Australian Biotechnology companies and networks: methodological issues in the replication of a major US study

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Abstract

This paper arises from a replication of a major US study on the 'network logic' of biotechnology companies. Walter Powell, the leading sociological authority in this field, has argued that such companies are exemplars of new forms of economic and organizational behaviour. He has also observed that 'this new logic of organising' might well 'diffuse globally', but alternatively national-level institutions might refract 'common competitive pressures' and produce 'divergent responses' (Powell 2001: 66): hence replication in the Australian context. Yet replication presents many challenges. There is no comparable publicly-available database of Australian biotechnology companies with which to work. There are also a variety of problems in applying the categories of the original study to Australian biotechnology companies and their partner organisations. Some of these problems have implications for the original study. Others arise in the Australian context, on account of differences in the configuration of the Australian industry. On this account, there is a risk that replication might actually obscure the differences that it is designed to address. By implication, replication must involve close attention to the raw data, and adjustment of categories to take into account differences across countries.

Introduction

The biotechnology industry has been described by some sociologists as an exemplar of new forms of economic and organizational behaviour. In particular, there is a substantial body of research on the 'network logic' of the industry (Powell 1990; Podolny and Page 1998; Powell 2001). Walter Powell, the leading sociological authority in this field, has observed that 'this new logic of organising' might well 'diffuse globally', but alternatively national-level institutions might refract 'common competitive pressures' and produce 'divergent responses' (Powell 2001: 66). This paper arises from the replication of a major US study of biotechnology networks in the Australian context. Replication has given rise to a variety of challenges. The paper

describes these challenges and discusses their implications for comparative research in economic sociology.

Powell on biotechnology companies

Powell and his collaborators have conducted the most comprehensive and influential studies of the biotechnology industry from a sociological perspective. Powell set out to map the network dynamics of biotechnology companies. He drew his annual sample from the April issue of BioScan, an independent industry directory, founded in 1988 and currently owned by Thomson American Health Consultants, a subsidiary of the US information giant Thomson Corporation. The directory is heavily focussed on the US, although it does include some companies from other countries including Australia. It reports information on company ownership, financial history, formal contractual linkages to collaborators, products, and current research (Powell et al. 2005:17).

Powell's focus was on what he called 'dedicated biotechnology firms', or DBFs. More specifically:

> We include 482 companies that are independently operated, profit-seeking entities involved in human therapeutic and diagnostic applications of biotechnology. We omit companies involved in veterinary or agricultural biotech, which draw on different scientific capabilities and operate in quite different regulatory climates. The sample of DBFs covers both privately-held and publicly-traded firms. We include publicly held firms that have minority or majority investments in them by other firms, as long as the company's stock continues to be independently traded. (Powell et al. 2005:17)

Powell excluded organizations that might otherwise have qualified as DBFs, but were wholly-owned subsidiaries of pharmaceutical or chemical corporations. Large pharmaceutical corporations, health care companies, hospitals, universities, and research institutes were also excluded from the primary database, although they featured indirectly through their collaborations. The rationale for excluding both small subsidiaries and large, diversified corporations was that subsidiaries 'do not make

decisions autonomously', while biotechnology 'may represent only a minority of the activities' of large corporations (Powell et al. 2005:17).

On the basis of this definition, Powell identified 482 DBFs over a 12-year period, 1988-99. The next step involved collection of network data. Powell defined a collaborative tie as 'any contractual arrangement to exchange or pool resources between a DBF and one or more partner organizations'. Powell then coded agreements in two main ways. First, he coded by the purpose of the agreement, distinguishing between four types; licensing, R&D, finance and commercialisation. Of these types, commercialisation was treated as a residual category for complex agreements that involved multiple stages of the production process, because such agreements invariably involved commercialisation activities.

Second, Powell coded agreements by the organisational forms of the partner organisations. There were six main forms:

> public research organizations, large multinational pharmaceutical corporations (as well as chemical and diversified health care corporations), government institutes (such as the National Cancer Institute or the Institut Pasteur), financial institutions (principally venture capital as well as banks and insurance companies); other biomedical companies (providers of research tools or laboratory equipment), and those DBFs that collaborate with other biotech companies. (Powell et al. 2005: 18).

Powell thereby arrived at a secondary list of non-DBF partner organisations, of which he identified more than 2,300.

On the basis of this approach, Powell concluded that the 'core competence of a firm, to use the new argot, is based on knowledge production and building a sustainable advantage that can be leveraged across products and services, thus enmeshing firms in all manner of different relationships and markets that were traditionally called industries' (2001: 5). In this context, 'network ties become admission tickets to high-velocity races'. In turn, 'a firm grows by becoming a player; it does not become a player by growing' (2001: 60). There are, Powell argued, 'abundant reasons to expect

that this new logic of organizing will diffuse globally, and equally compelling rationales for why national-level institutions have a resilient quality that both refracts common competitive pressures and produces divergent responses' (2001: 66). In other words, there is good reason to replicate the study in other countries, including Australia: hence our own research.

Identification of Australian DBFs

Following Powell, we wanted to identify 'independently operated, profit-seeking entities involved in human therapeutic and diagnostic applications of biotechnology' in Australia, and their partnerships. The first problem that we faced was identifying Australian DBFs. For reasons already discussed, *BioScan* is not a satisfactory source for an Australian sample. Australian companies are too marginal to the international industry to warrant comprehensive coverage.

There *is* an annual *Australian Bioindustry Review*, published by a small locally-owned private consultancy since 2001. The *Review* identifies the number of DBFs in Australia from one year to the next. For example, in 2001 it observed: 'Our analyses show that there are about 250 core biotech companies and at least another 100 with closely related activities' (Hopper and Thorburn 2001: 6). Yet it does not identify the names of its DBFs. Perhaps this is because to do so would compromise the intellectual property of the consultancy. The consultancy provides services for both federal and state governments, assisting in the publication of various reports on the industry (Victorian Government 2004; Australian Government 2004). If it published the database in its entirety, there might be less call for its services.

In this context, there is no authoritative publicly-available list of Australian DBFs, let alone their partnerships. The closest thing to such a list is the online membership directory of the peak industry organisation AusBiotech. In 2004 this directory had more than 700 entries, including not just DBFs, but public research organisations, government departments, venture capital groups and specialist service providers (such as lawyers, patent attorney and public relations organisations) (Australian

Government 2004: 57). It was a useful point of departure for our own list of DBFs, but it required heavy culling. It also required careful supplementation, identifying those DBFs that were not AusBiotech members. In the process, we necessarily drew upon a variety of other sources, including government reports (Victorian Government 2003), Australian Securities and Investments Commission (ASIC) records, and company websites.

On this basis, we arrived at a list of about 120 Australian DBFs specialising in human therapeutic and diagnostic applications in April 2004. This figure was well below the figure cited by the *Australian Bioindustry Review* – as well as other sources, such as a 2004 Australian Government report entitled *Global Partners,* informed by the consultancy responsible for the *Review*. According to *Global Partners*, 'over 215 of Australia's biotechnology firms aim to develop either human therapeutics or diagnostic products and services for human diseases' (Australian Government 2004: 17). Given that the report (like the *Review*) does not identify the firms, it is not possible to be certain of the reasons for the discrepancy with our own figure. Even so, there are at least three probable causes.

First, 'therapeutics and diagnostics' are rubbery categories. At the very least they include companies that are trying to develop treatments and diagnostic tools directed to human health. They might also include a wider array of companies: notably, service companies that provide routine testing, say paternity testing; finance companies that provide venture capital and management to DBFs, such as the Australian publicly listed company Circadian Technologies (identified in *Global Partners* as a biotechnology firm); and companies that do little more than sell, market and distribute products developed elsewhere, such as the local subsidiaries of giant US corporations such as Amgen and Applied Biosystems. Following Powell (personal communication), we followed a narrow definition of therapeutic and diagnostic applications.

Second, we insisted (again, following Powell) that the DBFs in our list were 'profit-seeking' companies. In practical terms, we defined this in terms of ASIC registration

as either a public company or a proprietary company, limited by shares. These are the two most common types of companies engaged in commercial activities. We did not include public companies, limited by guarantee. Such companies are not prohibited from making a profit, but this is not their prime purpose. Many public research organisations are public companies, limited by guarantee. *Global Partners* cites at least one such company - the Australian Stem Cell Centre (formerly the National Stem Cell Centre) – as a 'case study' of the DBFs in its own list (Australian Government 2004: 46). Presumably it included other such companies and organisations, excluded from our list.

Finally, we excluded companies that were subsidiaries, on the basis – as Powell observed – that they 'do not make decisions autonomously'. Some biotechnology companies have actively experimented with 'altogether different financial conceptions of a firm', creating spinoffs as a strategy to retain partial control, protect the legal liability of the established firm, and 'raise capital much as a start-up firm' (Powell 2001: 40). At least several prominent Melbourne-based biotechnology companies have a suite of subsidiaries, majority owned to greater or lesser extent (that is, from 50.1% to 100%). These subsidiaries are included in the Victorian Government's Biotechnology Directory as distinct companies (Victorian Government 2003). Perhaps they are also included in other lists, such as that of *Global Partners*. It is not possible to say.

Whatever the case, the high numbers of DBFs identified in government reports are revealing. Australian Governments actively promote the major Australian cities as locations for biotechnology research, pinning its 'New Economy' ambitions on this particular technology. Their inflated accounts of the sector support their policy ambitions, but they do not provide a reliable basis for international comparisons.

Replication problems

The lack of a comparable data base of Australian DBFs was a major problem in the replication of Powell's research in the Australian context. There were also a variety of other problems at various stages of the research process. In the first place, it was often difficult in practical terms to maintain Powell's exclusive focus upon therapeutic and

diagnostic companies in compiling the primary database of Australian DBFs. A significant minority of Australian companies were 'hybrids', branching into other biotechnology applications as the opportunity arose. Exploratory interviews with 14 CEOs of Australian DBFs confirmed Powell's point that different applications faced different regulatory environments, but they did not confirm his point about the different scientific capabilities of such applications. No firm demonstrates this point more clearly than the Melbourne-based public company Genetic Technologies, which uses its complementary technology to provide a high throughput genotyping service for human, veterinary and agricultural samples. As it happened, we counted hybrids as therapeutic and diagnostic companies, bearing in mind that we were edging away from Powell's criteria.

More difficulties arose in the course of identifying 'partner organisations', that is the 'secondary database'. The categories of public research organisations, multinational corporations and biomedical companies were straightforward enough. The categories of government institutes and financial institutions were not, each one presenting distinctive problems. In the case of government institutes, by far the most important government institute in Powell's study was the National Institutes of Health (NIH). The NIH are a distinctive US institution, often mentioned with envy in the course of interviews with the CEOs of Australian DBFs. They are a bountiful source of government funds for US DBFs, but they also involve collaboration with NIH personnel. There are a number of Australian institutions that have some measure of equivalence, but the comparisons are problematic in different ways. Most obviously, the CSIRO is a perhaps an Australian equivalent to the NIH, but it could be equally understood as a 'public research organisation'. The Government-funded Cooperative Research Centres (CRCs), designed to build and institutionalise networks between public and private organisations, are also ambiguous in this respect. Government grants through AusIndustry (BIF and R&D START grants) and the Australian Research Council (Linkage grants) provide crucial startup funds for industry, but they do not involve personnel. These ambiguities indicate different types of relationships between government and industry in different countries. If replication of Powell's study obscures these differences, then the whole point of replication is lost.

The category of financial institutions presents different problems. There is no doubt that the providers of finance, notably venture capitalists, play a critical role across the biotechnology industry. We learned as much ourselves in the course of exploratory interviews with Australian venture capitalists who provided funds for a suite of DBFs along the eastern seaboard (but not in the west – that was too far away). Yet there is a qualitative difference between relationships grounded in research, licensing and commercialisation on the one hand, and those grounded in financial investment on the other. This is apparent in Powell's own primary data source *BioScan,* which lists the relationships separately. Relationships grounded in research, licensing and commercialisation involve specific contractual agreements, explicitly identified as 'collaborations'. In contrast, relationships grounded in financial investment arise from the generic legal implications of ownership. In turn, it is difficult to distinguish between active owners such as venture capitalists, and passive owners such as some financial institutions. Powell makes no distinction in his study, but this means that it is difficult to gauge the meaning of the data on financial partner organisations – let alone compare the data across countries.

More generally, the fact that we had to access a variety of sources – and could not rely upon a comprehensive source such as *BioScan*, meant that we consistently contacted the DBFs themselves to check on the status of their partnerships. This process alerted us to a systematic bias in published data on partnerships. We found that we had consistently over-estimated the number of partnerships. In the light of Powell's analysis, there is an obvious reason for this. Partnerships are a means of building learning capacity and credibility in the industry. In the context of industry instability, there is good reason to publicise their commencement, and good reason not to publicise their termination.

Finally, replication in the Australian context meant that we paid attention to location in a way that was not so for the original study. Powell's DBFs (the primary database) were mostly US based, but not necessarily. Presumably they were also mostly US owned, but again this was not necessarily the case. The secondary database of partner organisations also consisted mostly of US based companies, but this was not

something that was highlighted in his research. The fact that the study was conducted in the world centre of the biotechnology industry meant that location was not a salient issue. Replicating the study at the periphery of the world industry (notwithstanding the ambitions of Australian governments) means that location is a fundamental issue. Not only does it address the articulation between markets, networks and institutions in different national contexts, as mooted by Powell. It also addresses 'how the processes of globalization form a core component of biological knowledge and practice' (Thacker 2005: xvii), in a way that extends beyond the original study.

Our DBFs by definition were those located in Australia, but they were not necessarily Australian owned. Partner organisations could be located anywhere, and their ownership could also be located anywhere. Whatever the case, it was imperative that we coded our companies in both primary and secondary databases by location (taking into account operations and ownership), drawing distinctions between the US, Europe and the Asia-Pacific region.

Briefly, replication of the Powell's US-based study raised a variety of problems in the Australian context. Some of these problems were embedded in the original study; notably partnerships with financial institutions and the tendency of DBFs to publicise the commencement of partnerships but not their termination. More commonly, they arose from the specifically Australian context, including the identification of Australian DBFs, support from government, and the geographical location and ownership of DBFs and partner organisations.

Discussion

The study so far suggests that replication of the original US study by Powell and his colleagues is a useful line of inquiry. What is true for biotechnology companies and network organisations in the US is not – as Powell acknowledged – necessarily true of biotechnology companies and network organisations in other parts of the world. Indeed, the challenges of replication themselves draw attention to these differences. By the same token, there are problems with the original study that require attention,

notably the mapping of financial partnerships and possible over-estimation of partnerships. More than this: the very differences that replication is designed to address are partially obscured by the template of the original study. By implication, replication must involve close attention to the raw data, and adjustment of categories to take into account differences across countries.

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