

Institution: University of Leeds		
Unit of Assessment: 17 - Business and Management Studies		
Title of case study: Providing better guidance on valuing infrastructure spend for the UK economy and its regions		
Period when the underpinning research was undertaken: 2011 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Professor Andrew Brown	Professor of Economics and Political Economy	01/11/2000 – present
Professor David Spencer	Professor of Economics and Political Economy	01/09/1998 – present
Dr Mary Robertson	Research Fellow in Economics	02/06/2014 – 31/01/2016
Dr Marco Veronese Passarella	Lecturer in Economics	02/02/2012 – present
Dr Elke Pirgmaier	Research Fellow, Sustainability Research Institute	01/10/2018 – 17/06/2020
Period when the claimed impact occurred: 1st August 2013 - 31st July 2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact (indicative maximum 100 words) Research undertaken by Brown and colleagues at the University of Leeds has developed an approach to infrastructure value based on non-standard ('system of systems') economics. The approach was used by HM Treasury (HMT) to significantly rewrite the guidance on valuing infrastructure spend in The Green Book – HMT's guidance for all public spending proposals. This led to collaborations with users of the Green Book: a) The Department for Environment, Food and Rural Affairs (DEFRA) used the research to better understand how plastic packaging systems operate and where inefficiencies arise. This enabled DEFRA to incorporate new metrics into their Resource and Waste Strategy and advocate for greater producer responsibility; b) Leeds City Council introduced new metrics for the measurement of impact and evaluation of their Inclusive Growth Strategy; c) The Key Cities Group used the research to lobby the Department for Business, Energy and Industrial Strategy (BEIS) and HMT; and d) The 'Our Spaces' initiative in Leeds City Council used the research to develop strategic narratives and change their evaluation procedures.		
2. Underpinning research (indicative maximum 500 words) Professor Andrew Brown, with colleagues Spencer, Passarella, Pirgmaier and Robertson, has authored a body of work related to a series of major research projects: FESSUD (i), iBUILD (ii) and CVORR (iii). These interdisciplinary research collaborations applied and developed the principles of non-standard ('system of systems') economics to the problem of valuing different types of infrastructure spending. A key argument of the research has been that, before any detailed economic assessment of alternative options can be undertaken, the strategic rationale for infrastructure provision needs to be evaluated using non-standard economics principles. The use of cost-benefit analysis is keenly contested. Brown and colleagues argue that valuing infrastructure requires non-standard economics, rather than the standard economic assumptions made in conventional cost-benefit valuations. Non-standard economics was explored in-depth in the international collaboration of 'Financialisation, Economy, Society and Sustainable Development' (FESSUD) led by Leeds (i). While standard economic value theory focuses on 'marginal' changes, infrastructure is often large, '<i>non-marginal</i>' (e.g. HS2, Crossrail and National Grid) and crosses different elements of systems. Assessing 'calculable risk' is a critical requirement of the standard economic cost-benefit analysis applied to all government policies		

and programmes. However, the long-term time span, typical of infrastructure projects and programmes, means they are subject to '*fundamental uncertainty*', a core concept of non-standard economics. Infrastructure investment decisions typically help shape the *future* preferences of individuals and interest groups, and these preferences are not static. For example, providing a good cycling infrastructure can increase preferences for cycling. However, because standard economics assumes a fixed set of preferences, this creates problems when valuing infrastructure investment, so it is more valid to take account of '*endogenous preferences*'.

Brown and colleagues draw on non-standard economics to argue that wellbeing and value are generated through 'systems of social provisioning' [1, 2]. This view, applied in the 'Infrastructure Business Models, Valuation and Innovation for Local Delivery' (iBUILD) project (ii), analyses UK infrastructure as a range of distinct '*systems of infrastructure provision*' (water, waste, energy, ICT, transport, etc.), each integrating distinct respective stakeholders, technical processes, ownership structures, types and processes of value generation (ii) [3]. These systems are interrelated; for example, building a railway may be a good opportunity to lay down a cable for broadband. Therefore, UK infrastructure must be seen as '*a system of systems*'. To obtain a true picture of the value of infrastructure across social domains (environment, health, well-being), it is necessary to identify and value '*interdependencies*' within and between infrastructure systems. This requires linkages between government departments to avoid '*siloes*' regulation and governance. Such an approach has the potential to identify additional cost-savings and benefits across a range of areas.

These major interdisciplinary projects (i and ii) led to **Brown** becoming involved with HMT and contributing directly to a revision of Supplementary Guidance on valuing infrastructure spend in the HMT Green Book – the key government guidance for major public sector infrastructure projects. Subsequently, the research has been further developed and applied to a range of different infrastructure systems, in several funded projects across industrial sectors at national, regional and local levels. Examples of these projects are:

Research on waste management infrastructure (iii) is synthesised in a report for the Department for Environment, Food and Rural Affairs (DEFRA) that analyses the structures, processes, commercial opportunities and constraints in the current UK system for plastic packaging waste in England [4]. This collaboration with DEFRA, led by **Brown** and Iacovidou (Brunel), developed and applied the systems of infrastructure provision approach as the economic basis of a comprehensive assessment procedure termed 'CVORR' (Complex Value Optimisation for Resource Recovery) (iii). CVORR involved systems conceptualisation, metrics selection and system modelling, all grounded in non-standard economics principles. The research identified factors limiting recycling rates and new metrics suitable for monitoring and assessing progress towards government ambitions on plastic packaging waste. A key finding was that the waste collection system is draining value from local authorities in England [4].

Regional collaboration with Leeds City Council on the Self-healing Cities project (iv) examined the methods for evaluation and implementation of strategic priorities in the Leeds Inclusive Growth Strategy. Further research on industrial strategy (v-vii) examined industrial systems of provision across 22 medium-sized local authorities e.g. Bradford, Wakefield, Hull and Oxford. The research report [5] applied the systems of provision approach to six industrial sectors (Healthcare, Education, Energy, Marine & Maritime, Digital, and Advanced Manufacturing), arguing that future investment should recognise the value of clusters of interdependent sectors.

The project (viii) on Green and Blue Infrastructure (e.g. parks and lakes), led by **Brown**, with Knowledge Transfer Placement, Pirgmaier, involved collaboration with Leeds City Council, West Yorkshire Combined Authority, Kirklees Council, West of England Combined Authority, Birmingham City Council, Yorkshire Water, DEFRA, the Environment Agency, HMT, and many other stakeholders. This research developed the system of systems approach to offer rigour in making the 'strategic case' for infrastructure programmes. This strategic case is one of the five interdependent dimensions of the 'Five Case Model' (Strategic, Economic, Commercial, Finance and Management cases) used in preparing business cases for spending proposals. This is detailed in HMT's Green Book.

3. References to the research (indicative maximum of six references)

- [1] **Brown, A. and Spencer, D. A.**, (2012). The nature of economics and the failings of the mainstream: Lessons from Lionel Robbins's Essay. *Cambridge Journal of Economics*, 36(4): 781-798. <https://doi.org/10.1093/cje/bes018>. [The contribution of economics to government.]
- [2] Boffo, M., **Brown, A.** and **Spencer, D. A.**, (2017). From happiness to social provisioning: Addressing well-being in times of crisis. *New Political Economy*, 22(4): 450-462. <https://doi.org/10.1080/13563467.2017.1259305> [This article applies the systems of provision approach to well-being.]
- [3] **Brown, A.** and Robertson, M., (eds), (2014). *Economic Evaluation of Systems of Infrastructure Provision: Concepts, Approaches, Methods*. Report – iBUILD/Leeds, 1-94. https://research.ncl.ac.uk/ibuild/outputs/reports/9940_iBuild_report_print_version%20WEB.pdf. [This policy report sets out the alternative approach to valuing infrastructure used in the Treasury's Supplementary Guidance.]
- [4] Iacovidou, E., Ebner, N., **Orsi, B.** and **Brown, A.**, (2020). Plastic Packaging - How Do We Get to Where We Want To Be? Report for DEFRA, 1-78. <http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=20471&FromSearch=Y&Publisher=1&SearchText=multidimensional%20value&SortString=ProjectCode&SortOrder=Asc&Paging=10>. [Applies the 'CVORR' framework, underpinned by the system of provision approach, to the case of UK waste management.]
- [5] **Brown, A.** et al, (2017). Industrial Strategy and Key Cities: An Evidence Review Focusing on Selected Industrial Sectors. Key Cities report supported by an ESRC IAA award (v). 1-87. <https://www.keycities.co.uk/sites/default/files/publications/Key%20Cities%20Research%20Project.pdf>. [Accessed 15.02.21] [Applies system of provision approach to Key Cities' industrial structure and strategy.]

Grants:

- (i) **Sawyer, M.C.**, European Union Framework 7. EUR7,923,728 (Amount to LUBS: GBP1,515,689). 01.12.11 – 30.11.16. Financialisation, Economy, Society and Sustainable Development (FESSUD). LUBS Co-investigators and Project Co-Directors: **Brown, Fontana** and **Spencer** with **Sawyer**. Grant Number: 266800.
- (ii) Dawson, R., Engineering & Physical Sciences Research Council and Economic & Social Research Council. GBP3,567,861 (Amount to Leeds: GBP1,020,317 and to LUBS: GBP222,062). 01.08.13 – 31.03.18. Infrastructure Business models, valuation and Innovation for Local Delivery (iBUILD). Leeds Co-Directors and Investigators: **Brown, Purnell** and **Steinberger** with Leeds Co-investigators including **Spencer** and others. Grant number EP/K012398/1.
- (iii) **Purnell, P.**, Natural Environment Research Council – Economic & Social Research Council. GBP1,008,502 (Amount to LUBS: GBP166,886). 13.12.12 - 05.04.13 and 31.08.14 – 30.09.19. Complex-Value Optimisation for Resource Recovery From Waste (CVORR). Co-investigators: **Brown**, Pearman and others. Grant numbers NE/L014149/1 and NE/K015834/1.
- (iv) **Purnell, P.**, Engineering & Physical Sciences Research Council. GBP2,971,671 (Amount to LUBS GBP257,135). 04.01.16 – 01.07.21. Balancing the Impact of City Infrastructure Engineering on Natural Systems Using Robots. Co-investigators: **Brown, Dymski, Graham** and others. Grant number EP/N010523/1.
- (v) **Brown, A.**, Economic & Social Research Council. GBP12,750. 2017. Public Policy Research Unit Partnership. [Collaborative work with Wakefield City Council led to Key Cities project.]
- (vi) **Brown, A.**, Sunderland City Council. GBP15,000. 2017. Key Cities Industrial Strategy Report.
- (vii) **Brown, A.**, Economic & Social Research Council Impact Acceleration Account/DTP Business Boost Fund. GBP14,000. July-November 2018. Key metrics for supporting national and local government waste policy improvements.
- (viii) **Brown, A.** Natural Environment Research Council. GBP184,177 (Amount to LUBS GBP31,723). 01.10.18 - 31.08.20. Green and Blue Infrastructure Business Case Project, (Grant made by the Yorkshire Integrated Catchment Solutions Programme (iCASP) NE/P011160/1).

4. Details of the impact (indicative maximum 750 words)**HMT's Green Book Guidance on Valuing Infrastructure Spend**

The UK HMT's Green Book Supplementary Guidance on Valuing Infrastructure Spend was published in March 2015. This new edition was a significant revision that included key and revised assumptions directly derived from research by **Brown** and colleagues. The guidance acknowledges the influence of the iBUILD report: *"The authors gratefully acknowledge the work which has been referred to and identified for further information within this guidance, notably the report 'Economic Evaluation of Systems of Infrastructure Provision' edited by Andrew Brown and Mary Robertson (iBUILD and University of Leeds), ... The continued support and work in this field by ... iBUILD ... has been essential in developing the content of this guidance."* (p37) **[A]**

HMT found the research conducted as part of the iBUILD project very helpful in preparing the guidance on valuing infrastructure spend which is still in use today **[B]**. From April 2014, **Brown** was invited regularly to meet and advise the HMT team authoring the new infrastructure evaluation guidance, offering detailed ongoing advice to its main author **[B]**. A knowledge transfer event took place in Leeds in July 2014, introduced by HMT economists and co-chaired by **Brown** who gave evidence from the iBUILD report. This was commented on by HMT officials and fed directly into the revised guidance. A letter from HMT confirms that the guidance includes the following principles which were explicated in the Leeds research: i) valuing interdependence and resilience (which relates to the interdependence between systems in an infrastructure network), ii) valuing scale effects (highlighting the importance of the greater impacts that can result from very large projects, more significantly than the sum of their parts), and iii) valuing non-marginal effects (covering the ability of large infrastructure projects to enable new activity and outcomes other than the primary purpose for which they are initiated) **[B]**. The Strategic Lead on cross-sector infrastructure delivery at HMT confirms: *"The contribution by Brown and colleagues at Leeds is referenced in the guidance on 'Valuing infrastructure spend'. I have no hesitation in confirming that the guidance document is widely utilised by public bodies (local authorities, LEPs, government departments and agencies) throughout the UK when preparing infrastructure proposals for Government spending."* **[B]**

The Green Book's international reputation means that many nations around the world replicate it, and their civil servants come to the UK for advice on how to set up equivalent guidance in their countries **[B]**. The reach of the HMT guidance is spelled out in the guidance itself: *"The guidance should be understood by all who are either responsible for developing and producing economic infrastructure spending proposals, or for their assessment and approval. This document is also relevant for the regulated economic infrastructure sectors, who will usually consider appraisal from the perspective of the investor and consumer."* (p4) **[A]**

UK infrastructure provision across scales and sectors

Following the influence of **Brown** and colleagues on the changes to Green Book guidance, the team were invited to work with institutions (e.g. Inter-American Development Bank, HMT, DEFRA, BEIS, HMRC and local/regional authorities) across a range of infrastructure sectors. Examples include:

- a) The report for DEFRA on plastics waste, as part of the CVORR project, was published on the DEFRA website in order to disseminate the findings to stakeholders in the waste and packaging sectors, including industry consultants and local authorities **[C and D]**. A letter from a government statistician at DEFRA confirms the report was used: a) to enable a better understanding within and outside of DEFRA of how the plastic packaging system operates and where inefficiencies exist; b) to incorporate a number of metrics in the report into the Resource and Waste Strategy monitoring and evaluation; c) as an evidence piece on making changes to the collection and management of plastic packaging waste; and d) to inform policy development on extended producer responsibility, making producers and users of plastic packaging pay a greater proportion of the costs of managing packaging waste and ensuring they put steps in place to further increase recycling and reduce the need for virgin plastic **[D]**.

- b) Leeds City Council (LCC) have used **Brown** and colleagues' research as a basis to develop Inclusive Growth metrics which are used to evaluate progress across all areas of council services. The resulting metrics were chosen on the basis of the 'system of systems' approach. LCC's Head of Economic Policy notes that *"via the knowledge transfer placement overseen by Professor Brown and I ... the system of systems approach to valuing infrastructure developed by economists at the University of Leeds has been an important basis for our choice of metrics for the measurement of the impact and the evaluation of our Inclusive Growth Strategy"* [E] and continues, *"the systemic approach developed by Brown and colleagues has helped us to better understand the linkages between our priorities and practices so as to achieve inclusive growth in the City."* [E]
- c) **Brown's** report for the Key Cities Group shaped the coordinated industrial strategy across infrastructure systems of local authorities across England and Wales. It is used in (confidential) Key Cities' cases for investment to HMT and BEIS where they are competing for funding with Core Cities in making business cases to Government. The influence of the research is acknowledged in a letter from the Chair of the Key Cities Group (covering 22 mid-size English and Welsh cities), which confirms that the research *"contributed significantly to [Key Cities] objectives and formed a major part of Key Cities evidence base in lobbying both BEIS and HM Treasury."* It continues: *"I believe evidence provided by the Leeds work had direct policy impact with UK Government, including the admission of Key Cities as a recognised stakeholder group in terms of government preparations for leaving the EU."* [F]
- d) Pirgmaier's knowledge transfer placement led to **Brown** and colleagues' research helping to develop the strategic narrative, and shape the evaluation procedures, of the 'Our Spaces' development programme in LCC [G]. The Head of Projects and Programmes commented that the collaboration *"helped the team develop their strategic narrative for the delivery and extension of the £500m+ OUR SPACES programme; in particular by linking city ambitions, such as the 'Best Council Plan', to global challenges related to climate emergency. Brown and Pirgmaier also helped to shape qualitative and quantitative measures to monitor progress towards the OUR SPACES ambitions. These essential measures will enable business case authors to bring the creation of green infrastructure to the forefront of all new development proposals that are brought forward in Leeds."* [G]

5. Sources to corroborate the impact (indicative maximum of 10 references)

- [A] HM Treasury (March 2015) *Valuing Infrastructure Spend: Supplementary Guidance to the Green Book* <https://www.gov.uk/government/publications/green-book-supplementary-guidance-valuing-infrastructure-spend>.
- [B] Letter from Commercial Specialist, Strategic Lead on cross-sector infrastructure delivery, Infrastructure and Projects Authority, HM Treasury [02.11.20] on the contribution of the research to the Green Book guidance.
- [C] DEFRA website referring to the research by Leeds with link to the Plastic Packaging report: <http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=20471> [downloaded 08.02.21].
- [D] Letter from UK Government Statistician [02.11.20] on waste management, natural resource use and agriculture, DEFRA that confirms how DEFRA used the plastic packing report.
- [E] Letter from the Head of Economic Policy at Leeds City Council [22.01.20] confirming the contribution of the research to the Inclusive Growth Strategy of Leeds City Council.
- [F] Letter from Chair of Key Cities Group [13.08.20] on the contribution of the research to the objective of the Key Cities Group and its use in forming an evidence base.
- [G] Letter from Head of Projects and Programmes at Leeds City Council [28.01.21] confirming contribution of the research to the 'Our Spaces' development programme of Leeds City Council.