The Economics of Knowledge Contribution and Distribution

Outline of Research Program Scope

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1 Overview

We propose to investigate the economics of knowledge contribution and its distribution broadly defined. An important array of economic activities arises from the contributions of people with either non-existent or secondary monetary motivations: academic science, news journalism, creative works, software development and product reviews as well as philanthropic contributions of money, time and other resources. Some invariably involve knowledge being created and communicated but, in tandem, a desire that contributions be widely accessible. Interacting with these activities are commercially driven ones that provide capital funding to generate knowledge and platforms to distribute that knowledge (including, in recent times, digital infrastructure). This gives rise to a paradox whereby agent contributions are predicated on open and often-free transacting but rely upon resources that, unlike effort and time, are more difficult to provide in the absence of a monetary return. The tension at the heart of the paradox shapes the operation of the contribution economy as well as how policy-makers should evaluate public good creation in its wake.

We see the notion of a 'knowledge contribution economy'[1] as a unifying theme across a number of fields in economics and strategic management; in particular, industrial organization and public economics. The project aims to coordinate research on markets where contributions to knowledge – driven significantly by non-monetary motives – are a pre-dominant economic activity so as to formulate an overarching theoretical framework to organize data and inform policy-making along a previously underemphasized set of dimensions. We will be addressing two broad research themes: understanding the economic drivers of scientific contributions and (ii) the impact of digitization on knowledge contribution

1.1 Motivation

Our motivation for establishing this research agenda stems from a number of phenomena observed historically, particularly over the last decade. The phenomena fall into two broad classes. First, it has been increasingly observed that individuals (and sometimes larger organizations) are engaging in the creation of information and knowledge independent of commercial motivations; in some cases, independent of any identifiable reward. The most prominent of these activities is the work by academic scientists although in some cases successful knowledge creation is associated with monetary rewards (e.g., career advancement and commercialization of knowledge) alongside non-monetary rewards (e.g., prizes and prestige). In such cases, it may be hard to distinguish the different motivational drivers for creative activity and many may be present. Elsewhere, however, the lack of a monetary driver is stark. The increasing incidence of user-based innovation (whereby users of technologies are responsible for

[1] The term "contribution economy" appears to originate with David Kirkpatrick writing in Fortune magazine in 2005 (http://www.rheingold.com/bookideas/archives/2005/07/fortune_magazin.html). However, it is not a generic term in academic or other circles despite being descriptive of the wide set of phenomena that motivate the present study. Many of themes have been discussed in a paper by Joshua Gans and Scott Stern "Is there a market for ideas?" Industrial and Corporate Change, 19 (3), 2010, pp.805-837.

their creation and improvement) has been documented by Eric von Hippel and his co-authors.[2] Open source software has become a phenomenon of critical importance and impact on information technology sectors around the world with much activity transpiring independent of commercial reward. Finally, the unexpected giving of time and effort by contributors to Wikipedia (and in an earlier age, the Oxford English Dictionary), the vast array of self-provided reviews of products (e.g., on Amazon, Tripadvisor or Yelp), the sharing of links and news by individuals in smaller communities and networks (e.g., on Facebook, Flickr or Twitter) and the large scale activity associated with blogging are all examples whereby the actual or even the promise of monetary reward does not appear to be a real or prime driver of contributions. This suggests that approaches to stimulating creative activity that are based purely or primarily on monetary motives may not be covering the range of phenomena that should inform policy in these areas.

Second, and often stemming from the first phenomenon, there have been movements devoted to the free disclosure of knowledge and information. For instance, the Open Science Movement has called for free and easy access to scientific knowledge.[3] This includes published knowledge as well as knowledge that might be held privately due to commercial and other strategic motivations. In economics, there have been specific concerns raised about the market power on the part of publishers and the impact of copyright laws on scientific dissemination and access.[4] Relatedly, there is growing pressure and indeed, action by governments to make data – particularly, large quantitative datasets – available for use by citizens but also for use by commercial entities. Some of these have emerged under the rubric of Government 2.0 [5] while others have come as a result of a pressure and investment by private organizations; Google's investment to digitize books is a primary example of this.[6] In each case,

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[2] Füller, Johann, Roland Schroll, and Eric von Hippel (2011) "Brands as User Generated Content: Evidence and Implications." MIT Sloan School of Management Working Paper (January). von Hippel, Eric (2009) "Adapting policy to user-centered innovation" Chapter 23 in Dominique Foray, ed. The New Economics of Technology Policy Edward Elgar Publishing, pp.327-336. von Hippel, Eric (2005) "Open source software projects as user innovation networks – no manufacturer required." in Perspectives on Free and Open Source Software, edited by J. Feller, B. Fitzgerald, S. Hissam, and K. Lakhani. Cambridge: MIT Press. von Hippel, Eric, "Innovation by User Communities: Learning from Open Source Software," Sloan Management Review, July, 2001.

[3] EPSRC (2010) Access to research outputs [online]. Available from: www.epsrc.ac.uk/about/infoaccess/Pages/roaccess.aspx
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Neylon, C. (2010) What should social software for science look like? [online]. Available from http://blog.openwetware.org/scienceintheopen.
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Waldrop, M. (2008) Science 2.0 – is Open Access Science the Future? Scientific American (online) April 2008. Available from www.scientificamerican.com/article.cfm?id=science-2-point-0

[4] Ted Bergstrom, "Free Labor for Costly Journals?" , Journal of Economic Perspectives, Fall 2001.

[5] H.R. 2272--110th Congress: America COMPETES Act. (2007). In GovTrack.us (database of federal legislation). Retrieved June 14, 2011, from http://www.govtrack.us/congress/bill.xpd?bill=h110-2272

[6] Samuelson, P. "Google Book Search and the Future of Books in Cyberspace," forthcoming in Minn. L. Rev.(2010).

calls for disclosure and free access have led to concerns by copyright holders and others that investments in the creation of knowledge and information might be harmed.

1.2 Approach

In order to understand these phenomena, economists would normally turn to the fields of industrial organization and public economics; the former to understand the productive supply of goods when competitive supply is difficult or unsustainable and the latter to understand the difficulties of generating public good provision. In other cases, the fields of the economics of organization and also possibly economic sociology would be engaged.

Industrial organization (IO) is a field of economics devoted to understanding the determinants and outcomes arising from competitive interaction of firms within industries. Research in this field has advanced our understanding of the formation of market prices and the drivers of firm investment in industries – both by incumbent entities but also by entrants that bring new resources to an industry. The field has been particularly useful in informing public policy whose intent is to improve the efficiency of resource allocation and production in industries specifically by promoting competition and also by regulating the exercise of market power. Relatedly, it is this field that has contributed to our understanding of the competitive drivers of research and development by private firms (specifically, those motivated by intellectual property protection) and also to public policy related to the government ownership of infrastructure assets.

Public economics shares with IO a focus on the promotion of economic and social efficiency. However, by contrast, it has concentrated on the direct activities of governments in this regard; most notably, the difficulties in raising revenue to fund non-private activities, and the use of taxes and expenditures to address issues of market failure. Of particular interest are the mechanisms used to ensure the efficient provision of public goods – that is, goods whose production permits the creation of utility (or value) across a relatively large number of economic agents.

Neither IO nor public economics is equipped to analyze the twin phenomena of open knowledge pressures and non-monetary creation. To be sure, each involves, at their heart, the production of public goods – both the provision of knowledge and information and its widespread distribution – that public economics is concerned with. But, in addition, each involves private supply of such goods and also competitive interactions that IO may be concerned with but attention in the past has been largely confined to private goods that are both rival (consumed by a limited number of agents) and excludable (can be supplied to only to that limited number of agents). To deal with the broader phenomena involves marrying elements of public economics with elements from IO to understand the competitive and private supply of public goods.[7]

However, we believe that it is not just a hybridization of distinct fields of economics that can be facilitated by this research program. It will likely require new over-arching developments. As an example consider the constraint in the supply of public goods – free-riding. This occurs because individuals would like to consume a public good but would prefer it to be supplied by someone else. Contributors to knowledge production (a public good) however do not necessarily prefer them to be supplied by others. Moreover, this is likely not altruism – where individuals would be indifferent between self and other provision of public goods – and has more in-common with ‘Veblen goods’ where individuals care that they consume a good of high conspicuous value while others do not; akin, say, to conspicuous

[7] An important exception is the Tiebout model that describes competition in local public goods provision. This combines elements of IO and public economics to yield a positive political theory of the provision of public goods. However, the application of that theory is somewhat limited to specific types of public goods that are distinct from the global public goods that have motivated the current proposal.

production. For our purposes, we make a related observation that often individuals place some value on *themselves* being the supplier of the public good rather than having it supplied by others. In this situation, there are competitive pressures that not only mitigate but potentially supplant entirely free riding constraints on public good provision. This, in turn, has important implications for policy efforts to ensure efficient public good supply.

1.3 Gaps in policy evaluation

By taking a broader approach we believe that the research under the program can lead to improved policy evaluation outcomes by directing attention to covering two critical gaps. First, in pressures to open up knowledge access, appeal is made to the public good nature of such knowledge and the efficiency of ensuring widespread consumption. However, in so doing, if that knowledge is being supplied privately and under some competitive pressure, it is critical that the full range of incentive effects from open access policies be evaluated both theoretically and empirically to ensure that unintended consequences are identified or, at the very least, intended and costed.

A second gap involves the attribution of monetary motives as the principal driver of incentives in reaction to policies designed to promote efficient public good creation and use. To the extent that motives are, for instance, 'Veblen like' in supply, the impact of policies for, say, public provision of such goods may actually reduce useful competitive pressures that would exist in the absence of direct government intervention. In this respect, government policy may be more fruitfully directed towards IO-like interventions that ensure a free competitive environment rather than supplanting private supply with government provision. Understanding this will also require theoretical developments and empirical approaches that can elicit, or at least account for, a diverse range of motives on the part of private agents.

In what follows, we outline how the research network will be organized to coordinate researchers from distinct economic and related fields to establish this new area of economic study and also how the network will engage with policy-makers to bridge the gaps as outlined above. This will involve identifying the specific hypotheses that we imagine researchers here will address, the type of activities the program will foster and finally a time-line for evaluation and progress.

2 The scope of research

The potential scope of research falling under this program is necessarily broad. In this regard, it is our intention to engage with a diverse set of researchers across fields in economics, management and elsewhere.

2.1 Personnel

The co-directors reflect this diversity. Joshua Gans is an economist who has researched in both industrial organization and public economics. In addition, he has now moved into strategic management and innovation taking up the Skoll Chair of Technical Innovation and Entrepreneurship at the University of Toronto. Fiona Murray holds a Harvard PhD in chemistry and the applied sciences but has made her career as a researcher at the Sloan School of Management (MIT) in the field of innovation strategy focussing on the management and commercialization of science. Both have had considerable experience on managing large grants and also digital infrastructure.

On 24th July, 2011, at MIT we will host – with the help of funding from the Sloan Foundation – a Workshop on "Science, Innovation and Entrepreneurship Policy" – that will bring together academics with US government officials from the CEA, USPTO, NEC, Commerce Department, NSF and OSTP to disseminate policy-oriented research in this area for government officials working on innovation policy; especially in relation to the COMPETES Act. The workshop has been organized by Jeff Furman (BU), Joshua Gans (Toronto), Josh Lerner (Harvard), Fiona Murray (MIT) and Scott Stern (MIT). It will feature a diverse set of presenters and participants.[8] We expect that these researchers will be the likely recipients of grants to focus research on aspects of the knowledge contribution economy.

2.2 Broad Research Areas

The research that will be promoted and developed in this program falls into three broad areas:

Theoretical framework(s): There is no distinct framework for understanding the knowledge contribution economy. The program will use a variety of methods – from direct funding, to workshops and more innovative online tools – to encourage the development of an economically grounded framework.

Measurement: There is no systematic approach to gathering data to supply policy analyses where knowledge is provided and disseminated using a mix of contribution and commercial funding. The program will fund the development of unique datasets designed to provide systematic ways of measuring likely and actual policy impacts.

Policy-motivated evaluations: The issues associated with understanding the impact of policy initiatives in environments characterized by a competitive supply of public goods are complex and require approaches that respect the phenomena being investigated. For policy areas, research will be encouraged that recognizes these issues and attempts to derive clear and consistent hypotheses that are capable of being tested to resolve policy debates.

2.3 Research questions

The research questions we intend to address can be classified into two broad thematic areas: (i) understanding the economic drivers of scientific contributions and (ii) the impact of digitization on knowledge contribution.

Understanding the drivers of contributions in science:

This theme places the notion that innovators are potentially motivated by non-monetary concerns at the core of analysis of the drivers of scientific production. In such environments, increasing the monetary prize from successful innovation for example may not be the most effective means of

[8] Presenters include Ajay Agrawal (Toronto), Pierre Azoulay (MIT), Erik Brynjolfsson (MIT), Joshua Gans (Toronto), Avi Goldfarb (Toronto), Shane Greenstein (Northwestern), John Haltiwanger (Maryland), Josh Lerner (Harvard), Fiona Murray (MIT), Paula Stephan (Georgia State) and Scott Stern (MIT). Other academic invitees include Iain Cockburn (BU), Wes Cohen (Duke), Kira Fabrizio (Duke), Richard Freeman (Harvard), Megan MacGarvie (BU), Adam Jaffe (Brandeis), Bill Kerr (Harvard), Margaret Kyle (Toulouse), Nicola Lacetera (Toronto), Bhaven Sampat (Columbia), Tim Simcoe (BU) and Arvids Ziedonis (Oregon).

encouraging more creativity activity.[9] This notion would be embedded in theoretical analyses as well as examined in empirical work for the questions that follow.

- *What drives secrecy in science?* As noted earlier, there have been many proposals for open science including open access to scholarly articles and publication of interim results. Of course, this leads to the natural question as to why they do not do so now. Is the reason strategic (part of a race for priority or recognition) or a reflection of a broader efficiency (e.g., bedding down results or saving time on communication until a later stage)? This requires understanding how the rewards scientists receive in terms of recognition create incentives for disclosure of interim results and whether these reward systems should be redesigned rather than interim disclosure being compulsory. This would also provide a means of relating potential reward biases such as the Matthew effect to incentives for scientific disclosure and to inform the design of scholarly reward systems more broadly.

- *What is the impact of research funding on the allocation of resources at the lab level?*

  At the core of policy debates as to whether capital constraints inhibit the production of science are concerns that the supply of key inputs into science are inelastic (e.g., Goolsbee's work on the elasticity of scientist labor supply).[10] However, little is known about the relationship between inputs and outputs at a lab level (as opposed to the broad sectoral level where recent work by Ben Jones and co-authors).[11] We propose to undertake a micro-level study of labs across several key disciplines aimed at extrapolating production functions for scientific output. Our anticipated contributions include the first ever micro production level data for labs as well as an understanding of the parameters driving policy debates.

- *Do contractual provisions for openness impact positively on the supply of scientific knowledge*? Many government agencies and foundations designed to promote science impose contractual provisions on funds distributed. Little is known about the application of such provisions or their impact in terms of having intended consequences.[12] We propose to compile the first large-scale dataset aimed at understanding the variation and performance of different contractual provisions to create.

- *Do non-monetary motivations on the part of scientists promote efficiency diversity in innovation?* One of the concerns raised about innovation motivated by commercial considerations or the hope of intellectual property protection is that they might lead to too little diversity and experimentation on innovative paths.[13] Does the existence of scientists with non-monetary motivations alleviate issues

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[9] Glen Weyl and Jean Tirole provide the current canonical approach based on purely monetary motives ("Market Power Screens Willingness-to-Pay" June 10, 2011; Available at: http://ssrn.com/abstract=1659449). Alternative approaches that take into account non-monetary motives include Maxim Engers and Joshua Gans "Why Referees are not paid (enough)" (1998) American Economic Review Vol. 88, No. 5 (Dec., 1998), pp. 1341-1349 and Patrick Francois (2000) "Public Service Motivation as an Argument for Government Provision", Journal of Public Economics Volume 78, Issue 3, November 2000, Pages 275-299; and Patrick Francois (2007), "Making a Difference," RAND Journal of Economics, 38(3) 714-732.

[10] Goolsbee, Austan. 1998, May. "Does Government R&D Policy Mainly Benefit Scientists and Engineers?" American Economic Review 88:298-302.

[11] Wuchty, Stefan, Benjamin F. Jones, and Brian Uzzi, "The Increasing Dominance of Teams in the Production of Knowledge," Science 316 (2007), 1036–1039.

[12] Joshua Gans and Fiona Murray, "Funding Scientific Knowledge: Selection, Disclosure and the Public-Private Portfolio," Rate and Direction of Inventive Activity, J. Lerner and S. Stern (eds), NBER, 2011 (forthcoming).

[13] Phillipe Aghion, Mathias Dewatripont and Jeremy Stein (2009), Academic freedom, private-sector focus and the process of innovation**.** *RAND Journal of Economics,* 39(3): 617-635; Daron Acemoglu (2010), "Diversity and Technological Progress," in J.Lerner et.al. (eds) 50th Anniversary of the Rate and Direction of Inventive Activity, NBER.

of diversity in a socially improving manner? Is a balanced system with mixed commercial and non-commercial motivations an optimal one? What are the types of alternative motivations that actually drive scientists (within universities but also outside the typical boundaries of academia)?

The impact of digitization on knowledge contribution:

This theme examines the impact of digitization and online platforms on the knowledge contribution economy. While anecdotal evidence suggests a large impact, there have equally been concerns regarding the quality of knowledge contributed online. There have also been suggestions that digitized models for attribution and rewards for knowledge contribution are still evolving in a way that could be significantly impacted on by public policy choices.

- *What is the optimal ownership structure of digitized content when users contribute*? Various parties own content presented for public consumption, and constraints may be imposed as to how that content is presented. For example, Wikipedia have made a conscious decision not to permit advertising associated with their content whereas search engines have made the opposite choice. These platforms trade-off clear presentation of interested and disinterested content with the need to fund content provision and dissemination. The issue of the optimal ownership and contract terms associated with content is related to analyses in public economics over the optimal ownership of public infrastructure. Here, however, the decentralized nature of content provision adds a competitive element. The program here intends to fund studies analyzing the costs, benefits and broad trade-offs associated with alternative ownership and contractual regimes for digital content.

- *What are the optimal models for sharing digital content?* As information has become embodied in 'zero marginal cost' digital form, this has opened up opportunities for sharing informational goods between individuals. While this has always existed – libraries being the case in point – old business models with a single payer and owner of the right to access information persist. At the same time, norms and institutions are emerging over data archives for which similar trade-offs of access and funding exist. This project will examine the reasons for the persistence of such models and potentially mechanisms to transition to different models for sharing digital content.

- *What is the impact of 'open science' requirements on incentives for broad scientific dissemination?* Calls for open access in scholarly publication are made to promote a greater flow of ideas (especially being combined with other ideas). However, these impact on investments made to support dissemination of publications and also the allocation of ownership and responsibility in ensuring quality in communicating scientific knowledge. What are the incentive consequences of such policies and what do they suggest regarding models that might be deployed to balance any resulting trade-offs (e.g., moving to collective rather than commercial provision of scientific publications, post-publication review and also engaging academics in the peer review of public reports)? That is, does open science end at the journal or does real accessibility also create responsibilities for 'translation' of scientific ideas into forms a broader audience can utilize?

- *How do reward structures and attribution facilitate user knowledge contributions?* Individuals are contributing, without apparent recognition, content to platforms such as Wikipedia but also reviews and other forms of content at places like Amazon or Tripadvisor. The phenomenon of user contributions is of independent interest but also leads to the question of whether such contributions could receive further incentives. For instance, are the 'right' people contributing to Wikipedia? Could more academics contribute? Would metrics on contributions that were publicly available provide further incentives for quality user contributions?

- *How do digital repositories operate as platforms for knowledge contribution?* A reasonable hypothesis regarding contributions motivated by non-monetary concerns is that contributors are looking for recognition in the form of attention and use. But as Vannevar Bush pointed out over half a

century ago, this interacts with the problem of searchable knowledge.[14] This means that digital infrastructure that makes data and knowledge accessible and searchable could be a key driver of liquidity in knowledge contributions. Infrastructure – both public and private – are operating in this space. Google's search engine (and its variants such as Google Scholar) provided a means of identifying individual contributions. Google Books similarly proposes to open up past contributions but also to provide a searchable platform for future contributions. We propose to identify several key examples of digital repositories with a view to analyzing their impact on the quantity and quality of knowledge contributions.

- *Could standards for data presentation and storage reduce information overload and create incentives of knowledge contribution?* While web search has assisted in resolving some issues associated with information overload, it is still the case that it is akin to directing you amongst different haystacks to find the one that has the needle you want. The reason is that content is presented in a diverse set of ways or data are tabulated and compiled according to different standards. Indeed, perhaps Wikipedia's chief innovation has been to standardize the form of an encyclopaedia entry as a consequence of allowing unfettered user editing. Wikipedia pages are organized in a manner that generates familiarity associated with a common standard. How important are standards for data presentation and storage and what institutions should promote the emergence of such standards?

[14]Vannevar Bush (1945), "As we May Think," *The Atlantic Magazine* (http://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/3881/).