Science and Public Policy, 46(1), 2019, 71–80
doi: 10.1093/scipol/scy038
Advance Access Publication Date: 24 April 2018
Article

OXFORD

Research funding's 'endorsement effect' on scientific boundary work and research production: Government legitimization of alternative medicine

Ryan Whalen*

University of Hong Kong, Faculty of Law, Room 5.05, Cheng Yu Tung Tower, Pokfulam, Hong Kong

*Corresponding author: whalen@hku.hk

Abstract

This article demonstrates how science and technology policy can have an 'endorsement effect' that legitimizes and increases the salience of scientific research areas. The validation and increased attention provided by state funding policies can support the discursive boundary work of interested parties as they seek to situate research fields within mainstream science. Increased validity and attention can subsequently lead to increased research activity, above and beyond that funded by the state. This article demonstrates the endorsement effect by examining how the founding of the NIH's Office of Alternative Medicine affected both the discourse surrounding the legitimacy of alternative medicine, and the production of alternative medicine-related patents. The existence of this endorsement effect suggests that policymakers should consider both the direct effects that innovation policy might have on researchers' incentives as well as the endorsement effects it can have on the research system.

Key words: innovation policy; research funding; policy evaluation; patent policy; endorsement effect; alternative medicine.

1. Introduction

Post-WWII innovation policy has largely been premised on the notion that governments can influence scientific and technological development by funding areas of strategic importance (Nelson and Rosenberg 1993; Bernanke 2011). Much of this funding takes the form of research grants from national funding agencies. For instance, in the USA, the National Institutes of Health (NIH)—the largest of the federal funding agencies—disbursed over $30 billion in funding in 2016. For the most part these funds originate in grants that are administered by the various institutes, centers, and offices that constitute the NIH.

The way these funding dollars are disbursed, and how impactful the associated research projects are, is subject to evaluation at numerous points during the funding application and research processes. Indeed, innovation policy more generally has been no exception to the general trend towards increasing accountability and policy evaluation that has accompanied the 'new public management' movement in public administration (Arnold 2004). However, when examining the state's ability to guide innovation, researchers, and policymakers often focus rather narrowly on the direct outcomes of isolated policies that attempt to set specific innovation incentives. That is to say, when examining the efficacy of funding decisions, scientists, bureaucrats, and policymakers tend to focus on the additional output generated as a direct result of the provision of research funding (Georghiou 1998). This focus on outcomes and the return attained when public dollars are invested in research funding is an instance of the more general trend towards evidence-based policymaking. However, this ROI-centric approach runs the risk of overlooking more general effects that the state can have on the innovation ecosystem. State choices to fund certain areas of research affect not only those who receive the funds but also those who aspire to do so. These choices send implicit signals about the importance and validity of the funded research areas. For instance, research policy campaigns such as the space race or war on cancer led to increases in directly funded research, but also almost certainly contributed to an increased overall profile and sense of legitimacy for both space and cancer-related research. Especially when dealing with emerging or contentious scientific areas, the state's role as research funder may be interpreted as a voice of authority, effectively endorsing areas of research and helping to set an innovation agenda.

This article will introduce the 'endorsement effect' by first briefly discussing innovation policy's background and how policymakers assess the effectiveness of their policies. It will then turn to the

effects that research funding decisions can have on the discourse surrounding scientific validity and how this can influence the way researchers choose to direct their research attention. The following section will subsequently use the example of the founding of the Office of Alternative Medicine to empirically demonstrate how funding priorities can affect the way individuals perceive the boundaries around what is and what is not legitimate science, and ultimately how these priorities may lead to an increase in R&D behavior above-and-beyond that which results directly from research funding programs.

2. Background

States have long tried to actively manage and encourage scientific and technical innovation. For instance, patent law regimes represent legal frameworks that encourage the production of new inventions, providing limited monopolies to inventors in exchange for the disclosure of their ideas. While patent law represents a 'pull' policy providing incentive for innovators to invest in R&D, state sponsored research funding represents a 'push' policy, encouraging researchers to investigate scientific areas prioritized by funding authorities. In most countries, innovation policy has evolved into multifaceted legal and regulatory regimes that seek to influence the increasingly complex innovation systems that exist in developed economies (Arnold 2004). Contemporary innovation policy instruments can be categorized into three broad types: regulatory instruments, economic and financial instruments, and soft instruments. Each of these types of policy instruments can be used to promote or guide scientific and technical innovation in a variety of ways. For example, regulatory instruments include legal frameworks such as intellectual property regimes, tax codes, and labour laws. Economic and financial instruments include public loan guarantees, and funding grants. Soft instruments seek to guide behaviors through non-monetary and non-regulatory manners. Examples include public information campaigns, science fairs, and voluntary technical standards (Borrás and Edquist 2013).

This article focuses on exploring how 'hard' economic and financial instruments can also have 'soft' instrument style effects on the innovation system. It does so by examining how policy decisions about research funding—and the attendant bureaucracy—can affect perceptions of a research field's importance and validity, and subsequently influence the production of new products and ideas associated with that field. Because in most jurisdictions research funding is tied to annual budget allocations, it is one of the more changeable dimensions of innovation policy. It is commensurately more political, leading to contentious debates about which areas are deserving of research funding, and which areas might deserve to have their funding reduced or cut entirely. Because of its changeable and politicized nature, it is important that policymakers understand how research funding decisions may affect innovation, not only in the traditional direct outcomes focused approach, but also from a more holistic perspective.

Research funding is traditionally considered a hard policy instrument that uses both actual funds, and the promise of funding potential to influence researcher behavior and promote research in desired areas (Laudel 2006). As such, its efficacy is usually assessed using the traditional ROI or 'additionality' perspective (Georghiou 2002). That is, when determining how effective a particular grant was, we ask to what degree the research funding generated valuable knowledge, or led to research output that, but for the funding, would not otherwise have occurred.

Although determining the additionality attained by research funding decisions is important, focusing exclusively on these direct outcomes runs the risk of ignoring other effects that funding decisions can have. If the decisions that researchers make about where they should invest their R&D resources were informed solely by economic factors, perhaps this sort of direct-outcome-oriented policy assessment approach might be sufficient. However, we know that there are a variety of non-economic factors that influence the way researchers choose the topics that they focus their research energy on. The scientific or technical areas that researchers consider worthy of their time, and the questions they consider important are determined at least in part by their scientific perspective or the 'paradigm' that they inhabit (Kuhn 1970).

There is a wide body of literature exploring how researchers are affected by social factors that extend beyond simple economic incentives or questions of scientific merit. Kuhn (1970) famously argued that, rather than representing a naturalistic progression of knowledge from one objective truth to another, science—and thus the scientific problems that researchers consider important—is paradigmatic, and is therefore inescapably subjective in some regards. Like the evolution of science, the evolution of innovation more generally is similarly not an objective linear progression from one development to another. Rather, innovation occurs within complex interdependent systems that are constituted by individuals, firms, universities, and governments (Nelson and Rosenberg 1993; Etzkowitz and Leydesdorff 2000). One of the implications of science and technological development's non-linearity is that scientific elites and other authorities exert influence on which research areas are seen as legitimate or important (Hart and Victor 1993; Frickel et al. 2010).

Certainly, some of the influence that authorities have on the promotion or legitimization of scientific fields comes by way of financial policy instruments mentioned above, and these bear assessment from an additionality perspective. However, these funding decisions also have an element of the soft policy instrument to them. Funding programs express implicit endorsement of the research areas that they opt to fund. In doing so, they have the potential to increase the visibility, denote the importance, and validate the legitimacy of specific scientific or technical research areas. This type of soft influence that research funding can have is rarely explicitly considered by policymakers, and is under-theorized by scholars of science and innovation.

I refer here to this soft influence that otherwise hard incentives can have on the research landscape as an 'endorsement effect' which I define as: the legitimizing and salience-increasing effects that research funding policies can have by way of tacitly endorsing specific research areas. By implicitly endorsing the scientific validity of the underlying field, research funding decisions can affect the discourse surrounding scientific legitimacy. This is significant because the perceived legitimacy—or non-legitimacy—of research areas does not arise from some objective ground truth. Rather, the distinction between what is scientific and what is non-scientific is discursively constructed through the 'boundary work' of interested parties as they seek to further their professional goals (Gieryn 1983). Gieryn defines boundary work as 'the discursive attribution of selected qualities to scientists, scientific methods, and scientific claims for the purpose of drawing a rhetorical boundary between science and some less authoritative residual non-science' (1999: 4–5). Boundary work arises in relation to research funding policies as many of the

associated activities—and indeed the very presence of research funding at all—can be pointed to as some of those 'selected qualities' that suggest a research area is within the boundaries of mainstream science.

In order to more fully understand the nuanced ways that research funding policies can affect innovation systems, we need to more thoroughly study the endorsement effect. Doing so will require in depth and multi-faceted research projects that seek to tease out the ways in which funding decisions affect both the legitimacy and salience of specific scientific and technical fields. In order to study the legitimizing effect of research funding decisions, scholars will need to analyze the relationship between new funding initiatives and emerging scientific fields. For instance, studies of how funding programs contributed to legitimizing boundary work related to emerging fields like climate science, or genetic modification, could help us better understand how research funding policies can influence the perceived legitimacy of scientific fields. To measure changes in salience that accompany new research funding programs, scholars can study both changes in the production of research and related products, as well as changes in markets related to the field in question. For instance, tracking changes in the production of (non-funded) research papers related to a field would help us better understand how the endorsement effect might influence how researchers choose their research questions. Similarly, changes in related markets following the introduction of research funding opportunities in a given area could contribute to our understanding of how the endorsement effect influences consumer and firm behavior.

In addition to positing the existence of the endorsement effect, this article will carve off a small piece of this larger research agenda by examining the relationship between changes in research funding and the legitimization and salience of a scientific subfield. The endorsement effect has the greatest potential to affect the boundary work that discursively delineates legitimate and non-legitimate research fields when the funding can be perceived as endorsing a field with contested validity. For instance, because of its well-established reputation, choosing to fund research into radiation therapy as cancer treatment is unlikely to do much to move the needle on that particular medical sub-discipline's perceived validity. However, choosing to fund research on a more contested field, such as those considered part of 'alternative medicine', is likely to have a more pronounced effect on the discourse surrounding alternative medicine's validity. For this reason, I focus below on exploring how the choice to establish the Office of Alternative Medicine under the auspices of the NIH had an endorsement effect on alternative medicine, leading to increased boundary work attempting to validate the field as well as increased alternative medicine research and development activity.

3. The Office of Alternative Medicine

The Office of Alternative Medicine (OAM)—later known as the National Center for Complementary and Alternative Medicine (NCCAM), and now the National Center for Complementary and Integrative Health (NCCIH)—was founded in 1991. Joseph Jacobs (1995), the initial director of the Office, described it as the 'brainchild of Senator Tom Harkin' (p. 40) of Iowa. At the time, Senator Harkin served as the chair of the Senate Labor–HHS–Education appropriations subcommittee and was thus able to exert significant influence on NIH research policy. Harkin believed his allergies had been cured after taking 250 bee pollen capsules in the span of 5 days, and thereafter became a 'true believer' in alternative medicine's potential (Young 1998: 279).

Inspired by his interest in alternative medicine, and empowered by his position as chair of the appropriations subcommittee, Harkin sponsored the law that directed the NIH to establish the Office. At the time, many doctors, scientists, and NIH insiders felt that the Office was an example of undue political interference in science policy. After her resignation, the NIH director at the time expressed deep reservations about the project, but explained that she had no choice but to follow through on its development because 'the agency could not refuse a mandate from Congress' (Young 1998: 281).

The Office had a rocky beginning, with its first director resigning after expressing concern about what he felt was political meddling in questions that were scientific in nature, accusing policymakers of 'attempting an end run around objective science' (Marshall 1994: 2000). However, despite its shaky start, the Office's budget increased regularly rising from the initial appropriation of $2 million, to recent funding levels around $125 million. Much of this increase came as the OAM transitioned from an office to an NIH center in 1998 (Fig. 1).

Despite the fact that the OAM had been founded and funded, policymakers had a hazy understanding of what exactly alternative medicine was (Eskinazi 1998). Alternative medicine is a broad set of treatments, philosophies, and approaches to medical science that is often defined more by what it is not rather than by what it is. Eisenberg et al. (1993) define alternative medicine as 'medical interventions not taught widely at U.S. medical schools or generally available at U.S. hospitals' (p. 246). This however is a shifting definition as the curriculum at medical schools and treatment availability at hospitals change over time. In fact, the founding of the OAM coincided with an increase in the number of universities offering alternative medicine training to their MD students (Jacobs 1995), immediately complicating the Eisenberg et al. definition.

Eskinazi (1998) frames the definition explicitly as a tension between dominant and non-dominant health care models, stating that alternative medicine is 'a broad set of health care practices ... that are not readily integrated into the dominant health care model, because they pose challenges to diverse societal beliefs and practices (cultural, economic, scientific, medical, and educational)' (p. 1622). This too is a somewhat shifting definition as social beliefs and practices change over time, but is less subject to rapid changes than the Eisenberg definition.

For the purposes of this article, I focus on a relatively narrow set of alternative medicine topics. They are topics drawn from discussions that surrounded the founding and development of the OAM, and as such provide insight into that how the Office understood alternative medicine.

The topics focused on[1] below were all mentioned as potential research areas in discussions about the OAM's focus around the time of its founding. Reflecting on the founding of the OAM, the inaugural Director included acupuncture, chicropractic treatment, taichi, and ayurveda as potentially promising alternative therapies (Jacobs 1995). Others discussed homeopathy, naturopathy, and reiki or energy healing as alternative medical areas currently in vogue and within the new OAM's mandate (Eisenberg et al. 1993; Marshall 1994).

The nature of the OAM's origins as the brainchild of a politician rather than the product of scientific demands helps provide insight into how federal funding signals can affect research and development investments. The OAM's founding was largely independent of changes in the science or technology surrounding alternative

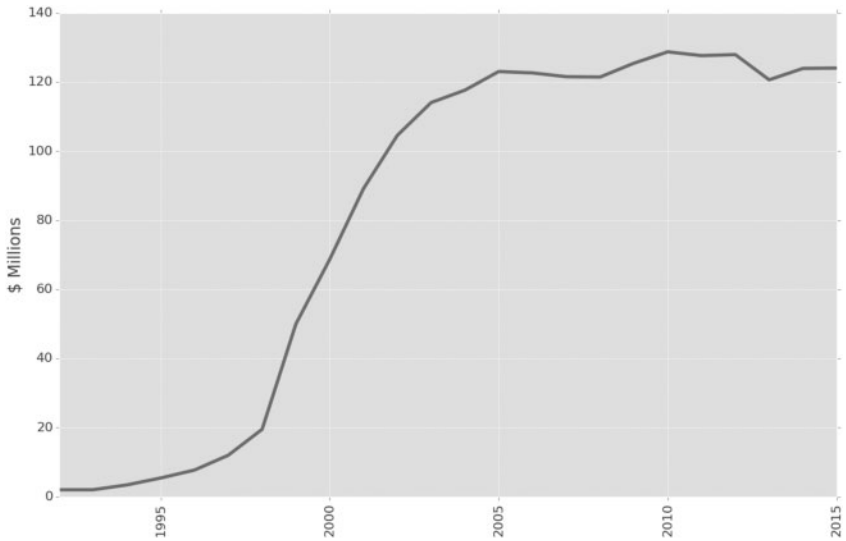

Figure 1. OAM, NCCAM, NCCIH appropriations history (NIH 2015).

medicine. Indeed, alternative medicine's roots in traditional medical practices meant that, prior to the Office's founding, it had long remained relatively unchanged. When innovation policymakers increase funding in a research area following an important discovery or break through, it is difficult to distinguish how much of the subsequent increase in research is due to policy changes, and how much is due to substantive changes to the research field. Because it arrived independent of any scientific or technical advances in alternative medicine, the founding of the OAM largely avoids this potential confound. The Office's founding thus provides an intervention that we can use to better understand how official actions that can be perceived as an endorsement of a marginal scientific area affects boundary work that attempts to demarcate valid research fields, and ultimately how it may affect research behavior.

4. The OAM, medical science boundary work, and research output

Founding and funding the OAM surely had a wide variety of effects on the alternative medicine research landscape. I focus here on those effects that are most likely to have gone overlooked by policymakers considering the impact of funding the OAM. Certainly, the advent of a new research office—and eventually full-fledged center—at the NIH, and the earmarking of new research dollars would have led to some increase in alternative medicine research activity. Indeed, this role in increasing research activity was largely what policymakers intended the Office to do. However, the focus here is on the soft instrument effects that founding the Office may have had. The below explores this in two parts. The first examines how the founding of the Office, and its subsequent activities, were used as rhetorical ammunition by those engaging in boundary work that attempted to define valid medical research. The subsequent section examines how the validation of alternative medicine as a research field coincided with increased research activity, above and beyond that funded by the OAM.

4.1 The OAM and medical science boundary work

Shortly after its founding, the OAM began to feature frequently in the discourse surrounding alternative medicine and its validity. Those wishing to see alternative medicine become considered a valid part of mainstream medical science were encouraged by the OAM's existence. However, these individuals rarely pointed to high-quality empirical evidence to support their claims, because frankly, especially in its early years, the OAM provided little in the way of empirical evidence to support the causes of alternative medicine boosters. Nonetheless, that did not stop many supporters from drawing support from the OAM. They would point to its mere existence as validation, suggesting that federal funding, especially from an organization as respected as the NIH, would not be granted were alternative medicine not valid and effective. The OAM's mere existence, along with the conferences it organized, books published by affiliates, increasing media coverage due to its visibility, and the funding of alternative medicine research projects all combined to provide signals and rhetorical ammunition that could be used by those engaging in boundary work attempting to situate alternative medicine within the mainstream.

Gieryn (1999) defines boundary work as 'the discursive attribution of selected qualities to scientists, scientific methods, and scientific claims for the purpose of drawing a rhetorical boundary between science and some less authoritative residual non-science' (p. 4–5). Shortly after the NIH received funding to establish the OAM, individuals began to point to the OAM's existence and the associated federal funding for alternative medicine research, as one of those 'selected qualities' that implies scientific validity. The subtext in many of these discursive forays is that: 'one can see that alternative medicine is a valid and increasingly mainstream component of modern medical science, because the NIH has created an official office focused on researching it.' For instance, when discussing alternative medical treatments, one contemporary newspaper article noted that '[e]ven the National Institutes of Health has established an Office of Alternative Medicine, whose very existence would seem to indicate the popularity and potential of alternative therapies' (Kadaba 1994: C01). Meanwhile, medical professionals wrote editorials arguing that founding and funding the OAM was 'a recognition that complementary and *alternative medicine is a valid and powerful force*' (Ellis and Zilko 2008: 14, emphasis added), and that the funding would help alternative medicine 'gain the respectability it deserved' (Gilbert 1993: 23).

The existence of funding not only attracted 'new researchers like bees to honey' but it also lent 'credibility to the ones already plugging away' suggesting that the mere existence of federal research funding acted as a signal of the field's validity and importance (Ochs 2001: C3). Doctor David Eisenberg argued that this funding had changed perceptions of alternative medicine, moving it closer to the mainstream and thereby reducing the once 'high academic price to be paid' for researching these once marginal treatments (Ochs 2001: C3). This trend of seeking validation for alternative medical fields extended widely. Even believers in fields as distantly removed from mainstream medical science as reincarnation found support in the founding of the OAM, titling their 1995 annual conference 'Into the Mainstream' and seeking out 'reputable MDs' as keynote speakers, including the Director of the OAM (Rosenfeld 1995: D1).

While some were arguing that the founding of the OAM and its affiliated funding brought respectability to alternative medicine, others suggested that the OAM was ushering in not simply an increase in alternative medicine research, but a 'revolution' that would lead to a 'paradigm shift' and a new era for medical science (Martyn 1995: C9). Doctor Wayne Jonas, Director of the OAM in the late 1990s, stated that '[w]e're going toward a new kind of medicine' integrating conventional and alternative practices (McKenna 1997a: D2). Similarly, Doctor David Eisenberg, a prominent alternative medicine researcher who received funding for alternative medicine conferences, argued that the surge in attention represented a 'historic transition' and that the alternative medicine 'field is beginning to come into its own' (McKenna 1997b: C3).

While the founding of the OAM and its funding of research projects provided frequently used signs of alternative medicine's legitimacy, supporters of alternative medicine and representatives of the OAM also engaged in other discursive activities that sought to situate alternative medicine more clearly within mainstream scientific medicine. For instance, by funding academic conferences affiliated with prestigious medical schools, the OAM helped alternative medical research more closely resemble mainstream medical science. These conferences 'made a stunning point' showing that the 'techniques of alternative medicine—including chiropractic, homeopathy, acupuncture and herbs—are becoming an issue for mainstream medical care' (McKenna 1995a: C8). By 1996, these conferences had gone international when the inaugural International Conference on Alternative Medicine was held in Washington. These conferences highlighted 'alternative medicine's growing legitimacy' (McKenna 1995b: A9) by moving it more in line with traditional medical scientific fields.

Along with new conferences, the founding of the OAM also presaged a boom in alternative medicine academic journals—another important quality for a field to feature when engaging in scientific boundary work. By 1995, health journalists pointed out that academic attitudes towards alternative medicine 'had been changing since the founding of the Office of Alternative Medicine' and that this had ushered in new journals such as *The Journal of Alternative and Complementary Medicine*, *Alternative and Complementary Therapies*, *Alternative Health Practitioner: The Journal of Complementary and Natural Care, Advances: The Journal of Mind–Body Health*, and the OAM's own newsletter (Miller 1995: D6). These journals, along with an increase in books published about alternative medicine (McKenna 1995a), including one co-authored by the Director of the OAM and heavily marketed as such (Kolata 1996), provided further rhetorical ammunition for those seeking to demarcate alternative medicine as within the boundaries of mainstream medical science.

To be sure, not all of the boundary work following the OAM's founding sought to situate alternative medicine within the realm of mainstream medical science. There was significant pushback by skeptical medical professionals who sought to retain the distinction between medicine and what they perceived as 'quackery' (Rochell 1994). This played out in numerous back-and-forths, with skeptics accusing the OAM of 'buying snake oil with tax dollars' and having an outsized effect on health policy (Park and Goodenough 1996: A15), while researchers from the OAM responded by touting the promise of alternative medicine (Fugh-Berman 1996) and the rigor of OAM's funded research (Jonas 1996). Indeed, the contest between proponents of alternative medicine and more conservative representatives of the established medical mainstream played out all the way to the top of the OAM's administration. Doctor Joseph Jacobs, the OAM's inaugural Director, resigned after less than 2 years on the job because 'he found himself at odds with the more militant proponents' of alternative medicine ('Conventional Tests for Unconventional Therapy' 1994: B6).

Although the post-OAM boundary work was contested, as skeptics and optimists struggled over the boundaries of medical science, the focus here has been on how founding the OAM had an endorsement effect that provided support to those who would have alternative medicine go mainstream. We saw above that the simple existence of the OAM lent legitimacy to the alternative medicine cause. Similarly, opportunities for federal research funding immediately lumped alternative medicine topics into the same 'funded research' category as more well-established therapies. The sponsorship of conferences, publication of books, and establishment of new alternative medicine journals all helped alternative medicine appear more similar to mainstream medical science.

The OAM's role in influencing the discourse around alternative medicine demonstrates how the endorsement effect can alter perceptions of scientific legitimacy. What is and is not considered valid science is subject to ongoing discursive contestation. When the state provides implicit endorsement of a scientific field, this in turn provides rhetorical ammunition to those engaging in the contest. Research funding policy can thereby affect opinions about the nature of science and knowledge. However, it remains an open question as to whether or not changed opinions coincide with changes in research behavior. The next section engages with this question by examining how alternative medicine research production responded to the OAM's founding.

4.2 Endorsement effects on R&D

The above demonstrates that the founding of the OAM featured prominently in boundary work seeking to have alternative medicine included within mainstream medical science's boundaries. While this is of interest, especially to scholars of scientific and professional fields, it is perhaps of only minor relevance to policymakers. As we saw above, one of the primary prisms through which innovation policymakers consider the effectiveness of their policy choices is the resulting additionality. If founding the OAM provided rhetorical ammunition for those seeking to cast an alternative image of medicine, but had little effect on research productivity beyond the projects funded by the OAM and related NIH centers, then a policymaker chiefly concerned with additionality may believe this 'endorsement effect' to be of little importance. However, if on the other hand the endorsement effect leads to not only changes in the discourse surrounding the funded field, but also the behavior of researchers, then the endorsement effect is indeed of concern to

innovation policymakers, and should be considered when assessing policy impact. To determine whether there was any additionality in the alternative medicine research field that both coincided with the founding of the OAM, and went beyond the research produced as a result of increased federal alternative medicine funding, this section will examine the patent record and track alternative medicine patenting rates in the years before and after the OAM was founded.

4.2.1 Method and Results

In order to explore the relationship between the founding of the OAM and R&D incentives, I take a time series approach to analyzing patenting rates, examining the rate of alternative medicine patenting both before and after the OAM was founded. Patents are a useful outcome measure for two reasons. First, patents provide a degree of external examination, where an individual—in this case a patent examiner—who is not a member of the research community assesses the claimed invention. This contrasts with using an intra-community research product such as a journal article, where articles are both reviewed by community insiders, and largely published in venues that presuppose the validity of the field. This outside perspective means that our outcome variable is less subject to being influenced by a growth in research production that never extends its impact beyond the research community's bounds.

Second, patents provide insight into applied research. Although many patents have little if any value (Bessen 2008), the applied research that they represent is closer to the market and thus to affecting the lives of those outside the scientific field than other measures of scientific community productivity such as conferences, graduate students trained, or journal publications. There is little research providing insight into how the endorsement of a scientific field via government research funding priorities, affects the sort of applied research that often results in patentable inventions. Better understanding the influence—or lack thereof—that official research funding priorities have on the R&D ecosystem can help inform future policymaking.

The analyses below draw on United States Patent and Trademark Office (USPTO) patenting data from 1976 to 2014. This provides coverage for the 15 years preceding and the 23 years following the establishment of the OAM. In order to assess any relationship between the establishment of the Office and patenting in related fields, I searched the full text (abstract, claims, and description) of every patent granted in each of these years for the following terms related to the Office's mission to research alternative medicine fields:

- Acupuncture
- Homeopathy
- Naturopathy
- Ayurveda
- Chiropractic treatment
- Reiki
- Tai chi/Qigong

Where appropriate, words were matched based on their stem (e.g. chiroprac*) would match any words beginning with the root of chiropractic. Figure 2 shows the trends for patents mentioning these words over time. These trends are expressed as a proportion of all patents granted each year so as to control for the overall growth in patenting over the study period.

In total, the term matching identified almost 3,000 alternative medicine patents. They are diverse in their subject matter ranging from patent 5,814,078 claiming a 'method and apparatus for regulating and improving the status of development and survival of living organisms' (mentioning both acupuncture, and qigong); patent 7,771,759 claiming a 'natural oriental medicinal composition for the promotion of hair growth' (mentioning homeopathy, and incidentally: consisting of black beans, tangerines, potatoes, and pine needles); and patent 7,101,384 claiming a 'method and system for illuminating a selected body component with light to encourage selected beneficial reactions of the body component as a result of such exposure and to provide phototherapy' (mentioning acupuncture).

A visual examination of Fig. 2 appears to support a claim that the founding of the OAM coincided with an increase in alternative medicine patenting. There is relatively slow growth in total alternative medicine patenting until the mid-1990s at which point the rate of growth appears to increase. To confirm this, I subject the total alternative medicine patenting rate to an interrupted time series analysis. This family of statistical model is well-suited to analyzing trends over time, and predicting future trends based on observed prior tendencies. An interrupted time series approach is particularly useful in assessing the effect of interventions that occur when there is no control group to compare against (Biglan et al. 2000). This situation arises often in innovation policy, as policy experiments are rare and often the best empirical insight we can draw from policy changes takes the form of assessing pre/post differences in relevant outcomes. To choose the model with the best fit, I rely on the Hyndman and Khandakar (2007) and Haslett and Raftery (1989) algorithms to choose the appropriate autoregressive integrated moving-average (ARIMA) model.

Although the OAM was initially discussed in 1991 and funded in 1992, one would not expect to see an immediate effect on patenting behavior. Patents are a lagging indicator of research activity, requiring time for both the research to occur and the patent application to be processed. In the mid-1990s, the average pendency time for patent applications was close to 2 years (GAO 1997). I assume that patentable alternative medicine inventions would take at least 1 year for research and 2 years for patent pendency, and thus have used 1995 as the beginning of the intervention period.

Table 1 reports the results of a fourth-order moving average interrupted time-series model, showing the effect of the intervention on patenting rates. This model uses patent count data as the dependent variable, so the coefficients can be interpreted as the effect on the number of patents granted.[2] These results show that, while there was no immediate significant change in the amount of alternative medicine patenting (the *level* coefficient), the trend at which alternative medicine patents were being granted did change significantly following the founding of the OAM (the *trend* coefficient). The interpretation here is that the *rate* of growth in alternative medicine patenting increased significantly following the founding of the OAM.

These results are shown graphically in Fig. 3. Here, we see both the trendline that preceded the founding of the OAM, the trend projected from that absent the Office's founding, and the modeled results for the post-Office reality. This clearly shows the dramatic change in the growth trend for alternative medicine patenting. The difference between the dashed line and the solid line following the intervention represents the estimated effect of the intervention. Some of this increase may be due to other non-OAM-related factors. Because innovation systems are the result of such a complex mixture of factors, estimating the precise magnitude of the endorsement effect will always be difficult. The intent here has been merely to

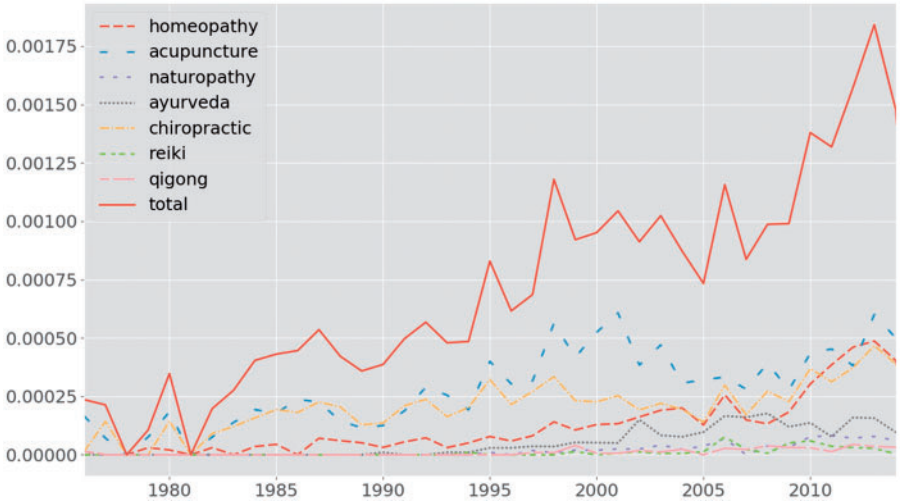

Figure 2. Alternative medicine patenting rates.

Table 1. Interrupted time-series results

	Dependent variable Alt. Med. Patents
Time	0.778
	(2.363)
Level	−12.211
	(15.921)
Trend	17.221***
	(4.193)
Constant	21.088
	(29.863)
Observations	38 (years)

Note: ***$P < 0.01$.

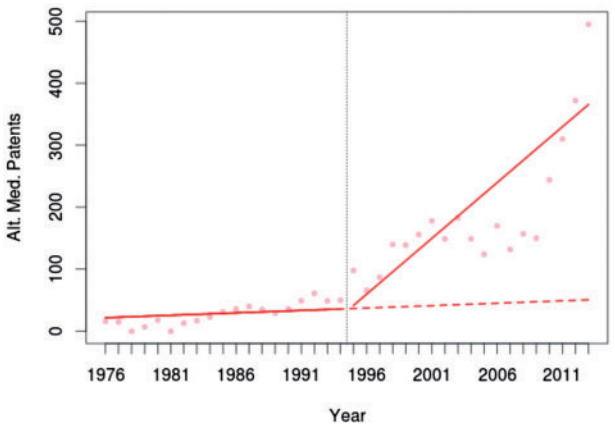

Figure 3. Showing the projected trend for alternative medicine patenting without the OAM intervention (dashed line), and the modeled effect with the intervention.

demonstrate the *existence* of the endorsement effect on R&D. The preceding sections argued that, by legitimizing research areas and increasing their salience, the endorsement effect has the potential to influence research behavior. This section provides empirical support for the claim that this does indeed occur.

The empirical findings above provide support for the claim that explicit government research priorities can alter the innovation agenda and contribute to increased R&D in the area endorsed by the government. Although the number of patents granted annually that contain keywords relating to alternative medicine was increasing slowly prior to the establishment of the OAM, the rate of growth accelerated after the Office was founded. That said, some of this increase may have been the result of direct incentives from the OAM—an interesting finding, but not necessarily one that supports the contention that federal priorities can have indirect innovation agenda setting endorsement effects. To demonstrate how an endorsement effect may have soft policy instrument style influence on research production, we must distinguish between inventions that are the product of federal research funding grants, and those that have no direct relationship to federal research priorities.

Finding a record of inventions directly related to the OAM is challenging, but one can detect the number of alternative medicine patents associated with federal research funding by tracking how many of those patents disclaim the government's Bayh–Dole interest in the invention. Passed in 1980, the Bayh–Dole Act established consistent federal policy allowing the recipients of federal research funding to patent their resulting inventions. Although funding recipients retain ownership of their federally funded inventions, the federal government retains some rights to the invention, most notably the right to march in and force licensing (Whalen 2015). To denote the existence of these rights, Bayh–Dole subject patents are required to explicitly state the government's interest in the invention.

To check for a more direct relationship between government funding and the observed rise in alternative medicine patenting, I checked each of the 2,936 identified alternative medicine patents to determine whether they were the result of government funding. Figure 4 shows the number of these patents over time. The timing of this growth in Bayh–Dole subject patents comes shortly after the OAM's 1998 transition to a research center when it was given a substantially larger budget and began granting many more research grants.

Figure 4 shows that a modest amount of the observed increase in alternative medicine patents can be directly attributed to federal funding priorities. However, these federally funded inventions make up only a small fraction of the post-OAM increase in alternative

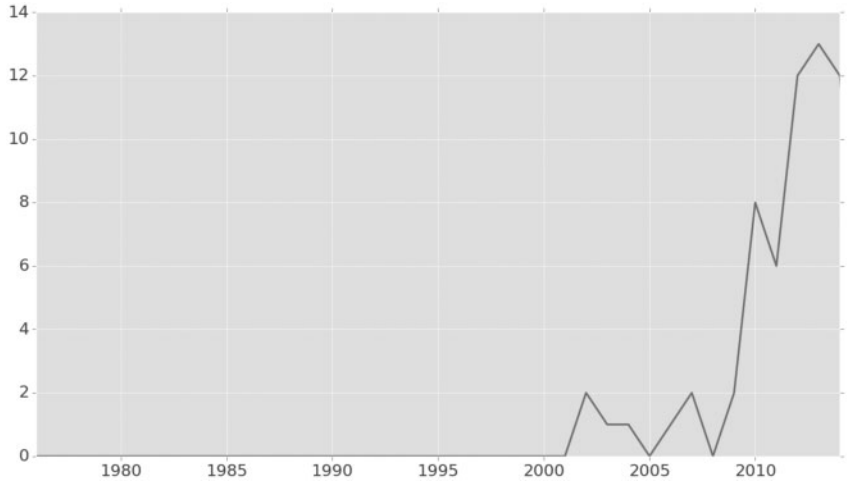

Figure 4. Alternative medicine patents resulting from federally funded research.

medicine patenting observed above. The majority of the increase in alternative medicine patenting can be attributed to other factors, one of which I argue is the endorsement effect that founding the OAM had.[3]

5. Discussion

Research funding decisions have impacts that extend beyond the factors traditionally considered in an additionality assessment. The implicit endorsement that accompanies state-sponsored research funding, especially when it extends to establishing a new office or center at an esteemed organization like the NIH, provides rhetorical support for those who have an interest in the funded area gaining mainstream support. This endorsement effect also has the potential to influence R&D behavior. State-sponsored funding suggests not only that a research field is valid, but also that it is important and deserving of research attention. The increased visibility that comes along with research funding as it gives rise to newspaper reports, conferences, journal publications, and book tours, all essentially act as marketing for research fields. This, along with increasing perceptions of validity, can in turn increase the field's salience, and lead firms and innovators to see a growing and potentially lucrative market deserving of R&D investment.

5.1 Implications

The government's ability to use the endorsement effect to influence the innovation agenda has implications for innovation policy communication. If official endorsement of a research area can lead inventors to direct more of their attention to that area, policymakers need to take care when sending signals that could be interpreted as an endorsement. Especially when dealing with an area of contested scientific merit like alternative medicine, officials need to be aware that the signals they send may alter research behavior and lead to more resources invested in questionable research. The founding of the OAM provides a clear cautionary tale in this vein—we see that aligning alternative medicine research under the auspices of the well-respected NIH led many to infer that this signaled that alternative medicine was a valid subfield within mainstream medical science. Subsequently, this corresponded with a dramatic increase in alternative medicine patenting.

Because of research funding's potential endorsement effects, policymakers should carefully consider the indirect effects that their decisions can have on perceptions of scientific validity and importance. Knowing that interested parties will capitalize on any implicit endorsement, policymakers should strive to use careful language so as not to express endorsement or legitimacy of a scientific field where such endorsement is not intended. Given that the existence and activities of official funding agencies will be used as rhetorical ammunition for the purposes of scientific boundary work, policymakers should consider the boundary work implications of their research funding decisions. For instance, research funding programs for emerging technologies like CRISPR/Cas9 or geoengineering responses to global climate change have the potential to affect public perceptions of legitimacy before we fully understand their ramifications and before we have implemented safeguards and ethical frameworks within which to use them.

If policymakers neglect to consider the endorsement effects that their decisions may have, they run the risk of implicitly endorsing pseudo-science and contributing to the already sizable challenges that arise when citizens reject mainstream science or selectively choose which well-established scientific theories fit their world view (Lewandowsky et al. 2013). In a world where many grasp at whatever rhetorical straws they can to support their—often ideologically–inspired—scientific worldview, policymakers should take care not to send unintended signals. Being cognizant of possible endorsement effects will help them do so.

This implication about the powerful endorsement effects that research funding decisions can have cuts both ways. On the one hand, policymakers should take care not to unintentionally endorse fields that feel are undeserving. However, on the other hand, the endorsement effect suggests that policymakers have a potentially powerful innovation agenda-setting tool that has heretofore remained under-theorized, and under-examined. The ability to lend legitimacy to research fields and signal their importance can be used by policymakers to influence R&D behavior and potentially encourage scientific 'hot topics' (Wei et al. 2013) that they *do* wish to endorse. This of course has long been practiced by innovation policymakers—see the war on cancer, state funding for biotechnology, or nanotechnology as examples of how governments try to encourage subfield development—but the *indirect* effects discussed here, above and beyond the production of research by state-funded

scientists, or scientists who wish to in the future become state-funded, has been largely overlooked by research policy scholars.

Because of its implications on perceptions of scientific validity and research production, the endorsement effect merits consideration when assessing policy impact. This means extending the focus beyond the direct return for research dollar spent—e.g., counting the papers and patents arising out of a research funding grant—and taking a more holistic view that takes into consideration how funding decisions may also have enndorsement effects on the research system. This corresponds with Arnold's (2004) call for a more system-like approach to research funding evaluation. He argues that additionality assessments should extend beyond input and output additionality to include 'behavioral additionality' that assesses changed behavior by recipients of state support. The findings here suggest that behavior additionality assessment should extend beyond recipients of state support and should also consider how funding decisions can influence behaviors across the research system.

5.2 Limitations

The evidence presented above suggests that the founding of the OAM, its subsequent activities, and the rhetoric surrounding alternative medicine following its founding bolstered efforts to legitimize alternative medicine, and contributed to an increase in alternative medicine research and patenting. However, the evidence presented has inherent limitations. Much of the argument for the existence of an 'endorsement effect' relies on correlational evidence, and the exact degree of causality at play between the founding of the OAM and the increased contestation over alternative medicine's validity, and subsequently the increased amount of alternative medicine R&D is difficult to determine.

I do not intend to claim that the growing popularity and visibility of alternative medicine during the 1990s was solely due to the OAM's founding. Rather, it is possible that alternative medicine was already increasing in popularity, and indeed Senator Harkin's initial personal experimentation with bee pollen was potentially related to this growing popularity. However, founding the OAM 'opened the floodgates' (Miller 1993: D6) for alternative medicine by implicitly endorsing the field. Even if alternative medicine was already growing in popularity and the founding of the OAM only hastened this growth, it does not preclude an endorsement effect as described above. Innovation systems are complex, and affected by a multitude of factors. Government actors play an important role in guiding their development (Nelson and Rosenberg 1993), and I argue here that the endorsement effect their policies can have is one of many policy implications that policymakers should consider.

Another potential limitation arises from the observation that the founding of the OAM presaged an increase in alternative medicine applied research activity. It is possible that the founding of the OAM may have led to increased alternative medicine patenting, but not necessarily an increase in R&D resources directed toward alternative medicine research. Under this scenario, inventors may have seen the founding of the OAM as a signal of alternative medicine legitimacy, leading them to apply for patents on their alternative medicine inventions that they may not otherwise have applied for, but not necessarily investing any more resources in R&D. This explanation for the observed increase focuses on the legitimization mechanism of the endorsement effect described above. However, again, even if the founding of the OAM did lead to an increase in patenting inventions that would have been invented absent the Office's founding, this does not preclude an accompanying increase in alternative medicine oriented R&D as well.

5.3 Future work

This article has sketched the outline of how official signals can affect the innovation agenda. By funding the OAM and implicitly endorsing alternative medicine research, policymakers helped legitimize and promote alternative medicine. This coincided with an increase in boundary work seeking to define alternative medicine as within the mainstream, and an increase in patenting of alternative medicine inventions. Future work is needed to better understand the role that the endorsement effect plays in innovation policymaking. In terms of the relationship between research funding decisions and the discourse surrounding scientific validity, more research is needed to tease out the impact that state funding can have on perceptions of scientific validity. Future work should examine how scientific and lay perceptions are influenced by different types of research funding and different messaging from funding bodies. In relation to questions about the endorsement effect's potential relationship to changes in research output, future work should expand the evidence beyond the patent record, to include marketed technologies and treatments as well as interviews with inventors to try and better understand to what degree government signals contribute to innovation agenda setting. Doing so would help us better understand the endorsement effect, and how policymaking may have indirect effects on research priorities.

6. Conclusion

The endorsement effect can arise when official innovation policies—especially research funding policies—appear to endorse a specific research area. This can lead to increased boundary work striving to validate the research area, much of which may draw discursive support from the endorsement effect. In the context of alternative medicine, we saw this play out as the founding of the OAM was used by interested parties in attempts to situate alternative medicine within the medical science mainstream. Furthermore, state endorsement can raise a research area's profile, leading to increased research activities. The rise in alternative medicine patenting shortly after the founding of the OAM suggests that the endorsement of alternative medicine research may have contributed to an increase in alternative medicine R&D, above and beyond state funded research projects.

Policymakers should consider the endorsement effects that their policies can have. This includes the potential discursive support their policies may lend to those contesting scientific boundaries, and the increased visibility that research policy programs can lead to. Ultimately, the existence of an endorsement effect is not, in and of itself, a concern. Provided policymakers carefully consider the indirect system-level implications of their policies, the endorsement effect can be yet another tool in the innovation policy toolbox.

Notes

1. Acupuncture, homeopathy, naturopathy, ayurveda, chiropractic treatment, tai chi, and reiki. These topics were chosen both because they featured in contemporary discussions about the types of alternative therapies that the OAM would encourage research into, and because they offer unique terms that can be used to identify inventions related to alternative medicine.

2. Robustness checks included modeling the intervention effect on alternative medicine patent *rate* data. In this case, the Hyndman Khandakar algorithm indicated that an AR(1) model was the best fit. The intervention effect remains statistically significant.
3. Robustness checks demonstrate no substantive change in the interrupted time series model results when removing Bayh–Dole subject patents from the dependent variable.

References

Arnold, E. (2004) 'Evaluating Research and Innovation Policy: A Systems World Needs Systems Evaluations', *Research Evaluation*, 13/1: 3–17.

Bernanke, B. S. (2011) 'Promoting Research and Development the Goverment's Role', *Issues in Science and Technology*, 27/4: 37–41.

Bessen, J. (2008) 'The Value of US Patents by Owner and Patent Characteristics', *Research Policy*, 37/5: 932–45.

Biglan, A., Ary, D., and Wagenaar, A. C. (2000) 'The Value of Interrupted Time-Series Experiments for Community Intervention Research', *Prevention Science*, 1/1: 31–49.

Borrás, S., and Edquist, C. (2013) 'The Choice of Innovation Policy Instruments', *Technological Forecasting and Social Change*, 80/8: 1513–22.

'Conventional Tests for Unconventional Therapy'. (1994). St. Louis Post-Dispatch (Missouri), Aug. 15, 1994, B, at 6.

Eisenberg, D. M., Kessler, R. C., Foster, C., Norlock, F. E. et al. (1993) 'Unconventional Medicine in the United States–Prevalence, Costs, and Patterns of Use', *New England Journal of Medicine*, 328/4: 246–52.

Ellis, M., and Zilko, J. (2008) *Complementary Medicine Has a Place*, Weekend Australian, Sept. 27, 2008, at 14.

Eskinazi, D. P. (1998) 'Factors that Shape Alternative Medicine', *JAMA*, 280/18: 1621–3.

Etzkowitz, H., and Leydesdorff, L. (2000) 'The Dynamics of Innovation: from National Systems and "Mode 2" to a Triple Helix of University–Industry–Government Relations', *Research Policy*, 29/2: 109–23.

Frickel, S., Gibbon, S., Howard, J., Kempner, J. et al. (2010) 'Undone Science: Charting Social Movement and Civil Society Challenges to Research Agenda Setting', *Science, Technology & Human Values*, 35/4: 444–73.

Fugh-Berman, A. (1996). *Letter to the Editor: "Modern Magic" Studies*, The New York Times, Jan. 6, 1996, 1, at 30.

GAO. (1997). *Comparison of Patent Examination Statistics for Fiscal years 1994 and 1995 (No. GAO/RCED-97-58)*. Washington, DC: Intellectual Property.

Georghiou, L. (1998) 'Issues in the Evaluation of Innovation and Technology Policy', *Evaluation*, 4/1: 37–51.

—— (2002) 'Impact and Additionality of Innovation Policy'. *Innovation Policy and Sustainable Development: Can Public Innovation Incentives Make a Difference*. Institute for the Promotion of Innovation by Science and Technology in Flanders, Brussels.

Gieryn, T. F. (1983) 'Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists', *American Sociological Review*, 48/6: 781–95.

—— (1999) *Cultural Boundaries of Science: Credibility on the Line*. Chicago, Illinois: University of Chicago Press.

Gilbert, A. E. (1993). *Letter to the Editor: What Mainstream Medicine Fears*, The New York Times, May 23, 1993, 13, at 23.

Hart, D. M., and Victor, D. G. (1993) 'Scientific Elites and the Making of US Policy for Climate Change Research, 1957-74', *Social Studies of Science*, 23/4: 643–80.

Haslett, J., and Raftery, A. E. (1989) 'Space-Time Modelling with Long-memory Dependence: Assessing Ireland's Wind Power Resource', *Journal of the Royal Statistical Society. Series C (Applied Statistics)*, 38/1: 1–50.

Hyndman, R. J., and Khandakar, Y. (2007) *Automatic Time Series for Forecasting: The Forecast Package for R*. Monash University, Department of Econometrics and Business Statistics.

Jacobs, J. J. (1995) 'Building Bridges Between Two Worlds: The NIH's Office of Alternative Medicine', *Academic Medicine*, 70/1: 40–41.

Jonas, W. B. (1996) *Letter to the Editor: "Modern Magic" Studies*, The New York Times, Jan. 6, 1996, 1, at 30.

Kadaba, L. S. (1994) *A Regimen of Hope*, The Philadelphia Inquirer, Aug. 29, 1994, C, at 1.

Kolata, G. (1996) *In Quests Outside Mainstream, Medical Projects Rewrite Rules*, The New York Times, Jun. 18, 1996, A, at 1.

Kuhn, T. S. (1970) *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Laudel, G. (2006) 'The Art of Getting Funded: How Scientists Adapt to their Funding Conditions', *Science and Public Policy*, 33/7: 489–504.

Lewandowsky, S., Oberauer, K., and Gignac, G. E. (2013) 'NASA Faked the Moon Landing? Therefore, (Climate) Science is a Hoax: An Anatomy of the Motivated Rejection of Science', *Psychological Science*, 24/5: 622–33.

Marshall, E. (1994) 'The Politics of Alternative Medicine', *Science*, 265/5181: 2000–3.

Martyn, P. (1995) *U.S. Medicine Faces Revolution Group of Politicians, Scientists Looking at the Merits of Alternative Medicine*, The Toronto Star, Mar. 5, 1995, C, at 9.

McKenna, M. A. J. (1995a) *Alternative Medicine Going Mainstream: Growing Acceptance of Unorthodox Practices Could Signal "the next Wave in Medical Care,"* The Atlanta Journal and Constitution, May 17, 1995, C, at 8.

—— (1995b) *Conference Highlights Alternative Medicine's Growing Legitimacy*, The Atlanta Journal and Constitution, Mar. 31, 1995, A, at 9.

—— (1997a) *Catching up with "New Kind of Medicine,"* The Atlanta Journal-Constitution, Mar. 12, 1997, D, at 2.

—— (1997b) *HEALTH WATCH; Alternative Medicine Has the Stage at Harvard*, The Atlanta Journal-Constitution, Mar. 10, 1997, C, at 3.

Miller, L. (1993) *Alternatives Go on the Record / Medical Journals Follow Growing Field*, USA TODAY, Jan. 12, 1995, D, at 6.

——(1995) *Alternatives Meet the Mainstream*, USA TODAY, Jul. 22, 1993, D, at 6.

Nelson, R. R., and Rosenberg, N. (1993) 'Technical Innovation and National Systems', *National Innovation Systems: A Comparative Analysis*, 322.

NIH. (2015) 'NCCIH Funding: Appropriations History'. *NCCIH*. <https://nccih.nih.gov/about/budget/appropriations.htm> accessed 1 April 2017.

Ochs, R. (2001). *With Data, Alternative Medicine Becomes a Big Deal*, South Bend Tribune (Indiana), Jun. 20, 2001, C, at 3.

Park, R. L., and Goodenough, U. (1996) *Buying Snake Oil With Tax Dollars*, The New York Times, Jan. 3, 1996, A, at 15.

Rochell, A. (1994) *Uncommon Cures Traditional Medicine Giving Alternative Therapies Their Due*, The Atlanta Journal and Constitution, Nov. 19, 1994, E, at 1.

Rosenfeld, M. (1995) *Haven't We Met Before? Past-Life Believers Link Up in Washington*. The Washington Post, May 6, 1995, D, at 1.

Wei, T., Li, M., Wu, C., Yan, X.-Y. et al. (2013) 'Do Scientists Trace Hot Topics?', *Scientific Reports*, 3/1: 2207.

Whalen, R. (2015) 'The Bayh-Dole Act & Public Rights in Federally Funded Inventions: Will the Agencies Ever Go Marching In?', *Northwestern University Law Review*, 109/4: 1083.

Young, J. H. (1998) 'The Development of the Office of Alternative Medicine in the National Institutes of Health, 1991-1996', *Bulletin of the History of Medicine*, 72/2: 279–98.