Higher Education Funding Report on the Virtual Study Group Nov 12-14th 2025

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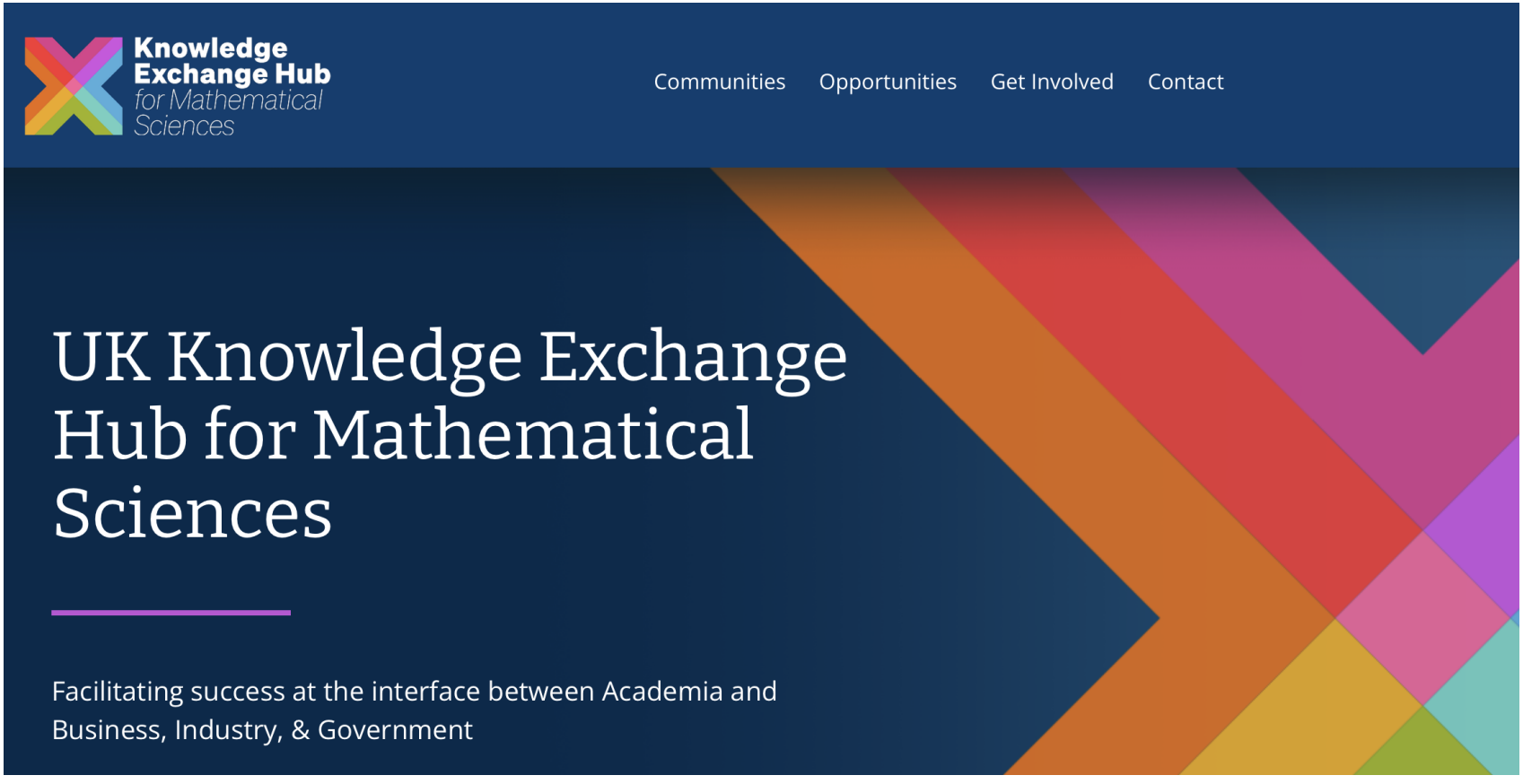
Outline

1. What is VKEMS?
2. What happened at the virtual study group
   - the question what we addressed
   - and what we did not address
3. Findings part 1: data
4. Findings part 2: model
5. Next steps

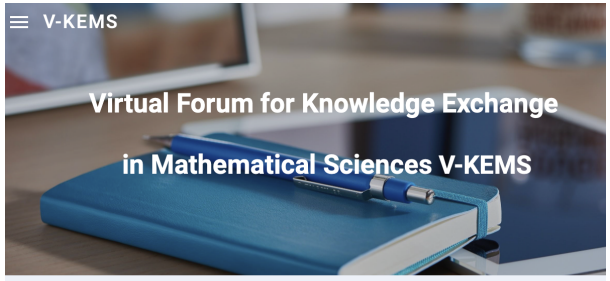
The KE Hub - wwww.kehubmaths.co.uk



Hub = umbrella for all things Knowledge Exchange in Mathematical Sciences

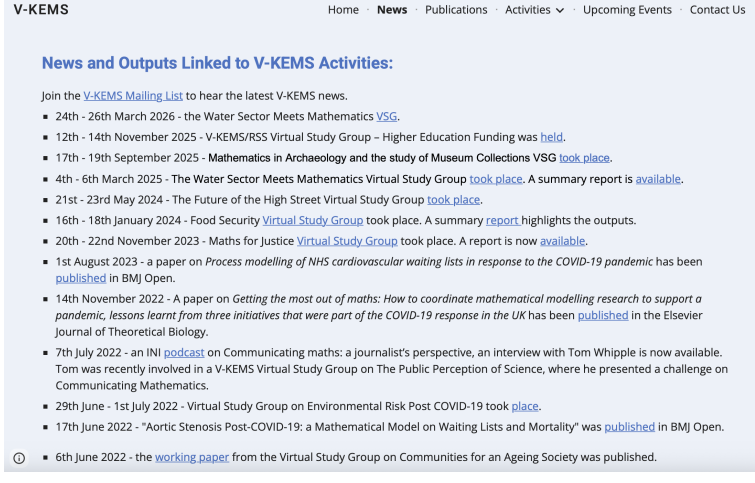
VKEMS - www.vkems.co.uk

- Virtual Forum for KE in Math Sciences
- part of the KEHub family
- pre-dates: set up during COVID-19
- with InnovateUK Business Connect, ICMS, INI, and loose affiliation of academics
- completely virtual (it doesn't exist!)
- now led by Lars Schewe (Edinburgh) & Jess Enright (Glasgow)
- to run virtual study groups (VSGs)
- focus on societal challenges
- anyone can get involved



V-KEMS

The International Centre for Mathematical Sciences (ICMS), Isaac Newton Institute (INI), Newton Gateway to Mathematics and Innovate UK Business Connect have worked with various representatives from the mathematical sciences community to develop a Virtual Forum for Knowledge Exchange in the Mathematical Sciences (V-KEMS). The main aim is to identify a range of virtual approaches that will help address challenges from **business** and **industry**, the **third sector**, and other **groups outside academia**. These challenges may be long-standing or may have arisen directly as a consequence of the present disruption to UK society.



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News and Outputs Linked to V-KEMS Activities:

Join the V-KEMS Mailing List to hear the latest V-KEMS news.

- 24th - 26th March 2026 - the Water Sector Meets Mathematics VSG.
- 12th - 14th November 2025 - V-KEMS/RSS Virtual Study Group – Higher Education Funding was held.
- 17th - 19th September 2025 - Mathematics in Archaeology and the study of Museum Collections VSG took place.
- 4th - 6th March 2025 - The Water Sector Meets Mathematics Virtual Study Group took place. A summary report is available.
- 21st - 23rd May 2024 - The Future of the High Street Virtual Study Group took place.
- 16th - 18th January 2024 - Food Security Virtual Study Group took place. A summary report highlights the outputs.
- 20th - 22nd November 2023 - Maths for Justice Virtual Study Group took place. A report is now available.
- 1st August 2023 - a paper on *Process modelling of NHS cardiovascular waiting lists in response to the COVID-19 pandemic* has been published in BMJ Open.
- 14th November 2022 - A paper on *Getting the most out of maths: How to coordinate mathematical modelling research to support a pandemic, lessons learnt from three initiatives that were part of the COVID-19 response in the UK* has been published in the Elsevier Journal of Theoretical Biology.
- 7th July 2022 - an INI podcast on Communicating maths: a journalist's perspective, an interview with Tom Whipple is now available. Tom was recently involved in a V-KEMS Virtual Study Group on The Public Perception of Science, where he presented a challenge on Communicating Mathematics.
- 29th June - 1st July 2022 - Virtual Study Group on Environmental Risk Post COVID-19 took place.
- 17th June 2022 - "Aortic Stenosis Post-COVID-19: a Mathematical Model on Waiting Lists and Mortality" was published in BMJ Open.
- 6th June 2022 - the working paper from the Virtual Study Group on Communities for an Ageing Society was published.

2. The VSG on HE Funding

- organised in collaboration with Royal Statistical Society
- expert talks from Universities UK,
  and VCs of Leicester University & City St Georges, London.
- The questions addressed:
  1. **Is the current funding model for UK universities sustainable, and what trends are visible in the data?**
  2. What lessons can be learned from funding models in other industrialised nations?
  3. The value proposition of investment in university education and research for the state, the private sector and individuals?
  4. **Can the UK higher education sector could be modelled in terms of flows of people, money, knowledge, academic reputation, social wellbeing and economic success?**
  5. **Can such models be used to explore "what-if" scenarios under alternative funding approaches and exogenous shocks?**
- all in 2.5 days !

What we did not address

- the “crisis facing UK maths departments” – why maths is special
- how to lobby the government to give us more money
- despite having ‘skin in the game’; try to be objective:
  1. We as a community are looking at the question of what the future of UK HE funding is.
  2. To do this we are using the intrinsic systems principles of how societies and populations interact where their are natural limitations to resource utilisation.
  3. The HE sector is a place that we all have a stake and interest in – and we care about the future direction.
  4. The results derived here are aimed to promote a healthy and positive conversation around the effective choices that appear to present themselves.
  5. The results may show that our HE system has evolved into a different part of its operation ’phase plane’ where it will help to further build on a “What is our best future HE culture?” type of conversation.

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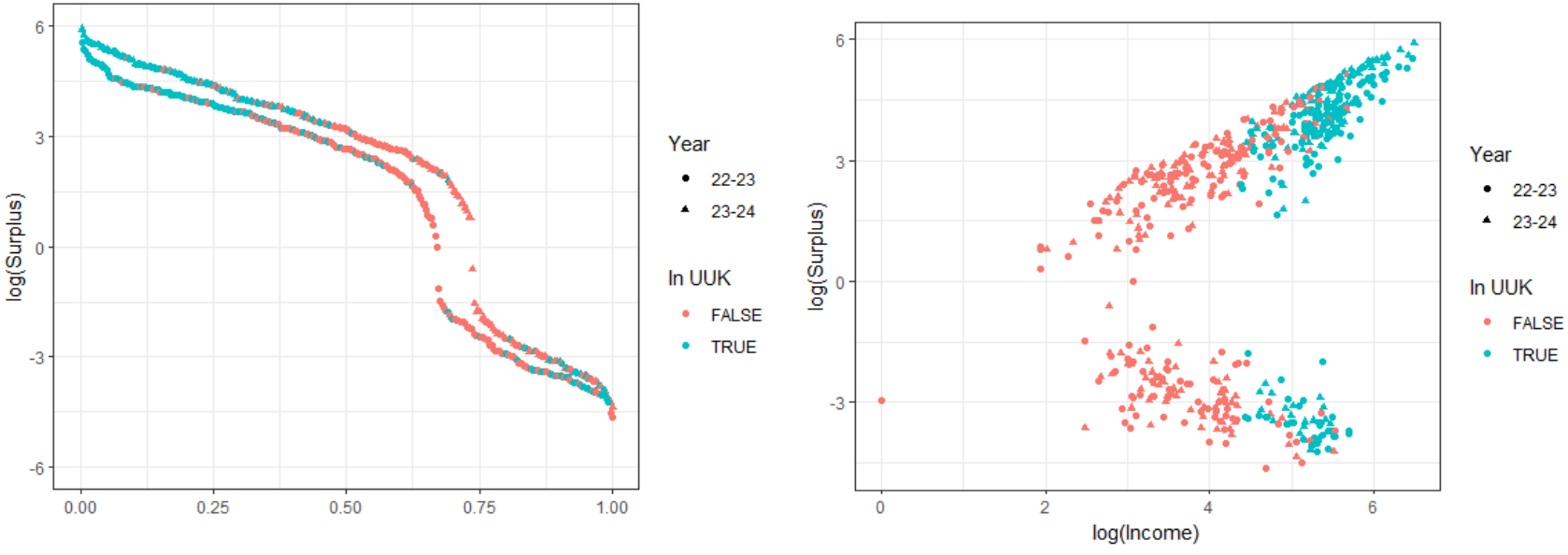
3. Findings - data

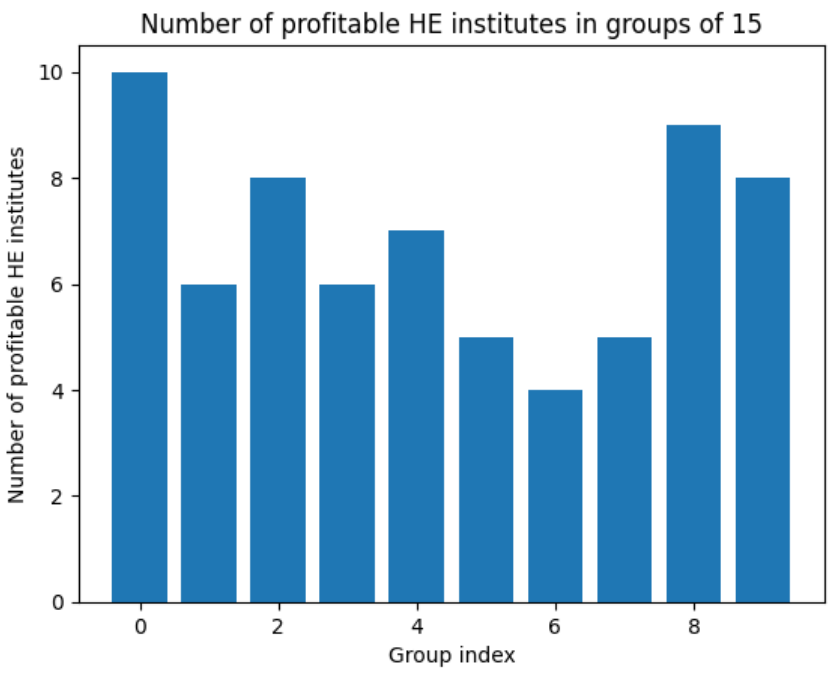
Surplus/deficit versus income:

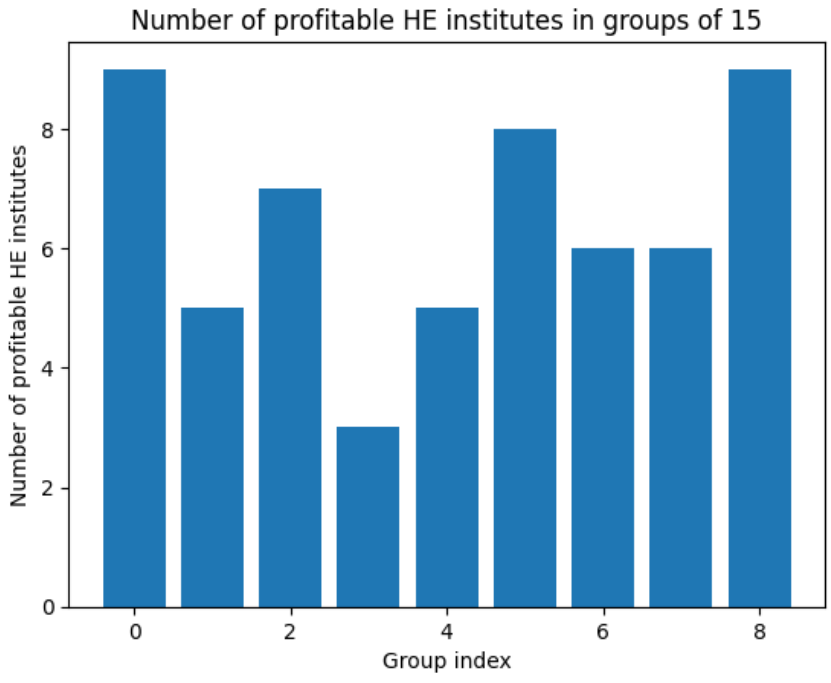


⇒ both big and small institutions are in surplus/deficit

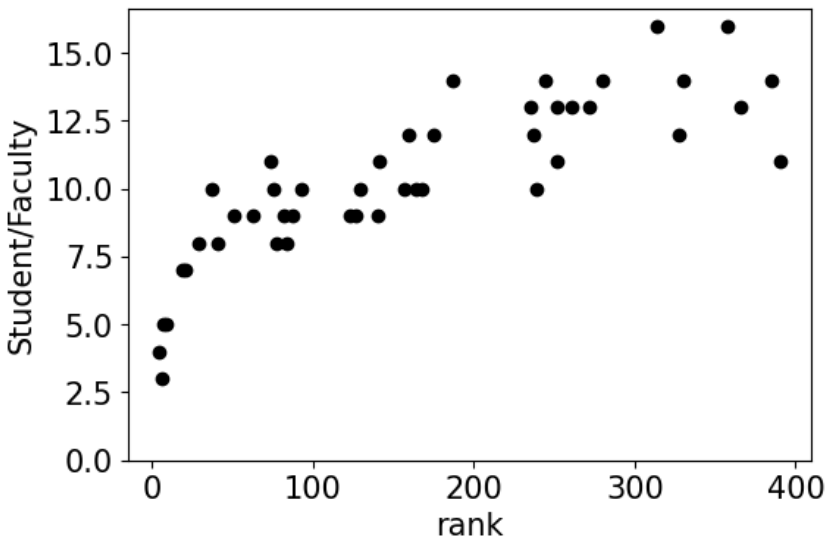
Surplus versus size and age

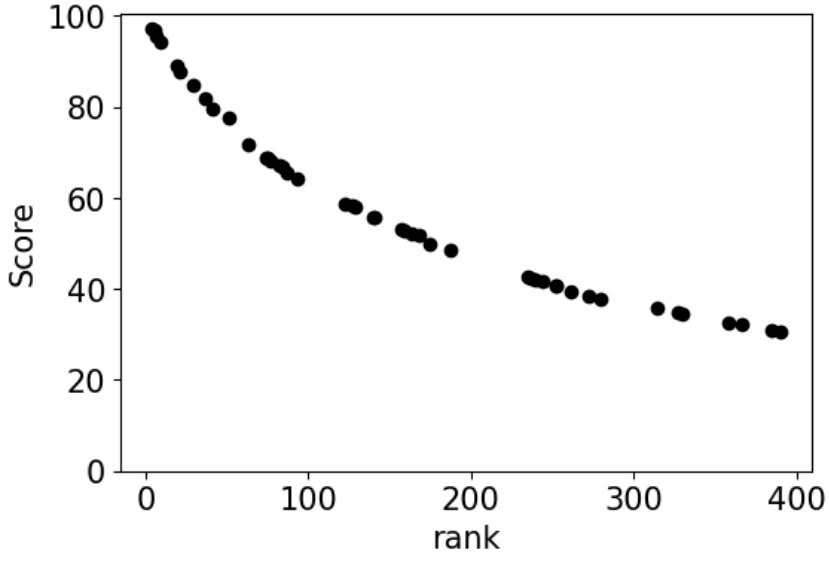
% of HEIs in surplus clustered by size (left) and age (right) of institution



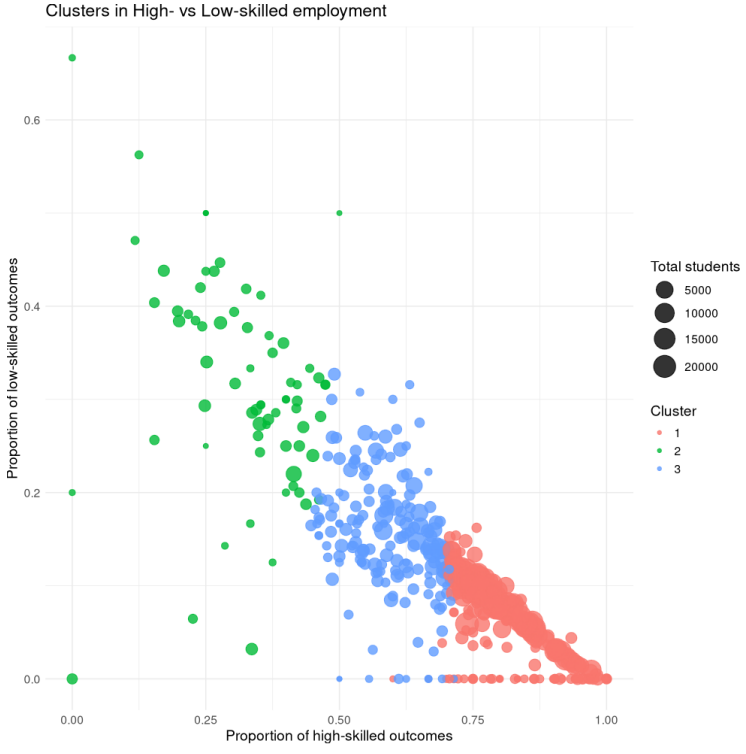


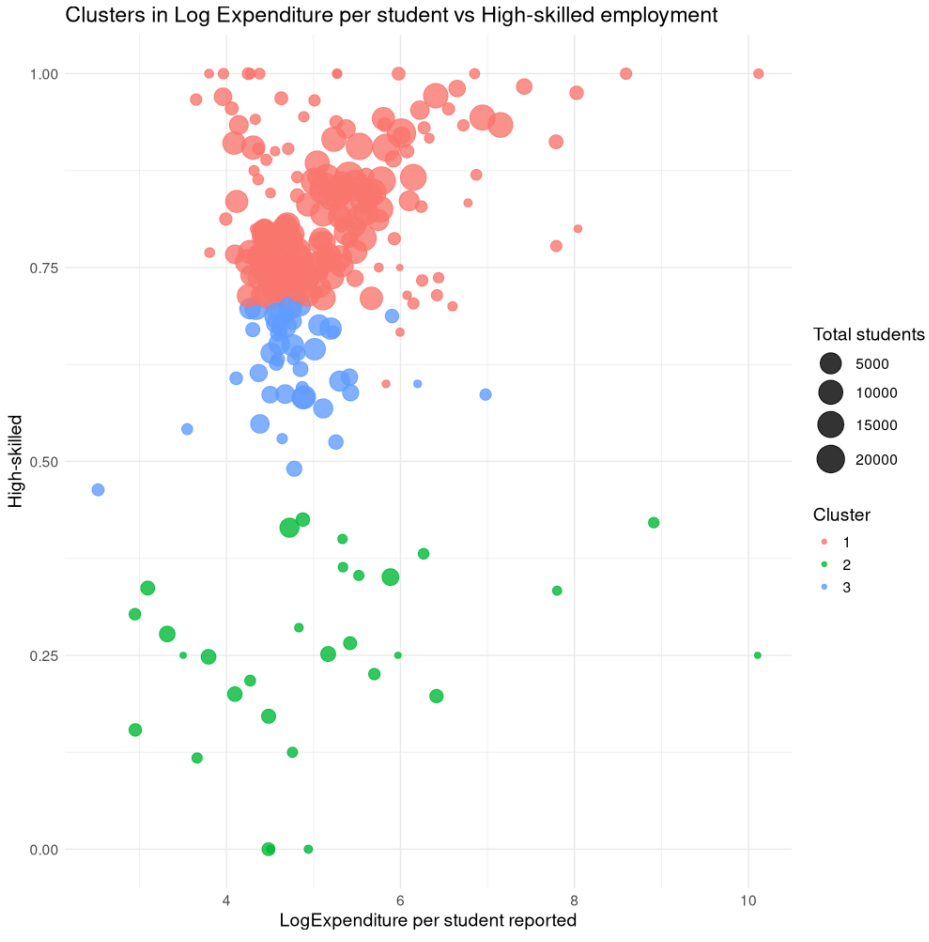
Student-staff ratio and QR ranking





High skilled jobs versus low skilled





Tentative conclusions form the data

- thinking of the sector as a whole is misguided
- rather we should look at clusters of HEIs that occupy different niches
- e.g. looking at student outcomes; there appear to be four clusters
  1. High Employment, Research-Oriented STEM Fields. e.g. biology & medicine, pure science. 60% STEM disciplines. Strong employment rates. Further study participation. Fields where postgraduate education is normative for career advancement. Strong labour market demand
  2. Moderate Employment, Balanced Disciplines. 40% STEM less further study; more direct employment pathways, but not vocational; reasonably effective labour market integration with some friction.
  3. Highly Applied STEM Fields. 80% STEM. E.g. Engineering, IT, Applied Science. Highest employment rates. Strong industry demand, 1st degree often sufficient. Labour market shortage.
  4. Employment-Challenged Discipline. 33.3% STEM, e.g. Arts Humanities. Career pathways are less standardized. High further study participation,
- deeper dive into other data suggests different ways of clustering

4. Findings: modelling

A simple simulation model to address dynamics of reputation verus profit
The elephant in the room; overseas students. (Clusters 1 & 2)

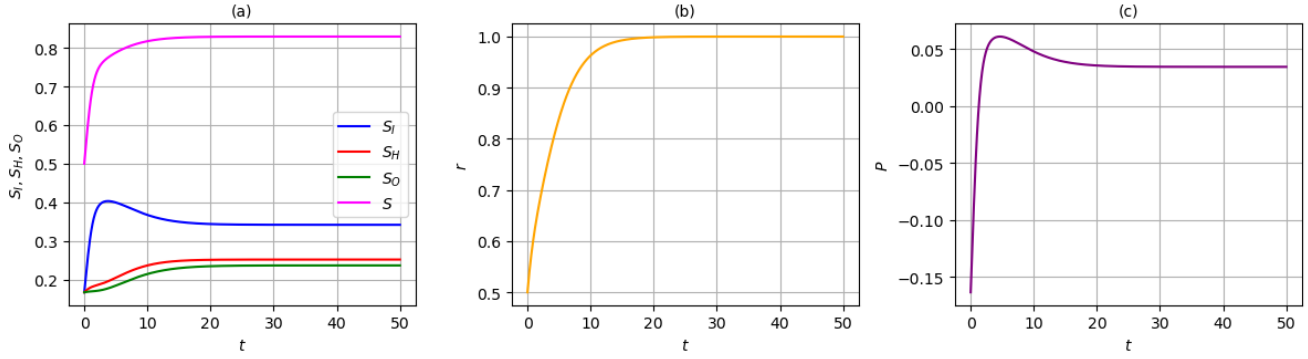
$$\frac{dS_I}{dt} = \alpha_{1I}\frac{H_T H_A}{H}\frac{r}{M_I} + \alpha_{2I}S_I\,(1-S) - \alpha_{3I}S_I,$$
$$\frac{dS_H}{dt} = \alpha_{1H}\frac{H_T H_A}{H}\frac{r}{M_H} + \alpha_{2H}S_H\,(1-S) - \alpha_{3H}S_H,$$
$$\frac{dS_O}{dt} = \alpha_{1O}\frac{H_T H_A}{H}\frac{r}{M_O} + \alpha_{2O}S_O\,(1-S) - \alpha_{3O}S_O,$$
$$\frac{dr}{dt} = r(1-r)\left(-\gamma_r + \gamma_H\frac{H}{S} + \gamma_V r\frac{H_R}{H} - \gamma_I\frac{S_I}{S}\right),$$
$$\text{Profit} = -\beta_0 - \beta_E H + \sum_j (M_j - \beta_j)S_j - \beta_V r\frac{H_R}{H} - \sum_j \beta_{\alpha_j}Q_j.$$

$S_I(t) =$ students , $S_H(t) =$ home, $S_O(t) =$ vocational, $r(t)$ reputation rank

Simulations

- hard to make a profit; a number of ways to do it, e.g.
  1. combining research and overseas students

$\alpha_{1I} = 3.00, \alpha_{1H} = 0.60, \alpha_{1O} = 0.30, \alpha_{2I} = 3.00, \alpha_{2H} = 0.60, \alpha_{2O} = 0.30, \alpha_{3H} = 0.50, \alpha_{3O} = 0.33, M_I = 1.00, M_H = 0.33, M_O = 0.25, H_R = 0.17, H_T = 0.17, H_A = 0.17,$
$\gamma_r = 0.60, \gamma_H = 1.00, \gamma_V = 1.00, \gamma_I = 0.02, \beta_0 = 0.20, \beta_E = 0.40, \beta_V = 0.01, \beta_I = 0.10, \beta_H = 0.03, , \beta_O = 0.03, \beta_{\alpha_I} = 0.00, \beta_{\alpha_H} = 0.00, \beta_{\alpha_O} = 0.00$



  2. no research

$\alpha_{1I} = 3.00, \alpha_{1H} = 0.60, \alpha_{1O} = 0.30, \alpha_{2I} = 3.00, \alpha_{2H} = 0.60, \alpha_{2O} = 0.30, \alpha_{3H} = 0.50, \alpha_{3O} = 0.33, M_I = 1.00, M_H = 0.33, M_O = 0.25, H_R = 0.00, H_T = 0.25, H_A = 0.25,$
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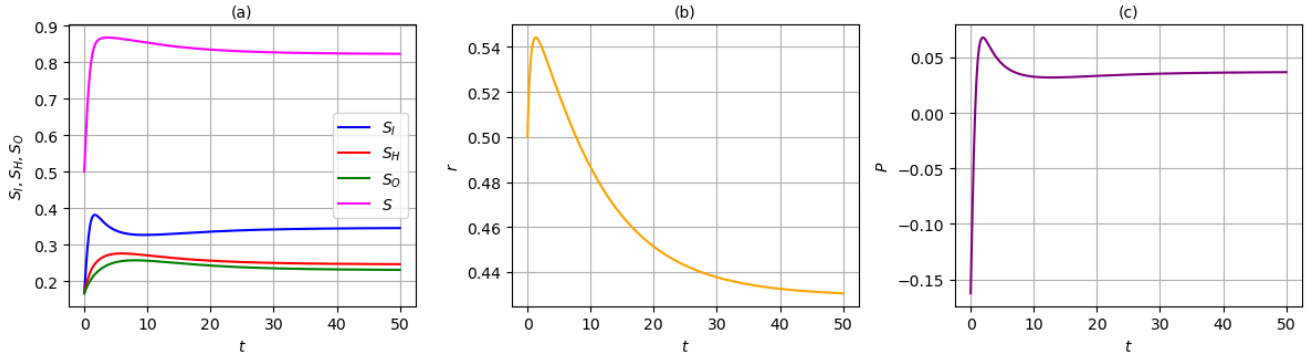
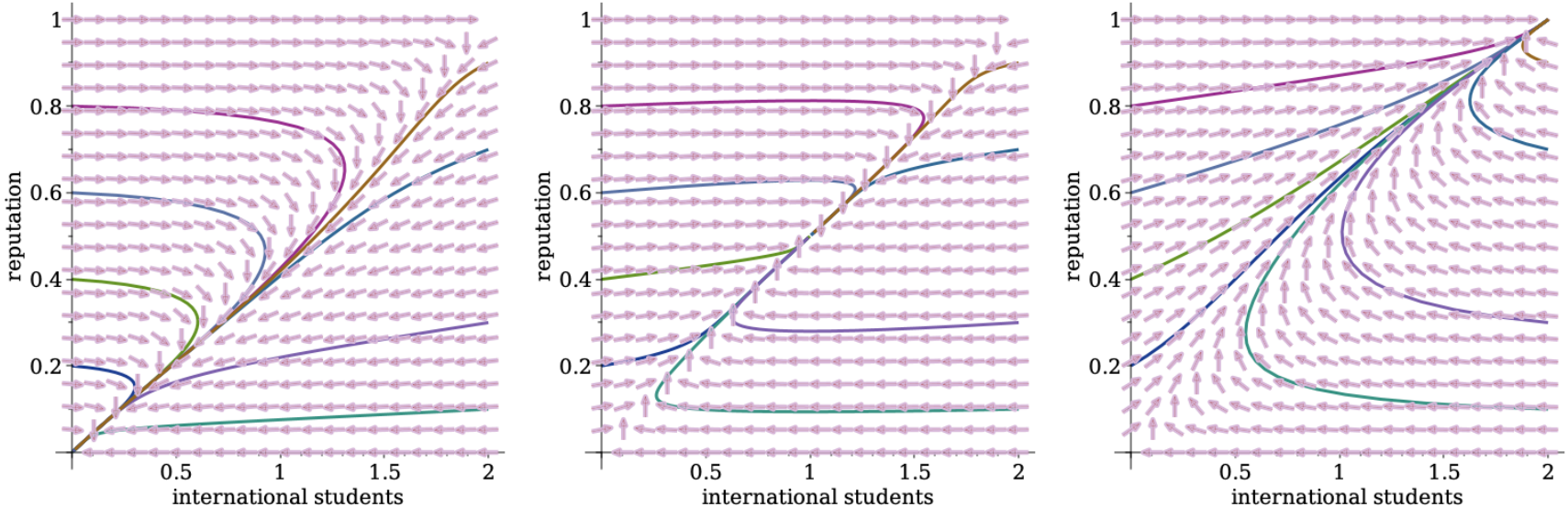


Simplified phase plan analysis

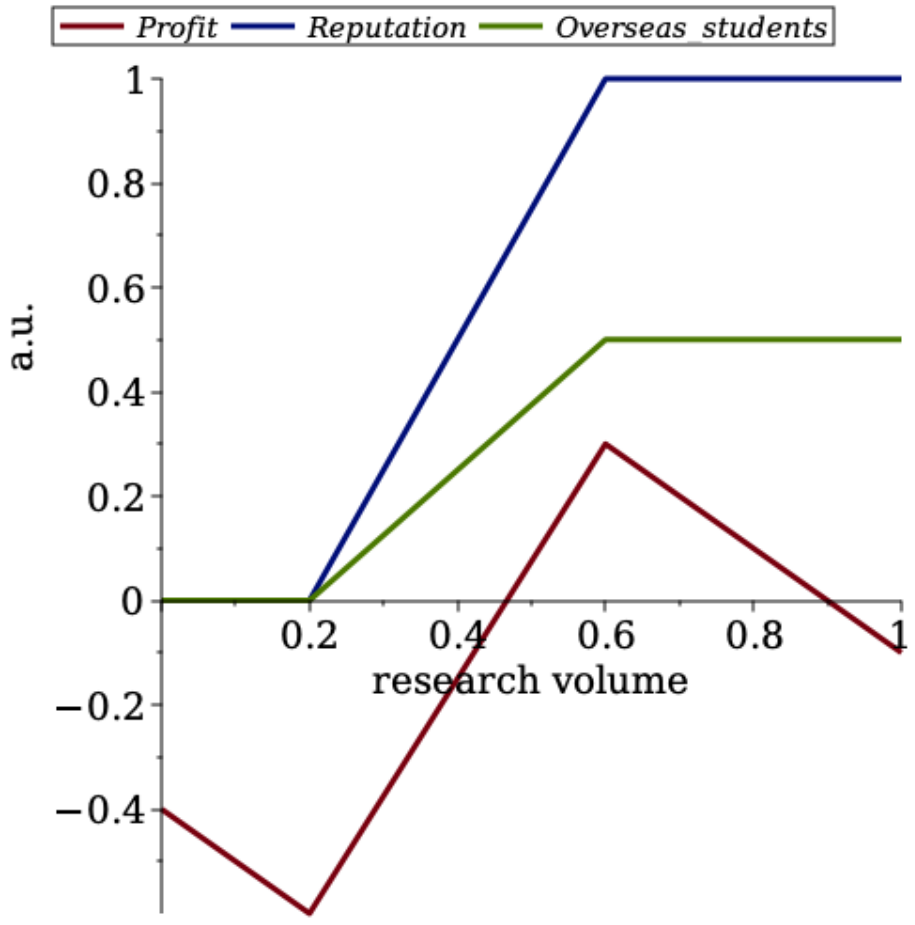
- dynamics of overseas students and reputation
- three types of equilibria:

reputation rank $= 0$ middle reputation rank rank $= 1$



But are any of these profitable?

research volume as control parameter



Next steps

- The report has been finalised (yesterday!)
  - will be available on the vkems website soon
- This is a feasibility study. Need funding for a proper project:
  1. Further investigate HESA data sets, especially as time series, to gain insight, and to inform parameters of any simulation model.
  2. Further work on and LLM pipeline; & automatically check accuracy of collected data.
  3. Take a small sample of institutions, e.g. Scottish HEIs, that has examples of institutions in each cluster, and different (simpler?) funding model
  4. Produce an inter-cluster simulation model that is fully calibrated
  5. Understand elasticities and sensitivities of operation to exogenous effects.
  6. Produce a single-institution optimisation model in collaboration with a parnter HEI
  7. Produce a report that scopes out a fully-functioning combined data-driven and playable model, that can be tailored to be used by a variety of stakeholders.
- Who will fund this?