Skills, Automation and Mega-projects

Construction Industry

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Overview

- Automation, Market Structure and Skills in the Construction Industry
- Frugal Innovation and cost over-runs in mega-projects

Humans versus Machines

"We can know more than we can tell . . . "

– Polanyi (1966)

Humans versus Machines

"We can know more than we can tell . . . "

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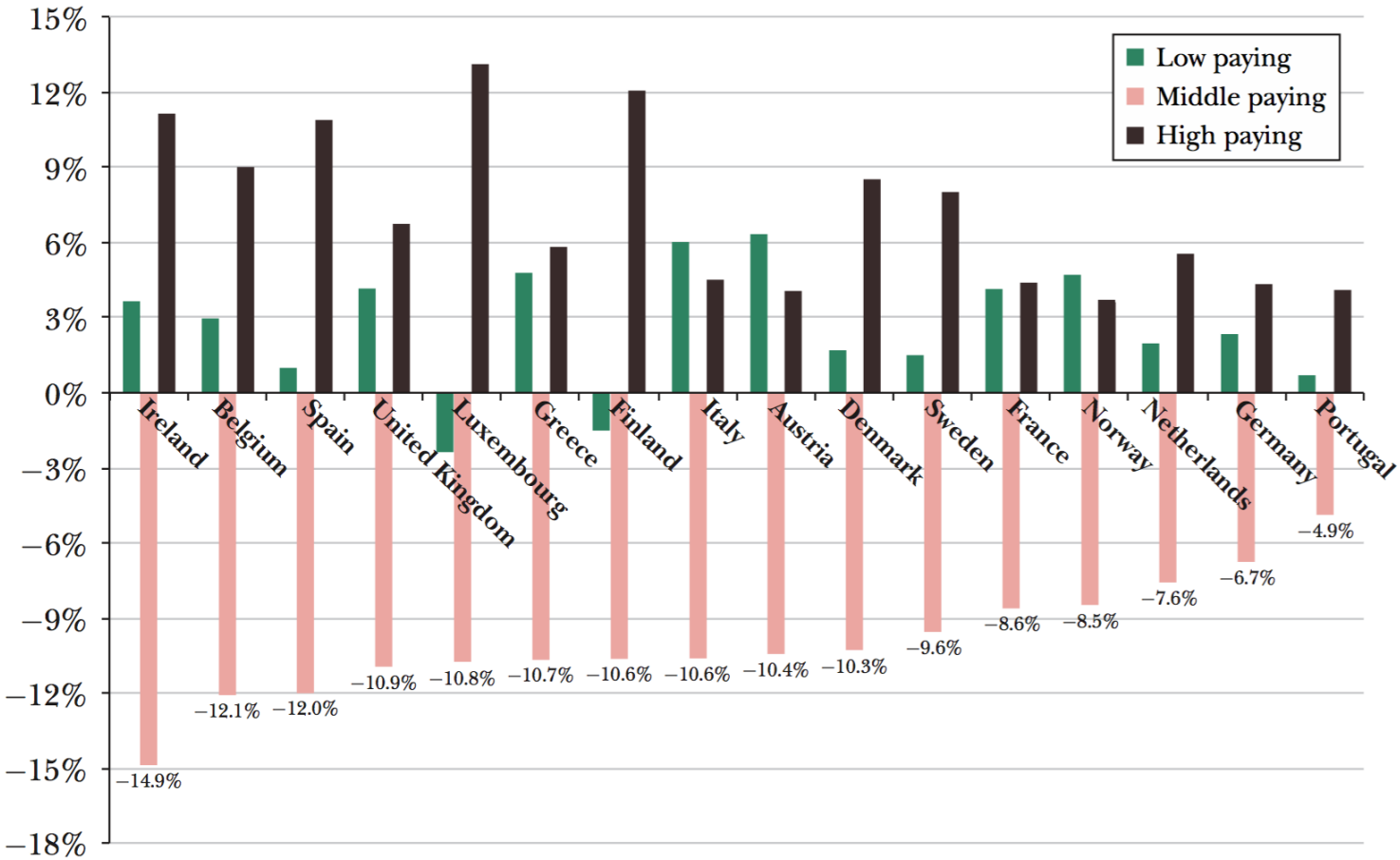
"Google cars don't drive on road, they drive on maps . . . "

– saying in machine learning community

European Jobs, 1993-2010

Change in Occupational Employment Shares in Low, Middle, and High-Wage Occupations in 16 EU Countries, 1993–2010



Goos, M., Manning, A., & Salomons, A. (2009). Job polarization in Europe. The American Economic Review.

Skill-Task distinction

Too many cooks spoil the broth *Many hands make work light*

A *task* is a unit of work activity that produces output.

Skill is worker's inalienable stock of capabilities for performing various tasks.

Task Framework

	Routine Tasks	*Non-Routine Tasks*	
		Abstract Tasks	*Manual Tasks*
Cognitive skills	✓	✓	
Non-cognitive skills	✓		✓

Routine Tasks: repetitive physical and mental operation in an unchanging environment and can be potentially codified

Non-Routine Tasks

Abstract Tasks: require problem solving abilities, intuition, creativity and persuasion.

Manual Tasks: require situational adaptability, visual and language recognition and in-person interaction.

Offshorability are tasks that can be relocated to a remote location without substantially degrading the quality of the output.

David, H. (2015). Why are there still so many jobs? The history and future of workplace automation. The Journal of Economic Perspectives

Routinisation and Offshorability in Jobs

Routine Task Intensity Index and Offshorablity of European Occupations

Occupations ranked by mean European wage	Routine Task Intensity Index	Offshorability	Employment Share in 1993	% change 1993 – 2010
High-paying occupations	-0.72	-0.12	31.67	5.62
Corporate managers	-0.75	-0.32	5.65	0.59
Physical, mathematical, and engineering professionals	-0.82	1.05	2.93	1.36
Life science and health professionals	-1.00	-0.76	2.01	0.57
Other professionals	-0.73	0.21	2.79	1.38
Managers of small enterprises	-1.52	-0.63	4.16	0.17
Physical, mathematical, and engineering associate professionals	-0.40	-0.12	4.44	0.21
Other associate professionals	-0.44	0.10	7.24	0.79
Life science and health associate professionals	-0.33	-0.75	2.45	0.55
Middling occupations	0.69	0.24	46.75	-9.27
Stationary plant and related operators	0.32	1.59	1.70	-0.25
Metal, machinery, and related trade work	0.46	-0.45	8.78	-2.08
Drivers and mobile plant operators	-1.50	-1.00	5.03	-0.48
Office clerks	2.24	0.40	10.60	-2.06
Precision, handicraft, craft printing, and related trade workers	1.59	1.66	1.45	-0.54
Extraction and building trades workers	-0.19	-0.93	1.45	-0.54
Customer service clerks	1.41	-0.25	7.35	-0.64
Machine operators and assemblers	0.49	2.35	2.13	0.06
Other craft and related trade workers	1.24	1.15	5.99	-1.63
Low-paying occupations	-0.08	-0.84	21.56	3.65
Labourers in mining, construction, manufacturing, and transport	0.45	-0.66	4.26	-0.55
Personal and protective service workers	-0.60	-0.94	6.86	2.36
Models, salespersons, and demonstrators	0.05	-0.89	6.06	-0.11
Sales and service elementary occupations	0.03	-0.81	4.38	1.95

Routinisation and Offshorability in Jobs

Routinisation and Offshorability in Occupations

Occupations	Non-Routine Occupations	Routine Occupations
Low-offshorability	*High Paying occupations* **Corporate managers** Life science and health professionals **Managers of small enterprises** Physical, mathematical, and **engineering** associate professionals Life science and health associate professionals *Middling Occupations* **Drivers and mobile plant operators** **Extraction and building trades workers** *Low-paying occupations* Personal and protective service workers	*Middling Occupations* **Metal, machinery, and related trade work** Customer service clerks *Low-paying occupations* **Labourers in mining, construction, manufacturing, and transport** Models, salespersons, and demonstrators **Sales** and service elementary occupations
High-offshorablity	*High Paying occupations* Physical, mathematical, and engineering professionals Other professionals Other associate professionals	*Middling Occupations* Stationary plant and related operators Office clerks **Precision, handicraft, craft printing, and related trade workers** **Machine operators and assemblers** **Other craft and related trade workers**

Construction Jobs in UK

Worker Employed in Construction in 2013	**2.9 Million**
White Collar Jobs	*22%*
Executive & Managerial	11%
Civil Mechanical Electrical Engineers	5%
Architects, town planners, surveyors	6%
Blue Collar Jobs	*40%*
Metal, electrical and mechanical trades	10%
Painters	3%
Bricklayers, masons, roofers, tilers	3%
Plumbers and heating and ventilating engineers	5%
Plasterers, glaziers and other trades	5%
Plant and machine operatives and drivers	7%
Carpenters and joiners	7%
Other occupations	**37%**

Workers, firms and consumer

Three factors that affect how employment reacts to automation.

- *Pool* of workers available that can supply complementary tasks
- Time it takes to acquire *skills* to supply complementary tasks
- Income *elasticity* of demand if the industry is competitive

UK Construction Industry

Shrinking *pool* of workers

Difficult to predict demand for which *skills* will survive automation and offshoring

Income *elasticity* of demand high, though property market unpredictable

Learning: Heckman and Cunha

Cunha, Flavio, and James Heckman (2007). "The Technology of Skill Formation." The American Economic Review.
Chetty, R., Friedman, J. N., and Rockoff, J. E. (2014a). Measuring the impacts of teachers: Evaluating bias in teacher value-added estimates. The American Economic Review.
Chetty, R., Friedman, J. N., and Rockoff, J. E. (2014b). Measuring the impacts of teachers: Teacher value-added and student outcomes in adulthood. The American Economic Review.

- *Hierarchy* of skills acquisition
- *Dynamic complementarities* across time

  Early education has a much greater impact

- Designing a path to T-levels should start early

Learning: Wieman

Wieman, Carl. Improving How Universities Teach Science: Lessons from the Science Education Initiative. Harvard University Press, 2017.

Research has established that people *do not develop true understanding of a complex subject* such as science *by listening passively to explanations*. *True understanding* comes only when *students actively construct* their own understanding via a *process of mentally building on their prior thinking and knowledge through "effortful study"*.

In addition to factual knowledge, *experts* have *distinctive mental organisational structures and problem-solving skills* that *facilitate the effective retrieval* and *useful application of that factual knowledge*. Experts also have important *meta-cognitive abilities*; they can *evaluate and correct their own understandings and thinking processes*. Developing these experts *competencies, which go beyond the factual*, is part of the *student's path to expertness*.

Mega-projects

European Commission's Cost Benefit Analysis approach (Florio, 2002). Korytárová Hromádka (2014).

A mega-project is an extremely large-scale investment project. Megaprojects are typically defined as *costing more than US$1 billion* and attracting a lot of public attention because of *substantial impacts on communities, environment, and budgets*.

Megaprojects can also be defined as "*initiatives that are physical, very expensive, and public*" (Altshuler, 2003).

Care in the project development process may be needed to *reduce any possible optimism bias and strategic misrepresentation*.

The logic on which many of the typical mega-projects are built is on its *collective benefits*.

The most common mega-projects are in the categories of *hydroelectric facilities*, *nuclear power plants* and *large public transportation projects*.

Beyond Cost-benefit Analysis

The Rocking Millennium Bridge

- Coordination, behaviour, multiple equilibria
- Algorithms embedded (reasonable) assumptions
- *Known unknowns:*
  - Rethinking cost-benefit analysis

Public and Private Capital Investment

Caselli, F., & Feyrer, J. (2007). The marginal product of capital. The quarterly journal of economics.

- Marginal product of capital is very similar across the world

Aniket, Kumar (2014). Poverty Trap with Convex Production Function: The role of Public and Private Capital.

- Marginal product of public and private capital related through tax revenues
- Borrowing constraints for government and entrepreneurs related
- Multiple equilibria and coordination game between lenders

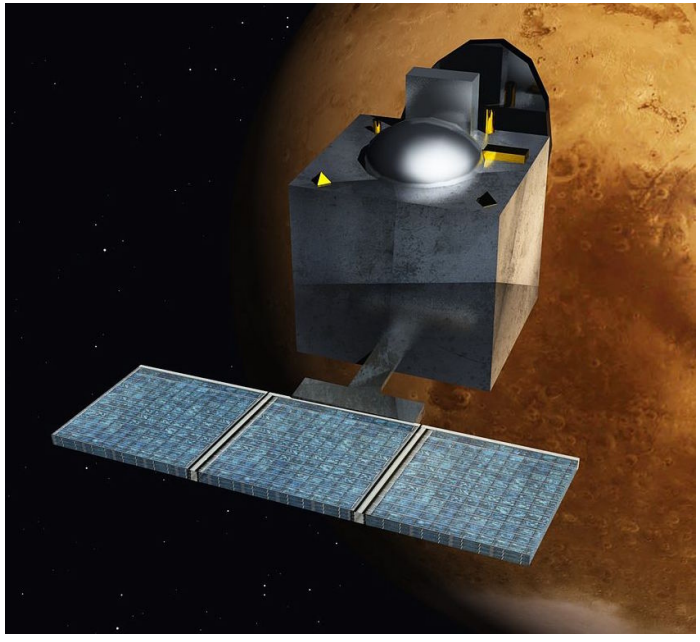
Frugal Innovation

Radjou, Navi, Jaideep Prabhu, and Simone Ahuja (2012). Jugaad innovation: Think frugal, be flexible, generate breakthrough growth.

Jugaad innovation:

Mars Orbiter Project.

Reality ($71M) cheaper than Fictionalised Reality ($100M)



Organisation of Mega-projects

Munshi, Kaivan (2011). Strength in numbers: Networks as a solution to occupational traps. The Review of Economic Studies.

Kremer, Michael (1993). The O-ring theory of economic development. The Quarterly Journal of Economics.

O-ring production and the Challenger disaster:

- complementarities between factors
- perils of market

Diamond cutting industry:

- high quality products that require initiative and innovation require long term contracts

Scale and Competition

"Too many cooks spoil the broth" versus *"Many hands make work light"*

"We can know more than we can tell . . . "

– Polanyi (1966)