Institution: University of Kent		
Unit of Assessment: 17: Business and Management Studies		
Title of case study: Modelling the Future: Investments in an Uncertain World		
Period when the underpinning research was undertaken: 2013-2019		
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:**
Ekaterini Panopoulou	Professor	2013-2019
Period when the claimed impact occurred: 2013-2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact (indicative maximum 100 words)

Research carried out at Kent Business School has led to the development of an economic evaluation model that is used in HM Treasury's Green Book to provide guidance on how to appraise, cost, and evaluate public projects in the UK. The model enables institutions and policy-makers to pursue projects that balance short-term costs and benefits with long-term implications. The model has been utilised for a wide range of publicly funded projects, including: all facilities investment by NHS Scotland; the assessment of the economic value of green spaces in the city of London; the construction of the Third River Yarmouth Crossing. The model is also used by the private sector, think tanks, and other non-governmental bodies (such as NESTA and the Transport Knowledge Hub) for the valuation of future assets.

2. Underpinning research (indicative maximum 500 words)

Evaluation of public projects by policy-makers and practitioners often involves a cost-benefit analysis (CBA). The future value of the potential benefits of these public projects has been traditionally assessed using New Approach to Investment (NATA) or Cost-Effectiveness Analysis. Professor Panopoulou's research offers a novel approach to a project's future value assessment, using Declining Discount Rates (DDR): it allows for greater flexibility and imperfect datasets. DDR models usually compare the future benefits of a specific course of action to its benefits in the present **[R1, R2]**. If present benefits are equal to potential future benefits, then the discount rate is 0%. Under a positive discount rate, the short-term benefits of a project are classified as more important than potential future ones. The divergence between present and future benefits increases with the increase in the discount rate: short-term benefits are increasingly prioritised. However, it is challenging to calculate the value of future benefits when the future is uncertain.

Panopoulou and her collaborators developed a method of addressing this uncertain discount rate in the context of public projects, especially those that contribute to the well-being of future generations **[R1, R2]**. Their research builds on the Expected Net Present Value (ENPV) approach, which evaluates the future value (for example, cash flows) of projects and assesses their potential for a positive net result (often profitability). The authors show that a constant but uncertain discount rate can be proxied by using a certain but decreasing discount rate in ENPV computations. Panopoulou calculates these certainty-equivalent discount rates using historical time-series data **[R2]**.

Several existing models were tested:

- A 'random walk' and mean-reverting model, along with an AR-IGARCH model that allows the conditional variance to change over time.
- A regime-switching model that allows the interest rate to shift randomly between two states that differ in their mean and variance.
- A state-space model that allows both the degree of mean reversion and the variance of the process to change over time.

Of the three models, the state-space model performs best in out-of-sample forecasts on the US data. The results suggest that, compared to the other models, the estimated discount rate declines more rapidly in the short term: this is ultimately comparable to the higher discount rate derived from the other models. As a further empirical test, the models are used to estimate certainty-equivalent discount rates for Australia, Canada, Germany, and the UK. Panopoulou established that the regime-switching model (with its estimated certainty-equivalent discount rates) best approaches the behaviour of the historical interest rates in all four countries **[R2]**.

Panopoulou's research contributed to the ENPV's theoretical framework. The research team estimated certainty-equivalent discount rates by estimating the dynamics of nominal interest rates jointly with expected inflation instead of using a mixture of nominal and real interest rates to proxy them. This approach built on the previous empirical models but, compared to previous CBA approaches, provided significantly more flexibility. It also helped to address an irregularity in the datasets used in previous work. Specifically, previous research used the nominal interest rates data until 1950 and real interest rates thereafter, generating problems when comparing pre- and post-1950 empirical findings and generating unreliable conclusions. Panopoulou's research provided an updated discounting advice and methodological guidance at a time when governments around the world were reviewing their guidelines on social discounting.

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

[R1] Freeman, M. C., Groom, B., **Panopoulou, E.**, and Pantelidis, T. (**2015**). 'Declining discount rates and the Fisher Effect: Inflated past, discounted future?'. *Journal of Environmental Economics and Management* 73: 32-49. ISSN 0095-0696. https://doi.org/10.1016/j.jeem.2015.06.003

[R2] Panopoulou, E., and Pantelidis, T. (**2016**). 'The Fisher effect in the presence of time-varying coefficients'. *Computational Statistics and Data Analysis* 100: 495-511. ISSN 0167-9473. https://doi.org/10.1016/j.csda.2014.08.015

4. Details of the impact (indicative maximum 750 words)

Changing national and regional policy in the UK

Since its introduction to HM Treasury in the 1970s, long-term project discounting has been an active area of research in economics and finance. This branch of financial research, which Professor Panopoulou and her collaborators have further developed in recent years, investigates modelling the future value of public goods, such as public buildings and infrastructure. Long-term discounting is widely used to assess the economic viability of a given project.

Research conducted at Kent Business School by Panopoulou led to the development of a new mathematical model for the calculation of the future value of a significant investment through the use of a constantly declining discount rate **[R1, R2]**. This model has since informed important policy discussions in the UK **[a, b]**, where it has been adopted in official national and regional policy **[a, c]**. Since the end of 2013, the research has been an active part of policy discussions through working groups and advisory Councils **[b]**. Panopoulou's research outcomes – i.e. her

novel DDR mathematical model – were included as part of the national guidelines for project and asset discounting, entered in Section A6 of the Green Book **[a]**. These national guidelines have gone on to inform the discounting practices of all national bodies administering public funds, such as the Scottish and UK Governments **[a, c]**.

Implementing project discounting in public projects

Through its adoption in the Green Book, Panopoulou's evaluation model has been used extensively throughout the UK public sector in calculating the future value of projects and assets. Examples of its use:

- Since 2017, the Scottish Government has used the discounting methods to assess the best allocation of resources for infrastructure investment across NHS Scotland **[d]**.
- In 2019, the Scottish Government used the model to appropriately determine the socio-economic impact of district heating projects, using indicators such as decarbonisation and fuel poverty across an area **[c]**.
- Panopoulou's evaluation model was used in October 2017 by the National Trust, the Heritage Lottery Fund, and the Mayor of London Office to assess the economic value and benefits of preserving green spaces in the city of London **[e]**.
- Norfolk City Council used the discounting method in 2017, as part of the appraisal of the Great Yarmouth Third River Crossing construction **[f]**. This project was approved in May 2019 and is projected to bring £186 million to the area through an estimated 2.7 Benefit-Cost Ratio **[f**, **g]**.

Influencing businesses' approaches to discounting

Through the inclusion of the discounting methods developed by Panopoulou into the general 'Project Business Case' guidelines used to develop and assess any publicly funded project **[h]**, her research has influenced the practices of businesses nationally. This influence can be seen in the increasing number of reports developed by think tanks to improve current Public Project Management and Valuations. Examples include:

- Innovation think tank Nesta uses the concepts arising from Panopoulou's research to develop new models for managing and growing the value of public assets **[i]**.
- The Institute for Government uses early findings from Panopoulou's research to suggest better management and valuation processes for infrastructure spending **[j]**.

Furthermore, Panopoulou's research findings have been used in outreach texts, including housing blogs **[k]** and *The Economist* **[l]**.

In summary, the evaluation model has proved useful in the valuation of future assets in settings as diverse as healthcare, urban green spaces, and transport infrastructure, and has been adopted by private sector organisations, think tanks, and other non-governmental bodies.

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

[a] The Green Book: Central Government Guidance on Appraisal and Evaluation. This is a guidance document issued by HM Treasury on how to appraise policies, programmes, and projects. The Green Book adopts the Declining Discount Rate (DDR) mathematical model developed by Panopoulou and colleagues (see p. 117). The evidence includes a supporting statement by Professor Groom outlining Panopoulou's contribution to the research, and development of the DDR mathematical model.

[b] Report for the Office for National Statistics (2016). Discounting for Environmental Accounts. The report recommends that the Office for National Statistics discounts natural capital for use in environmental accounts using the schedule of discount rates given in HM Treasury's Green Book.

[c] District Heating: Guidance on Project Level Socio-Economic Assessment (draft methodology). Scottish Government.

[d] Scottish Capital Investment Manual: Option Appraisal Guide. A practical guide to the appraisal, evaluation, approval, and management of policies, programmes, and projects.

[e] Natural Capital Accounts for Public Green Space in London (2017). Report prepared for Greater London Authority, National Trust, and Heritage Lottery Fund.

[f] Development consent (2018): Third River Crossing.

[g] Great Yarmouth, Third River Crossing (2017). Outline business case. Appendix H: Note on Scheme Costs and Discounting.

[h] HM Treasury: *Guide to Developing the Project Business Case* (2018). Better business cases for better outcomes.

[i] Nesta White Paper (2019). 'Public Value: How Can It Be Measured, Managed and Grown?'

[j] Institute for Government (2017). 'How to Value Infrastructure: Improving Cost Benefit Analysis'.

[k] Blog post (23 January 2018): 'Are you Uplifted? Land Value Uplift and Economic Appraisal'. https://lichfields.uk/blog/2018/january/23/are-you-uplifted-land-value-uplift-and-economic-appraisal/

[l] Article in *The Economist* (11 January 2020): **'**Government spending: the coming splurge on northern infrastructure'.
https://www.economist.com/britain/2020/01/09/the-coming-splurge-on-northern-infrastructure