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LINCOLN UNIVERSITY



# Wellbeing and Knowledge

Paul Dalziel

Treasury Guest Lecture  
The Treasury, Wellington.

12 November 2019

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**Suggested citation for this publication**

Dalziel, Paul (2019). 'Wellbeing and Knowledge.' Treasury Guest Lecture, The Treasury, Wellington, 12 November, available at <https://www.sustainablewellbeing.nz/wellbeing-book>.



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## Acknowledgements

The ideas presented in this lecture draw on collaborations over the last two decades with colleagues in the Agribusiness and Economics Research Unit at Lincoln University as part of its mission to exercise leadership in research for sustainable wellbeing. I particularly thank Caroline Saunders, Peter Tait, Anita Wreford, John Saunders, Meike Guenther, Tim Driver, Paul Rutherford, Jay Whitehead, Simon Duff, Tiffany McIntyre and Teresa Cunningham. Caroline Saunders and Simon Duff provided very helpful feedback on an early draft.

I thank Joe Saunders (Durham University), who was a co-author of *Wellbeing Economics: The Capabilities Approach to Prosperity* (London: Palgrave Macmillan, 2018). I also thank Arthur Grimes (School of Government, Victoria University of Wellington), who provided extensive and insightful feedback on first drafts of chapters for that book.

This lecture presents material prepared while a Visiting Fellow at Hannan University, Osaka, Japan. I thank Kunihiro Kajiyama and Hiroaki Aoki for their generous hospitality to make that time possible. I also thank the Our Land and Water National Science Challenge and the MBIE Endeavour Fund for financial support of AERU research mentioned in the lecture.

I thank Treasury economists for illuminating conversations about wellbeing and the Living Standards Framework, including Hilary Blake, Tony Burton, Kristie Carter, Diana Cook, Margaret Galt, John Janssen, Girol Karacaoglu, Anita King, Suzy Morrissey, Tim Ng and Jez Tavita.

## Abstract

Knowledge has always been a powerful driver of human wellbeing. Economists since Adam Smith have created models to understand living standards growth. Solow's neoclassical model was a great advance. Romer's endogenous growth model extended Solow's work to show that knowledge is the foundation of all living standards growth. Hence, a living standards framework at the frontier of economic theory must address the creation and utilisation of knowledge. This lecture expands on Romer's insights. It presents the AERU wellbeing economics and public policy framework to analyse distinctive roles of public policy in the development and utilisation of knowledge.

## Wellbeing and Knowledge

Paul Dalziel

E ngā tāne, e ngā wāhine, e tau nei, tēnā koutou katoa.  
Ka tino nui tāku mihi o aroha ki a koutou i tēnei ra.  
Kei te mihi ahau ki ngā taonga katoa o Te Atiawa,  
tangata whenua o tēnei rohe.  
Kei te mihi ahau ki te mātauranga o ngā iwi me te mohio  
o ngā tāngata katoa o Aotearoa New Zealand.  
Nā tō rourou, nā taku rourou, ka ora ai te iwi.  
Tēnā koutou. Tēnā koutou. Kia ora tātou katoa.

### Introduction

More than 200,000 years ago, one of nature's species began to develop an advanced capacity to create language and engage in symbolic thought.<sup>1</sup> Reflecting on that capacity, the species named itself *Homo sapiens*, the human who is “wise” or “knowing”.<sup>2</sup> Throughout our history, knowledge has been a powerful driver of human wellbeing. Public policy has a distinctive role in its development and use. These are the topics of my lecture.

### Using knowledge to transform nature

For tens of thousands of years, *Homo sapiens* lived in hunter-gatherer societies. Our earliest ancestors learned to develop tools and weapons, and how to sustain complex social networks. Population growth led to human dispersion from our origins in Africa to reach Australia more than 65,000 years ago.<sup>3</sup>

About 11,500 years ago, *Homo sapiens* discovered agriculture, slowly learning to manage selected areas of nature for domesticated crops and animals.<sup>4</sup> This Neolithic Revolution saw humans discover new technologies, and develop new forms of social organisation, to transform nature for our own purposes.

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<sup>1</sup> Darwin (1871, chapter 3); White (1940); Wilson *et al.* (2014).

<sup>2</sup> Linnaeus (1758); Spamer (1999, p. 112).

<sup>3</sup> Bae *et al.* (2017); Clarkson *et al.* (2017).

<sup>4</sup> Price and Bar-Yosef (2011); Weisdorf (2005).

Creating knowledge to increase agricultural productivity has proceeded for thousands of years. It was only in 1865, for example, that Mendel published results of his hybridisation experiments to establish genetics, and it took another ninety years before the development of modern crop varieties in the 1950s launched the Green Revolution.<sup>5</sup>

Discovering and implementing new agriculture knowledge continues. The recent IPCC report on *Climate Change and Land* states with high confidence that “actions can be taken in the near-term, *based on existing knowledge*, to address desertification, land degradation and food security while supporting longer-term responses that enable adaptation and mitigation to climate change”.<sup>6</sup>

As observed by scientists advising the United Nations on the Sustainable Development Goals, ‘knowledge-based transformations’ in the production and distribution of food are as important as ever.<sup>7</sup>

The discovery of agriculture supported population growth, but living standards remained at subsistence for reasons explained by Malthus.<sup>8</sup> This began to change only with the first industrial revolution in the late eighteenth century. Many factors contributed, but a key event introducing the industrial age was the commercialisation of the steam engine by Matthew Boulton and James Watt in 1776.<sup>9</sup>

The steam engine is an example of ‘physical capital’; that is, it is a produced, durable, tangible asset capable of increasing the productivity of human work. Economists treat physical capital as conceptually separate from the natural environment, but all physical capital is material. Hence, creation of physical capital involves using human knowledge to transform elements of nature for human purposes.

Growth in knowledge and physical capital is not always used for benign purposes. *Homo sapiens* in the twentieth century developed scientific knowledge and industrial facilities to harness nature for nuclear weapons.<sup>10</sup> In August 1945, humans used atomic bombs to kill tens of thousands of people in Hiroshima and Nagasaki. *Homo sapiens* has demonstrated a unique capability to use knowledge and capital to destroy large numbers of its own species.

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<sup>5</sup> Dunn (2003); Evenson and Gollin (2003).

<sup>6</sup> IPCC (2019, p. 38, emphasis added).

<sup>7</sup> IGS (2019, pp. 21-24).

<sup>8</sup> Malthus (1798); see Taylor and Dalziel (2002, Figure 9.3, p. 197).

<sup>9</sup> Hansen and Prescott (2002); Roll (1930, pp. 28-29).

<sup>10</sup> Kelly (2007).

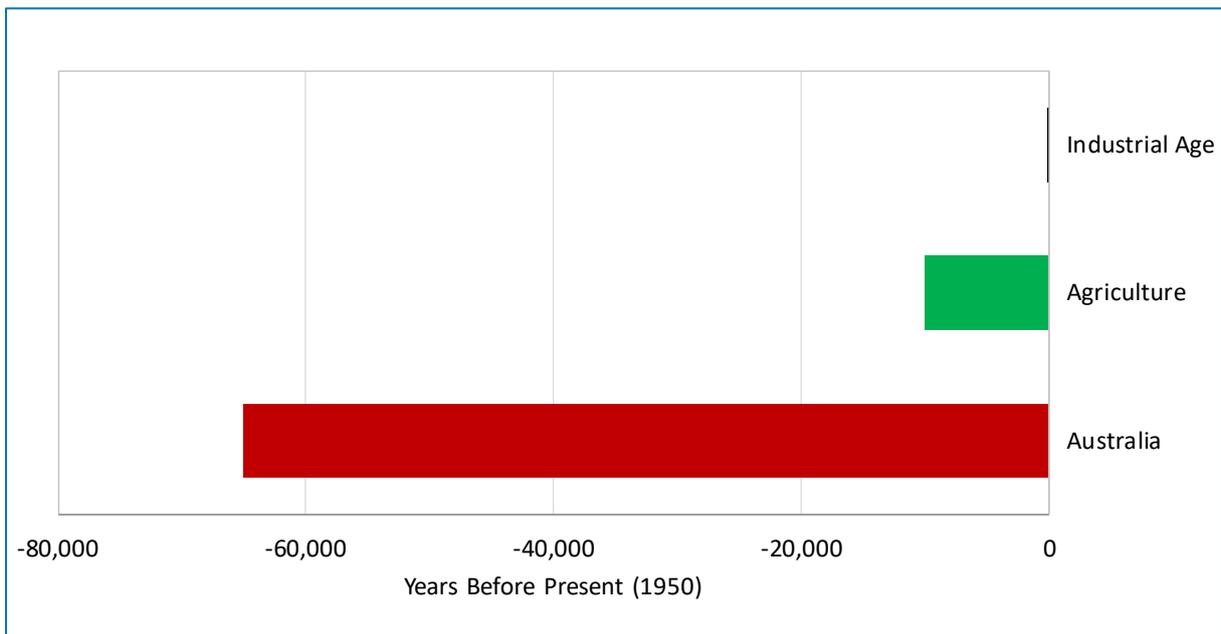
Self-awareness of this destructive capability is important because *Homo sapiens* now knows its industrial activities are producing greenhouse gas emissions on an unprecedented scale affecting the global climate:

Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years.<sup>11</sup>

The human skill of transforming nature into physical capital has reached the point where the human use of physical capital is now transforming nature. This has led some scientists to argue that we have entered a new Anthropocene epoch.<sup>12</sup>

This should not surprise us. It took millennia to discover important knowledge for agricultural productivity, and on that scale the industrial age is very young (Figure 1). *Homo sapiens* is just at the start of developing the required knowledge for transforming nature into physical capital without adverse consequences for wellbeing.

**Figure 1: Number of years since *Homo sapiens*: (1) reached Australia; (2) began agriculture; and (3) began the industrial age**



<sup>11</sup> IPCC (2015, p. 4).

<sup>12</sup> Waters *et al.* (2016).

## The Neoclassical Growth Model

Consistent with its advanced capacity for symbolic thought, *Homo sapiens* has created models for understanding living standards growth. This is the work of economists. Recall that a key event in the first industrial revolution was the commercialisation of the steam engine in 1776. Adam Smith published the founding text of modern economics in the same year. The economics discipline is as old as the industrial age, which is no coincidence.

Smith's project was *An Inquiry into the Nature and Causes of the Wealth of Nations*. During the agricultural age, a nation's wealth depended on the size and productivity of the *land* it controlled. Smith revealed how that changed in the industrial age. Wealth depends more on the productivity of the nation's *labour*, which increases greatly with access to *physical capital*. Investment in physical capital breaks the Malthusian curse, and living standards can rise.

Smith demonstrated the importance of the market economy for productivity, and hence for the wealth of nations. I do not need to repeat Smith's analysis for this audience, but simply cite John McMillan's conclusion:

In fact, markets are the most effective means we have of improving people's well-being. For poor countries they offer the most reliable path away from poverty. For affluent countries, they are part of what is needed to sustain their living standards.<sup>13</sup>

Jumping forward 180 years, Robert Solow in 1956 published one of "the most influential and revered articles in economic theory".<sup>14</sup> It introduced the neoclassical growth model. Let output, divided between items for consumption and items for investment in new physical capital, be a constant-returns-to-scale function of labour, physical capital and the state of technological progress. Solow's model demonstrated that the aggregate capital stock stabilises at a fixed ratio to the economy's quantity of labour.

It is a truly remarkable result. Regardless of the output share devoted to investment, sometimes called the saving rate, the capital stock ends up growing at the same rate as the population. A permanent increase in the investment share, *ceteris paribus*, has no permanent impact on economic growth beyond a one-off jump in the *level* of per capita output.

Solow's insight is on a par with Smith's analysis that land is but a small aspect of the wealth of nations. Solow demonstrated that the contribution of physical capital also has limits. Only technological progress (recognising this is embodied in new capital investment<sup>15</sup>) can drive growth in per capita living standards.

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<sup>13</sup> McMillan (2002, p. 13).

<sup>14</sup> McAdam and Allsopp (2007, p. 1). Trevor Swan (1956) independently developed the same theory.

<sup>15</sup> Solow (1962).

## Endogenous Growth and Knowledge Capital

In 2018, the Nobel Prize in Economics<sup>16</sup> honoured William Nordhaus and Paul Romer for building on Solow's model in two dimensions. Nordhaus integrated climate change into the analysis, while Romer advanced understanding of how technological innovations drive growth. I will concentrate on the latter, since endogenous growth theory lies at the current frontier of economic analysis of living standards growth.

Knowledge is at the heart of Romer's endogenous growth theory. As a Treasury perspectives paper on this topic has similarly observed, knowledge in this context is not the knowledge and skills embodied in persons as part of their human capital. Knowledge in this context means the accumulating global stock of ideas resulting from technological and intellectual discoveries by humans.<sup>17</sup>

Following a seminal paper in this field by Kenneth Arrow and colleagues, we can refer to this stock of ideas as 'knowledge capital'.<sup>18</sup>

Romer conceptualises technological progress as growth in the stock of knowledge or ideas, produced by workers specialising in research and development. These knowledge workers cannot simultaneously participate in the production of consumption goods; hence there is a trade-off within the model that allows an equilibrium to be determined.

Romer further assumes the discovery of *new* knowledge is proportional to the amount of *existing* knowledge. Knowledge builds on knowledge; or, as Newton famously wrote, "If I have seen further it is by standing on the shoulders of Giants."<sup>19</sup>

Romer thought initially that the rate of knowledge growth depends simply on the absolute number of knowledge workers. This led to an implausible implication that economic growth increases with more of these workers.<sup>20</sup> A second generation of models proposes instead that the effectiveness of research effort diminishes with scale.<sup>21</sup> Under this assumption, the rate of economic growth is related to the *proportion* of knowledge workers in the labour force.

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<sup>16</sup> Strictly, the award is the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel.

<sup>17</sup> Blakeley *et al.* (2005, p. 7).

<sup>18</sup> Arrow *et al.* (2012, p. 321).

<sup>19</sup> Newton (1675, p. 1).

<sup>20</sup> Jones (1995).

<sup>21</sup> See Romer (1986, 1990). Key publications introducing the second generation of models include Young (1998), Howitt (1999), Ha and Howitt (2007) and Ang and Madsen (2011). Jones and Vollrath (2013) is a good textbook.

There is nothing mysterious about how knowledge drives living standards growth in a way that capital cannot. Using the language of economists, knowledge is non-rival in consumption; that is, if I know something and share it with you, I retain access to that knowledge. This means knowledge can sustain increasing returns in production, which is the essential condition for growth.<sup>22</sup> Charles Jones is wonderfully clear on this point, making the following comment:

Throughout history – 25 years, 100 years, or even 1,000 years – the world is characterized by substantial growth, both in the total stock of ideas and in the number of people making them. Because ideas are nonrival, this is all that is required for *sustained growth in living standards*.<sup>23</sup>

Nordhaus might not agree “this is *all* that is required”, since we must also consider planetary boundaries when judging sustainability. Nevertheless, there is an important lesson in the italicised phrase, which is the major point of this lecture.

**A living standards framework at the frontier of economic theory *must* address the creation and utilisation of knowledge.**

## Knowledge Capital and Human Actions

Figure 2 presents a framework developed by the Agribusiness and Economics Research Unit (AERU) that has this property of making knowledge capital visible for policy advice.<sup>24</sup> The AERU framework builds on the Treasury’s Living Standards Framework (LSF). It places current wellbeing at the top of the diagram, for example, using the same twelve wellbeing domains defined in the LSF.<sup>25</sup> It also places capital stocks at the bottom of the diagram. This includes ‘the four capitals’ core to the LSF, but adds three more: *cultural capital*; *diplomatic capital*; and *knowledge capital*.<sup>26</sup>

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<sup>22</sup> Recall that a key assumption in Solow’s neoclassical growth model is that the production function has *constant* returns to scale.

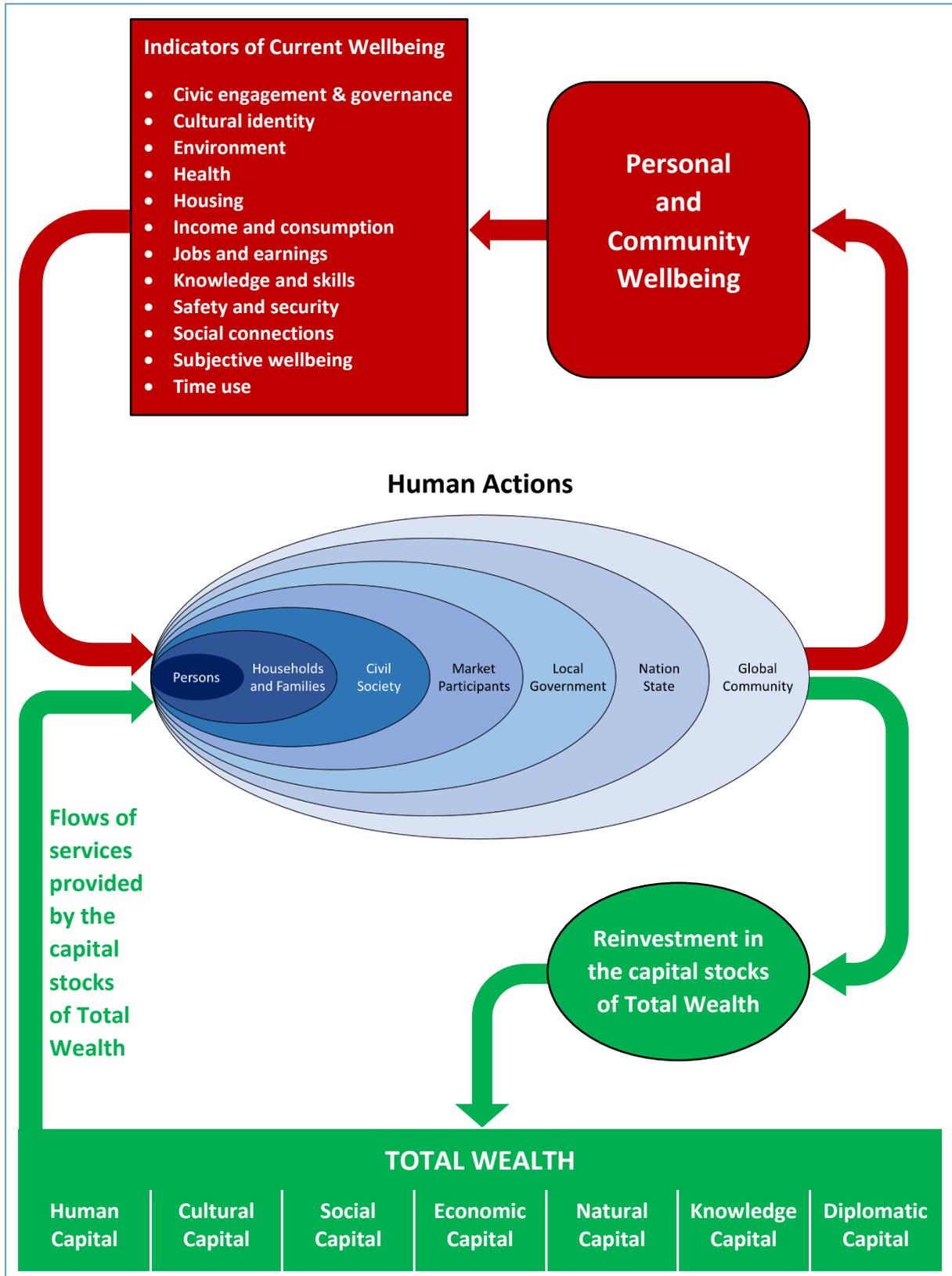
<sup>23</sup> Jones (2019, p. 861, emphasis added).

<sup>24</sup> Dalziel, Saunders and Saunders (2018); Dalziel (2019).

<sup>25</sup> Treasury (2018).

<sup>26</sup> The Treasury is aware, of course, that ideas behind these concepts are important. Frieling (2018, p. 1) observes, for example, that “a fifth type of capital, cultural capital, can be seen as an integral part of all four capitals”; see also Dalziel, Saunders and Savage (2019). Ormsby (2018, p. 8) explains that “while the Treasury has always appreciated the importance of other countries for our wellbeing, and governments make international commitments, the LSF itself is designed specifically for New Zealand”; hence the LSF does not include an item comparable to diplomatic capital. Janssen (2018) discusses how ‘knowledge-based capital’ might fit in the LSF, proposing that relevant measures currently in New Zealand’s system of national accounts could be added.

**Figure 2: The AERU Framework for Wellbeing Economics and Public Policy**



Source: Dalziel (2019, p. 480), drawing on Dalziel, Saunders and Saunders (2018) and Treasury (2018).

The AERU framework extends the LSF by inserting a set of ovals representing seven levels of human actions. This begins with persons making individual choices, always in relation to others,<sup>27</sup> but many human actions require wider collaborations. Thus, we observe persons form households and families. People engage in movements and institutions of civil society. People participate in the market economy. Actions by local government and the nation state can expand capabilities for wellbeing. Some initiatives require global collaborations.

This extension of the LSF has four purposes. First, it incorporates human agency. Wellbeing is not a gift of public policy, or even of the capital stocks, but is the result of human actions.

Second, it recognises the dynamism of the system, reflected in the arrows of Figure 2. The stocks provide services that people use to create wellbeing. The wellbeing can be monitored by statistical indicators defined across wellbeing domains. A higher level of wellbeing feeds back into expanded capabilities for human actions. These actions must include reinvestment in the capital stocks if future generations are to sustain and expand their own wellbeing.

The third purpose is to encourage analysis of differences in the abilities of people to access the flows of services from the capitals. The LSF pays attention to distribution across the 12 domains of current wellbeing. This is a useful monitoring tool. Public policy, however, aims to expand capabilities for future wellbeing, and future wellbeing depends on the capitals. Hence, analysts need to pay close attention to the distribution of access to services derived from the country's total wealth.

The fourth purpose of the ovals is to invite the question: What *distinctive* contributions can the nation state make in the range of human actions that sustain and expand wellbeing? The nation state should not do what persons, households, families and civil society can do for themselves. Nor should it crowd out activities better undertaken by market enterprise.

Indeed, note that the AERU framework places market participants at the centre of analysis. This reflects our research on how New Zealand's land-based sectors can expand prosperity through fostering 'dynamic capabilities', which combines Amartya Sen's capabilities approach with David Teece's capability theory of the firm.<sup>28</sup>

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<sup>27</sup> Mackenzie and Stoljar (2000) call this 'relational autonomy'.

<sup>28</sup> See Saunders (2019, pp. 585-590) and Dalziel (2019, p. 489). Sen (1993) and Sen (1999) are good introductions to the capabilities approach, as is Nussbaum (2011). Teece (2017, 2019) has written two recent surveys of the capability theory of the firm. The dynamic capabilities are "three primary clusters of activities: (1) identification, development, co-development and assessment of technological opportunities in relationship to customer needs (*sensing*); (2) mobilization of resources to address needs and opportunities, and to capture value from doing so (*seizing*); and (3) continued renewal (*transforming*)" (Teece, 2017, p. 698).

## Distinctive Contributions of the Nation State: An Illustration

It is reasonable to hypothesise that the nation state can make distinctive contributions in the governance of knowledge provision, since knowledge generally has the twin characteristics of an economic public good.<sup>29</sup> Knowledge is non-rival in consumption, as explained above. If I tell a person something I know, I retain access to that knowledge. In the absence of intellectual property laws or some other restriction, knowledge is non-excludable. If I observe someone applying knowledge, I cannot be excluded from doing the same.

All agree that public policy can make distinctive contributions in the governance of public goods provision, recognising this is no simple matter and bedevilled with issues of government failure.<sup>30</sup> So let me discuss a topical example to illustrate this general point.

The New Zealand Productivity Commission has documented a persistent gap between labour productivity in New Zealand and average productivity in the top half of the OECD.<sup>31</sup> One of several possible factors identified by the Commission is “a failure of productivity-enhancing technologies to diffuse from firms operating at the global productivity frontier to firms operating at the domestic frontier and then to domestic laggards”.<sup>32</sup>

The Government’s innovation framework calls this an issue of ‘innovation behind the frontier’, which it defines using a knowledge lens: “Innovation behind the frontier is about adopting ways of doing things that are new to an organisation *but are already known to others*”.<sup>33</sup> This elevates our analysis to a second tier: how do economic agents develop *knowledge* about *knowledge*? The policy issue then becomes: Are there *distinctive contributions* that the nation state can make to foster behind-the-frontier innovation by market enterprises?

This is a burning question in our own work at the AERU. The AERU is part of the public sector, created by a decision of Cabinet in 1962 and hosted at Lincoln University.<sup>34</sup> Universities are a key strategic asset in a country’s knowledge-based policies.<sup>35</sup> As an example of the distinctive contribution of knowledge public policies, how can the knowledge that the AERU discovers (and the global knowledge at our fingertips) be made easily accessible to New Zealand enterprises?

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<sup>29</sup> Recognising exceptions to this general observation, Romer (1990, section II) refers to knowledge as “a partially excludable good”, while Stiglitz (1999, p. 310) refers to it as “an impure public good”.

<sup>30</sup> Batina and Ichori (2005, p. 1); Buchanan (1968).

<sup>31</sup> Conway (2016); Nolan *et al.* (2019).

<sup>32</sup> Conway (2018, p. 43), drawing on OECD (2015).

<sup>33</sup> New Zealand Government (2019, p. 28, emphasis added).

<sup>34</sup> Driver and Dalziel (2012).

<sup>35</sup> Dalziel, Saunders and Guenther (2020).

The AERU publishes in academic journals, puts reports on our website and distributes research updates. We maintain an on-line data portal, we invite end-users to co-design our research, we present at industry events, we participate in the Go Global Expo and write blogs, we give media interviews, we serve on national and international committees and we published *Wellbeing Economics* with an open access licence. Initiatives such as these help, but the AERU Advisory Board and the Our Land and Water National Science Challenge are asking us to think still more creatively about how to make it easier for enterprises to access AERU knowledge.

This requires looking at the question from the firm's perspective. Finding relevant and reliable knowledge among the global set of knowledge claims is difficult and costly. *Ex ante*, it may not be obvious which firms will define the knowledge frontier, even if this is easily seen *ex post*. It may not be easy for an outsider to judge what particular knowledge is the driver of a firm's success; nor may that particular knowledge be readily applied in different settings.

Further, the discovery of knowledge about relevant and reliable knowledge is a non-rival and non-excludable event; that is, it is an economic public good. Consequently, competitive firms underinvest in this discovery process, for rational reasons. This returns us to the key policy question: Can well-designed public policy make it easier for firms?

The equation below summarises the hypothesis: Given the global stock of knowledge capital,  $K$ , knowledge available to a firm,  $K_j$ , depends not only on the firm's capability to absorb knowledge,  $A_j$ , but also on the effectiveness of the nation state's knowledge policies,  $K_p$ .

$$K_j = F(A_j, K_p; K)$$

Where:  $K_j$  is a measure of the knowledge used by firm  $j$ .  
 $A_j$  is a measure of the absorptive capability of firm  $j$ .  
 $K_p$  is a measure of the effectiveness of knowledge public policy.  
 $K$  is a measure of the global stock of knowledge capital.

This rests on two claims: (1) knowledge about knowledge has the twin characteristics of a public good; and (2) public policy has the potential to make distinctive contributions to the governance of public goods provision. Thus, it is right for policy to pay attention to the addition of new knowledge to the global stock and to improving absorptive capacities of firms. We must not overlook, however, the effectiveness of public policies designed to make it easier for firms to access relevant and reliable knowledge.<sup>36</sup>

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<sup>36</sup> There are economic theories that highlight access to knowledge as an important consideration. Examples in regional economics include competitive advantage (Porter, 1990; Crocombe, Enright and Porter, 1991), new economic geography (Krugman, 1991; McCann, 2009) and smart specialisation (McCann and Ortega-Argilés, 2015). Behavioural insights, or nudge theory, is another good example (Thaler and Sunstein, 2008; Halpern, 2015; Kibblewhite, 2016).

## Conclusion

The Wellbeing Budget 2019 has attracted international attention.<sup>37</sup> The development by the Treasury of the Living Standards Framework, from the original pentagon diagram to its current representation, represents a significant achievement.<sup>38</sup> The Treasury recognises its work must continue, and will review the LSF in 2021 as a further milestone in a long-term development process.<sup>39</sup> I conclude with three summary points from this lecture for that review.

First, the central point of this lecture has been **a living standards framework at the frontier of economic theory must address the creation and utilisation of knowledge**. I don't think there can be any controversy about this. Endogenous growth theory is at the frontier of economists' knowledge on living standards growth, and knowledge is at the heart of endogenous growth theory.

Second, I think the living standards framework will benefit from making human agency visible within the framework – in order to focus policy attention on **the distinctive contributions the nation state can make in the range of human actions that sustain and expand wellbeing**. Again I don't think this is controversial. Since 1776, economists have highlighted the ability of the market economy to co-ordinate decentralised decision-making. That feature must be carried over into our new policy frameworks for wellbeing economics.

Third, I think the LSF should include careful attention to the power of the market economy for expanding wellbeing capabilities. I therefore recommend that the Treasury **bring business enterprises within the LSF, perhaps drawing on David Teece's capability theory of the firm**. Effective public policies to help firms access knowledge about knowledge is a key issue.

I began this lecture by observing that knowledge is a powerful driver of human wellbeing. Nevertheless, there are problems. The human skill of transforming nature into physical capital, for example, has reached the point where the human use of physical capital is now transforming nature. This and other challenges to wellbeing mean we need to be more analytical about wellbeing and knowledge in our policy frameworks. My hope is the New Zealand Treasury will lead this work in its Living Standards Framework.

*Kua mutu tāku korero mo tēnei rā.*

*Tēnā koutou. Tēnā koutou.*

*Kia ora tātou katoa.*

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<sup>37</sup> Anderson and Mossialos (2019); Dalziel (2019).

<sup>38</sup> See, for example, Gleisner *et al.* (2011, 2012); Treasury (2015, 2018).

<sup>39</sup> Treasury (2018, p. 14).

## References

- Anderson, M. and E. Mossialos (2019). Beyond gross domestic product for New Zealand's wellbeing budget. *The Lancet: Public Health*, 4(7), pp. e320-e321.
- Ang, J. and J. Madsen (2011). Can second-generation endogenous growth models explain the productivity trends and knowledge production in the Asian miracle economies? *Review of Economics and Statistics*, 93(4), pp. 1360-1373.
- Arrow, K. J., P. Dasgupta, L. H. Goulder, K. J. Mumford and K. Oleson (2012). Sustainability and the measurement of wealth. *Environment and Development Economics*, 17(3), pp. 317-353.
- Bae, C. J., K. Douka and M. D. Petraglia (2017). On the origin of modern humans: Asian perspectives. *Science*, 358, Issue 6368, eaai9067.
- Batina, R. G. and T. Ichori (2005). *Public Goods: Theories and Evidence*. Berlin: Springer-Verlag.
- Blakeley, N., G. Lewis and D. Mills (2005). *The Economics of Knowledge: What Makes Ideas Special for Economic Growth?* New Zealand Treasury Policy Perspectives Paper 05/05. Wellington: The Treasury.
- Buchanan, J. (1968). *The Demand and Supply of Public Goods*. Chicago: Rand McNally.
- Clarkson, C., Z. Jacobs, B. Marwick, R. Fullagar, L. Wallis, M. Smith, R. G. Roberts, E. Hayes, K. Lowe, X. Carah and S. A. Florin (2017). Human occupation of northern Australia by 65,000 years ago. *Nature*, 547, pp. 306-310.
- Conway, P. (2016). *Achieving New Zealand's Productivity Potential*. Research Paper 2016/1. Wellington: New Zealand Productivity Commission.
- Conway, P. (2018). Can the Kiwi fly? Achieving productivity lift off in New Zealand. *International Productivity Monitor*, 34 (Spring), pp. 40-63.
- Crocombe, G. T., M. J. Enright and M. E. Porter (1991). *Upgrading New Zealand's Competitive Advantage*. Auckland: Oxford University Press.
- Dalziel, P. (2019). Wellbeing economics in public policy: A distinctive Australasian contribution? *Economics and Labour Relations Review*, 30(4), pp. 478-497, available at <https://doi.org/10.1177/1035304619879808>.
- Dalziel, P., C. Saunders and M. Guenther (2020). *Lincoln University and Intergenerational Wellbeing*. AERU Research Report commissioned by the Lincoln University Council. Lincoln University: Agribusiness and Economics Research Unit, forthcoming.
- Dalziel, P., C. Saunders and J. Saunders (2018). *Wellbeing Economics: The Capabilities Approach to Prosperity*. London: Palgrave Macmillan.

- Dalziel, P., C. Saunders and C. Savage (2019). *Culture, Wellbeing, and the Living Standards Framework: A Perspective*. Discussion Paper 19/02, prepared for the Ministry of Culture and Heritage and the Treasury. Wellington: The Treasury.
- Darwin, C. (1871). *The Descent of Man*. London: Murray.
- Driver, T. and P. Dalziel (2012). *50 Years of the AERU: A Celebration of the Agribusiness and Economics Research Unit, 1962 – 2012*. Lincoln University: Agribusiness and Economics Research Unit.
- Dunn P. M. (2003). Gregor Mendel, OSA (1822–1884), founder of scientific genetics. *Archives of Disease in Childhood – Fetal and Neonatal Edition*, 88, pp. F537-F539.
- Evenson, R. E. and D. Gollin (2003). Assessing the impact of the Green Revolution, 1960 to 2000. *Science*, 300, Issue 5620, pp. 758-762.
- Frieling, M. (2018). *The Start of a Conversation on the Value of New Zealand’s Social Capital*. New Zealand Treasury Discussion Paper 18/04. Wellington: The Treasury.
- Gleisner, B., M. Llewellyn-Fowler and F. McAlister (2011). *Working Towards Higher Living Standards for New Zealanders*. Treasury Working Paper 11/02. Wellington: The Treasury.
- Gleisner, B., F. McAlister, M. Galt and J. Beaglehole (2012). A living standards approach to public policy making. *New Zealand Economic Papers*, 46(3), pp. 211-238.
- Ha, J. and P. Howitt (2007). Accounting for trends in productivity and R&D: A Schumpeterian critique of semi-endogenous growth theory. *Journal of Money, Credit and Banking*, 39(4), pp. 733-744.
- Halpern, D. (2015). *Inside the Nudge Unit: How Small Changes Can Make a Big Difference*. London: WH Allen.
- Hansen, G. D. and E. C. Prescott (2002). Malthus to Solow. *American Economic Review*, 92(4), pp. 1205-1217.
- Howitt, P. (1999). Steady endogenous growth with population and R&D inputs growing. *Journal of Political Economy*, 107(4), pp. 715-730.
- IGS (2019). *Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development*. Report prepared by Independent Group of Scientists appointed by the Secretary-General. New York: United Nations, New York.
- IPCC (2015). *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva: Intergovernmental Panel on Climate Change.
- IPCC (2019). *Climate Change and Land – Summary for Policymakers*. Geneva: Intergovernmental Panel on Climate Change, accessed 6 October 2019 at <https://www.ipcc.ch/report/srccl/>.

- Janssen, J. (2018). *The Start of a Conversation on the Value of New Zealand's Financial/Physical Capital*. Discussion Paper 18/07. Wellington: The Treasury.
- Jones, C. I. (1995). R & D models of economic growth. *Journal of Political Economy*, 103(4), pp. 759-784.
- Jones, C. I. (2019). Paul Romer: Ideas, nonrivalry, and endogenous growth. *Scandinavian Journal of Economics*, 121(3), pp. 859-883.
- Jones, C. I. and D. Vollrath (2013). *Introduction to Economic Growth*, Third Edition. New York: W. W. Norton.
- Kelly, C. C. (Editor) (2007). *The Manhattan Project: The Birth of the Atomic Bomb in the Words of Its Creators, Eyewitnesses, and Historians*. New York: Black Dog & Leventhal Publishers.
- Kibblewhite, A. (2016). 'People-centred Policy.' Address to the GEN 2016 Annual Conference, Wellington, 6 December. Accessed 2 November 2019 at <https://dpmc.govt.nz/sites/default/files/2017-03/hopp-address-to-gen-conference-6-dec-2016.pdf>.
- Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, 99(3), pp. 483-499.
- Linnaeus, C. (1758). *Systema Naturae*, Tenth Edition. Stockholm: Laurentius Salvius.
- Mackenzie, C. and N. Stoljar (Editors) (2000). *Relational Autonomy: Feminist Perspectives on Autonomy, Agency, and the Social Self*. Oxford: Oxford University Press.
- Malthus, T. (1798). *An Essay on the Principle of Population*. London: J. Johnson.
- McAdam, P. and C. Allsopp (2007). The 50th anniversary of the Solow growth model. *Oxford Review of Economic Policy*, 23(1), pp. 1-2.
- McCann, P. (2009). Economic geography, globalisation and New Zealand's productivity paradox. *New Zealand Economic Papers*, 43(3), pp. 279-314.
- McCann, P. and R. Ortega-Argilés (2015). Smart specialization, regional growth and applications to European Union cohesion policy. *Regional Studies*, 49(8), pp. 1291-1302.
- McMillan, J. (2002). *Reinventing the Bazaar: A Natural History of Markets*. New York: W. W. Norton.
- New Zealand Government (2019). *From the Knowledge Wave to the Digital Age: Mai I Te Ao Mātauranga Ki Te Ao Matihiko Nei – Growing Innovative Industries in New Zealand*. Wellington: Ministry of Business, Innovation and Employment.
- Newton, I. (1675). Letter to Robert Hooke, dated 5 February 1675. Simon Gratz collection, Historical Society of Pennsylvania Digital Library, accessed 6 October 2019 at <https://digitallibrary.hsp.org/index.php/Detail/objects/9792>.
- Nolan, P., R. Pomeroy and G. Zheng (2019). *Productivity by the Numbers: 2019*. Research Paper 2019/2. Wellington: New Zealand Productivity Commission.

- Nussbaum, M. C. (2011). *Creating Capabilities: The Human Development Approach*. Cambridge, MA: Belknap Press.
- OECD (2015). *The Future of Productivity*. Paris: OECD Publishing, accessible at <https://dx.doi.org/10.1787/9789264248533-en>.
- Ormsby, J. (2018). *The Relationship between the Living Standards Framework and the Sustainable Development Goals*. Discussion Paper 18/06. Wellington: The Treasury.
- Porter, M. E. (1990). *The Competitive Advantage of Nations*. New York: The Free Press.
- Price, T. D. and O. Bar-Yosef (2011). The origins of agriculture: New data, new ideas. *Current Anthropology*, 52, pp. S163-S174.
- Roll, E. (1930). *An Early Experiment in Industrial Organisation: Being a History of the Firm of Boulton & Watt, 1775–1805*. Abingdon: Frank Cass and Co.
- Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94(5), pp. 1002-1037.
- Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5, Part 2), pp. S71-S102.
- Saunders, C. (2019). Sustainable agriculture – life beyond subsidies: Lessons from New Zealand. *Journal of Agricultural Economics*, 70(3), pp. 579-594.
- Sen, A. (1993). Capability and well-being. Chapter in M. Nussbaum (Ed), *The Quality of Life*. London: Routledge, pp. 30-53.
- Sen, A. (1999). *Development as Freedom*. Oxford: Oxford University Press.
- Smith, A. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: W. Strahan and T. Cadell.
- Solow, R. M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics*, 70(1), pp. 65-94.
- Solow, R. M. (1962). Technical progress, capital formation, and economic growth. *American Economic Review*, 52(2), pp. 76-86.
- Spamer, E. E. (1999). Know thyself: Responsible science and the lectotype of *Homo sapiens* Linnaeus, 1758. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 149, pp. 109-114.
- Stiglitz, J. E. (1999). Knowledge as a global public good. Chapter in I. Kaul, I. Grunberg and M. Stern (Eds), *Global Public Goods: International Cooperation in the 21st Century*. Oxford: Oxford University Press, pp. 308-326.
- Swan, T. W. (1956). Economic growth and capital accumulation. *Economic Record*, 32(2), pp. 334-361.
- Taylor, J. and P. Dalziel (2002). *Macroeconomics: New Zealand Edition*. Milton: John Wiley.

- Teece, D. J. (2017). Towards a capability theory of (innovating) firms: Implications for management and policy. *Cambridge Journal of Economics*, 41(3), pp. 693-720.
- Teece, D. J. (2019). A capability theory of the firm: An economics and (strategic) management perspective. *New Zealand Economic Papers*, 53(1), pp. 1-43.
- Thaler, R. H. and C. R. Sunstein (2008). *Nudge: Improving Decisions about Health, Wealth, and Happiness*. New Haven: Yale University Press.
- Treasury (2015). *An Introduction to Using the Living Standards Framework*. Wellington: The Treasury.
- Treasury (2018). *Our People Our Country Our Future – Living Standards Framework: Background and Future Work*. Wellington: The Treasury.
- Waters, C. N., J. Zalasiewicz, C. Summerhayes, A. D. Barnosky C. Poirier, A. Gałuszka, A. Cearreta, M. Edgeworth, E. C. Ellis, M. Ellis, C. Jeandel, R. Leinfelder, J. R. McNeill, D. deB. Richter, W. Steffen, J. Syvitski, D. Vidas, M. Wagnreich, M. Williams, A. Zhisheng, J. Grinevald, E. Odada, N. Oreskes and A. P. Wolfe (2016). The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science*, 351(6269), p. 137.
- Weisdorf, J. (2005). From foraging to farming: Explaining the Neolithic revolution. *Journal of Economic Surveys*, 19(4), pp. 561-586.
- White, L. A. (1940). The symbol: The origin and basis of human behaviour. *Philosophy of Science*, 7(4), pp. 451-463.
- Wilson, D. S., S. C. Hayes, A. Biglan and D. D. Embry (2014). Evolving the future: Toward a science of intentional change. *Behavioral and Brain Sciences*, 37(4), pp. 395-460.
- Young, A. (1998). Growth without scale effects. *Journal of Political Economy*, 106(1), pp. 41-63.