

POWERING PRODUCTIVITY 2/2 —Exploring the links between energy and productivity

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Executive Summary

Find the full report at: www.cusp.ac.uk/powering-productivity

The UK is experiencing a period of low productivity growth. Although exacerbated by the financial crisis of 2008, the underlying trend is longer and more persistent. Trend labour productivity growth has been declining since the mid-1960s. Conventional understandings fall short of explaining the reasons behind this decline. The quality and availability of energy has been proposed as one driver of productivity growth. However, the links between energy and productivity are mediated by many factors and the relationship is contested.

This report aims to expand conventional understandings of productivity by exploring the literatures which relate productivity to the availability, production and use of energy in the economy. The report is the result of a survey, a desk-based literature review, and a participatory mapping process (Boehnert et al 2019). We provide an introduction to key theoretical issues regarding productivity analysis and review work on the historical relationship between energy and labour productivity. We then review six channels through which it has been proposed that energy and productivity may be related. They are: 1) Capital; 2) Prices; 3) Energy Consumption; 4) Energy Return on Energy Invested; 5) Economic Structure; and 6) Climate Change. Key findings and research gaps are summarised below.

Key finding 1

There are numerous potential links between energy and productivity.

• Researchers have proposed a variety of links between energy and productivity. Key suggested links include the way that capital uses energy, and the way that economic actors respond to energy prices. There may also be more indirect links, particularly through climate change and the quality of the energy supply. Links often cut across physical and social aspects of economic systems.

Key finding 2

There is insufficient empirical evidence to prove or disprove many of the proposed links.

• While many researchers suggest that energy and productivity are linked, there is relatively little consensus in the empirical literatures either confirming or rejecting these views. In some cases (notably the relationship between capital and energy), we do not appear to have robust methodologies for making empirical assessments.

Key finding 3

Mitigating against the negative impacts of energy use may require transformative change.

• Fossil fuel energy use drives climate change, which is itself likely to reduce productivity levels. Reductions in the quality of available energy may also impact productivity in a number of ways. Mitigating these impacts could require transformative changes in the way we use energy, and potentially also a rethinking of productivity growth itself.

Research area	Recommended topics for further research
Productivity measurement	 Different partial productivity measures give different understandings of the productive process. The literature would benefit from studies of the relationships between different partial productivity measures. Many productivity measures use a narrow output measure based on market metrics. This dictates a particular relationship with energy. Productivity research would benefit from engaging with a wider set of output measures and associated methodologies.
Long run relationships between energy and labour productivity growth	• There is evidence that energy transitions have played some role in long-run productivity growth. However, there is no agreement on how. Further research is needed into the causal mechanisms underlying cultural or institutional shifts that gave rise to the simultaneous increases in fossil fuel use and labour productivity growth that we observe over the long run.
The capital- energy relationship	 There is no robust empirical basis for determining whether energy and capital are complements or substitutes. Establishing this key relationship requires us to examine empirical methods at a fundamental level. In particular research is needed that closely examines the core concepts of production theory, and the ways in which they are operationalised. Likewise, we need more pluralism in the methods and concepts applied in energy-capital debates. Currently there is a homogeneity of methods and metrics that limits our ability to fully explore the energy-productivity relationship
Energy prices and productivity	 Further empirical research at the firm level is needed to examine the effects of the change in energy prices on their performance in different economic sectors. Examination of the short-run adjustment costs associated with the reallocation of labour and their ability to shift from one sector to another due to the changes in the energy prices, specifically in the context of emerging technologies. Work to clarify questions around asymmetry and the persistence of the relationship of energy prices and productivity.

Recommended areas for further research | Summary

Energy consumption	• One way to reduce the potential impacts of energy price or supply shocks is to change our relationship to energy use. Marginal behaviour changes appear to have limited effectiveness. We recommend more research into transformation possibilities of the macro-level social structures that governing energy use.
Energy return on energy investment	• Changes in energy return on energy investment (EROI) could have significant and long-lasting impacts on productivity. Although a number of potential impacts are clearly set out in the literature, work explicitly linking EROI and productivity is relatively scarce. We recommend further work on EROI-productivity links, particularly how they are mediated by socio-political systems.
Economic structure	 The services-productivity link. On both an empirical and theoretical level, the issue of how services are linked to productivity is relatively poorly understood – especially in light of emerging technologies. The services-energy-social value link. As of yet it is unclear just how great a potential the service sector has to reduce our energy dependence. Further work in this area should focus on the social structures that drive demand growth for service sector activities, and the link with broader productivity measures beyond market value.
Climate change	 Systematic comparison of the theoretical assumptions of different climate-economy models with respect to productivity. CGE models appear to find small impacts via productivity, while others find much more substantial impacts. Research into the specific mechanisms by which energy capital may influence productivity. There is little empirical work on the ways that capital may be impacted by climate change or mitigation efforts. Transformational strategies to avoid climate change. A substantial body of work suggests that productivity growth may be driving climate change. Consequently, structural transformation may be required to avoid it.





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