and Public Policy, volume 27, number 2, pages 137-145, April 2000, Beech Tree Publishing, 10 Watford Close, Guildford, Surrey GU1 2EP, England.

Social capital

Building a social capital model of research development: the case of the Experimental Program to Stimulate Competitive Research

James S Dietz

This paper argues that social capital theory, originally developed to explain collective, cooperative behavior, can be applied in understanding how better to use science and technology to advance social and economic objectives of underdeveloped regions. Using the case of the Experimental Program to Stimulate Competitive Research (EPSCoR), broad issues affecting priority setting, knowledge utilization, and program evaluation are examined to shape a revised theory of social capital, EPSCoR, and the use of science as a social and economic development strategy. A 'scientific and technical human capital' model for the evaluation of EPSCoR is presented.

James S Dietz is in the School of Public Policy, GCATT Building, Room 120, Georgia Institute of Technology, 250 14th Street NW, Atlanta, GA 30318-0490, USA; Tel: +1 404 894 9455; Fax: +1 404 894 9372; E-mail: gt7631a@prism.gatech.edu.

The author thanks Barry Bozeman, Gordon Kingsley, and Michael C Farmer for their comments.

CAN SOCIAL CAPITAL THEORY, originally developed by Bourdieu (1986), Coleman (1988; 1990), Putnam (1993), and others to explain collective behavior among individuals, be applied in evaluating programs that use science and technology as a means of advancing the social and economic objectives of underdeveloped regions? If so, what would a 'social capital model of research development' look like and how can it be used to improve policymaking? This paper seeks to answer these questions using the evaluation of the Experimental Program to Stimulate Competitive Research (EPSCoR) as an illustration.

Occasionally criticized within academic circles as little more than research and development (R&D) hush money for scientifically-poor states, EPSCoR was established by the US National Science Foundation (NSF) in 1978 in response to Congressional mandate:

> ". . .it shall be an objective of the Foundation to strengthen research and education in the sciences and engineering, including independent research by individuals, throughout the United States, and to *avoid undue concentration* of such.. ." (US Congress, 1978, emphasis added).

The program supports academic R&D in states that historically have been among the most underdeveloped in terms of their scientific and technical capability, and, not coincidentally, their economic and industrial strength as well.

 0302-3427/00/020137-9 US$08.00

James S Dietz is a Senior Research Associate of the Research Value Mapping Program at the Georgia Institute of Technology, School of Public Policy. Dietz is on leave from the National Science Foundation where he has served as an Associate Program Director for Research, Evaluation, and Communication since 1989. His research interests include scientific workforce issues, knowledge and technology transfer, and R&D evaluation. His current work involves modeling flows of scientific and technical human capital and research value.

A host of other federal science agencies (and countries incidentally) have recently started their own EPSCoR initiatives, with the NSF initiative alone accounting for US$50 million annually (NSF, 1999). In addition to this sum, states are required to provide matching funds. Given such a large investment, a thorough understanding of EPSCoR's strengths and weaknesses is warranted.

Yet such an analysis requires a thorough understanding of the relationship between basic R&D and social and economic development of underdeveloped regions. A central point advanced in this paper is that traditional measures used to evaluate R&D projects are inappropriate to science development programs such as EPSCoR because they ignore this point. It makes little sense to evaluate the program along traditional lines such as citation, publication, and patent counts because such measures fail to capture the complexity of 'science as development.' Also, barring some miracle, share of federal R&D funding — the central measure used in the only existing evaluation of the program (Yin and Feller, 1997) is unlikely to register any improvements in R&D competitiveness, at least not in the short term.

Originally designed to enhance the ability of eligible' states to compete for peer-reviewed federal and NSF research grants (see Figure 1), EPSCoR has evolved over time, expanding its mission, taking on new functions, and raising its expectations. EPSCoR's objectives now include the enhancement of educational and human resource opportunities for students and faculty from groups underrepresented in the science and engineering workforce, and the transfer of research findings to the private sector (Yin and Feller, 1997). The first EPSCoR awards were made to five states[2] in 1980 to undertake a five-year program of self-improvement with no expectation that the experimental initiative would continue beyond that time.

Initially, more so than at present, the program worked by supporting small individual-investigator and group projects that were prescreened by the states and peer reviewed by NSF. The very best of the projects proposed were and still are, counterintuitively, not supported by the program[3] nor are the very worst of the projects. Under the belief that the middle quartile is what most needs a boost, EPSCoR supports only those projects that review well, not too well.

At the time the program was initiated, EPSCoR was viewed both by eligible states and apparently by NSF rather naively (from programmatic and political standpoints) as a one-shot scientific bootstrapping operation or, at very least, a temporary and 'experimental' catalytic initiative (Lambright, 1996). Yet perhaps there was, in some sense, a more tacit agreement between the parties.

NSF, an agency that had long viewed 'merit' as a sacred cow of science policy, faced a political mandate to award research funds to projects that were not 'meritorious' in the mainstream competitive peer-review process. Universities in these states, in dire need of funding, accepted the prestigious research grants regardless of their stated purposes. The two would agree to look the other way on development.

In case studies of five EPSCoR states, Lambright (1996) recounts this 'knotty' history of the program and suggests that NSF may have, at least early on, failed to acknowledge the level of effort that would be required to bootstrap the states. In fact, many of the states continue to suffer from some of the problems Lambright identifies, such as difficulty obtaining

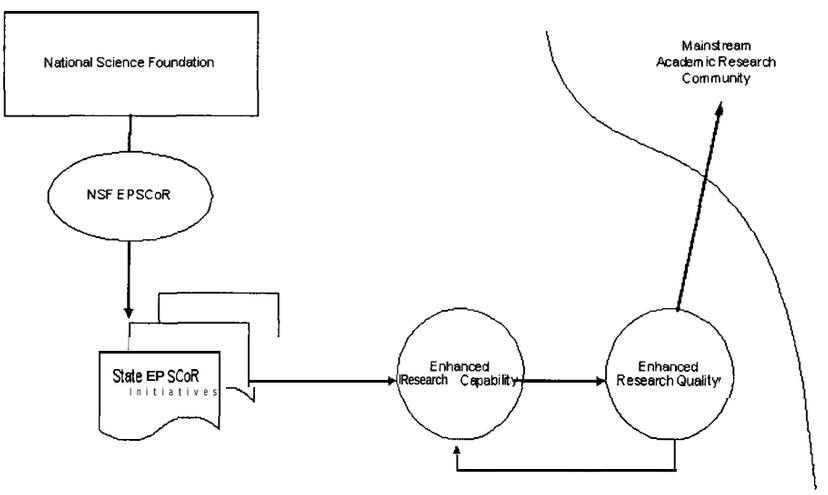

Figure 1. Original EPSCoR concept model

required matching funds from the state legislature, fluctuating political attitudes and public policy agendas, and difficulty effecting systemic change beyond the grant-recipient institutions (Lambright, 1996; Yin and Feller, 1997).

As Lambright discovered, to move a state forward in science

> "requires the building of a system-wide capacity involving individual researchers, research institutions, and governmental policies. . . . [And], absent a crisis, the competitive change process normally moves slowly and incrementally, and the state research system has a hard time jelling." (Lambright, 1996, page 138)

Twenty years after the experimental program got its start, 18 states and Puerto Rico are still jelling and the program seems to have become a more or less permanent, if not expanding, fixture of US science policy.

Along the way, the program's goals have matured to include 'systemic change' in state science and technology environments, technology transfer to the private sector, and enhancement of human resources. According to the NSF, the present mission of EPSCoR is:

> ". . . based on the premise that universities and their science and engineering faculty and students are valuable resources that can potentially influence a state's development in the twenty-first century much in the same way that agricultural, industrial, and natural resources did in the twentieth century. *EPSCoR's goal, therefore, is to identify, develop, and utilize a state's academic science and technology resources in a way that will support wealth creation and a more productive and fulfilling way of life for [its] citizenry* [emphasis added].
>
> NSF . . . actively cooperates with state leaders in government, higher education, and business to establish productive long-term partnerships. In each EPSCoR state, the NSF's role is catalytic in nature and is designed to stimulate local action that will result in lasting improvements to the state's academic research infrastructure and increased national R&D competitiveness." (NSF, 1999)

Social capital and EPSCoR

In its simplest form, social capital can be thought of as the stock of good will or mutual trust that accrues from cooperative relations among two or more parties. As a concept, social capital has been applied in a wide range of sociological settings: from explaining the behavior of sports club members (Putnam, 1993), to high school dropouts (Coleman, 1988), to business managers (Burt, 1997). As a theory, it has traversed a number of orders of magnitude: individuals (for instance, Coleman, 1988), organizations (for instance, Baker, 1990), geographic regions (Putnam, 1993), and nations (for instance, Fukuyama, 1995; Knack and Keefer, 1997).

In its simplest form, social capital can be thought of as the stock of good will/mutual trust accruing from cooperative relations among two or more parties: so far, it has flirted only from a distance with science and technology policy

However, as of yet, social capital theory has flirted only from a distance with science and technology policy. What little policy literature exists on the topic (see, for example, Fountain, 1998; Gabbay and Zuckerman, 1998) does not view social capital as agent for social and economic change of entire underdeveloped geographic regions.

For Putnam (1993, page 167), social capital is the "features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions.. . ." Putnam's interest in social capital arose in explaining the rather puzzling differences in civic engagement and cooperative behavior he observed between northern and southern Italy (Putnam, 1993).

Coleman asserted that social capital is not a singular concept but multiple phenomena that share in common some aspect of social structures that facilitate actions of individuals or groups (Coleman, 1990). He shares observations of the Kahn El Khalili market of Cairo where the boundaries in a sea of merchants are at the surface unclear, but underneath, elaborate networks of kinship and friendship provide a kind of insurance (Coleman, 1988; 1990).

Some key, recurring words in social capital theory, as Nahapiet and Ghoshal(l998) have pointed out, include cooperation (Coleman 1988; Putnam, 1993), trust and trustworthiness (Coleman, 1988; Putnam 1993), norms and sanctions (Coleman 1988, 1990; Putnam, 1993), and obligations and expectations (Burt 1992; Coleman 1988, 1990; Granovetter, 1985). For Nahapiet and Ghoshal(1998) social capital is the

> "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit. Social capital thus comprises both the network and assets that may be mobilized through that network." (page 243)

Similarly, Granovetter (1973), argues that through acting upon "weak ties" network members gain access to new sources of information, avoid inefficient

information redundancies, and ease information flow to wider social circles.

At the center of social capital as it has been conceived is trust. Some authors stress the importance of an initial expectation that cooperative behavior will be reciprocated as a basis for the initiation of such behavior in the first place (Boix and Posner, 1998). Others place emphasis on patterns of past as well as expected future behavior: "As long as the pattern of interaction has no foreseeable end, actors will have no incentive to defect from cooperation and a virtuous circle of social capital-building will be initiated" (Boix and Posner, 1998, page 687). These cooperative actions result in a "credential" (Bourdieu, 1986), or "credit slips" (Coleman, 1988) which can be redeemed at any time for a host of returned favors.

However, unlike other forms ofcapital, social capital does not reside in the solitary confines of private ownership but among the collective hands of the communities that mold it. In the words of Coleman (1988), social capital "inheres" in the structure of the relationship among cooperating parties.

> "Social capital . . . comes about through changes in the relation among persons that facilitate action. If physical capital is wholly tangible, being embodied in observable material form, and human capital is less tangible, being embodied in the skills and knowledge acquired by an individual, social capital is less tangible yet, for it exists in the relations among persons. Just as physical capital and human capital facilitate productive activity, social capital does as well." (Coleman, 1988, pages S100–S101)

It should be pointed out that social relations, particularly ones that depend on highly cooperative and complex roles (such as is the case in the subject of this paper), are difficult to maintain, can be physically or intellectually taxing, and often do not succeed in obtaining their initial goals despite longer term intentions.

Where does this leave states such as Montana and Maine, Kansas and Kentucky, South Carolina and South Dakota? Is the stock of scientific social capital chronically low in those states? Has EPSCoR succeeded in its most fundamental mission to enhance the capability of eligible states to compete for "unsheltered" federal R&D grants? An independent evaluation commissioned by NSF and completed by Cosmos Corporation in 1997 claims that the program has largely met its stated goals (Yin and Feller, 1997). However, the evaluation supplies weak evidence at best that the states are any more competitive in R&D today than they were 20 years ago.

A reanalysis of the evaluation data by the author shows no clear pattern of increase in competitiveness of EPSCoR states. In 1975 (before the program had started), EPSCoR states accounted for 7.5% of total federal academic R&D expenditure. During the 1980s, that share dropped to about 6.7%, and rebounded in the early 1990s to just over its pre-EPSCoR level (7.7%).[4] An examination of total academic R&D expenditure over the life span of the program indicates that EPSCoR states grew at just slightly above the national average. Finally, it is useful to keep in mind that it is not clear, aside from its own direct expenditure to the states, that EPSCoR can take credit for this slight increase in funding.

Does this mean that the program can be discarded as a deadpan failure? Not necessarily. It may mean that the wrong measures of success have been tracked since the beginning, that is, federal R&D dollars awarded to EPSCoR states. If, for purposes of illustration, program evaluation can be likened to a crime scene, it is possible that NSF is tracking the incorrect set of footprints (Scriven, 1976). The detective who shows up at the wrong residence looking for evidence of a murder, had better have an astonishingly good justification for declaring that he has solved the crime if, all the while, the body lies undisturbed in the house next door. The body in this case can be thought of as the social capital that is created by EPSCoR projects.

It is also useful to consider the possibility that any measure of federal R&D expenditure awarded to scientitically-poor states as compared to richer ones, will always, barring some miracle, show homeostasis or uneven, miniscule growth at best. The denominator in such comparisons is so immensely large as to make any increase in EPSCoR states look vanishingly small. Moreover, it is clear from NSF's own programmatic language that EPSCoR's mission has evolved over time, while its prime measures of success have not. NSF continues to measure 'undue concentration' rather than systemic development.

Redefining social capital and EPSCoR

There are three main problems with current social capital theory as it affects economic and social development through enhanced science and technology capabilities. First, the argument that 'trust' forms the core of social capital is somewhat misleading and must be revised. Brehm and Rahn (1997) found, in examining social capital formation at the level of the individual, that the effect of civic engagement on trust was much stronger than the reverse effect.

Thus, trust is more the symptom of social capital than the syndrome. It is necessary, yet not sufficient. Certainly two individuals or organizations may trust each other without creating social capital. Conversely, no productive long-term relationship between organizations is built on a foundation of distrust.

So if trust, while not unique to social capital formation, is always present to some degree by definition, there is very little new to be learned here about the concepts of social capital or cooperative behavior. Certainly, trust can be found at the scene of social capital formation, but it lurks in the background, and it

Social capital must be used in order to become useful; it must exploit the complementary assets of organizations toward an agreed, mutually beneficial end; value must be created through the appropriation of information into knowledge or know-how

reveals itself only in the form of mutual confidence to act. Perhaps it is the absence of distrust that is most important.

The second major problem with social capital theory is its emphasis on the obligations generated by actors in return for a form of social capital promissory note or "as a credit slip held by A for performance by *B*" (Coleman, 1988, page S 102). There is nothing necessarily erroneous with this notion, but it fails to take us very far beyond what is known about any basic bartering exchange. From this angle, social capital provides only limited intellectual advance over the notion of a 'favor bank'.

The third major shortcoming with social capital theory is its failure to use social capital outcomes or consequences as a mechanism for defining social capital itself. If there is anything at all to this concept, then it is empirical findings that must lead the way. Its effects must somehow be distinguishable from any other generic form of social relation.

Little research has been done on the consequences, outcomes, and utilization of social capital (a few exceptions being Brehm and Rahn (1997); Knack and Keefer (1997); Pennings *et al* (1998)). This is chiefly because it has been defined in such a fleeting and ephemeral way as to make it difficult, if not impossible, to measure. Characterized as so many things — trust (Putnam, 1993), future credits (Coleman, 1988), the closure of information gaps (Burt, 1992), weak connections to other social groups (Granovetter, 1973), the social structure itself (Burt, 1992) — social capital, sometimes written using economists' lingo K_S, is in danger of standing for nothing more than 'Kitchen Sink.'

How can social capital be reconceived to explain better the character of institution building exemplified, at least on paper, by programs such as EPSCoR? First and foremost, as with all forms of capital, social capital must be used in order to become useful. It must be convertible into something more concrete than trust, such as a partnering arrangement; a new organization; changed norms, rules, policies, and strategies; or other forms of capital such as the human or physical.

Secondly, it must exploit the complementary assets of organizations toward an agreed upon and mutually beneficial end (that is, no favor banks). Finally, value must be created through the appropriation of information into knowledge or know-how in whatever of its many formal and informal manifestations (Ingham and Mothe, 1998). From this perspective, social capital can be likened to the movement of energy from the potential to the kinetic form, while cooperation, trust, and networking serve as social capital conductors and insulators, not social capital itself.

Evidential glimmers of this perspective can be found in the extant literature. Nahapiet and Ghoshal (1998, page 245) argue that social capital facilitates the development of "new forms of association and innovative organization. The concept, therefore, is central to our understanding of institutional dynamics, innovation, and value creation."

Drawing from the development literature, Evans (1996) coins the term "complementarity" to describe social capital formation between the public and private actors when they serve separate roles but are, at the same time, "embedded" in the same social system.

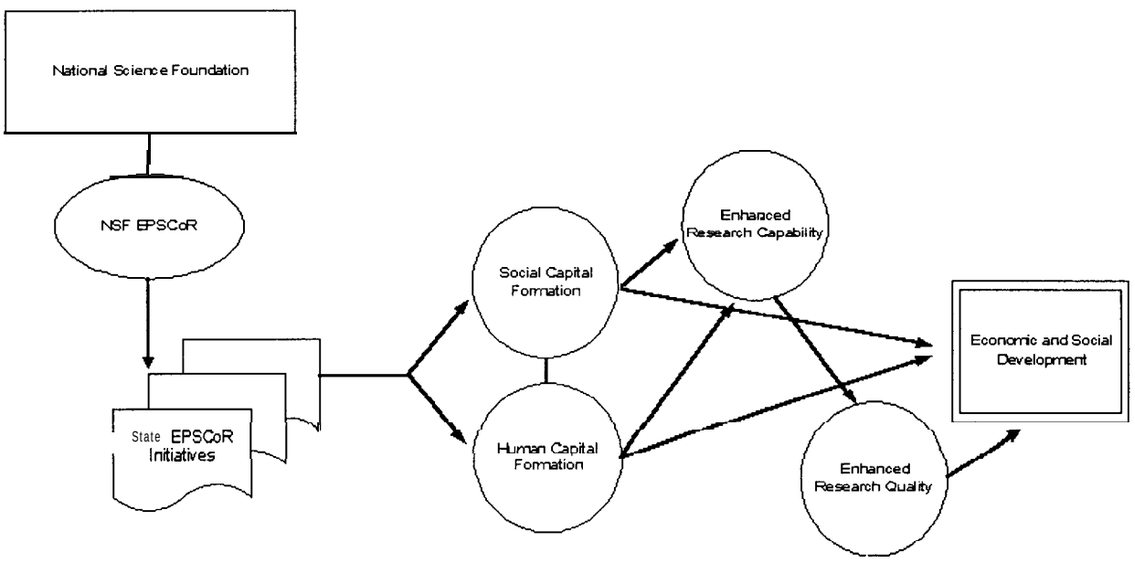

Figure 2. Social capital EPSCoR concept model

The result is a form of synergy not unknown to management scholars of earlier times:

> "the fair test . . . is whether you have a business with all its parts so co-ordinated, so moving together in their closely knit and adjusting activities, so linking, interlocking and inter-relating, that they make a working unit, not a congerie of separate pieces." (Follet, 1949, page 6 1)

Perhaps it is this definition that is most useful in thinking about R&D policy for the development of whole states.

Turning to the implications of all of this for EPSCoR (see Figure 2), there are a number of potential avenues for how the states can proceed in the future. One obvious strategy would be to look to the clear, regional success stories such as Silicon Valley and Route 128 for clues. Although this may be criticized as unrealistic and therefore impractical or irrelevant, there are some similarities between the two regions and EPSCoR states.

For one, both Silicon Valley and Route 128, like EPSCoR, were kick-started by federal government funding of research universities Stanford and MIT (Saxenian, 1994). Both institutions, incidentally, became embedded in regional development, taking on active, even aggressive, roles spinning off new organizations, working closely in partnership with them, and, in turn, using them to advance their own goals and research agendas.

Both regions' success was built on regional and institutional strengths. They succeeded not by issuing a dollar to every scientific project in the state, but by capitalizing on obvious regional assets. Zucker *et al* (1998a; 1998b) found, in studying the growth of the biotechnology industry, that the industry has grown up literally around so-called scientific superstars of the field. It was investments in basic R&D, many of which were supported by the federal government, that led to start-up firms that clustered geographically around universities where these biotech superstars worked.

The human capital capacity generated by government investments led to social capital, more human capital, and then to economic wealth. However, in funding those projects, the government was not making financial investments, but scientific capacity generating ones. Arguably, then, R&D policy as a developmental instrument should center not on the equity of distribution of scientific research funds, nor on the scientific outcomesperse, but on the growth of capacity (Bozeman and Rogers, 1998; Bozeman *et al*, forthcoming; Farmer and Kingsley, 1999) on human and social capital.

Government funding of biotechnology was a scientific capacity generating investment: maybe R&D policy as a developmental instrument should center not on equity of distribution of funds, nor on scientific outcomes but on growth of capacity

Evaluating R&D development

Traditional quantitative measures of scientific output (such as, bibliometrics, publication, or patent counts) are not congruent with the basic factors that drive the development of geographic regions, whether the development be social, economic, scientific, or all three. Nor does it make much sense to measure the success of programs such as EPSCoR based solely on how much funding (an input measure) the states are able to attract from federal sources.

Programs that are geared toward improving the R&D competitiveness of whole regions should focus on the growth of social capital and the capacity that it generates for still more social capital development. It makes sense to focus evaluative energies here for numerous reasons:

- capacity must precede competitiveness: in many ways R&D competitiveness programs for underdeveloped regions *are* capacity development programs;
- social capital is a broad concept that adds into the mix a number of essential ingredients not normally called into question in the allocation of federal R&D dollars (such as institution building);
- change in capacity is relatively time-friendly from an evaluative point of view in that changes can be detected and measured more readily than could shifts in the proportional allocation of federal R&D funds across states; and
- a shift in emphasis toward social and human capital measures integrates well with more traditional sorts of economic and human resources development programs often operated by states (Kingsley and Melkers, 1999).

However, capacity that goes underused or is poorly coordinated is capacity that is wasted, something that EPSCoR states can ill afford to do. The active exercise of developing capacity among multiple actors working as a unit fosters complementary strengths, and it is these complementary strengths — for instance, areas of research strength, institutional missions, sectors of the economy, and levels of the education system that are the basis for the development and exploitation of social capital and its attendant effects on human capital.

So, how can EPSCoR be evaluated within this kind of framework? Recognizing that, even within EPSCoR states, there is quite a range in where the states may be in their developmental journey, Table 1 provides a quick diagnostic on what type of evaluation a state

Table 1. Evaluation diagnostic: type of evaluation

Evaluative Dimensions		Capacity	
		LOWER	HIGHER
Complementarity	LOWER	Planning	Formative
	HIGHER	Formative	Summative

may emphasize. States with low capacity that is not well articulated might consider a planning evaluation. States that are further along in developing capacity and coordinating its use, would focus on summative evaluation, and states where there is some mixture of the two might emphasize formative evaluation. This decision has substantial importance in determining what to measure.

Figure 3 shows a conceptual model for how an EPSCoR project (or any development initiative for that matter) may be evaluated over time. In another paper (Bozeman et *al*, forthcoming), we developed a similar model which we call "scientific and technical human capital value mapping" (also see Kingsley et ***al,*** 1996). One nice feature of this model is that it works both for tracking the progress of individual states and for evaluative comparisons across states.

There are two major components to these diagrams: an indicators box and a social capital map. At time *t*, inside the box is displayed the two main evaluative dimensions — capacity and complementarity. Within each dimension, take capacity, there are a number of indicators, and each state may 'load' differently on each indicator. Indicators for capacity may include, for example, a numeric or qualitative assessment of the organizational (for instance, universities, state authorities and agencies, businesses) participation within an EPSCoR initiative. Or, an indicator may track growth in the quantity of research instrumentation possessed by state institutions of higher education, or perhaps measures of human resources development.

The complementarity dimension may include indicators of how well the existing capacity is articulated. Indicators may include measures of intersectoral partnerships such as memoranda of understanding between a university research center and a local industrial firm or consortium. Indicators may focus on state, local, and institutional articulation of policies that are relevant to science and economic development.

The map indicates the entities that the EPSCoR planning or coordinating body (such as a steering committee or a principal investigator) has brought on board to participate in some way in the initiative. So, for example, the fictitious state depicted in Figure 3 has included four institutions of higher education (denoted by the squares) and one government agency within the state (the triangle) at time *t*.

These organizations play different roles in the initiative. Two are involved in the performance of research (dotted), one is a provider of funds (shaded), and two others are on board in an advisory capacity (clear). These roles are chosen somewhat arbitrarily for illustrative purposes; in reality, they can be any number of things depending on the objectives of the initiative. At time *t*+1, the initiative involves a much larger social capital network within and outside the state than at time *t*.

It can readily be seen how this might surface in the various evaluation modalities discussed earlier. In a planning evaluation, these scientific and technical value maps would most certainly affect the way an EPSCoR initiative is planned and formulated. In formative evaluations, the maps may be used in ways similar to the discussion above. In a summative evaluation, the indicators and the growth of capacity and its complementary coordination may be tracked along side (and/or measured against) more traditional scientific and economic outcome indicators.

Finally, one of the major 'problems' that EPSCoR states have involves the siphoning off of human capital or social capital to other states. The EPSCoR program is not intended to make less scientifically developed states into a training ground for institutions of higher education and industries in better developed states. Unfortunately for EPSCoR, human capital these days is highly mobile and is likely to remain so. However, the model presented in this paper

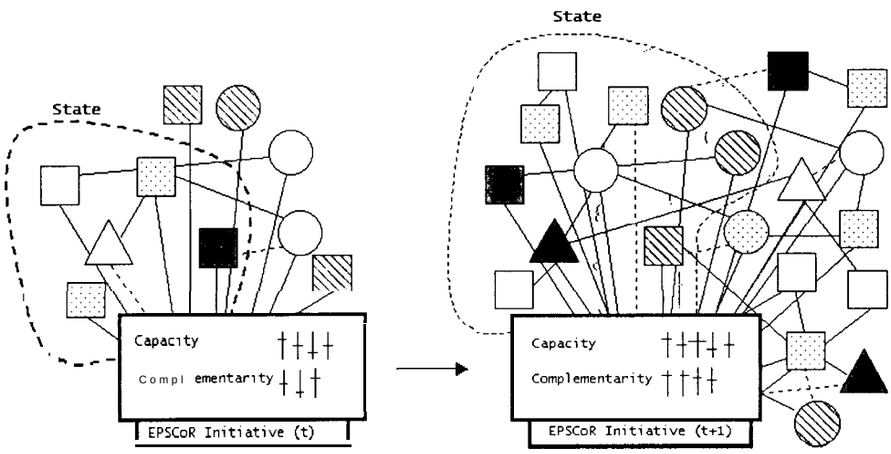

Figure 3. EPSCoR value map over time

recognizes that social capital ties remain even when people go elsewhere. This mobile human capital can be thought of as an expanding social capital network that actually connects the EPSCoR social capital network to still more networks (through "weak ties" [Granovetter, 1973]) in other states as depicted in Figure 3.

Conclusion

Silicon Valley holds important lessons for EPSCoR about the reciprocal nature of economic, scientific, and social development of a region once rural, agricultural, and sparsely populated. In this case, social capital appears to have grown in concert with, if not preceding, the formation of strong economic and scientific assets, and all three developed synergistically, while regional actors kept very clear and mutually beneficial roles and goals in mind.

To benefit from social capital formation, EPSCoR and the states may consider ways to adopt strategies more conducive to systemic social, economic, and scientific development, recognizing that:

- Scientific achievement in underdeveloped states must serve some economic or social end (Lambright, 1996).
- The relationship between the three may be recursive or reciprocal. That is, although the route to the economic end may be scientific and social, the route to the scientific end may well be economic and social. Berger and Luckman (1966, page 78) noted that "[t]he relationship between man, the producer, and the social world, his product, is and remains a dialectical one. That is, man (not, of course, in isolation but in his collectivities) and his social world interact with each other. The product acts back upon the producer." This is perhaps a good way of thinking about the development of scientific, social, and economic infrastructures in EPSCoR states.
- There has been perhaps too much emphasis on funding research and not enough on how research is used, too much emphasis on competing against the 'big' states, not enough on generating capacity through cooperation across sectoral and organizational boundaries. Putnam (1993) asserts that success at a small-scale level permits the tackling of yet larger and more complex problems. He calls this the "accretion of institutional capital." NSF and EPSCoR states can recognize this concept not by bypassing the strongest of research projects in the state as is currently the practice, but by making them focal points — science and technology strategic 'chessmen' — in the developmental strategy.

Likewise, by building on obvious strengths and current conditions, R&D evaluation methods must articulate well (in both practical and theoretical ways) with the reality of developmental programs if such programs are expected to mature and improve over time. Programs like EPSCoR, and the R&D evaluation enterprise itself, would benefit by considering a social capital model of research development because capacity generation and institution building are central to the objectives of these initiatives. Furthermore, capacity generation and institution building necessitate a recognition of the role of social and human capital in meeting these ends, Not all R&D initiatives are like this and for them more traditional models may suffice. However, for R&D development programs, the conduct of scientific research is not an end in itself, nor is it the sole means.

Notes

1. Eligibility to participate in EPSCoR is determined on a state level rather than at the individual or institutional levels as is more common among NSF programs. A state's eligibility is determined on the basis of an index of historical levels of funding received from NSF and the federal government at large, along with a host of socioeconomic indicators. For a more complete discussion of EPSCoR eligibility criteria see www.ehr.nsf.gov/EHR/EPSCOR or Yin and Feller (1997).
2. The following states were awarded cooperative agreements by NSF under the EPSCoR initiative (beginning in the years indicated): Arkansas, Maine, Montana, South Carolina, West Virginia (1980); Kentucky, Nevada, Oklahoma, Puerto Rico (1986); North Dakota, Vermont, Wyoming (1987); Alabama (1988); Idaho Louisiana, Mississippi, South Dakota (1989); Kansas, Nebraska (1991) (Source: Yin and Feller (1997)).
3. Presumably, these projects are supported by NSF's regular, disciplinary research programs.
4. Because the states were phased into the program over time, Yin and Feller (1997) favor a per state average rather than aggregate yearly proportions. They report that the EPSCoR states averaged 0.25% per state participating in the program of total federal academic R&D expenditure in 1980, which rose to steadily to 0.40% by 1994 (the last year of data included in the evaluation). However, it is not clear in the author's mind that this represents a per state proportional increase. It is quite possible that the earliest of funded states were also the neediest, and therefore, the proportional increase may be an artifact of cohort differences.

References

W Baker (1990), "Market networks and cooperative behavior", *American Journal of Sociology, 96,* pages 589-625.

P L Berger and T Luckman (1966), The *Social Construction of Reality* (Penguin Press, London).

C Boix and D N Posner (1998), "Social capital: explaining its origins and effects on government performance", *British Journal of Political Science, 28,* pages 686-693.

P Bourdieu (1986), "The forms of social capital", in J G Richardson (editor), *Handbook of Theory and Research for the Sociology of Education* (Greenwood, New York).

B Bozeman and J D Rogers (I 998), "Knowledge value collectives: a theory of knowledge for research evaluation", in submission.

B Bozeman, J S Dietz and M Gaughan (forthcoming), "Scientific and technical human capital: an alternative model for research evaluation", *International Journal of Technology Management.*

J Brehm and W Rahn (1997), "Individual-level evidence for the causes and consequences of social capital", *American Journal of Political Science,* 41(3), pages 999–1023.

R S Burt (1992), *Structural Holes: the social structure of competition.* (Harvard University Press, Cambridge, MA).

R S Burt (1997), "The contingent value of social capital", *Administrative Science Quarterly,* 42, pages 339–365.

J Coleman (1988). "Social capital in the creation of human capital". *American Journal of Sociology,* 94(supp), pages S95–S120.

J Coleman (1990), *Foundations of Social Theory* (Belknap Press, Cambridge).

P Evans (1996), "Government action, social capital and development: reviewing the evidence on synergy", World Development, 24(6), pages 1119–1132.

M C Farmer and G Kinasley (1999), "Locating critical components of regional human capital", unpublished manuscript.

M P Follet (1949), "Coordination", in L Urwick (editor), *Freedom and Co-ordination: lectures in business organization* (Management Publications Trust, London).

J E Fountain (1998) "Social capital: its relationship to innovation in science and technology", *Science and Public Policy,* 25(2), pages 103-I 15.

F Fukuyama (1995), *Trust: social virtues and the creation of prosperity* (Hamish Hamilton, London).

S M Gabbay and E W Zuckerman (1998), "Social capital and opportunity in corporate R&D: the contingent effect of contact density on mobility expectations", *Social Science Research,* 27(2), pages 189–217.

M S Granovetter (1973), "The strength of weak ties", *American Journal of Sociology,* 78(6), pages 1360-I 380.

M S Granovetter (1985), "Economic action and social structure: the problem of embeddedness", *American Journal of Sociology, 91,* pages 481–510.

M Ingham and C Mothe (1998), "How to learn in R&D partnerships?", *R&D Management,* 28(4), pages 249-261.

Kingsley Gordon, Barry Bozeman, and Karen Coker (1996), "Technology transfer and absorption: an 'R&D value-mapping' approach to evaluation", 25(6), pages 967-995.

G Kingsley and J Melkers (1999), "Value-mapping social capital outcomes in state R&D programs", in submission.

S Knack and P Keefer (1997), "Does social capital have an economic payoff? A cross-country investigation", *Quarterly Journal of Economics,* 112(4), November, pages 1251–1288.

W H Lambright (1996), "Developing science: notes from the states", in A H Teich (editor), *Competitiveness in Academic* Research (American Association for the Advancement of Science, Washington, DC).

J Nahapiet and S Ghoshal (1998). "Social capital, intellectual capital, and the organizational advantage", *Academy of Management Review,* 23(2), pages 242-266.

NSF (1999), Electronic website of EPSCoR: www.ehr.nsf.gov/EHR/EPSCOR.

J M Pennings, K M Lee and A van Witteloostuijn (1998), "Human capital, social capital, and firm dissolution", *Academy Of Management Journal,* 41(4), pages 425–440.

R D Putnam (1993), *Making Democracy Work: civic traditions in modern Italy* (Princeton University Press, Princeton).

A Saxenian (1994), *Regional Advantage: culture and community in Silicon Valley and Route* 128 (Harvard University Press, Cambridge).

M Scriven (1976), "Maximizing the power of causal investigations: the modus operandi method", *Evaluation Studies Review Annual,* 1, pages 101-118.

US Congress (1978), *National Science Foundation Act of 1950 (as amended) (42* U.S.C. 1962, Sec. 3e).

R K Yin and I Feller (1997), *EPSCoR Evaluation,* draft (Cosmos Corporation, Bethesda, MD).

L G Zucker, M R Darby and J Armstrong (1998), "Geographically localized knowledge: spillovers or markets?", *Economic Inquiry,* 36(1), pages 65–86.

Lynne G Zucker. Michael R Darby and Marilynn B Brewer (1998). "Intellectual human capital and the birth of US biotechnology enterprises", *The American Economic Review,* 88(1), pages 290–306.

Outlook on Science Policy

The monthly report on national and international science and technology policy

Some news items in recent issues:

Africa discussion group: an invitation, February, 21
Australia's chief scientist and the summit, March, 31
Brazil-UK climate change collaboration, February, 23
British Council reviews activities, February, 20
Canadian budget invests in innovation, March, 27
Chile's Fondecyt: keep doing what you can, February, 18
Clinton: $500m on nanotechnology, etc, etc, February, 15
Defence R&D gets lion's share of US federal funds, March, 32
Eastern France weds industry and universities, March, 34
EU R&D: what's in it for the UK?, March, 35
Euro food agency options, February, 18
Germany promotes equal opportunities, January, 4
Human Frontiers celebrates ten years, January, 4
Hungary reforms its universities, March, 29
Industry and engineers criticise UK RA Exercise, February, 13
Innovation: the Australian viewpoint, March, 30
Japan Science Council gets radical, January,1
Korea to be number 7 in world S&T by 2025, January, 4
Latin American S&T statistics and indicators, March, 34
NSF seeks 17.3% budget increase, March, 26
OECD forum on the knowledge economy, February, 22
Quebec examines its HE research system, January, 4
Russian space developments, February, 16
Southern Africa gets S&T subcommittee, January 2
Spain promotes biosciences and IT, February, 14
UK science white paper Coming?, February, 22
US R&D funding: a look back, January, 3

Outlook on Science Policy is a monthly newsletter on science policy, edited by Paul Cunningham (PREST, Manchester, UK) and Paul Dufour (Industry Canada).

Beech Tree Publishing, 10 watford Close, Guildford, Surrey GUI 2EP, UK
Telephone +44 1483 824871 Fax +44 1483 567497
Email page@scipol.demon.co.uk Website **www.scipol.demon.co.uk**

Ask ***for a few free sample copies.***

Volume 27 Number 2 April 2000

Science and Public Policy

Journal of the International Science Policy Foundation

Science and Public Policy

ISSN: 0302-3427

Published from Great Britain by Beech Tree Publishing

Volume 27 Number 2 April 2000

Science and Public Policy

Journal of the International Science Policy Foundation

Main articles in this issue **Full summaries: see individual articles**

Published from Great Britain by Beech Tree Publishing, 10 Watford Close, Guildford, Surrey GU 1 2EP