Science networks, productivity, and institutions:

Realized publicness at public and private research universities

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Abstract

One of the perennial questions in the public administration is: Are public organizations different from private organizations? Some research finds that public and private organizations are distinct along lines of mission, ownership, external controls, function, and structure. Most of the literature comparing public and private focuses on traditional government agencies and private organizations, ignoring the tertiary education system – an education and science enterprise that produces a number of public goods. Universities in the U.S. represent a massive public investment in organizations charged with educating the public, serving the public good, and contributing to local and state economic, agricultural, scientific, mechanical, technical, and professional development. Developed through federal and state legislation, present on public lands, and funded through state appropriations and public research and development funds, public universities represent a behemoth public enterprise.

Although public universities as compared to traditional federal and state agencies are somewhat removed from "government", the work processes within public universities remain constrained by public resources, external political forces, and public priorities (e.g. stem cell research bans). The primary research question for this manuscript is: *How does organizational and individual publicness shape public outcomes in universities?* Specifically, we investigate the ways in which regulative, normative/associative, and cultural cognitive components of publicness shape faculty behavior and public outcomes including knowledge creation, training and education, and service. This research draws upon data from a survey of a random sample of 3,677 faculty scientists in nonmedical biology, chemistry, computer science, earth and atmospheric sciences, electrical engineering, and physics at 148 research-intensive universities. We conclude with a discussion of the results and the implications for public management.

Introduction

One of the oldest, and arguably most important, questions in public administration research is the distinction between public and private organizations. Are public and private organizations distinct? And if so, to how and to what affect? Early public administration scholars argued that public organizations are distinct from private organizations because they handle problems where government action is required and markets alone fail (Dahl & Lindblom 1953; Lindblom 1977); because they produce goods or outcomes that benefit the public in general (Blau & Scott); and because of organizational ownership and funding (Wamsley & Zald 1973). The growth of outsourcing and government-sponsored corporations and authorities, the hybridization of organizations, and the rise of private, not-for-profit organizations delivering public services has contributed to a blurring of the public and private sectors (Cooper 2002; Kettl 1993; Weisbrod 1977, 1988). In the case of universities, the reduction of state appropriations to public universities and the rise of business-like practices such as technology transfer and endowment building have blurred the distinctions between public and private universities.

Although many scholars warn against oversimplifying the distinctions between public and private organizations (Bozeman 1987; Simon 1995, 1998), much of the research comparing public and private university outcomes in the United States assesses organizational distinctions and outcomes with a simple, dichotomous variable indicating whether the university is public or private – a distinction made by ownership (de Groot et al. 1991; Owen-Smith & Powell 2003; Turk-Bicakci and Brint 2005). Others complement the public-private measure with additional measures. For example, when examining the development of university–industry partnerships, Turk-Bicakci and Brint (2005) include three measures of institutional characteristics: public or private control, land grant status, and the ratio of total operating budget per student. Geiger (1985) notes that the "public/private distinction in higher education is largely a phenomenon of the past hundred years" (387) and that in fact, many universities are better described as not-for-profit organizations, especially those which are distinct the government sector and not primarily driven by profit-maximizing, as is the case for private universities in the US.

Unfortunately, categorizing all research universities as not-for-profit organizations does not give us a clear understanding of the ways in which origins, funding, structure, and priorities and values are related to some universities producing more public outcomes than others.

Because the distinctions between public and private universities can be blurry, it is possible to understand different levels of universities' public outcomes by focusing on dimensions of publicness (Perry & Rainey 1988). In *All Organizations are Public*, Bozeman (1987) argues that the degree of political authority and economic authority facing an organization can be used to assess its publicness, with increased political authority being associated with publicness and economic authority being related to increased privateness. Publicness can be measured by resource ties to government, political control and influence over the organization, or dedication to or ability to deliver public outcomes (Bozeman & Kingsley 1998; Bozeman et al. 1992; Heinrich & Fournier 2004; Lynn et al. 2001; Wamsley & Zald 1973). For example, Geiger (1985) argues that levels of regulation and political authority and the provision of public goods (Weisbrod 1977) drive sector distinctions for higher education.

Public administration researchers argue that publicness can be measured by the extent to which an organization expresses and provides public values (Bozeman 2007; Jorgensen & Bozeman 2007). This public values approach is less concerned with the role of political authority and government influence in defining publicness and more concerned with the role of normative values both inside and outside of the organization – helping to explain how public values become institutionalized and actualized through individual actions and organizational outputs and outcomes. This research seeks to apply a publicness analysis of research extensive universities to assess the ways in which institutional and individual public values are related to public outcomes. Using a sample of academic research scientists at public and private universities this research draws on Moulton's (2009) recent work integrating descriptive and normative indicators to assess how organizational and individual factors are related to individual behavior and realized public outcomes at research intensive universities.

Realized Publicness

Scholars of public administration have long sought to understand how the production and distribution of public goods and services are related to the publicness of organizations. Is publicness described by social control, economic authority, political authority, ownership status, organizational mission, or public outcomes? Although measures such as the percent of government resources and ownership are easily operationalized, they fail to capture the full spectrum of publicness because they center on describing organizational characteristics and tell us little about how organizations vary in their achievement of public outcomes (Antonsen & Jorgensen 1997; Bozeman 2007; Moulton 2009; Scott 2001). Rather than ask how to categorize organizations as public or private, we should be characterizing the ways in which organizations achieve public outcomes and values (Moulton 2009). If the goal of public organizations is the achievement of public outcomes, it is critically important for us to understand the ways in which normative processes within organizations result in public outcomes.

Moulton (2009) proposes a framework for publicness outcomes which centers on two components: "(1) realized publicness, or the realization of public values demonstrated by organizational behavior or outcomes; and (2) institutionalized public values as influences of publicness (public value institutions), including regulations, associations, and cultures in an organization's environment (including but not limited to government) that embody public values and thus influence the organization toward realized public outcomes" (pg 891). Moulton notes that by identifying an organization's public outcomes, policy makers working across sectors will be armed with better information about how to best achieve public outcomes. Furthermore, assessing publicness outcomes enables a larger realization of governance where organizations along the spectrum of ownership, authority, and goals can individually and jointly contribute to the achievement of public value outcomes (Bozeman 2007; Lynn et al. 2001; Moulton 2009).

Building on the work of Scott (2001), Moulton (2009) develops a framework for assessing the institutional environment consisting of regulative, normative (associative) and cultural cognitive features that can be operationalized to evaluate an organization's publicness and achievement of public value outcomes. Regulative institutions are formal

institutions such as political, economic, and legal ownership (North 1990; Rainey & Bozeman 2000; Scott 2003) and can include the percentage of organizational resources from government (CITES), government or political control and oversight (Bozeman & Kingsley 1998), communication with government (Bozeman & Bretschneider 1994; Bozeman et al. 1992; Feeney & Bozeman 2009), and goal and mission publicness (Bozeman & Bretschneider 1994; Bozeman 2007). Moulton (2009) notes that the key to regulative influence is that it is not directly related or causal to organizational outcomes. Rather, the organization's environment may place competing demands on the production of realized public outcomes.

The second component of Moulton's framework for realized publicness is the role of normative and associative institutions. These institutions are not sanctioned, but rather morally grounded and driven by associations and norms, involving "the creation of expectations that introduce a prescriptive, evaluative, and obligatory" (Scott 2003, pg. 880) dimension of organizational life and behavior. Measures of normative (associative) institutions can include participation in networks (Heinrich & Fournier 2004), associations and memberships, interorganizational relationships (Bozeman et al. 1992), and ties to the community (Moulton 2009; Moulton & Feeney, under review).

This third component for understanding realized publicness is cultural cognitive features. Cultural cognitive features in organizations are the shared concepts that develop within the culture of organizations, such as mission publicness (Golstein & Naor 2005; Antonsen & Jorgensen 1997; Scott 2003). Most research capturing the cultural cognitive features in organizations rely on self-reported survey data, with employees in the organization reporting about the culture of their work environment and the organization's values (Moulton 2009). This research can focus on the individual's tendency toward public service (Perry 2000; Perry & Wise 1990) or the ways in which the organization emphasizes the achievement of public outcomes (Antonsen & Jorgensen 1997; Lynn et al. 2001; Perry & Wise 1990; Rainey & Steinbauer 1999).

The framework for realized publicness brings together three measures of publicness, regulative, associative (normative), and cultural cognitive features, and their potential to achieve public outcomes. Moulton (2009) proposes that researchers seeking

to assess organizational publicness take the following three steps. First identify the desired public outcomes. Second, identify the public value institutions in the organization. Third, develop hypothesized relationships about the relationship between the public value outcomes and institutions, while controlling for the broader organizational context. We take these three steps to develop hypotheses about the relationships between desired public outcomes and public values institutions at research intensive universities. In the next section, we identify the desired public outcomes for research intensive universities, identify the public value institutions, and propose a set of hypotheses about the relationships between regulative, normative, and cultural cognitive institutions and realized public outcomes.

Desired Public Outcomes at Research Intensive Universities

While American universities come in all shapes and sizes, most – if not all – share the mission of creating knowledge and training and educating the public. The first universities established in the U.S. were private, elite institutions that sought to train the *Renaissance man*. With the passage of the 1862 Morrill Land-Grant College Act, which established publicly funded land grant universities in each state, university activities became tied to public goals such as training agricultural, mechanical, and engineering experts and advancing education in the states. In the mid-1900s, shifts in higher education policy, such as the GI bill and the Federal Pell Grant Program, made higher education more accessible to veterans, minorities, women, and middle and lower-income students. In addition to expanding the type of students educated at institutions of higher education, universities, both public and private, have continued to expand their missions and influence in society to include activities such as technology transfer and the development of technology and research parks. According to Duderstadt and Womack "The American university is more deeply engaged in society than ever before, playing an increasingly critical role in shaping the economic, culture, and sense of national well-being" (2003 p. 2). Modern American universities are responsible for producing a wide array of public goods including: services through extension offices; unbiased, neutral expertise for governments and the public; an educated public and well-trained scientists

and engineers; economic development in rural and urban communities; and an expansion of the pool of knowledge.

While universities produce a variety of public outcomes, Carnegie designated research extensive and intensive universities (formerly known as Research I universities) are distinguished from other types of universities because of their extensive engagement in research activity and because they offer a full range of baccalaureate programs, grant more than 50 doctoral degrees each year, give high priority to research, and receive more than $40 million dollars in federal support annually.[1,2] Research extensive universities include public and private universities that engage in federally funded research activities which result in outcomes including publications, patents, spin-off companies, and trained scientists and engineers.

Most research extensive universities have a threefold mission: research, teaching, and service. Faculty are evaluated and rewarded based on their performance in these three areas and the university describes its activities within these areas. Outcomes under the rubric of research, teaching, and service include knowledge creation, training and education, and service. Researchers interested in the outcomes of higher education activities regularly operationalize knowledge creation as the number of publications (Allison & Stewart 1974; Dietz & Bozeman 2005; Levin & Stephan 1991; Long 1978), citation rates (Allison & Stewart 1974; Levin & Stephan 1991; Long 1978), patent production (Bozeman 2000; Dietz & Bozeman 2005; Owen-Smith & Powell 2003), and collaborative activities (Pfeffer & Langton 1993). Training and education outcomes are typically measured as number of graduates, PhDs granted, course credits completed, and prestige (CITES). Service outcomes can be categorized as service to the department and university, service to the field or discipline, service to the local community, city, or state

[1] http://www.carnegiefoundation.org/about/sub.asp?key=18&subkey=405#1.2

[2] The Carnegie Classification aims to enable researchers to distinguish between the 4,400 degree-granting colleges and universities in the U.S. Note that this research uses the Research I category of Carnegie Classification (n=152), because the data were collected under that system. As of 2005, doctorate-granting universities are now defined as awarding at least 20 doctoral degrees per year and are described as RU/VH: Research Universities (very high research activity) (n=96); RU/H: Research Universities (high research activity) (n=103); and DRU: Doctoral/Research Universities (n=84). (Sources: 2005 Carnegie Classification; National Center for Educations Statistics, IPEDS Fall Enrollment (2004) and http://www.carnegiefoundation.org/classifications/index.asp?key=805

through extension services and expert services, and service to the broader public through guest lectures, invited speaker engagements, and applied research activities and outreach. For the purposes of this research, we describe the primary realized public outcomes for research-intensive universities as: knowledge, training and education, and service.

Public Value Institutions at Research Extensive Universities

Regulative. When investigating the ways in which universities differ, in their training of students and scientists or production of outcomes (e.g. publications, patents) some researchers seek to understand how university structures and activities vary due to ownership (public or private). At the inception of many universities, the distinction between public and private was important, with private institutions funded by individual and private wealth (e.g. Carnegie Mellon) and public institutions funded by state appropriations and focused on local economic needs such as agricultural training, mining, and extension services. Thus, one of the basic regulative distinctions among research extensive universities is whether they were founded as private or private institutions.

A second regulative distinction among research extensive universities is designation of being a land-grant institution (Tornquist & Kallsen 1994). The Morrill Acts of 1962 and 1890 designated institutions that would receive benefits including granting federally controlled land for states to develop colleges focused on the teaching, research, and training of agriculture, science, mining, and engineering. Land-grant status and benefits were expanded through the creation of agricultural experiment stations (Hatch Act 1887) and cooperative extension offices (Smith-Lever Act 1914). In addition to the granting of land, the 76 modern land-grant institutions receive federal appropriations for research and extension services that are matched by state appropriations. One would expect that land-grant institutions would be more likely to produce public outcomes that advance the interests of the state, including training of in-state residents in areas of science and engineering, educating in-state residents, and engaging in service activities related to local needs.

While public/private status and land grant designation are originating and legislative distinctions between research extensive universities, neither of these measures capture the variance in state and governmental resource allocations, and the ways in

which these allocations have shifted in modern universities. Some researchers argue that federal funding for R&D activities has displaced the need for public universities to rely on state appropriations and federal student financial aid as a source of income and thus has resulted in public universities putting less emphasis on the mission of educating local residents (Slaughter 1998). For example, federal support for R&D activities at some research extensive public universities are now higher than federal student financial aid (Gladieux, Hauptman, & Knapp 1994). Today, both private and public research universities house federal labs, rely on extensive amounts of federal R&D grants and contracts, and accept federal aid and subsidies for students (e.g. Pell Grants). Assessing variance in these regulative public values institutions should help advance our understanding of how publicness at universities affects public outcomes.

P1. Resource allocation at research universities will be related to the production of realized public outcomes.

One of the most common measures of capacity is federal, state, and industry R&D at the university (Fairweather 1988; Tornquist & Kallsen 1994; Turk-Bicakci & Brint 2005; Zucker et al. 1998). Because all research extensive universities receive federal funding for research activities, it is important to distinguish between the goals and priorities associated with different types of government resources. Federal resources are typically tied to research grants and contracts (allocated based on competition and merit) and financial aid to students (allocated based on both need and merit). Because universities engage in research and teaching activities, the balance of these two types of aid can help us to differentiate between universities that are differently committed to these two public outcomes. We would expect that universities with a higher proportion of federal R&D funding as compared to federal funding in the form of financial aid to students will produce higher research outcomes, while increases in financial aid will be related to increased teaching outcomes.

P1a. Increases in federal R&D funding will be related to increased research outcomes.

P1b. Increases in federal financial aid to students will be related to increased teaching outcomes.

State appropriations to research extensive universities can fall into a number of categories including R&D funds, financial aid to students, and state appropriations to operating costs and capital expenditures. State appropriations to public universities are tied to state commitments to the university and the understanding that the university is obligated to produce public outcomes including an educated public, training to local communities, extension services and expertise to the state. Today, the distinction between public and private universities is blurring as state appropriations for some public universities have dropped to less than 20% and others maintain strong state support. According to Benderly (2004), from 2002 to 2004 state funding for higher education in Washington dropped 3.5% and more than 20% in Virginia and Massachusetts. For example, SUNY at Buffalo and at Binghamton both report more than 50% of their revenue coming from the state. Georgia State University, Northern Illinois University, and the University of Georgia receive 47%, 45%, and 44% of their revenue from the state. In comparison, the universities of Vermont, Oregon, Illinois at Chicago, and Utah report respectively 9%, 15%, 18% and 17% of their revenue being from the state.

These state-serving universities that receive less than one fifth of their revenues from state appropriations have different mechanisms for funding the remainder of their budgets, including increased grants and contracts, tuition, and business-like activities to fund operating budgets. For example, the Universities of Oregon and Vermont raise nearly 40% of their budgets through tuition and fees. In fact, among the 148 research universities in this study, 49 of the public institutions generate more revenue per FTE from tuition and fees than from state appropriations per FTE. In comparison, the University of Illinois at Chicago and the University of Utah rely on tuition and fees for less than 15% of their revenue and instead rely heavily on grants and contracts to generate revenue. Thus, state appropriations to public universities are not only an indication of changing commitments to universities, but also leave universities to make important decisions about how to generate revenue. We expect that the balance of funding from sources including tuition and fees, grants and contract, and other activities

such as operating hospitals, medical facilities, and technology parks will affect the types of public outcomes generated by universities.

> *P1c. Increases in revenue generated by state appropriations to universities will be significantly related to increased realized public outcomes.*
>
> *P1d. Increases in revenue generated by tuition and fees will be significantly related to increased realized public outcomes.*

Kane, Orszag, and Gunter (2003) note that declines in public spending at public universities may be related to declining quality of faculty, students, and education, which is troublesome considering that public institutions enroll roughly 75 percent of college students national wide and ultimately affect public outcomes such as income inequality and social well-being (Selingo 2003; Symonds 2003). In addition to being a signal of public support, state appropriation to public universities is reciprocated to state residents in the form of discounted in-state tuition. As state budgets have tightened, many public universities have found that they can raise revenue by increasing out-of-state tuition, thus taxing out-of-state residents.

Recent reports indicate that out-of-state students in all types of universities[3] in the US make up around 14% of the enrollment at public universities and that these students, on average, pay $16,640 (not accounting for reductions in costs due to student aid) more than their in-state counterparts (Standard & Poor's, 2008, 15). According to 2008 data from the College Board, on average 63% of the first year students at research extensive universities are in-state residents. The proportion of in-state students in public universities is nearly the reverse of that at private universities, with about 79% of the first year students enrolled at public research extensive universities being in-state residents, compared to 27% at private universities.[4] The gaps in tuition costs for out-of-state and in-state students can range from $4000 at the University of Minnesota to as much as $22,669 at the University of California-Santa Cruz (see Table 1). Thus, declines in state appropriations, which are implicitly tied to a commitment to further local education and

[3] This figure includes liberal arts colleges and non-research extensive institutions.
[4] SOURCE: http://collegesearch.collegeboard.com/search/index.jsp

training, may result in lowered commitments to producing realized public outcomes for in-state residents. It may be universities use out-of-state tuition to subsidize the education of local residents. On the other hand, it is possible that universities are using this out-of-state revenue to supplement funding for other activities. Widening gaps in in-state and out-of-state tuition rates at public universities may be signaling a shift to raising revenue at the expense of local residents' access to higher education.

P1e. The difference in tuition costs between out-of-state and in-state students attending a university will be significantly related to realized public outcomes.

Many public universities are increasingly behaving like private institutions, developing endowments, raising revenue through tuition, private capital, and commercialization activities, and taking other measures to protect themselves from the ebbs and flows of state budgets (Priest and St. John 2006; Mehta 2004; Slaughter 1998). Modern public and private universities compete for federal research and development (R&D) funding, compete for students funded through Pell grants and other forms of federal aid (Slaughter 1998), and seek to produce outputs such as publications, trained graduates, patents, licenses, and spinoff companies. Some public universities have endowments equal to private universities (see table 2). For example, the University of Michigan has an endowment of $7 billion, which is in the same range as the endowments at Columbia University and the University of Notre Dame. Other public universities have been on the forefront of developing venture capital funds and ties to private industry. For example, in 1974 Purdue University created one of the first venture funds and Oklahoma State University created a seed fund in 1977 (see table 3), long before private universities began developing these same ties to universities. Some argue that raising revenue through endowments and development, although seen as a response to public finance constraints, also detracts from public universities ability to produce public outcomes (Conley & Temple 2006).

P1f. Increases in the proportion of a university's budget generated through an endowment will be significantly related to decreases in realized public outcomes.

This research seeks to help us understand the ways in which universities responding to funding constraints and expanding activities measured as variation in organizational and individual regulative public values institutions affect outcomes. Understanding and measuring the regulative public values at public and private universities will enable us to better understand organizations that advance public missions, but find themselves in a modern funding environment that requires business-like activities that may contradict those public-serving agendas and activities.

Normative / Associative. Similar to other types of organizations, normative and associative public value institutions can greatly influence universities' public values outcomes. A university community comprised of researchers, teachers, and students that share norms, associations, and values will likely be more successful at generating public outcomes tied to those norms. Especially in the case of public universities, where state appropriations can be closely tied to the ways in which state and local communities perceive the university, ties to the community can play an important role in the allocation of state funds to the organization, and norms in the academic system are constituted via variation in research funding within departments and across individuals (Benner & Sandström 2000). In addition to organizational level normative and associative characteristics, we can also measure individual level normative and associative values. For example, while faculty scientists at a university typically share similar regulative (structural) public institutions that influence their research, teaching, and service activities, there is likely to be associative variation at the departmental and individual level. We expect that organizational and individual associative influences, including shared norms, associations, research funding, professional networks and ties, and informal relationships (Benner & Sandström 2000; Moulton 2009; Powell 1990; Scott 2003) will be related to individual scientists' behavior in their official and unofficial roles and will influence realized publicness outcomes at universities.

Universities and individual scientists can associate with one another and the community in a number of ways including membership in associations and programs. One such distinction for research extensive universities is membership in the Association of American Universities (AAU). The AAU is an association of 62 leading research

universities in the US and Canada. AAU membership is by invitation and is determined by the university's scholarship and research and excellence in research and education programs. Indicators for AAU membership include National Research Council faculty quality ratings; federal, state, and industry funded research; faculty awards in arts and humanities; fellowships; citations (indicating research volume and quality); postdoctoral appointees; and doctoral and undergraduate education. Past researchers have used membership in the AAU as an indicator of university prestige (Slaughter 1993; Turk-Bicakci & Brint 2005). For the purposes of this research, AAU membership should be related to increased outcomes related to research outcomes.

The National Academies of Science (NAS) is an honorific society that recognized scholars that are engaged in and exemplary scientific, engineering, and technological research. Membership in the NAS is a prestigious recognition and limited to about 2,100 individuals. For academic scientists, NAS membership is an important associative indicator of visibility and commitment to the advancement of science. Unlike AAU, which is a university affiliation and association, NAS membership is granted to individual scientists. Thus, individual activities, supported by universities, result in membership. While NAS membership is an individual level association, in the literature, the number of NAS members at a university is used as a proxy for a university's level of prestige and distinction in research and achievements in discovery and the advancement of knowledge (Krimsky et al. 1991).

> *P2. Variation in organization level associative and normative public value institutions at research universities will be significantly related to realized public outcomes.*

In addition to measuring organizational level normative and associative public values institutions, we are interested in measuring the normative and associative institutions for individual scientists. For academic scientists, in addition to capturing network based norms, it is important to capture resource and research funding factors, which are often allocated based on peer review and norms and are critical drivers of individual outcomes (Benner & Sandström 2000). Additionally, we will want to capture

individual normative and associative values by assessing individual scientist's collaboration and professional networks (Burt 1992; Granovetter 1973; Uzzi 1999).

Research notes that scientists' norms and activities can be closely tied to incentives and priorities dictated through research funding. For example, in response to the Bayh-Dole act, the development of technology transfer offices, and other policies and programs, there are now strong motivators and incentives for university scientists to patent their research outputs and engage in technology transfer activities. Although this is only one example of how research funding can drive academic productivity and outcomes, it makes sense that the balance of resources and funding will be related to faculty research and public outcomes.

At the individual level, regulative indicators include resources funding individual scientists and past and present work experience. Departmental and individual resource capacities enable faculty scientists to engage in public outcomes including teaching, research, and service. For example, departments that offer course buy outs will see that increases in research grants and contracts will be related to decreased teaching commitments from those faculty who buy-out of teaching commitments. Similarly, faculty that affiliate with research centers will have additional commitments which may or may not complement or compete with the department's goals.

Of course, centers differ in their norms and values and the ways in which they complement or compete with other faculty priorities (Boardman & Bozeman 2007; Bozeman & Boardman 2003; Geiger 1990; Stahler & Tash 1994). For example, Blumenthal and colleagues (1996) investigate the ways in which university-industry research relationships (UIRRs) in biotechnology and other industrial support for faculty pull them away from other activities such as scholarship and teaching. The authors find that faculty involved in UIRRs report increased publications in peer reviewed publications and no change in teaching commitments. Corley & Gaughan (2005) report similar findings, that center-affiliated scientists engaged in increased research activities, but do not reduce their other department commitments. These findings support case study research, which suggests that center-affiliated university researchers perform "double duty" engaging in research activities and other academic duties (Bozeman & Boardman

2003). On the other hand, research also notes that faculty that affiliate with research centers that are tied to industry are expected to engage in activities, such as technology transfer, which may increase private outcomes of public research (Arreola et al. 2003; Dietz & Bozeman 2005).

Given previous research on the ways in which lab affiliation is related to productivity outcomes, we expect that affiliation with a federal lab and increases in the proportion of individual research funds coming from federal grants and contracts will be related to increased research outcomes, and either stable or declining outcomes related to teaching and service (Blumenthal and colleagues 1996; Bozeman & Boardman 2003). Moreover, because collaborations with and research supported by industry is related to increased expectations for engagement in activities such as technology transfer, we expect that stronger ties to industry will be related to decreased public outcomes (Arreola et al. 2003; Dietz & Bozeman 2005).

P3. Increased associations with federal funding (lab affiliation) will increase publicness outcomes.

In addition to understanding the role of research funding on realized public outcomes, it is critical to investigate the relationships between professional and informal associations and publicness outcomes. Associative relationships are related to relationships of individual scientists interacting with individuals and organizations that do not have formal authority over the scientists, but that can affect individual behavior (Moulton 2009; Powell 1990; Scott 2003). We can capture the ways in which professional networks can affect behavioral outcomes by measuring the types and frequency of interactions between individuals (Burt 1992; Granovetter 1973; Uzzi 1999). For example, scientists that report large numbers of government employees in their collaboration networks might be expected to produce more public outcomes, while those that are closely affiliated with private industry might be expected to produce research outcomes related to private outcomes (e.g. intellectual property, patents, private spin off companies). Additionally, we might expect that individuals who describe their networks as primarily situated within their employing organization will in turn be more closely engaged in outcomes favored by the organization, while those with more external ties

will be engaged in activities and outcomes valued by those outside the organization. We might also seek to understand the role of organizational citizenship behavior (Organ 1988, 1997) among university scientists and the ways in which individuals engage in behaviors that are not explicitly rewarded (e.g. service) by the formal reward systems in the organization.

> *P4. Individual associative and normative public value institutions will play a stronger role in realized publicness outcomes as compared to organizational associative and normative public value institutions.*

Cultural -Cognitive. Public values institutions described as cultural cognitive are indicated by the culture and values of the organization and are usually best measured by assessing the perceptions and beliefs of individuals in the organization. In the case of research extensive universities, one might describe cultural cognitive public values as efforts to increase service to undergraduates, commitments to diversity, and beliefs that the organization's values can shape public outcomes. For example, researchers have been interested in understanding the ways in which faculty perceptions of shifting university priorities toward commercialization affect faculty commitments to traditional university activities such as publishing and teaching (Bozeman 2000). Some argue that university-industry partnerships, at the expense of the production of public goods, increase university commitments to private market demands (Slaughter & Leslie 1997). The ways in which faculty interpret the priorities of the university, the department, and their research labs and the ways in which they set priorities of their own can serve as indicators for cultural cognitive public values institutions.

Additionally, university commitments to values such as increased diversity can be measured with organizational-level indicators such as the diversity of the student body and the faculty. These types of measures would include diversity of income (measured as the number of students on grants and aid), racial diversity, acceptance rates, and diversity of in-state and out-of-state students. One might also measure commitments to diversity in the range of programs and degrees offered at research extensive universities. The presence of liberal arts programs, which are not typically funded through research activities, indicate a commitment to a diversity of disciplines and students seeking that

training. Slaughter (1998) argues that public research universities have shifted recourses toward departments that are closely tied to research activities, with the effect being a shift away from non-research fields, or those disciplines that do not promise the generation of R&D funding and eventual commercial development. Slaughter (1998) goes on to note that fields that are farther away from research activities and income generation are typically the departments that house larger numbers of women and minority faculty (pg. 11), thus shifting away from liberal arts, arts and sciences, and social welfare based professional schools (e.g. social work) and toward science extensive departments can be an indicator of lower commitment to diversity of training, field of science, and ultimately sex and race.

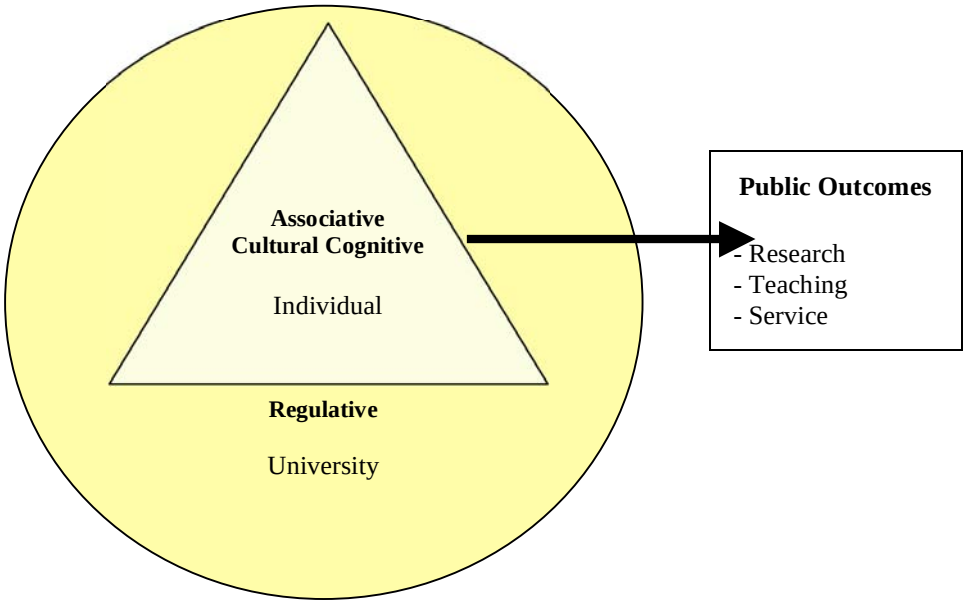
While we are eager to develop organizational level variables for cultural cognition, cultural cognitive public institutions can also be captured through surveys of individual perceptions and behavior. For example, we can ask faculty about commitments to diversity in hiring faculty and recruiting students. We can also ask about the climate and treatment of minority and women faculty. In addition to faculty perceptions of the work environment, we can assess the ways in which their activities and collaborations demonstrate commitments to research, teaching, and service. Do faculty collaborate with different types of faculty or researchers at other institutions, in other fields? Are these interactions indicators of heterogeneous or homogeneous relationships? We expect that the ways in which individual scientists perceive the university's commitment to teaching, research, and service will be related to the production of these outcomes.

> *P5. Individual level cultural cognitive public values institutions will be significantly related to variation in realized public outcomes at research extensive universities.*

Similar to Moulton's (2009) work assessing public values operationalized in the context of mortgage lending, our research uses "indictors of public value institutions, together with indicators of economic authority" (pg 891) as independent variables in hypotheses about realized public outcomes at public and private universities. One of the important contributions that we hope to make with this analysis is capturing organizational and individual public values that shape individual behavior and public

outcomes. We extend Moulton's (2008) framework for realized publicness to consider the ways in which universities and individual scientists vary in their regulative, normative, and cultural publicness and therefore produce differing levels of realized public outcomes. Figure 1, the Conceptual Model of Realized Publicness at Research Universities, illustrates the relationships that this research tests. The regulative public institutions at the university level are not directly related to realized public outcomes, but condition the environment in which individuals, influences by normative and associative and cultural cognitive public values institutions, take actions and behave to produce public outcomes.

Figure 1 Conceptual Model of Realized Publicness at Research Universities



Data

The data for this paper come from two primary sources: a national survey of academic scientists in six fields: electrical engineering, physics, chemistry, biology, earth and atmospheric sciences and computer science and institutional data collected from the US Department of Education's Integrated Postsecondary Education Data System (IPEDS), which is available online (http://nces.ed.gov/IPEDS/). Other institutional data sources are discussed below.

Individual-Level Survey Data. The population for the national survey of scientists includes all men and women faculty at the ranks of assistant, associate and full from the six fields in the 151 Carnegie Designated Research I universities in the United States.[5] Of the 151 universities, two universities (Yeshiva University and Columbia Teachers College) were excluded because they did not grant doctoral degrees. Names of scientists were collected from departmental websites of the 149 remaining universities and manually entered into a database along with data on rank, gender and field. In numerous cases, it was necessary to visit several departmental websites to obtain the full list of faculty (eg. Biology names were collected from Zoology and Botany departments at one university).[6]

From this population, a stratified sample of 3,720 faculty was selected based on three strata: field, rank and gender. The survey was implemented online using Sawtooth Software®. One of the advantages of conducting the survey online is that questions could be electronically branched depending on respondent characteristics (e.g. faculty rank). Responses were fairly evenly distributed across the six fields (18% biology; 18% chemistry; 16% computer science; % earth and atmospheric sciences; 13% electrical engineering; 17% physics), gender (48% women) and rank (27 % assistant professor, 30 % associate professor, and 44 % full professor.) Overall, 1,764 survey were returned for a 50.1% response rate and a usable response rate of 47%. Emeritus and research scientists were removed from the sample for this paper, resulting in a final total sample size of 1,601. See appendix 1 for more details about the NETWISE survey.

The survey included three major categories of questions. First, the most extensive of these questions was a series of name generators questions, the design of which was based on research methods typical to sociological studies of social networks. The name generator questions were used to identify key collaborators or advisors in several key categories, including formal as well as research advice networks. Second, a series of

[5] Carnegie designations changed in 2006, during the administration of the survey.

[6] Data analyzed in this paper were collected under the auspices of the 2005-09 project, "Women in Science and Engineering: Network Access, Participation, and Career Outcomes", (NETWISE) a project funded by the National Science Foundation (Grant # REC-0529642; Co-PIs Dr. Julia Melkers and Dr. Eric Welch). All content is the expression of the authors alone and does not represent the views of the NSF or NETWISE principal investigators. All usual disclaimers apply.

name interpreter questions were used to capture the nature of the collaboration (nature of research product), details of the level of relationship such as strength of relationship, and length of relationship, and general demographics. The online administration enabled automatic deletion of duplicate names and forward piping into name interpreter questions. The resulting dataset includes the names and characteristics of each of the network contacts. Third, the survey collected all other types of survey data typically collected in surveys including attitudinal, behavioral, work history, demographic, professional activity, and productivity data.

Institution-Level Data. In addition, institution-level data were collected for all 149 universities present in the survey data set. Although IPEDS was the primarily source from which data were collected, three other sources, National Science Foundation[7], USNews[8], and the College Board[9] provided data on medical schools and a measure of the difference between in-state and out-of-state tuition, respectively. Descriptions of all variables contained in the dataset used in this study are presented in Table 4.

Dependent Variables. We operationalize three dependent variable measures of research, teaching, and service. Research is measured as the number of peer reviewed journal articles accepted or published in the previous two academic years. This variable, called *Journal Articles*, is a categorical response variable with seven categories: zero, one to two, three to four, five to six, seven to nine, 10 to 14 and 15 or more. Teaching is measured as the number of courses taught or co-taught in the past academic year. The name of this variable is *Courses*. Service to the university community is measured as the number of department committees and university committees served on in the previous academic year. The variable is named *Committees*. All variables are approximately normally distributed.

It is important to note that the three dependent variables do not capture outcomes that are relevant, necessarily, to the same publics. For example, a journal article, to the extent that it advances knowledge, represents an outcome that has value to a broad public (academic researchers, practitioners, the media, policy makers, students etc) while

[7] http://webcaspar.nsf.gov/
[8] http://colleges.usnews.rankingsandreviews.com/best-colleges/national-universities-rankings
[9] http://collegesearch.collegeboard.com/search/index.jsp

committee work is relevant more locally, primarily to the university. The target public for courses lies somewhere between the broad and the narrow in that teaching advances student training and the university's contribution to society, but attending a college course requires enrollment in the institution and is not publicly available in the same way that published knowledge is publicly available over time.

Independent Variables. Independent variables used in the estimations are presented in Table 5. The variables categorized in terms of their publicness characteristics – regulative, associative, and cognitive – and in terms of their level of analysis: individual or university. In this model, cognitive variables are categorized at the individual level where survey data best captures individual perceptions, while regulative variables are categorized at the university level where institutions provide the public values environment within which individuals realize public outcomes. In the middle, we have categorized associative variables as primarily university level variables. However, this is primarily due to the data constraints; both individual and university level associations are relevant.

Most of the institution level independent variables may be easily understood from the variable descriptions in Table 5 (e.g. Percent Students Federal Support or Endowment Size FTE). However, two variables – Public Service Expenditures FTE and Student Services Expenditures FTE, require some additional explanation. The first of these includes university expenditures per full time equivalent student for several types of activities that are targeted to constituencies outside of the university. For example, public service expenditures includes activity related to non-instructional services that are beneficial to groups or individuals external to the institution including community service programs, patient care services, cooperative extension services, and other similar services to the local public. The second variable – student services expenditures per full time equivalent – includes university expenditures for activities and programs that contribute to student well being, as well as their development outside of instructional programs. For example, student service expenditures include student health services, career planning and placement services, mentoring, student government and student organizations, and recreational and intramural programs. These variables may capture the institutional

regulative determinants of the different public outcomes, especially as they relate to more localized public outcomes (teaching and committees).

Controls. We control for field of science, rank, salary, and citizenship. Field of science is measured using six dummy variables: biology, chemistry, computer science, earth and atmospheric sciences, electrical engineering, and physics. Rank is measured using the following three binary variables: assistant (=1), associate (=1), and full professor (=1). Salary is a continuous variable with a mean of $93,857. Citizenship is coded one if the respondent is a US citizen (by birth or naturalized) and zero if not a US citizen. In addition, for each of the three models (*Journal Articles*, *Courses*, *Committees*), we include the other two production variables. For example, in the Journal Articles model, we include Courses and Committees as explanatory variables.

Method

The hierarchical linear modeling (HLM) method applies maximum likelihood estimation to a nested structure of equations to explain individual- and group-level variance. To empirically operationalize the conceptual model above, HLM estimated two equations simultaneously, one at the scientist-level that assesses within university determinants of *Realized Public Value*, and one at the university-level that assesses between-university effects. The empirical model is:

Equation 1: "scientist" model:

$$Y_{jk} = ß_{0k} + ß_{1k}\,(\text{Federal Lab Affiliation}) + ß_{2k}\,(\text{Number of Association Memberships}) + ß_{3k}\,(\text{Worked for Public}) + ß_{4k}\,(\text{Worked for Private}) + ß_{5k}\,(\text{Worked for NPO}) + ß_{6k}\,(\text{Government Collaborators}) + ß_{7k}\,(\text{Industry Collaborators}) + ß_{8k}\,(\text{Collaboration Network Size}) + ß_{9k}\,(\text{External Collaboration}) + ß_{10k}\,(\text{Department Resources Available}) + ß_{11k}\,(\text{Departmental Multidisciplinarity}) + ß_{12k}\,(\text{Assistant Professor}) + ß_{13k}\,(\text{Associate Professor}) + ß_{14k}\,(\text{Citizen}) + ß_{15k}\,(\text{Salary}) + ß_{16k}\,(\text{Computer Science}) + ß_{17k}\,(\text{Electrical Engineering}) + ß_{18k}\,(\text{Chemistry}) + ß_{19k}\,(\text{Biology}) + ß_{20k}\,(\text{Physics}) + ß_{21k}\,(\text{Number of Articles}) + ß_{22k}\,(\text{Number of Courses}) + ß_{23k}\,(\text{Number of Committees}) + ß_{24k}\,(\text{Federal Grant Percentage}) + ß_{25k}\,(\text{Number RAs and TAs}) + R_{jk}$$

Equation 2: "university" model:

$$ß_{0k} = \gamma_{00} + \gamma_{01}\,(\text{Medical Program})_k + \gamma_{02}\,(\text{Difference In/Out State Tuition})_k + \gamma_{03}\,(\text{Percent Undergrads})_k + \gamma_{04}\,(\text{Number Undergrads (log)})_k + \gamma_{05}\,(\text{Endowment Size}$$

FTE) $_k$ + γ_{06}(Gov. Grants and Contracts FTE) $_k$ + γ_{07}(Public Service Expenditures FTE) $_k$ + γ_{08}(Student Service Expenditures FTE) $_k$ + γ_{09}(Tuition and Fees FTE) $_k$ + γ_{010} (State/Local Appropriations FTE) $_k$ + γ_{011}(Percent Students Federal Support) $_k$ + γ_{012}(Percent Students State Support) $_k$ + γ_{013}(AAU Membership) $_k$ + γ_{014}(Number NAS Members) $_k$ + γ_{015}(Weekend/Evening Classes) $_k$ + γ_{016}(Percent White) $_k$ + γ_{017}(Admission Rate) $_k$ + U_{0k}

In the level 1 model, $ß_{0k}$ is the university specific intercept where the 25 named variables are the scientist level covariates and $ß_{ik}$ is the associated coefficient signifying the partial effect of each variable on *Realized Public Value* associated with each respondent in university *k*. R_{jk} is the random error (independently distributed with a constant variance) associated with the scientist. To ensure that the level 1 model captures within-group variation only, we center all variables at the university's means.

In the level 2 model, γ_{00} is the adjusted mean *Realized Public Value*, and the other 17 γ coefficients indicate the effect that variation in the university variables have on scientist level coefficients in equation 1. U_{0k} is the random error (independently distributed with a constant variance) associated with the university.

Hierarchical linear modeling also requires that the distinction be made between fixed and random effects. Fixed effects are defined as those coefficients that do not vary across groups, while random effects are allowed to vary across groups. In this case, the level 2 group (university) intercept, $ß_{0k}$, is designated to vary around its overall mean, while the other variables in the equations are fixed. Finally, HLM provides estimates of the variance component associated with level 1 (scientist) and level 2 (university) residuals. The variance component enables the comparison of total variance explained across different estimates of the model. For example, it is useful to compare the unconditional variance (the HLM model without fixed effects included) with the full model specification to understand the proportion of within- and between-level variation explained.

Results

The results for the three models predicting the dependent variables, Journal Articles, Courses, and Committees are presented in Table 6. The level 1 (scientist) and level 2 (university) variables are presented separately and organized within those two groups as regulative, associative/normative, cultural cognitive, and controls. We find that

two-thirds of the within university variance in knowledge production (journal articles) can be explained by the variables in our model, while 42% of the between intuitional variance in the production of journal articles being explained by university–level measures. The second model, predicting teaching outcomes (courses) indicates that one-third of the within university variance in teaching activity among faculty at research intensive universities is explained by organizational-level variables and 19% of the between university variance in teaching loads is explained by individual-level variables. The model is a substantially better predictor of journal articles than it is of either teaching or committee outcomes. While this is probably a function of the specificity of many of the independent variables to journal production, it may also highlight the relative narrow public audience associated with the teaching and committee outcomes.

In the following sections we discuss the results as related to the three types of publicness institutions outlined in the paper's framework and the findings as related to our propositions. In general, we find evidence in support of the general expectation that each of the three publicness institutions matters for the realization of public values, and in most cases the findings are justifiable in terms of the theory.

Regulative. The three models included 12 variables measuring the regulative publicness institutions at public and private universities. These variables are all measured at the university level (level 2 on table 6) and include measures of university size (percent and number of undergraduate students, presence of a medical school), revenue sources (state, grants and contracts, tuition and fees, appropriations), and variance in tuition rates for in-state and out-of-state students. The models indicate that regulative publicness institutions are related to publicness outcomes at research-intensive universities. Specifically, universities that house a medical program are significantly more likely to produce journal articles. This finding is important because the presence of medical programs is often used as a measure of cost structures at research universities and the expanding roles of universities (de Groot et al 1991; Owen-Smith and Powell 2003). Additionally, increases in state appropriations per FTE and an increased gap in the difference between in-state and out-of-state tuition at public universities is related to an increase in the production of journal articles. Increases in public service and student

service expenditures are positively related to faculty reporting increased numbers of courses taught and committee service, respectively. An increase in tuition and fees per FTE is significantly related to an increase in public outcomes of teaching and committee service.

Proposition 1, and its subpropositions, is concerned with the relationships between regulative public values institutions and public outcomes at universities. We find support for our first, general proposition that resource allocation at research universities is related to the production of realized public outcomes. However, we find no support for the first subpropositions, P1a and P1b, which anticipated a relationship between federal financial aid to students and teaching and research outcomes. This may be interpreted to mean that federal aid to students is substantially formula-based. Because universities may have little local control over these formula and because their implementation may be rather uniform, this variable may not sufficiently capture regulative public value at the federal level. In fact, as we will see below, the federal effect appears to be more strongly apparent at the individual level of analysis.

Proposition 1c, 1d, and 1e predicted that increased revenue from state appropriations, tuition and fees, and out-of-state tuition rates would be related to increased public outcomes. The literature indicates that these forms of funding should also be related to increased outcomes that are student-centered (Slaughter 1998), in particular teaching outcomes. Somewhat in contrast to expectations, we find that an increase in state appropriations per FTE and increases in the difference between out-of-state and in-state tuition rates are significantly related to increased journal articles, but do not predict course teaching loads or committee service. It may be that state support is a necessary enabler of the production of the most broadly recognized public output – knowledge. When state support falters, universities seek alternate forms of funding that are tied to requisite non-research activities or demand a change in regulative values away from research.

We find support for P1d in two of the models, with increased tuition and fees per FTE being related to increased public outcomes measured as course teaching and committee service. We should reiterate that according to the model tuition and fees are

fundamentally associated with teaching and service; recent retreat by states from funding higher education appears to be having the effect of transferring realized public values away from research outcomes and toward teaching and service. While these value choices are socially and politically determined, they are may also be forcing universities to "choose their publics" preferring the more local public rather than the global knowledge public. This finding raises an interesting paradox: higher state funding leads to greater globally relevant public outcomes (publication of more journal articles), whereas lower state funding demands that universities pay more attention to local relevant realized public outcomes.

We find no support for Proposition 1f, which expected that university endowments would be related to realized public outcomes. This may be because traditionally public institutions have made up substantial ground on the acquisition of endowments as compared to traditionally private institutions. In sum, the three models indicate some relationships between regulative public values institutions and public outcomes.

Normative/Associative. The models include 14 variables measuring associative / normative public values institutions. There were five university-level measures indicating the associative values of the universities. These measures include formal associations such as membership in the AAU and indicators for a university's norms and values, such as the acceptance rate, percent of minority students, and offering weekend and evening classes. The models also include nine measures for individual-level associations, such as membership in professional associations, affiliation with a federal lab, previous work experience in the private sector, and an assortment of measures for the strength and type of individual collaboration networks.

Proposition 2 expected that variation in organizational level associative and normative public value institutions at research universities would be significantly related to realized public outcomes. We find some support for this proposition. Of the five measures for university-level associative public value institutions, three are significant. Membership in the AAU is positively related to the public value outcomes of journal articles and committee service, and is negatively related to teaching loads. Additionally,

an increase in the number of NAS members on faculty at the university is negatively related to committee service. Offering classes in the evenings and on weekends, which typically serve non-traditional students and local professionals, is negatively related to the number of journal articles published by faculty. We speculate that AAU membership, even though is supposed to indicate substantial teaching prowess or members, is a better indicator of traditional academics in which teaching is less valued than research and internal governance. The NAS membership may signify institutional prestige based on research capacity. Prestige may be considered a private good or the expression of strong normative values associate with publication. Either way, it appears to dampen production of service to the department and university.

Proposition 3 expects that increased associations with federal funding (e.g. federal lab affiliation or federal grant funding) will increase publicness outcomes. We find mixed support for this proposition at the individual level and limited support at the organization level. Affiliation with a federal lab is not related to teaching or research outcomes, but it is associated with lower committee service. By contrast, the percentage of federal grant funding to the individual scientist is associated with the production of journal articles. These findings help refine previous research that has found that lab affiliated faculty report increased publications and no change in teaching commitments (Blumenthal et al. 1996) and increased research activities but no reduction of other department commitments (Corley & Gaughan 2005). Here we find that, within a nested model, it is not the association with the lab that matters as much as the source of the funding of the scientist's research. We expect that our findings have two explanations. First, affiliation with a federal lab may require faculty to engage in additional activities at the expense of committee service (Dietz & Bozeman 2005). Second, increased individual federal funding, whether associated with a lab or not, leads to more publications.

At the university level, more government grants and contracts are associated with higher production of courses, but no difference in articles produced or committee memberships of scientists. This finding may indicate that federal funding is either increasingly directly associated the creation of new courses (e.g. NSF IGERT or other

funded training and education programs), or indirectly associated: federal funding may enable universities to reallocate internal dollars toward course development.

Proposition 4 expects that individual associative/normative public value institutions will play a stronger role in realized publicness outcomes as compared to organizational associative and normative public value institutions. We find that having worked in the private sector and having an increased number of close collaborators who work in government are both negatively related to the production of journal articles. There are a number of possible explanations for these findings. Perhaps scientists that have worked in the private sector have more ties to industry and engage in the production of more private outcomes, such as patenting, and put less emphasis on journal publications. Second, faculty scientists with close collaborators who work in government may be more engaged in practitioner activities and less engaged in academic knowledge creation. It is also possible that those who have worked in the private sector or have increased ties to government are simply less responsive to academic motivators and priorities.

We also find that larger close collaboration networks, as compared to small close networks, and a greater proportion of external collaborators in the network are positively related to the number of journal articles published. A larger network is probably an indicator of capacity and while strength of external networks may indicate an overriding interest in the production of knowledge relevant to a broader public. Respondents with increased association memberships report higher committee service outcomes. None of the individual associative measures are related to the number of courses taught, which probably indicates that course loads are relatively stable at research-intensive universities. Faculty may be expected to teach a certain number of classes even if they receive grant funding (e.g. limited buyouts as a result of grant awards).

Cultural Cognitive. The models include three individual-level variables measuring cultural cognitive public values institutions. We find support for Proposition 5 that individual level cultural cognitive public values institutions are significantly related to variation in realized public outcomes at research extensive universities. Specifically we find that increased availability of department resources is negatively related to the

production of journal articles. This may indicate either that scientists who request resources and are not provided them (typically known as bridge funding) are high-risk investments; they may be less likely to receive new grant awards. As a result, departments are less likely to invest in them, even though they are more likely to seek internal resources. Second, perceiving the work environment as multidisciplinary is positively related to increased teaching outcomes among faculty and decreased committee service. Multidisciplinarity may indicate a more cosmopolitan (Bozeman & Corley 2004) view of the scientific world or a more open perspective on the development of new knowledge. Individuals who operate in these environments may be able to package and communicate these interactions through new courses. Third, an increase in the individual's perceived level of influence in the department is negatively related to the number of courses taught and positively related to service on committees. Scientists who recognize the opportunity to affect the local environment are more likely to engage in efforts to affect internal governance rather. Similarly, individuals who have less influence may be required to teach more. This finding further reflects the NAS and AAU membership findings in which some elements of reputation may dampen teaching and service outcomes. Thus we find that individual measures of cultural cognitive public values institutions are related to variation in realized public outcomes at research extensive universities, but that those relationships are not uniformly positive or negative.

Controls. The control variables in these models indicate some important relationships between rank, field of science, citizenship, and the balance of work responsibilities and demands. First, assistant professors are significantly less likely to produce all three types of public outcomes, as compared to full professors. This finding points to some of the important ways in which tenure and seniority are related to increased public outcomes at universities. Second, there are significant variations in public outcomes by field of science. For example, chemists and physicists produce significantly more journal articles than the reference group, earth and atmospheric scientists (EAS), and computer scientists produce significantly fewer journal articles. Chemists and electrical engineers report significantly more committee service as compared to EAS, and four fields of science report significantly lower numbers of

courses taught as compared to the reference category (EAS). These findings point to important variations across field of science, which may be related to reward structures, culture, types of research conducted, and the structure and demands of student training in these fields.

The control variable for citizenship indicates that US citizens produce significantly more journal articles as compared to non-citizens, while non-US citizens serve on significantly more committees than do citizens. This may be an indication of trade-offs in departments, where those who are not as productive in producing articles are asked to serve on committees.

Finally, the control variables enable us to see the ways in which public outcomes of knowledge production, teaching and training, and service are related to one another. First, an increase in the number of journal articles published is negatively related to teaching outcomes. Second, an increase in the number of courses taught is related to a decline in journal production and an increase in committee service. These findings indicate that teaching and committee service are positively related, while the third public outcome (publishing) pulls faculty away from the production of teaching and service outcomes. As universities move forward seeking to advance multiple missions, it will be important to understand how these diverse public outcomes missions may require faculty to choose between activities, favoring one at the expense of others.

Interpretation and Discussion

Just as simplified distinctions between public and private organizations fail to advance our understanding of hybrid organizations, distinctions among universities are not easily captured by a binary measure of public and private. Table 7 provides simple correlations between the university level variables in the model and a discrete variable indicating whether or not the university is considered to be a "public" institution. The blurring of the sectors is strongly apparent. "Public" is moderately positively correlated with more undergrads, the difference between in-state and out-of-state tuition, admission rate, and state and local appropriations, and moderately negatively correlated with *Tuition and Fees* and *Endowment Assets*: relationships expected to be indicative of public institutions. However, these correlations are not as high as one might think and vary

substantially in strength, indicating that "publicness" may depend upon how it is measured. Other variables in the list, such as percent of students on *State and Federal Support, Weekend and Evening Classes,* and *Public Services Expenditures* are not strongly correlated. Correlations between "Land Grant Institution" and these variables are lower and less cohesive across the board. Hence, there is a need to go beyond simplistic institutional approaches to publicness.

One way this paper addresses the limitations of an institutional approach is through the use of a two-level nested model. Results show that in the case of federal support of funding, individual associations have complex effects on publicness outcomes: a scientist's association with a federal lab depresses committee activity while federal funding to the individual publication outputs. Similarly complex, prior work in the private sector and current collaboration with government are both negatively correlated with production of journal articles. The analysis here shows that both public and private associations can lead to reduction of public outcomes, a finding that seems to redefine the blurring: public outcomes in universities may depend upon an appropriate mixture of public and private associations. Moreover, organizational culture and individual cognitions at individual level, although not well examined here due to data limitations, are strongly associated with realized public values. The sign shifts that occur across courses and committees for two variables – *Multidisciplinarity* and *Influence* – show that beyond the regulative and associative institutional effects, the less obvious aspects of organizational environment matter for the willingness of individuals to invest in the realization of public outcomes. The take away is not whether these variables fully capture this public values institution, but rather that the institution matters for public outcomes.

Researchers have raised concerns that the shift toward supply-side institutional resource allocation (Slaughter 1998) and enhanced marketization, privatization, and commercialization of university activities (Priest and St. John 2006; Slaughter 1998; Williams, 1995) that have resulted in making higher education "a subsector of economic policy" and "a vehicle for wealth creation" (Slaughter 1998, page 7) at the expense of public outcomes including increasing the pool of knowledge, training undergraduates, and engaging in service. To some extent, our research provides some support for this

expectation: findings seem to indicate expose the paradox of state funding as critical to the realization of public research outcomes and the specific allocation of tuition and fees to teaching and service outcomes. Federal funding does not affect realized public outcomes at the institutional level, but does affect the production of science at an individual level. Hence, efforts by universities like UIC to backfill reductions from state dollars with grant funding does not yet appear to help realize publication outcomes. Over time, this strategy may result in greater publication outcomes.

However, the inflexibility of grant funding, as compared to state funding, may make it more difficult for universities to maintain the basic infrastructure and human capital necessary to produce public research outcomes. The fact that the benefits of public research outcomes accrue to a broader audience outside the state does not bode well in the current political climate for a reversal in state appropriations to universities. Nevertheless, regulative institutions that provide support for public or student services appear to result in furthering course and committee outcomes, respectively. Additionally, the offering of weekend and evening courses, in response to local communities, appears to dampen journal article production. These findings highlight the trade-offs inherent in the realization of public outcomes that are difficult to perceive through the blurring of the public-private divide. Under fiscal constraints, universities make decisions about the publics that they seek to serve and the trade-offs in regulative and associative/normative institutions that they make result in differential impacts on realized public outcomes.

The blurring of the sectors comes into some focus as the result of the operationalizing the public values framework and the HLM findings. Moulton's framework for realized public outcomes offers an adaptable model for testing propositions about the ways in which a shift in the balance of regulative, normative and associative, and cultural cognitive public value institutions can affect realized public value outcomes. The models presented in this paper indicate that the variance in public outcomes produced at public and private research-intensive universities can be partly accounted for by regulative, associative, and cultural cognitive public values institutions.

Table 1: Difference between out-of-state and in-state tuition at public universities

UNIVERSITY NAME	Difference	UNIVERSITY NAME	Difference
University of New Mexico Main Campus	.	University of Alabama	$12,200
University of California-Santa Cruz	$22,669	University of Hawaii at Manoa	$12,048
University of Michigan-Ann Arbor	$22,492	Old Dominion University	$11,670
University of California-Davis	$22,021	Wayne State University	$11,641
University of California-San Diego	$22,021	Pennsylvania State University Park	$11,530
University of Virginia	$22,000	University of Louisville	$11,328
University of California-Berkeley	$21,670	Iowa State University	$11,220
University of Texas at Austin	$21,670	University of Nebraska - Lincoln	$11,154
University of California-Los Angeles	$21,669	West Virginia University	$11,098
University of California-Riverside	$21,669	University of Missouri - Columbia	$11,091
University of California-Santa Barbara	$21,669	Washington State University	$11,076
University of Colorado at Boulder	$20,254	University of Oregon	$10,860
University of California-Irvine	$20,021	University of South Florida	$10,809
University of Florida	$19,371	Kansas State University	$10,707
Georgia Institute of Technology	$18,210	University of Kansas Main Campus	$10,683
University of Vermont	$17,856	Rutgers State University of New Jersey, NB	$10,632
Indiana University at Bloomington	$17,547	New Mexico State University Main Campus	$10,536
University of North Carolina at Chapel Hill	$16,898	Southern Illinois University at Carbondale	$10,463
University of Washington	$16,675	Oklahoma State University Main Campus	$10,354
University of Rhode Island	$16,498	University of Idaho	$10,080
Purdue University Main Campus	$16,480	University of Oklahoma Norman Campus	$9,981
Michigan State University	$16,335	University of Wisconsin-Milwaukee	$9,728
University of Georgia	$16,312	University of Pittsburgh, Pittsburgh Campus	$9,698
University of Maryland College Park	$15,937	University of Maryland Baltimore County	$9,341
Colorado State University	$15,922	Temple University	$9,280
University of Connecticut	$15,600	Louisiana State University, A&M College	$9,150
University of Iowa	$15,374	Utah State University	$8,974
University of South Carolina - Columbia	$14,576	Ohio University Main Campus	$8,964
Georgia State University	$14,568	University of Arkansas Main Campus	$8,878
Texas A&M University	$14,550	University of Toledo	$8,811
University of Cincinnati Main Campus	$14,523	Southern Illinois University	$8,775
Florida State University	$14,445	University of Kentucky	$8,555
Clemson University	$14,310	Texas Tech University	$8,310
University of Wisconsin-Madison	$14,250	University of North Texas	$8,310
University of Illinois at Urbana-Champaign	$14,142	University of Texas at Arlington	$8,310
University of Tennessee, Knoxville	$14,096	University of Massachusetts	$8,224
University of New Hampshire	$13,970	University of Mississippi	$7,944
University of Delaware	$13,700	University of Wyoming	$7,920
Virginia Commonwealth University	$13,672	State University of New York at Albany	$7,900
Ohio State University Main Campus	$13,572	State University of New York at Binghamton	$7,900
University of Maine	$13,410	State University of New York at Buffalo	$7,900
University of Arizona	$13,134	State University of New York at Stony Brook	$7,900
Arizona State University Main	$13,103	Mississippi State University	$7,870
Oregon State University	$12,924	Northern Illinois University	$7,800
Virginia Polytechnic Institute & State Univ.	$12,883	University of Southern Mississippi	$7,650
University of Utah	$12,548	Kent State University Main Campus	$7,432
North Carolina State University	$12,485	University of Memphis	$6,937
Auburn University	$12,480	University of Alabama at Birmingham	$6,336
Florida International University	$12,399	Northeastern University	$6,090
University of Illinois at Chicago	$12,390	University of Houston	$5,576
University of Nevada, Reno	$12,340	University of Minnesota-Twin Cities	$4,000

Source: US News and World Report. http://colleges.usnews.rankingsandreviews.com/best-colleges/national-universities-rankings

Table 2: Top 20 Endowments at US Research I Universities

Name	Status	Endowment
Harvard University	Private	$36,926,693,000
Yale University	Private	$22,686,282,000
Stanford University	Private	$17,214,373,000
Princeton University	Private	$16,727,060,000
Massachusetts Institute of Technology	Private	$10,068,787,000
University of Michigan-Ann Arbor	Public	$7,462,302,000
Columbia University	Private	$7,146,806,000
University of Notre Dame	Private	$6,351,855,000
University of Pennsylvania	Private	$6,233,271,000
Duke University	Private	$6,123,743,000
University of Chicago	Private	$5,933,760,896
Cornell University	Private	$5,578,101,861
Emory University	Private	$5,515,479,092
Washington University	Private	$5,428,641,000
Northwestern University	Private	$5,342,297,000
Rice University	Private	$4,609,863,000
University of Virginia	Public	$4,517,750,000
University of Southern California	Private	$3,589,225,000
Vanderbilt University	Private	$3,495,439,000
University of California-Berkeley	Public	$3,070,746,000

Source: US News and World Report. http://colleges.usnews.rankingsandreviews.com/best-colleges/national-universities-rankings

Table 3: Early Founders of University Venture Arms

Name	Status	Founding Date
Purdue University – Trask Venture Fund	Public	1974
Boston University – Technoogy Fund	Private	1975
Oklahoma State University – Seed Fund	Public	1977
University of Chicago – ARCH Venture Partners	Private	1987
University of Michigan – Wolverine Venture Fund	Public	1997
Stanford University – Licensing Seed Funds	Private	1999
Cornell University – BR Venture Fund	Private	2002
University of Kentucky – R&D Voucher Fund	Public	2002

Source: Drawn from Mehta (2004).

Table 4. Descriptive Statistics

	Variable	N	MEAN	SD	MIN.	MAX.
Regulative	Medical Program	148	0.61	0.49	0	1
	Difference In/Out State Tuition	148	8720	7027	0	22669
	Percent Undergrads	148	0.69	0.15	0	0.91
	Number Undergrads (log)	148	9.54	0.92	1.61	10.88
	Endowment Size	148	100975	260988	0	1896891
	Government Grants & Contracts FTE	148	12819	15450	0	116289
	Public Service Expenditures FTE	148	1874	2103	0	13162
	Student Service Expenditures FTE	148	2113	2711	0	25969
	Tuition and Fees FTE	148	10551	6293	0	26352
	State/Local Appropriations FTE	148	6210	6099	0	45916
	Percent Students Federal Support	148	19.90	9.11	8	62
	Percent Students State Support	148	29.73	21.67	0	90
Associative / Normative	AAU Membership	148	0.41	0.49	0	1
	Number NAS Members	148	12.16	26.96	0	185
	Weekend and Evening Classes	148	0.31	0.46	0	1
	Percent White	148	63.11	16.53	1	93
	Admission Rate	148	59.25	22.06	9	95
	Worked for Public	1601	0.12	0.33	0	1
	Worked for Private	1601	0.08	0.28	0	1
	Worked for NPO	1601	0.04	0.19	0	1
	Government Close Collaborators	1442	0.13	0.47	0	7
	Industry Close Collaborators	1442	0.05	0.27	0	4
	Size Close Collaboration Network	1447	5.09	2.48	0	10
	External Collaboration Network	1441	0.00	0.53	-1	1
	Number of Association Member	1601	1.90	1.15	0	4
	Federal Grant Percentage	1478	0.33	0.42	0	8
	Federally Funded Lab	1601	0.08	0.27	0	1
Cultural Cognitive	Department Resources Available	1601	0.07	0.46	0	7
	Work Environment Multidisciplinary	1542	6.56	2.09	3	12
	Level of Influence Perceived	1601	7.46	1.73	4	12
Controls	Assistant Professor	1601	0.30	0.46	0	1
	Associate Professor	1601	0.27	0.44	0	1
	Citizen	1578	1.60	0.92	1	4
	Salary	1460	93857	43053	0	850000
	Biology	1601	0.17	0.38	0	1
	Chemistry	1601	0.18	0.38	0	1
	Electrical Engineering	1601	0.13	0.34	0	1
	Computer Science	1601	0.16	0.37	0	1
	Physics	1601	0.17	0.38	0	1
	Number of Articles	1591	3.82	1.70	1	7
	Number of Courses	1587	3.42	1.12	1	6
	Number of Committees	1570	5.66	2.11	2	12
	Number of RAs and TAs	1559	6.47	2.50	2	12

Table 5: Variables and Measures

	Variable Name	Level	Variable Description	Source
Regulative	Medical Program	U	The university has a medial program (Yes = 1)	NSF
	Difference In/Out State Tuition	U	Difference between in state and out of state tuition costs ($).	USNews
	Percent Undergrads	U	Percent of enrolled student body that is undergraduate (%)	IPEDS
	Number Undergrads (log)	U	Log of the number of undergraduate students enrolled.	IPEDS
	Endowment Size	U	Dollar amount of endowment ($)	IPEDS
	Government Grants/Contracts FTE	U	Revenue from government grants and contracts, full time equivalent	IPEDS
	Public Service Expenditures FTE	U	Public service expenditures by university, full time equivalent	IPEDS
	Student Service Expenditures FTE	U	Student service expenditures by university, full time equivalent	IPEDS
	Tuition and Fees FTE	U	Revenue from tuition and fees, full time equivalent	IPEDS
	State/Local Appropriations FTE	U	State and local government appropriations, full time equivalent	IPEDS
	Percent Students Federal Support	U	Percent of students who receive federal aid (%)	IPEDS
	Percent Students State Support	U	Percent of students who receive state and local aid (%)	IPEDS
Associative / Normative	AAU Membership	U	The university is a member of AAU (Yes = 1)	AAU
	Number NAS Members	U	Number of faculty at the university who are NAS members (#)	NAS
	Weekend and Evening Classes	U	Weekend and evening classes are offered by the university (Yes = 1)	IPEDS
	Percent White	U	Percent of the enrolled student body that is white, non-Hispanic (%)	IPEDS
	Percent Students Federal Support	U	Percent of students who receive federal aid (%)	IPEDS
	Percent Students State Support	U	Percent of students who receive state and local aid (%)	IPEDS
	Admission Rate	U	Percent of applying students accepted for admission (%)	IPEDS
	Worked for Public	S	Scientist has worked full time for a government agency during the last 10 years (Yes = 1)	Survey
	Worked for Private	S	Scientist has worked full time for private industry during the last 10 years (Yes = 1)	Survey
	Worked for NPO	S	Scientist has worked full time for a non-profit organization (non-academic) during the last 10 years (Yes = 1)	Survey
	Government Close Collaborators	S	Number of named close collaborators who work for government (#).	Survey
	Industry Close Collaborators	S	Number of named close collaborators who work for industry (#).	Survey
	Size Close Collaboration Net	S	Total number of close collaborators named (#).	Survey
	External Collaboration Net	S	E-I index = (ECL – ICL) / (ECL + ICL), where ECL is the number of external collaborative links and ICL is the number of internal collaborative links. The possible scores of E-I index ranges from -1.0 to +1.0. As the E-I index approaches +1.0, the ratio of external links to internal links rises (positive means more external). As the E-I index approaches -1.0, the ratio of internal links to external links rises (negative=more internal).	Survey
	Number of Association Memberships	S	Number of associations named in survey responses (#)	Survey
	Federally Funded Lab	S	Scientist is affiliated with a center that is part of a formal, national centers program funded by a federal agency (Yes = 1)	Survey

Table 5: Variables and Measures Cont'd

	Variable Name	Level	Variable Description	Source
Cultural Cognitive	Department Resources Available	S	Difference between number of resources requested from and number of resources provided by respondent's department/unit in the past two academic years: (a) graduate students, postdoctoral fellows or laboratory; (b) travel money for conferences; (c) laboratory space; (d) equipment: purchases, maintenance, and technical support; (e) software: upgrades, troubleshooting, etc; (f) special classroom facilities; (g) administrative support for grant writing & management.	Survey
	Work Environment Multidisciplinary	S	Linear combination of responses to three questions: a) interdisciplinary research is important for advancement in my field, b) Multidisciplinarity is a requirement for most of the grant proposals that I submit; c) The direction of my research has changed as a result of interdisciplinary research (strongly agree - strongly disagree, 4-point scale) (alpha=0.77)	Survey
	Level of Influence Perceived	S	Linear combination of responses to four items. Compared to the colleagues in your department/unit, how much influence do you have over the following decisions: a) selection of new faculty; b) selection of unit head; c) who receives tenure or a promotion; d) allocation of budget/departmental research funding. (Three point scale: less influence, about the same influence, more influence) (alpha = 0.78)	Survey

U=University; S=Scientist

Table 6. Estimation Results

	Level 1	Journal Articles Coeff.	Journal Articles SE	Journal Articles p-value	Courses Coeff.	Courses SE	Courses p-value	Committees Coeff.	Committees SE	Committees p-value
	Intercept	**3.856**	**0.051**	**0.000**	**3.474**	**0.040**	**0.000**	**5.753**	**0.069**	**0.000**
Associative / Normative	Federal Lab	0.105	0.187	0.573	-0.036	0.146	0.804	**-0.390**	**0.226**	**0.085**
Associative / Normative	Federal Grant Percentage	**0.318**	**0.111**	**0.005**	-0.110	0.103	0.285	0.007	0.162	0.965
Associative / Normative	Number of Association Member	-0.010	0.043	0.812	0.013	0.031	0.667	**0.134**	**0.058**	**0.021**
Associative / Normative	Worked for Public	0.015	0.139	0.913	-0.008	0.093	0.933	-0.133	0.175	0.447
Associative / Normative	Worked for Private	**-0.391**	**0.148**	**0.009**	-0.082	0.124	0.509	0.018	0.224	0.936
Associative / Normative	Worked for NPO	0.085	0.230	0.712	0.120	0.141	0.395	-0.264	0.308	0.392
Associative / Normative	Govt Close Collaborators	**-0.204**	**0.091**	**0.025**	-0.058	0.078	0.457	0.044	0.121	0.718
Associative / Normative	Industry Close Collaborators	-0.021	0.131	0.874	0.028	0.087	0.743	-0.089	0.210	0.672
Associative / Normative	Size Close Collaboration Network	**0.142**	**0.021**	**0.000**	-0.010	0.013	0.466	0.042	0.028	0.129
Associative / Normative	External Collaboration Network	**0.295**	**0.093**	**0.002**	-0.066	0.067	0.320	-0.179	0.128	0.164
Cultural Cognitive	Dept Resources Available	**-0.261**	**0.090**	**0.004**	-0.011	0.067	0.873	0.077	0.159	0.627
Cultural Cognitive	Work Environment Multidisciplinary	-0.033	0.021	0.120	**0.035**	**0.014**	**0.015**	**-0.078**	**0.029**	**0.007**
Cultural Cognitive	Level of Influence Perceived	0.014	0.033	0.678	**-0.081**	**0.019**	**0.000**	**0.233**	**0.039**	**0.000**
Controls	Assistant Professor	**-0.502**	**0.150**	**0.001**	**-0.286**	**0.088**	**0.002**	**-0.964**	**0.176**	**0.000**
Controls	Associate Professor	-0.088	0.122	0.470	0.083	0.083	0.317	**-0.576**	**0.156**	**0.000**
Controls	Citizen	**0.224**	**0.053**	**0.000**	0.015	0.036	0.670	**-0.181**	**0.071**	**0.012**
Controls	Salary	**0.000**	**0.000**	**0.048**	0.000	0.000	0.180	0.000	0.000	0.911
Controls	Biology	0.026	0.150	0.860	**-0.653**	**0.124**	**0.000**	**0.575**	**0.213**	**0.007**
Controls	Chemistry	**0.634**	**0.130**	**0.000**	**-0.653**	**0.120**	**0.000**	**0.403**	**0.216**	**0.063**
Controls	Electrical Engineering	0.224	0.170	0.188	-0.141	0.137	0.304	-0.045	0.232	0.845
Controls	Computer Science	**-0.788**	**0.161**	**0.000**	**-0.406**	**0.124**	**0.001**	-0.294	0.227	0.196
Controls	Physics	**0.739**	**0.149**	**0.000**	**-0.630**	**0.112**	**0.000**	0.304	0.220	0.168
Controls	Number of Articles				**-0.055**	**0.019**	**0.004**	0.044	0.041	0.284
Controls	Number of Courses	**-0.129**	**0.044**	**0.004**				**0.211**	**0.062**	**0.001**
Controls	Number of Committees	0.026	0.024	0.283	**0.054**	**0.017**	**0.002**			
Controls	Number of RAs and TAs	**0.062**	**0.021**	**0.004**	**0.095**	**0.013**	**0.000**	**0.124**	**0.027**	**0.000**

Table 6. Estimation Results cont'd

	Level 2	Journal Articles			Courses			Committees		
Regulative	Medical Program	**0.213**	**0.113**	**0.062**	-0.003	0.092	0.971	-0.095	0.158	0.550
	Difference In/Out State Tuition	**0.000**	**0.000**	**0.022**	0.000	0.000	0.695	0.000	0.000	0.669
	Percent Undergrads	-0.461	0.622	0.460	-0.142	0.424	0.738	-0.413	0.859	0.631
	Number Undergrads (log)	-0.056	0.074	0.449	0.039	0.065	0.551	-0.053	0.120	0.655
	Endowment Size FTE	0.000	0.000	0.408	0.000	0.000	0.675	0.000	0.000	0.274
	Government Grants & Contracts FTE	0.000	0.000	0.544	**0.000**	**0.000**	**0.039**	0.000	0.000	0.706
	Public Service Expenditures FTE	0.000	0.000	0.765	**0.000**	**0.000**	**0.000**	0.000	0.000	0.821
	Student Service Expenditures FTE	0.000	0.000	0.137	0.000	0.000	0.371	**0.000**	**0.000**	**0.080**
	Tuition and Fees FTE	0.000	0.000	0.660	**0.000**	**0.000**	**0.007**	**0.000**	**0.000**	**0.035**
	State/Local Appropriations FTE	**0.000**	**0.000**	**0.041**	0.000	0.000	0.868	0.000	0.000	0.144
	Percent Students Federal Support	0.008	0.008	0.336	-0.001	0.007	0.911	0.000	0.011	0.994
	Percent Students State Support	0.001	0.003	0.755	-0.002	0.002	0.422	**0.008**	**0.004**	**0.036**
Associative	AAU Membership	**0.461**	**0.120**	**0.000**	**-0.241**	**0.100**	**0.017**	**0.423**	**0.174**	**0.017**
	Number NAS Members	-0.002	0.003	0.462	-0.002	0.002	0.347	**-0.008**	**0.005**	**0.093**
	Weekend and Evening Classes	**-0.205**	**0.112**	**0.068**	0.082	0.094	0.387	-0.200	0.162	0.219
	Percent White	-0.005	0.004	0.236	-0.002	0.003	0.491	-0.005	0.006	0.366
	Admission Rate	0.005	0.004	0.189	0.001	0.003	0.818	-0.003	.0.006	0.605
	Universities in Sample		129			129			129	
	Individuals in Sample		1148			1148			1148	
	Within Unit Variance Explained		0.24			0.19			0.19	
	Between Unit Variance Explained		0.42			0.33			0.11	

The reference category for the fields of science is Earth and Atmospheric Sciences. The reference category for rank is Full Professor.

Table 7. Correlations

		1	2	3	4	5	6	7	8	9	11	12	13	14	15	17	18	19
1	**Public University**	**1.00**																
2	Percent Undergrads	**0.48**	1.00															
3	Number Undergrads (log)	**0.63**	0.55	1.00														
4	In/Out State Tuition Diff.	**0.78**	0.54	0.56	1.00													
5	NAS Members	**-0.26**	-0.26	-0.22	-0.03	1.00												
6	AAU Member	**-0.16**	-0.13	-0.02	0.13	0.47	1.00											
7	Tuition and Fees FTE	**-0.78**	-0.52	-0.52	-0.59	0.27	0.28	1.00										
8	State/Local Aprop. FTE	**0.57**	-0.20	0.31	0.30	-0.13	-0.13	-0.46	1.00									
9	Gov. Grants/Cont. FTE	**-0.40**	-0.47	-0.43	-0.24	0.64	0.35	0.36	-0.18	1.00								
11	Endowment Assets FTE	**-0.53**	-0.36	-0.47	-0.41	0.59	0.25	0.39	-0.31	0.52	1.00							
12	Student Svcs Exp FTE	**-0.47**	-0.58	-0.42	-0.45	0.45	0.18	0.45	0.01	0.50	0.75	1.00						
13	Public Svcs Exp FTE	**0.19**	0.10	0.17	0.13	-0.09	-0.10	-0.15	0.14	-0.03	0.00	0.03	1.00					
14	Medical School	**0.00**	-0.04	0.05	0.07	0.03	0.14	-0.01	0.02	0.12	-0.04	-0.10	0.37	1.00				
15	Percent White	**0.29**	0.32	0.24	0.09	-0.41	-0.21	-0.24	-0.01	-0.35	-0.23	-0.29	0.19	0.06	1.00			
17	Admission Rate	**0.68**	0.53	0.46	0.44	-0.50	-0.35	-0.63	0.27	-0.52	-0.58	-0.53	0.16	-0.02	0.54	1.00		
18	% Students State Support	**0.31**	0.11	0.14	0.30	-0.14	-0.15	-0.35	0.29	-0.13	-0.22	-0.24	0.08	0.05	-0.09	0.07	1.00	
19	% Students Federal Support	**0.24**	0.09	0.06	0.13	-0.02	-0.18	-0.27	0.17	-0.07	-0.19	-0.15	-0.07	-0.02	-0.33	0.10	0.31	1.00
20	Weekend/Eve Classes	**0.08**	0.10	0.15	-0.02	-0.17	0.00	-0.08	-0.09	-0.14	-0.09	-0.16	-0.04	-0.05	0.06	0.13	0.19	0.14

Appendix I

NETWISE Survey - Data analyzed in this paper were collected under the auspices of the 2005-09 project, "Women in Science and Engineering: Network Access, Participation, and Career Outcomes", (NETWISE) a project funded by the National Science Foundation (Grant # REC-0529642; Co-PIs Dr. Julia Melkers and Dr. Eric Welch).

The survey was implemented online using Sawtooth Software®. Individuals were alerted to the survey via personal emails and provided with a unique user id and password. Three reminders were sent, with a combination of email and post card reminders. One of the advantages of conducting the survey online is that questions could be electronically branched depending on respondent characteristics (e.g. faculty rank). Responses were fairly evenly distributed across the six fields, gender (48% women) and rank (27 % assistant professor, 30 % associate professor, and 44 % full professor.) In terms of field, approximately 18% of respondents are from biology, 18% from chemistry, 13% from electrical engineering, 17% from physics, 16% from computer science and 18% from earth and atmospheric sciences. About 13% of respondents reported having worked for government while the numbers were 8% and 4% for private and non-profit, respectively.

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The survey included three major categories of questions. First, the most extensive of these questions was a series of name generators questions based, the design of which was based on research methods typical to sociological studies of social networks. The name generator questions were used to identify key collaborators or advisors in several key categories, including formal as well as research advice networks. While the name generators are useful for identifying collaborators, it was important to understand characteristics of these individuals especially from the standpoint of this paper. To do this, a series of name interpreter, questions were used to capture the nature of the collaboration (nature of research product), details of the level of relationship such as strength of relationship, and length of relationship, and general demographics. The online administration enabled automatic deletion of duplicate names and forward piping into name interpreter questions. The resulting dataset includes the names and characteristics of each of the network contacts. For example, based on the name interpreter questions, we know whether a collaborator works in government or the private sector, or if the collaborator works at the same university as the respondent or at a different university. A third category of data includes all other types of survey data typically collected in surveys. These include attitudinal, behavioral, work history, demographic, professional activity, and productivity data.

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