1: Box List for Register records at the U.S. National Archives (cont'd)

TR-0241-2017-0042 - Patent Assignment - Government Licensees

Box 91 of 174	ARMY - LICENSES	3,000,000 - 3,999,999
Box 92 of 174	ARMY - LICENSES	4,000,000 - S.N. 6/410,220
Box 93 of 174	NASA - ASSIGNMENTS	2,700,000 - S.N. 105,846
Box 94 of 174	NASA - LICENSES	2,400,000 - S.N. 08/095,930
Box 95 of 174	NAVY - ASSIGNMENTS	1,115,000 - 2,899,999
Box 96 of 174	NAVY - ASSIGNMENTS	2,900,000 - 3,149,999
Box 97 of 174	NAVY - ASSIGNMENTS	3,150,000 - 3,499,999
Box 98 of 174	NAVY - ASSIGNMENTS	3,500,000 - 3,899,999
Box 99 of 174	NAVY - ASSIGNMENTS	3,900,000 - 4,399,999
Box 100 of 174	NAVY - ASSIGNMENTS	4,400,000 - S.N. 7/501,996
Box 101 of 174	NAVY - LICENSES	432,000 - 2,409,999
Box 102 of 174	NAVY - LICENSES	2,410,000 - 2,549,999
Box 103 of 174	NAVY - LICENSES	2,550,000 - 2,749,999
Box 104 of 174	NAVY - LICENSES	2,750,000 - 2,959,999
Box 105 of 174	NAVY - LICENSES	2,960,000 - 3,149,999
Box 106 of 174	NAVY - LICENSES	3,150,000 - 3,999,999
Box 107 of 174	NAVY - LICENSES	4,000,000 - S.N. 08/128,124
Box 108 of 174	DOE - ENERGY - ASSIGNMENTS	3,000,000 - S.N. 567,679
Box 109 of 174	DOE - ENERGY - LICENSES	3,000,000 - S.N. 08/128,124
Box 110 of 174	HEW - HHS	DEPT OF HEALTH ...
Box 111 of 174	INTERIOR	DEPT OF INTERIOR
Box 112 of 174	VARIOUS GOV'T AGENCIES	A - K
Box 113 of 174	VARIOUS GOV'T AGENCIES	L - Z
Box 114 of 174	O.S.R.D ASSIGN - LICENSES	APP 527,364 - 639,139
Box 115 of 174	DESIGN	FOREIGN APPLICATIONS
Box 116 of 174	REVERSIONARY/UNID'D	NO INTEREST (NAVY)
Box 117 of 174	R.F.C. & ARMY	UNIDENTIFIED / Designs
Box 118 of 174	ABANDONED (Ø)	APPLICATIONS (650,000)
Box 119 of 174	ABANDONED (650,000)	APPLICATIONS (800,000)
Box 120 of 174	ABANDONED 1948 & 1960	SERIES FORFEITED
Box 121 of 174	ABANDONED (567)	1948 SERIES (400,000)
Box 122 of 174	PATENTS	400,000 - 1,749,999
Box 123 of 174	PATENTS	1,750,000 - 1,949,999
Box 124 of 174	PATENTS	1,950,000 - 1,989,999
Box 125 of 174	PATENTS	1,990,000 - 2,259,999
Box 126 of 174	PATENTS	2,260,000 - 2,349,999
Box 127 of 174	PATENTS	2,350,000 - 2,399,999
Box 128 of 174	PATENTS	2,400,000 - 2,429,999
Box 129 of 174	PATENTS	2,430,000 - 2,457,999
Box 130 of 174	PATENTS	2,458,000 - 2,489,999
Box 131 of 174	PATENTS	2,490,000 - 2,529,999
Box 132 of 174	PATENTS	2,530,000 - 2,569,999
Box 133 of 174	PATENTS	2,570,000 - 2,614,999
Box 134 of 174	PATENTS	2,615,000 - 2,664,999
Box 135 of 174	PATENTS	2,665,000 - 2,709,999
Box 136 of 174	PATENTS	2,710,000 - 2,749,999
Box 137 of 174	PATENTS	2,750,000 - 2,789,999

3

Appendix Figure A.1: Box List for Register records at the U.S. National Archives (cont'd)

TR-0241-2017-0042 - Patent Assignment - Government Licensees

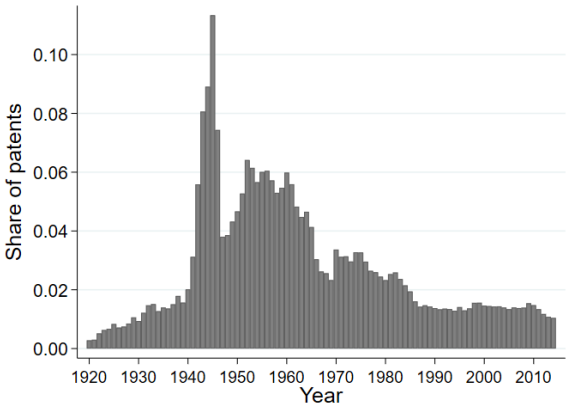
Box 138 of 174	PATENTS	2,790,000 - 2,826,999
Box 139 of 174	PATENTS	2,827,000 - 2,859,999
Box 140 of 174	PATENTS	2,860,000 - 2,896,999
Box 141 of 174	PATENTS	2,897,000 - 2,934,999
Box 142 of 174	PATENTS	2,935,000 - 2,969,999
Box 143 of 174	PATENTS	2,970,000 - 3,002,999
Box 144 of 174	PATENTS	3,003,000 - 3,039,999
Box 145 of 174	PATENTS	3,040,000 - 3,084,999
Box 146 of 174	PATENTS	3,085,000 - 3,133,999
Box 147 of 174	PATENTS	3,134,000 - 3,179,999
Box 148 of 174	PATENTS	3,180,000 - 3,229,999
Box 149 of 174	PATENTS	3,230,000 - 3,284,999
Box 150 of 174	PATENTS	3,285,000 - 3,332,999
Box 151 of 174	PATENTS	3,333,000 - 3,389,999
Box 152 of 174	PATENTS	3,390,000 - 3,449,999
Box 153 of 174	PATENTS	3,450,000 - 3,520,999
Box 154 of 174	PATENTS	3,521,000 - 3,619,999
Box 155 of 174	PATENTS	3,620,000 - 3,709,999
Box 156 of 174	PATENTS	3,710,000 - 3,779,999
Box 157 of 174	PATENTS	3,780,000 - 3,869,999
Box 158 of 174	PATENTS	3,870,000 - 3,939,999
Box 159 of 174	PATENTS	3,940,000 - 3,999,999
Box 160 of 174	PATENTS	4,000,000 - 4,069,999
Box 161 of 174	PATENTS	4,070,000 - 4,149,999
Box 162 of 174	PATENTS	4,150,000 - 4,219,999
Box 163 of 174	PATENTS	4,220,000 - 4,299,999
Box 164 of 174	PATENTS	4,300,000 - 4,399,999
Box 165 of 174	PATENTS	4,400,000 - 4,499,999
Box 166 of 174	PATENTS	4,500,000 - 4,599,999
Box 167 of 174	PATENTS	4,600,000 - 4,699,999
Box 168 of 174	PATENTS	4,700,000 - 4,799,999
Box 169 of 174	PATENTS	4,800,000 - 4,899,999
Box 170 of 174	PATENTS	4,900,000 - 5,099,999
Box 171 of 174	PATENTS	5,100,000 - 5,349,999
Box 172 of 174	PATENTS	5,350,000 - 5,573,999
Box 173 of 174	PATENTS	5,574,000 - 6,413,999
Box 174 of 174	DESIGN - H SERIES	T SERIES (Design)
Box ___ of ___		
Box ___ of ___		
Box ___ of ___		
Box ___ of ___		
Box ___ of ___		
Box ___ of ___		
Box ___ of ___		
Box ___ of ___		
Box ___ of ___		
Box ___ of ___		

4

B. Extended Descriptives, 1920-2014, using "Modern Register" Data

Figure B.1: Share of U.S. patents produced with government funding, overall and by agency (extension of Figure 3 to 1920-2014)

Panel (A): Overall



Panel (B): By agency

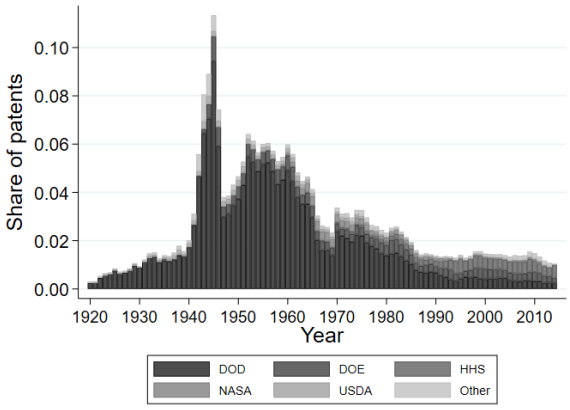
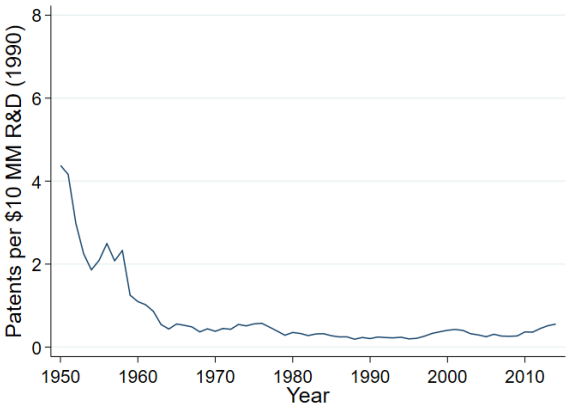


Figure B.2: Share of patents and patents per R&D dollar, overall and by agency (extension of Figure 4 to 1920-2014)

Panel (A): Overall



Panel (B): By agency

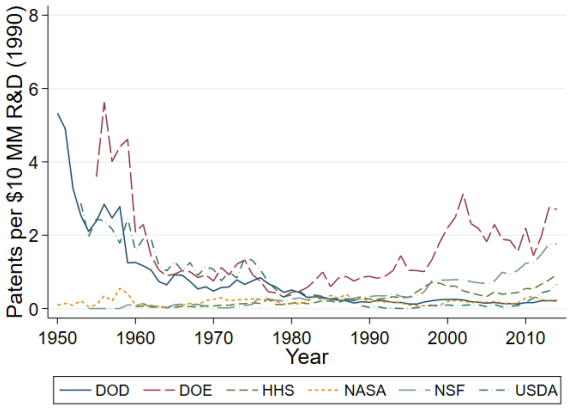
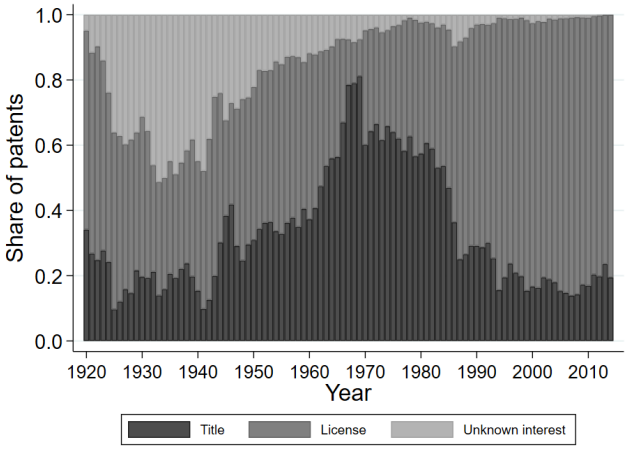
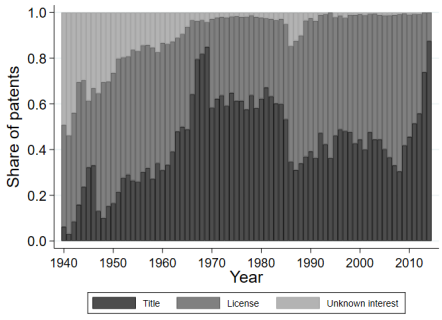


Figure B.3: Title vs. license shares
(extension of Figure 5 to 1920-2014)

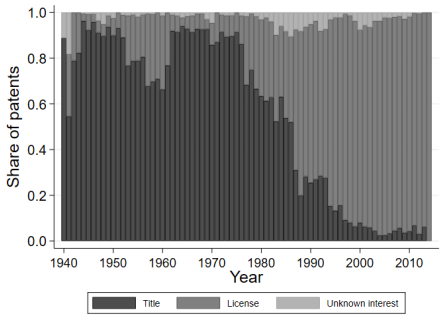
Panel (A): All agencies



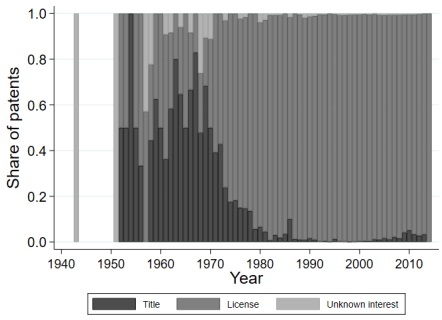
Panel (B): Dept. of Defense



Panel (C): Dept. of Energy



Panel (D): Dept. of Health & Human Serv.



Panel (E): Dept. of Agriculture

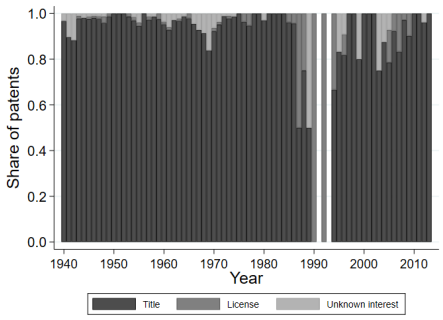
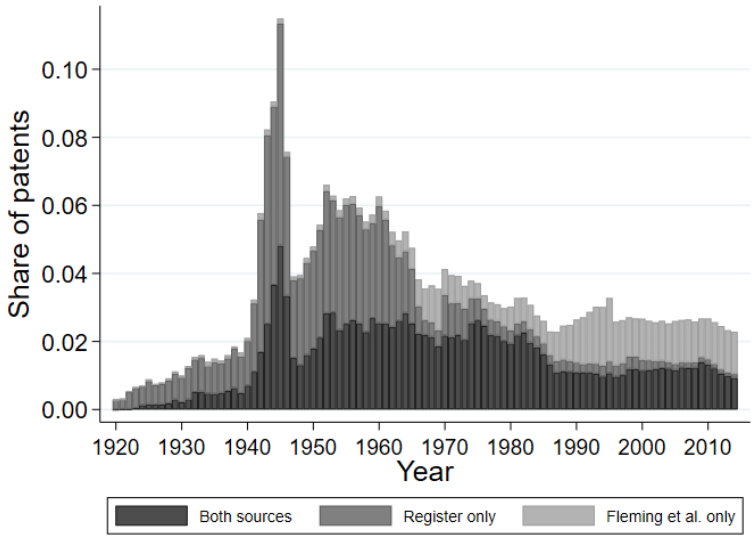
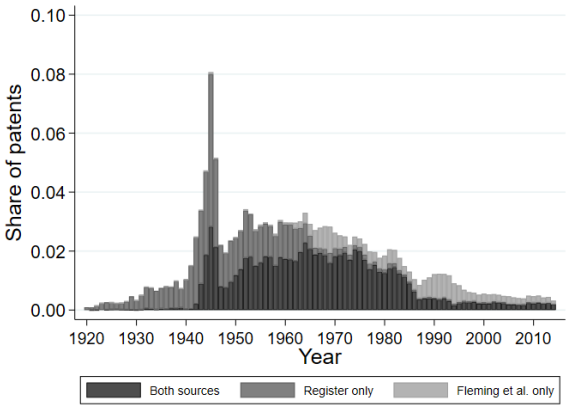


Figure B.4: Comparison to Fleming et al. (2019)
(extension of Figure 6 to 1920-2014)

Panel (A): All interests (title + license)



Panel (B): Title patents



Panel (C): License patents