Article

Devolution of New Zealand Research to a Gig Economy: time for investment

Subtitle

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Introduction

In 2005 the New Zealand Tertiary Education Commission's (TEC) put out a call for academic feedback on their Strategic Review of the Tertiary Education Workforce. In response, we highlighted significant career development issues facing contract research staff and the excessive dependence of New Zealand's research on fixed-term contract staff in our universities (Bennet et al., 2005). We suggested that it was important to invest a greater proportion of our gross domestic product (GDP) on research and development (R&D), but also that there needed to be a transformation in how we structure and fund career pathways for research scientists particularly for those working in tertiary institutions.

Since 2005 there has been little to no progress on the issues we raised, despite numerous consultations and reform proposals, all recognising the need to increase GDP expenditure to 2.0% or higher, and more financial workforce support. The last proposed reform of the science sector (at time of writing) from the Ministry of Business, Innovation and Employment (MBIE) was released in late 2022: the Te Ara Paerangi Future Pathways reform programme. This reform has now been cancelled in favour of – more consultation (MBIE, 2018). In this brief position statement, we highlight the ongoing loss of investment in research since 2005, and the perils we face if we do not move from consultation to constructive action that addresses substantial research and workforce support deficits for research undertaken in tertiary institutions.

Why do we fund research and why is funding universities economically sound?

Societies that invest in R&D have stronger, more competitive, growing economies, and are less reliant on the economic fluctuations of other countries (Woetzel et al., 2018). We also want to invest in R&D that targets issues specific to our country including meeting our commitment to Te Tiriti with investment in Māori research science and innovation activity. Such investment helps grow and sustain an educated, skilled and scientifically literate workforce who can not only implement and sustain science and technology products and discoveries, but who can innovate to take us further (Woetzel et al., 2018). This goes beyond simply ensuring professional training. There is significant concern that governments have come to view our universities as training businesses with customers, and that science funding should be targeted at utilitarian goals as opposed to enhancing society by expanding knowledge (Caulfield and Ogbogu, 2015).

In New Zealand, total spending on research and development increased 11% between 2020 and 2022, to a total of $5.2 billion. The increase was largely driven by the business sector and thus for universities this has not translated into significant investment for investigator driven research (Stats NZ, 2024). While commercial research investment within universities has grown, it remains limited and such investment is often also not feasible or effective for many types of research given constraints on academic freedom, publishing and the perceived pressure for fast research outcomes and premature implementation (Caulfield and Ogbogu, 2015). However, despite this increase in total New Zealand R&D spending, gross expenditure on R&D as a proportion of GDP is only 1.47% (2021-2022 latest data) compared to the OECD average of 2.7% (Australian Government, 2023; Stats NZ, 2024). Of this, direct New Zealand government investment was just 0.29 percent of GDP in 2021 compared with the OECD average of 0.5 percent (Hunter and Paton, 2024).

GDP expenditure above 2% for R&D is generally considered important to sustain effective R&D (OECD, 2018). It has been a touted target by successive governments. Indeed, the current Government have signalled their intention of getting R&D investment to 2% by 2028 (New Zealand Government, 2024), largely through tax-incentivisation. Again, this will not address the issue facing tertiary institutions and their scientific workforce. Yet, funding our universities is of significant economic benefit as highlighted in the 2018 Deloitte survey (Deloitte/UNZ, 2018). Investment in university R&D over the last 3 decades increased the New Zealand GDP by $129 billion, a return of $5 for every $1 spent (Deloitte/UNZ, 2018). Deloitte calculated that higher education research in New Zealand was worth $26 billion in 2017 alone – around 9% of GDP (Deloitte/UNZ, 2018). This report made it clear

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that university research plays a key role in creating new knowledge and ideas, that might not otherwise occur with commercial funding, and creates a platform for engagement with and transfer of science and innovation to industry and business for use and commercialisation. Universities New Zealand state that an increase of just 10% in university research funding would generate $6 billion in economic returns in the next decade, and that New Zealand's GDP is up to 6% higher due to the impact of university education on productivity (see: https://www.universitiesnz.ac.nz/).

Thus, significantly increasing investment in university R&D to at least the OECD mean, or preferably better, would pay substantial dividends and is a powerful economic strategy that should be readily embraced. Yet our universities and funding agencies supporting university research are significantly underfunded. Investment has not kept up with inflation, household cost of living pressures, or general salary increases; this problem is magnified by caps on major grants such as those from Marsden Fund and the Health Research Council (HRC).

The fixed caps on grants now make it nearly impossible to pay full salary costs beyond entry level scales. It is important to note that in New Zealand government funders provide support for indirect costs though 'overhead' payments, which are typically calculated as a percentage of staff salaries. This is a well-intentioned policy to help ensure that the institutions support research, although there is little transparency regarding how such funds are used by institutions to support research. There are no easily accessible data on the exact level of overheads internationally, the total amount of these overheads negotiated by New Zealand institutions seems to be broadly comparable to other high income countries. However, the approach can vary considerably; in Australia for example, overheads are provided to institutions separately, as a rolling average, and so their project grants seem smaller as they are not bundled with overheads. The immediate concern for researchers is that because the total quantum of grants has not been increased for many years, it is becoming increasingly difficult to include the full salaries of contract researchers, particularly as it is combined with institutional pressure to increase the proportion of permanent staff salaries, further reducing the amount available for the salaries of contract staff.

This highlights another fundamental issue: workforce career development. The Deloitte report highlighted the importance of university activity as the primary place for training the scientific workforce. It can only do this, if in fact there are strong research teams to train with, and a career structure that attracts students into science and ensures retention of talented scientists. In turn, the Early Career Researcher Forum of the Royal Society Te Apārangi highlighted that NZ trains far more PhD students (1,480 in 2019) than there are research-centred positions in public research institutions or the private sector (Aung et al., 2022). Moreover, most were not trained for more diverse careers, which likely limited their options outside of academia. The focus on postgraduate training is an important contributor to New Zealand's research productivity, and is similar to other high income countries, but could be better managed. Arguably, now would be an appropriate time for a new survey, given that the worst of the Covid crisis is over.

Workforce career precarity – redundancies, disaffection and the critical loss of talent

Research requires a critical mass of skilled staff at all levels who can carry out high quality research, who can innovate in their disciplines and who are invested in training the next generation (Bennet et al., 2005). Kiwi scientists, and their science, are worth investing in. New Zealand routinely ranks in the top 30 in the Nature Index, which tracks high quality research outputs in thousands of research institutions (https://www.nature.com/nature-index/). In 2023, New Zealand ranked 29th. We are clearly punching well above our weight given the scarcity of research investment. Imagine what we could achieve with secure investment! The key limitation for progress is that the majority of research staff in universities are on fixed term contracts, with few permanent ('tenured') posts on offer. For example, at Otago University, in total 169 of 497 of academic and professional research staff (34%) were on fixed-term contracts (Stamp et al., 2021). As expected, the proportion of early and mid-career researchers was much higher: of 42 who completed a survey, 34 (81%) were on fixed-term contracts (Stamp et al., 2021). Because we lack a significant number of well-established fellowship schemes (from junior to senior levels), tenure-track for successful fellows, and non-inflation linked capped grants that don't meet full salary costs, fixed term contract staff are essentially now working in a "gig" economy, which is failing.

For some, the gig economy concept offers freedom, autonomy and flexibility. Potentially, at least, it may support delivery of some types of science that suit freelancing on specific projects, data management, problem solving consultancy etc (Kwok, 2017), but in reality mostly science does not fit the gig model. Skills, expertise and knowledge are not easily interchangeable between disciplines and leadership and innovation in science requires building a significant depth of knowledge and expertise over time. Permanent university academics are expected to obtain grants to support their work, and the university pays their salary for a range of tasks that go beyond research (i.e. teaching and service). Fixed-term contract staff must also raise the funds for their research and their salary and are typically on a succession of short term "gigs" (research contracts). Fixed-term staff must spend a substantial amount of time writing grants to get their next gig, instead of carrying out research. Given the financial state of universities in New Zealand, many of these fixed-term researchers are also being asked to contribute to other duties (teaching, service) to fill the void left by permanent staff redundancies, spreading the time of contract staff even thinner. The Covid epidemic highlighted the vulnerability of contract researchers to social and economic disruption

(Stamp et al., 2021).

The lack of investment in university research now means these grants have an absurdly low success rate (necessitating more grant writing) and, increasingly, insufficient funds to cover the full salary of fixed-term researchers. Note that this also includes funding on research fellowships. In our experience, a striking number of research staff in our institutions are on contracts with less than 100% of their salary, often with multiple contracts to achieve full funding. Even prestigious fellowships such as the Rutherford Discovery Fellowships do not pay the full cost of salary for the duration of the grant, leaving fellows to either shorten contracts, work on reduced tenths, or hope that their university can make up the shortfall. The latter does happen, but is dependent on local "grace and favour". This has concerning equity implications, because any such approach is intrinsically fraught with what has been termed 'affinity bias'. That is to say that people are more likely to support junior staff who feel like them, and so may inadvertently not support researchers from minority groups. Of course, as the times become more austere, even this "grace and favour" funding becomes unavailable.

For early and mid-career investigators the problem is compounded by the fact that more senior staff are now applying for smaller charity or research society grants to make up the research and salary cost shortfalls on bigger grants due to the lack of investment. Such grants once were the ideal place to start to develop independence, and were readily obtainable by early career researchers. In the USA, evidence shows that such early-mid career awards are very cost effective (Pomeroy-Carter et al., 2018). Now, junior scientists must compete against more established researchers. Women, especially if they have family commitments, find it particularly difficult to build career momentum in this Darwinian environment (Stamp et al., 2021).

In 2005 we noted that it was very hard to track the numbers of fixed-term contract staff in our system and their contract situations (Bennet et al., 2005). This has not really changed as universities continue to fail to account for such staff within their institution. This was highlighted by the precarious work in New Zealand Universities report (Simpson et al., 2022). This review noted that precarious staff, such as fixed-term researchers, are not clearly identified and officially reported in statistics and there is a need for universities to collect and report data on numbers of fixed-term staff and their FTE. The authors concluded that the increasing corporatisation of universities and a business model that drives cost cutting, including reduction of permanent posts, has normalised the situation and become increasingly exploitative. Others have also highlighted the growing corporatisation of universities, and that senior leadership now often do not fully recognise what it takes to do research or the contributions of their fixed term staff (Bone, 2021).

Normalisation has worsened career development prospects, increased workloads, insecurity and stress and in many cases financial hardship, and fostered further inequities for Māori and Pasifika and female staff who are more likely to have career breaks for family. Māori and Pasifika are consistently under-represented amongst researchers (McAllister et al., 2020), with little change over time. In 2017, there were only 75 Māori and Pasifika post-doctoral fellows in New Zealand's universities, compared with 575 non-Māori and non-Pasifika post-doctorates (Naepi et al., 2020). Testifying to the continuing relevance of the precarity report has been the lack of engagement by universities and indeed governments in developing functional career pathways for staff through numerous fellowships at all levels (early to later career) and opportunities to transition to permanent positions. This is not simply about establishing a career framework, there must be significant and sustained funding and this is totally lacking.

The consequence of this new normal is that we are failing to attract students into research pathways and fixed term contract staff are losing their jobs, or are now so disaffected by the situation that they are choosing to leave. In New Zealand (personal observation), there is still an excessive dependence on fixed term contract staff to undertake research and to train the next generation for academic and commercial research. Thus, an inability to attract and retain the next generation of talented researchers has significant implications for our nation's capacity to undertake and deliver R&D in the future. Further, we face losing top talent overseas. It is plausible that greater job security, with a formal career structure for scientists would make science much more attractive to wider parts of our community – potentially mitigating the issue of a lack of representation of certain groups within the science community.

Solutions

Invest:

Investing in university science is an economically vital proposition, and delivers the key knowledge necessary to create and use new techniques, technologies, products and of course to better understand ourselves and our world. Additionally, ongoing research fosters the next generation of scientists. The OECD has repeatedly shown us what we need to do. Let us stop consulting and invest properly and consistently. This needs to have cross-political party commitment to ensure a long-term sustained strategy. We should start by at least meeting the OECD average and then grow beyond that. This has to be government expenditure, not the vagaries of tax incentives and a bit of hope. If we do not invest appropriately, we will lose staff, new research opportunities and the potential to sustain critical areas that underpin future directions in science.

There is a strong case for prioritising investigator led grants, rather than defaulting to investment primarily in large scale funded grants such as the New Zealand Science Challenges (funding for which came to an end on the 30th of June 2024 with no replacement announced at the time of writing) and Centres of Research Excellence (CoRES). These grants, while useful for bringing large, complex teams

together, exclude many scientists. We must also be cautious of changing our competitive grant structure in a similar manner to that seen with the National Health and Medical Research Council grants, with a switch to the big science missions led by senior investigators rather than researcher initiated grants. This approach and lack of other investment has seen as significant reduction in funding and has hit emerging researchers hardest (Blakely, 2022; Cox, 2020).

There have been recent commentaries on how to improve New Zealand Science, including the Academy submission to the Science System Advisory Group's phase 1 consultation (Academy Executive Committee, 2024), and individual eminent scientists (Hunter and Paton, 2024). They emphasize the need to grow the investment in science, the importance of working together both as smaller or larger teams depending on the question to be solved, and in particular of growing industry specific connections, perhaps through internships and training in entrepreneurship. As part of this, it will be critical to foster and support innovative startup companies until they can stand on their own feet. New Zealand is small but well connected. We need to build on this, by maintaining and developing international linkages, including through competitive international funding collaborations, such as Horizon Europe, and conversely to support New Zealanders who have developed their skills and linkages overseas to return home. Finally, they emphasize the importance of long-term funding for promising initiatives, and not frustrating progress with 3 yearly funding cycles.

We suggest that a strong framework would recognise the current biomedical and health-related research strength and leadership currently flourishing in New Zealand. New Zealand scientists are well trained and globally well connected, they are making local and international impact and often do more with less money compared to overseas colleagues. It would be unfortunate if funding for this currently successful group of New Zealand researchers were dismantled by reliance on a determined set of priorities that pushes for translation without supporting the foundation.

It has been suggested in some of the many reviews of scientific funding over the last 40 years that research should be limited to prioritised areas (https://scientists.org.nz/Reshaping/13350462). The concept that prioritising research in particular areas will generate improved outcomes is intuitively attractive, but perhaps surprisingly to many, there is no empirical evidence that this is the case. In fact, the opposite appears to be true. The Harvard Gazette recently commented on a new study showing that scientific research driven by curiosity is "the best route to the generation of powerful new medicines" (Bergman, 2018).

Career support strategy:

Funding research as a whole is only part of the issue. Science is about people: the scientists who create the ideas and through whose knowledge, experience and capacity to innovate to deliver scientific results. We invest a huge amount of time and money training students and supporting fellows in developing research skills. It is entirely unsatisfactory that we have not yet established a system which recognises science as a career and puts in place expectations of performance and mechanisms to support that performance in terms of salary. Rather, we expect the majority of scientific workforce within universities to continue to pay themselves despite the lack of fellowships, research project grant funding success rates well below sustainable critical thresholds (the Marsden Fund success rate is below 10% for example), research funding that is capped and which has not kept up with inflation – and all of this in a major cost of living crisis. This system has failed.

The key issues for research career development are that across the board there are too few research fellowships and no coherent strategies for how to transition successful junior scientists from contracts into more permanent roles. Investment is needed to provide more fellowships, that are appropriately funded (and inflation indexed). There are well established examples of junior-to-senior fellowship systems overseas. For example, the Australian approach has been to offer a structured series of fellowships at early, mid and senior career stages, with the largest number of grants available at the most junior levels, with progressively harder criteria at each stage. Fellowships are still highly competitive and peer reviewed. Salary support can still be obtained through project grants of course, but there is an expectation that the lead researchers will hold a fellowship. The same distinction between a fellowship that provides primarily personal support and a research contract that provides working expenses combined with defined fractional support for specific personnel is the same in both countries. The major difference is that there are very few fellowships, and so contract researchers in New Zealand are much more dependent on specific research contracts. As well, New Zealand academics with permanent contracts are expected to buy out part of their time in order to undertake research. This is seen by some as paying for time that the host institution is already paying for. However, importantly it directly incentivises the institution to support research, and puts contract researchers on a much more equal footing with permanent staff.

Funding is needed to provide sufficient fellowships at all levels and this includes senior positions. There are an increasing number of senior staff on fixed term contracts, including those whose performance is good enough to be promoted to associate professor. Without a cohesive career track strategy for fixed-term researchers, these clearly excellent staff are in a very vulnerable position as senior staff on higher salaries on fixed-term grants in particular struggle to reliably get sufficient grants to fund their salary.

Many researchers will not stay in academia for a variety of reasons. Of course, some are not suited to the field, but lack of career support remains a major issue even for the most effective researchers. The authors, who represent New Zealand's two biggest universities, can personally attest that the brain drain is already underway: a significant risk to our future R&D capacity. Development of a national career structure framework can help address this. Further, we need a funding mechanism to support the transition

of talented staff from fellowships or grants to permanent university or CRI contracts. The number of permanent academic positions in our universities is low and in some cases falling, because they are directly linked to teaching, which is considered to be relatively stable. With current moves to more on-line content and reducing or abolishing practical laboratory teaching, the number of permanent academic staff tertiary institutions are willing to support is threatened further if research is not valued by decision makers. While the Crown research institutes do have permanent research positions, in practice they also have essentially static internal and external funding (Science New Zealand, 2023). The external funding bodies including the Marsden Fund and the HRC, support short term funding (research contracts plus a few fellowships), which is essential for career development, but intrinsically cannot support careers in the long term.

Equally, not everyone will be or wants to be the high flyer who runs their own team, but their technical expertise is often part of the critical mass required to deliver impactful science. Funding is needed from government to the universities and funding agencies to ensure all of this. It cannot be left to universities or funders to either slice the existing significantly underfunded pie further or, worse still, ignore the issue.

There is also the opportunity to grow academic contract opportunities by addressing the rise of managerialism within our universities and the growing imbalance in the non-academic to academic staff ratio (Hill et al., 2023). A recent review of the issue in New Zealand universities, based on Ministry of Education statistics, has shown that there has been a steady increase in non-academic staff over the past few decades, with the growth driven by management positions, with a reduction in technical staff (Kierstead and Johnston, 2023). In 2021, New Zealand universities had a ratio of 1.5 non-academics employed for every 1.0 academic, that is to say 59% of all university staff are non-academics.

While there has been growth in student numbers and the need to ensure compliance with regulations requiring some degree of increased management numbers, this growth far outstrips the growth of academic positions, i.e. employment of staff who are key to generation of university income. A significant change in this ratio would create income to employ more academic staff to grow and sustain research excellence and discipline rich teaching and mentoring, and professional technical and teaching staff to support these endeavours.

Many academics would argue that despite the significant growth in non-academic managers they remain burdened by ever increasing time-consuming administration, which is mired in layers of management and cumbersome online processes that reduce the ability to deliver core teaching and research in a timely manner (Kierstead and Johnston, 2023). As part of this, academics often feel they are side-lined in processes that set the institutional strategies for their work. Thus, it is well past time to re-establish the role of university academics as leaders of core business. A financially transparent review is needed to optimise non-academic staff levels to ensure support for effective delivery of core academic business. In this manner we can free up budgets to pay those who are tasked with delivery of that business and ensure the finances to retain and transition of fixed-term contract staff into permanent roles.

Save New Zealand Science

In the mid-1980's, the research funding situation in the UK was so dire with lack of adequate investment and increasingly low morale, with scientists both junior and senior leaving or considering doing so. The then Thatcher government had significantly reduced funding to the point that the science community had come to the realisation that they could not hope to be competitive to meet future challenges with the status quo in funding. Normally taciturn scientists mobilised. Researchers from Oxford University came together and started the advocacy group Save British Science (now CaSE), and were readily joined by many others to address the issue (CaSE, 1995). NZ is now in the same situation. Save New Zealand Science has now been launched to advocate for all of the points we raised above (Save Science Coalition, 2024), and previously (Bennet et al., 2005). Given the substantial proposed science budget cut in the 2024 New Zealand budget for four major research funds: Health, Endeavour, Marsden and Strategic Science, advocacy is clearly needed.

In conclusion, in this position paper we strongly argue that that the key to improving both New Zealand's science and economy is greater investment. Aiming for the average OECD investment of 2.7% of GDP must be a minimum; as discussed above the international evidence is that the best outcome for NZ would be to invest significantly more (Deloitte/UNZ, 2018). As part of this, funding should be indexed to inflation to avoid the pattern that each burst of investment is followed by steady erosion over time. Finally, we must not forget that typically it takes 15-20 years for a discovery to evolve from concept to starting translation. In this context, three yearly funding cycles are unrealistically short. Ideally, funding science and technology should be part of a longitudinal support platform. A well balanced investment strategy will support research from blue skies discovery research, refinement of findings, to practical testing and final translation to everyday life over decades.

References

Academy Executive Committee (2024), 'Academy submission to the Science System Advisory Group's phase 1 consultation'. Accessed September 2024. https://www.royalsociety.org.nz/who-we-are/our-people/our-fellows/academy/academy-responses/academy-submission-to-the-science-system-advisory-groups-phase-1-consultation/

Aung, H. L., Bolton, A., Lim, K., McFarlane, K., Matthews, B., Davis, S., Naepi, S., and Moss, S. (2022), 'Integrated Research Sector: Future Pathways for Emerging Researchers. Early Career Researcher (ECR) Forum of the Royal Society Te Apārangi'. https://www.royalsociety.org.nz/early-career-researche

r-forum/ecr-resources/integrated-research-sector-future-pathways-for-emerging-researchers/

Australian Government (2023), '2023. Total business expenditure on R&D'. Accessed July 2024. https://www.industry.gov.au/publications/science-research-and-innovation-sri-budget-tables-2023-24/science-and-research-data

Bennet, L., Nicholson, L. and Gunn, A. (2005), 'Contract academic staff career development: An oxymoron?', *New Zealand Science Review* **62**(3), 62–68. https://doi.org/10.26686/nzsr.v62.8910

Bergman, M. T. (2018), 'For new medicines, turn to pioneers. Most transformative medicines originate in curiosity-driven science, evidence says', *The Harvard Gazette* .

Blakely, T. (2022), 'More money and smarter choices: how to fix Australia's broken NHMRC medical research funding system'. Accessed July 2024. https://theconversation.com/more-money-and-smarter-choices-how-to-fix-australias-broken-nhmrc-medical-research-funding-system-188003

Bone, K. D. (2021), 'Cruel Optimism and Precarious Employment: The Crisis Ordinariness of Academic Work', *Journal of Business Ethics* **174**(2), 275–290. https://doi.org/10.1007/s10551-020-04605-2

Caulfield, T. and Ogbogu, U. (2015), 'The commercialization of university-based research: Balancing risks and benefits', *BMC Medical Ethics* **16**(1), 70. https://doi.org/10.1186/s12910-015-0064-2

Cox, D. (2020), 'Emerging researchers face uphill struggle at NHMRC'. Accessed July 2024. https://www.researchprofessionalnews.com/rr-funding-insight-2020-9-emerging-researchers-face-uphill-struggle-at-nhmrc/

Deloitte Access Economics for Universities New Zealand (2018), 'Economic impact of universities' contribution to innovation'. Accessed August 2024. https://www.universitiesnz.ac.nz/sites/default/files/Deloitte%20Access%20Economics%20Final%20Report.pdf

Hill, P., Aitken, R., Anderson, G., Brown, C., Campbell, R., Cook, G., Conner, T., Crampton, P., Edwards, R., Ellis, L., Eyers, D., Frauendiener, J., Gearry, R., Grattan, D., Green, S., Hales, S., Hancox, B., Hodge, K., Jackson, R., Knowles, S., Jaye, C., Kawharu, M., Kettle, T., Krause, K., Lyons, K., Mann, J., Matisoo-Smith, L., McBride, D., McCane, B., McCarthy, A., Patman, R., Parkin, L., Reese, E., Regenbrecht, H., Reynolds, J., Robins, A., Russell, B., Schultz, M., Smith, A., Spronken-Smith, R., Summerhayes, G., Taylor, B., Taylor, R., Trebilco, P., Turner, R., Tucker, H., Voci, P., Walker, R., Walter, R., Whalley, G. and White, J. (2023), 'The perils to our universities from the rise of managerialism', *The Post* . https://www.thepost.co.nz/nz-news/350097483/perils-our-universities-rise-managerialism

Hunter, P. and Paton, J. F. (2024), 'A new model for science funding', *Newsroom* . https://newsroom.co.nz/2024/05/29/a-new-model-for-science-funding/

Kierstead, J. and Johnston, M. (2023), 'Blessing or Bloat? Non-academic staffing in New Zealand universities in comparative perspective'. Accessed September 2024. https://www.nzinitiative.org.nz/assets/Report-summary_Blessing-or-Bloat.pdf

Kwok, R. (2017), 'Flexible working: Science in the gig economy', *Nature* **550**(7676), 419–421. https://doi.org/10.1038/nj7676-419a

McAllister, T. G., Naepi, S., Wilson, E., Hikuroa, D. and Walker, L. A. (2020), 'Under-represented and overlooked: Māori and Pasifika scientists in Aotearoa New Zealand's universities and crown-research institutes', *Journal of the Royal Society of New Zealand* **52**(1), 38–53. https://doi.org/10.1080/03036758.2020.1796103

Ministry of Business, Innovation, and Employment (2022), 'Te Ara Paerangi Future Pathways White Paper'. https://www.mbie.govt.nz/science-and-technology/science-and-innovation/agencies-policies-and-budget-initiatives/te-ara-paerangi-future-pathways/te-ara-paerangi-future-pathways-white-paper/white-paper/

Naepi, S., McAllister, T. G., Thomsen, P., Leenen-Young, M., Walker, L. A., McAllister, A. L., Theodore, R., Kidman, J. and Suaaliia, T. (2020), 'The Pakaru 'Pipeline': Māori and Pasifika Pathways within the Academy', *New Zealand Annual Review of Education* **24**, 142–159. https://doi.org/10.26686/wgtn.12592181.v1

New Zealand Government (2024), 'Boosting R&D to transform the NZ economy'. Accessed July 2024. https://www.rdti.govt.nz/how-does-the-rdti-work/

OECD (2018), 'Gross domestic spending on R&D'. https://doi.org/https://doi.org/10.1787/d8b068b4-en

Pomeroy-Carter, C. A., Williams, S. R., Han, X., Elwood, W. N. and Zuckerman, B. L. (2018), 'Evaluation of a mid-career investigator career development award: Assessing the ability of OppNet K18 awardees to obtain NIH follow-on research funding', *PLOS ONE* **13**(2), 1–13. https://doi.org/10.1371/journal.pone.0192543

Save Science Coalition (2024), 'Science Under Threat'. Accessed September 2024. https://scientists.org.nz/Save-Science-Coalition

Science New Zealand (2023), 'Crown Research Institutes'. Accessed September 2024. https://sciencenewzealand.org/about/crown-owned-research-organisations

Simpson, A. B., Joliffe Simpson, A. D., Soar, M., Oldfield, L. D., Roy, R. and Salter, L. A. (2022), 'The Elephant in the Room: Precarious Work in New Zealand Universities'. https://doi.org/10.17608/k6.auckland.19243626.v2

Stamp, L. K., Cameron, V. A., Woodfield, T. B. F., Walker, L., Currie, M., Templeton, E., Pilbrow, A. P., Tabakakis, K., Phillips, E. and Lim, K. S. (2021), 'Impact of COVID-19 on health research in New Zealand: a case study of a research-intensive campus', *Journal of the Royal Society of New Zealand* **51**(sup1), S75–S85. https://doi.org/10.1080/03036758.2020.1867202

Stats NZ (2024), 'Research and development survey: 2023'. Accessed July 2024. https://www.stats.govt.nz/information-releases/research-and-development-survey-2023

The Campaign for Science and Engineering (1995), 'Campaign for Science and Engineering'. https://www.sciencecampaign.org.uk/

Woetzel, L., Madgavkar, A., Seong, J., Manyika, J., Sneader, K., Tonby, O., Cadena, A., Gupta, R., Leke, A., Kim, H. and Gupta, S. (2018), 'Outperformers: High-growth emerging economies and the companies that propel them. McKinsey Global Institute'. https://www.mckinsey.com/featured-insights/innovation-and-growth/Outperformers-high-growth-emerging-economies-and-the-companies-that-propel-them