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Creating economic growth and prosperity: the role of universities

***Economists famously differ over many things, so it is worth noting that growth is a surprising area of unanimity. All theories of economic growth are in agreement: growth rests ultimately on technological change* (Keith Smith, 2006)[1].**

New Zealand has a pressing and well-documented need to diversify its economy and lift its productivity, but progress has been limited. Productivity growth lags behind that of leading OECD countries, and we are still heavily reliant on agriculture and tourism. Yet, as pointed out in the most recent OECD report on New Zealand's environmental performance, our growth model "based largely on exploiting natural resources, is starting to show its environmental limits".[2]

The need to lift productivity and diversify the economy while protecting the environment is not the only pressure for change. Major technological and demographic forces are also at play, not least the changing nature of work and the job market. Commentators predict that 10-50% of jobs existing today are at high risk of disappearing within the next two decades due to automation and computerisation.[3,4] Many of the occupations we know today will disappear and so we will need to create new career opportunities for future generations.

In this issue of *Commentary* we look at what may be needed to accelerate the transformation of the New Zealand economy and job market, and the role that our universities can play in this process.

New innovative firms as drivers of wealth and job creation

The importance of innovation for productivity and prosperity is well recognised. Yet not all kinds of new firms are of equal benefit to New Zealand in terms of wealth and job creation. What we need are more firms that are net creators of new jobs, and that remain in New Zealand with those jobs.

This leads to two obvious questions.

First, what kind of firms are net creators of new jobs? This is not a simple question, but international research indicates that a few rapidly growing firms generate a disproportionately large share of all new jobs. These firms tend to be young [5,6], and based on innovation and technology.[7] In the US, the Kauffman Foundation has shown that new high-tech and ICT firms contribute disproportionately to employment growth. In their study of firms' employment performance over the period 1990–2011, they observed that "while older firms are the major source of employment, new and young companies are responsible for net new jobs. This has been especially true for high-tech and ICT firms where job gains among young businesses have been strong enough to offset job losses from early-stage firm failures".[8] MBIE research

- Growing innovation and entrepreneurial capability in New Zealand is vital. It will give New Zealand the ability to shape and invent its own future and make the most of the opportunities that come with rapid change.
- Universities are unique in that they both create innovative technologies and graduate highly-skilled people with the ability to be creative, innovative and entrepreneurial.
- Some overseas universities have made substantial contributions to the development of successful high-tech economies in their regions.
- There is significant potential in New Zealand universities to foster an innovative and entrepreneurial economy through enhanced focus on ground-breaking, radical research and its commercialisation, and the growth of an innovation-capable workforce.
- Our continuing unwillingness as a country to achieve a high level of investment in university research, particularly fundamental research, is a critical limiting factor in creating an innovative, entrepreneurial economy. Without it, we will not create the new industries and jobs that we desperately need.

on high-growth firms in New Zealand finds the same to be true here.[9] New Zealand's top 200 technology firms – the TIN200 – experienced job growth of just over 7% from 2016 to 2017[10], which compares very favourably to the 3% growth in the total number of jobs in New Zealand over the same period.[11]

Innovative companies are important not only for their direct impact on employment, but also for the large multiplier effect they have on jobs in other sectors. Stanford economist Enrico Moretti's research concludes that "for each new high-tech job, five additional jobs are ultimately created outside of the high-tech sector" in both skilled and unskilled occupations.[12] The multiplier effect is three times larger than in many other sectors (e.g. extractive industries, manufacturing). In other words, innovative firms generate jobs not just for the highly-skilled, but for others too, so resulting in broad-based job growth.

The second question is, what kinds of firms stay in their own region and country? Again, this is not straightforward, but some types of companies are more likely to stay close to their origins than others. Scott Shane has noted that radical inventions are more likely than incremental developments to lead to the formation of spin-offs because "radical inventions cannibalise existing assets, undermine existing organisational competencies and are often rejected by managers in existing companies. Spin-off companies are more common when the knowledge needed to exploit the technology is tacit than when it is codified. Tacit knowledge makes it difficult for anyone other than the inventor to understand how to commercialise the technology; and spin-offs are a better vehicle than established firms for securing the inventor's involvement in the exploitation process."[13] This explains why spin-off companies based on radical technologies are typically "sticky" to their inventors and the institutions, cities and countries in which they were invented.

It does not necessarily follow, of course, that technology companies will create only jobs that "stay at home". In some cases, the jobs they create will be a mix of local and international jobs, while in others the company will move offshore to access markets or lower manufacturing costs, or as a consequence of being bought out by overseas interests. This points to the importance of securing a pipeline of new companies, at least some of which will stay in New Zealand.

The other critical element, both to grow the number of innovative start-ups and to enhance innovative capabilities of existing firms, is a highly-skilled workforce with strong innovation and entrepreneurial capabilities. Indeed, the new economy is placing differing and challenging demands on the workforce.[14] Future workers will need to be more agile, innovative, resourceful and adaptable – all of which are largely entrepreneurial competencies.[15]

Research in Australian and New Zealand organisations also supports the importance of these skills, finding that "organisations have rated the most important skills for the talent of the future as communication, problem solving, adaptability, agility, and resilience. These skills are less able to be replaced by technology, and will be vital in an uncertain world." [16]

The role of universities

Among all the institutions in our society, universities are unique in having major roles both in creating innovative technologies *and* in educating highly-skilled people with the ability to be creative, innovative and entrepreneurial. One would therefore expect them to be able to play a major role in the development of the modern economy, and international experience demonstrates that this is indeed the case.

The potential contribution of universities is illustrated rather spectacularly by the early years of the (US) biotechnology sector, which grew from virtually nothing to over 700 active firms in just 15 years, and is now one of the most significant industries in the world. As is illustrated in Figure 1, growth in the number of new biotechnology firms followed (and was highly correlated with) growth in the number of "research stars" (highly productive researchers) with a further lag to the number of their research collaborators. The vast majority of the research stars were located in universities, which is where most of the fundamental genetics research that gave rise to biotechnology occurred. As Lynne Zucker and her colleagues observed, "This industry is a testament to the value of basic scientific research." [17]

At least in the early stages of the biotechnology industry, the new firms were clustered close to the research stars, who tended themselves to be concentrated in a few geographical areas. This again evidences the "stickiness" of spin-offs to leading researchers and their universities. In the US, 80% of university spin-offs operate in the same state as the university from which they originated.[19] Figure 2 provides an illustration of this in the clustering of biotech companies around the Massachusetts Institute of Technology (MIT). MIT-founded biotech companies are indicated in red. And the tendency for firms to stay close to the institutions that spawned them is not a uniquely US phenomenon: a similar pattern has been observed in the European context.[20,21]

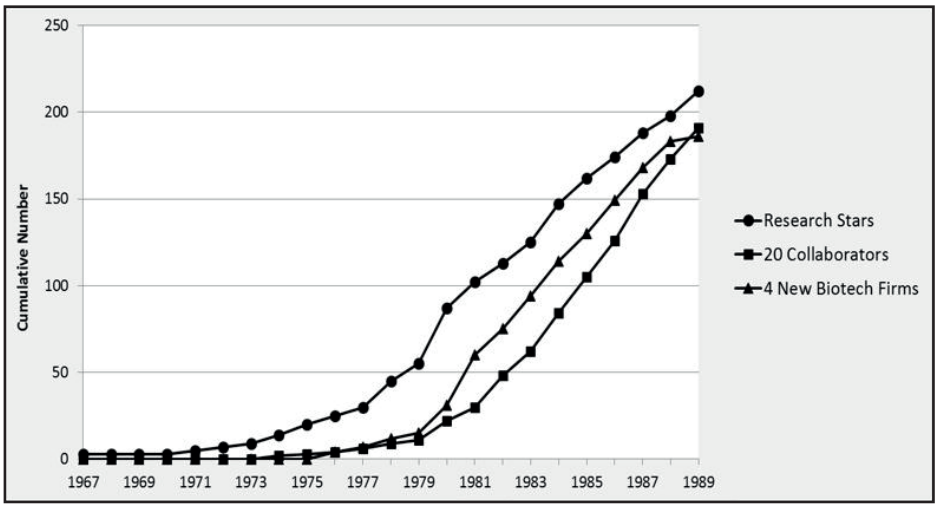

Figure 1: Cumulative number of research stars, collaborators and bio-tech firms, 1967–1989[18]

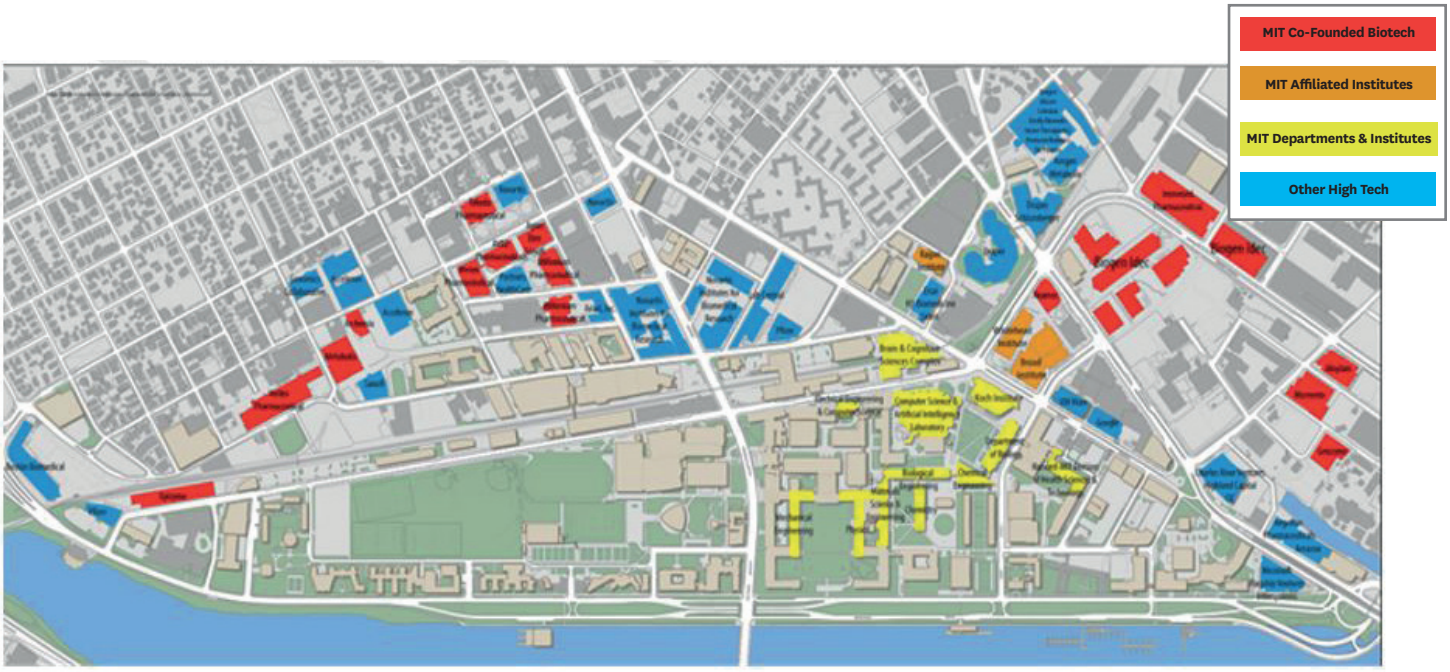

Figure 2: An example of 'stickiness' – clustering of biotech companies around MIT[22]

Universities can also play a significant role in the provision of entrepreneurial education that "establishes entrepreneurship as a viable career option, and exposes students to explicit and tacit knowledge and networks that might increase their chances of success if they do found a firm".[23] The stickiness of firms extends to those founded by graduates as well as by entrepreneurial researchers. For example, 38% of the software, biotechnology and electronics companies founded by MIT graduates are located in Massachusetts while fewer than 10% of MIT students are drawn from the state. In short, MIT has allowed Massachusetts to become a significant "importer" of those who will go on to found companies.[24] Other graduates will go on to become intrapreneurs (internal entrepreneurs), helping to reinvent our traditional industries as they face the challenges of technological disruption.

Because of these three factors – the creation of radical innovation, the stickiness of new firms to their inventors, and the output of highly-skilled graduates – some universities overseas have made substantial contributions to the development of successful high-tech economies in their regions and countries, with significant impacts on wealth and job creation. For example:

- Stanford alumni had, by 2011, founded nearly 40,000 companies generating an estimated 5.4 million jobs and annual world revenues of US$2.7 trillion.[25]
- Alumni of MIT had, by 2014, created 30,000 still-active companies that employed 4.6 million people and generated annual global revenue of nearly US$2 trillion, roughly equivalent to the GDP of the world's 10th largest economy as of 2014.[26]

These are, of course, outstanding examples, but they demonstrate that the model of the entrepreneurial university is well established and that such universities can make very substantial contributions to the creation, for their regions and countries, of very successful high-tech economies and societies. Research into these institutions typically identifies four critical success factors:

- High-quality academics who have the "ability to generate radical innovation conducive to commercialisation"[27]
- A high level of public and private investment in university research
- A well-established technology transfer office
- A good availability of venture capital in the university's immediate geographical vicinity

Although some New Zealand universities have effective technology transfer offices and access to venture capital ("good" is a relative term), the first two of these conditions are not yet fully satisfied. There are many high-calibre academics in New Zealand, but we do not yet have a critical mass of entrepreneurially-focused academics. Further, the nature of the New Zealand university funding model, which is based on student numbers in each discipline, has resulted in recruitment decisions being driven primarily (and logically under the circumstances) by the courses that each academic would need to teach. Nevertheless, the numbers of entrepreneurial academics are increasing slowly, and some new schemes are in place to promote this. The most critical limiting factor, though, is our continuing unwillingness as a country to achieve "a high level of public and private investment in university research". Until we begin to invest seriously in university research, and particularly the fundamental research that leads to radical innovation, we will not achieve the new industries and jobs that a country "at its environmental limits" so desperately needs.

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Commentary is produced on an occasional basis by the Office of the Vice-Chancellor at the University of Auckland, and brings together some of the research-based evidence relevant to current issues in higher education and research.

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