Energy and Productivity in the UK: Demand and Supply Perspective

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Why productivity is relevant?

Figure 1 Productivity Growth trends for G7 (based on GDP per hour worked and constant prices of 2007)

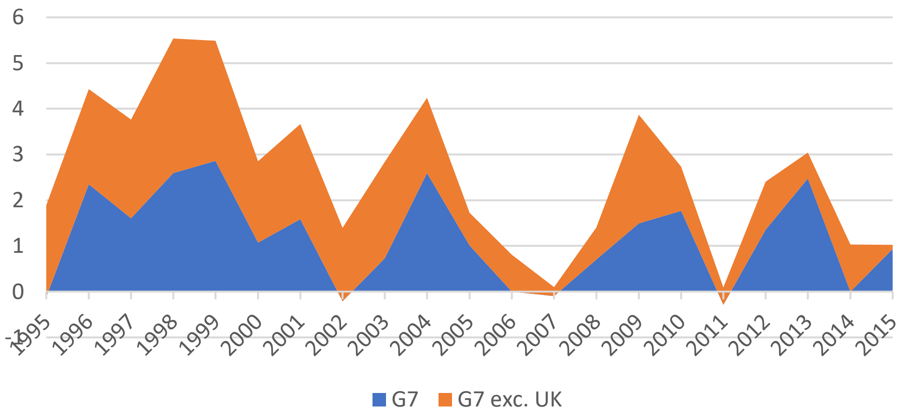
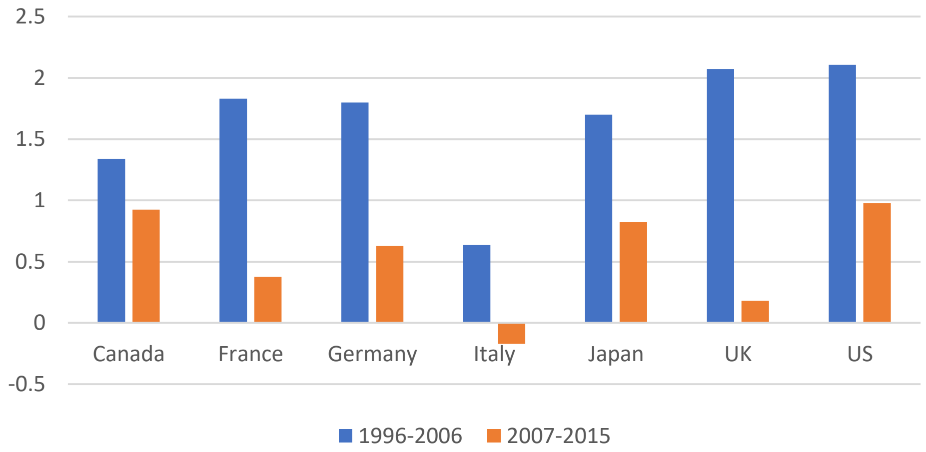


Figure 2 Average Productivity Growth before and after the Financial Crisis in 2008



Source: Author's work based on OECD data

How energy prices affect productivity?

Multiplier Effect

This would capture all the indirect effects of prices changes on productivity that exceeds the direct effect on cost of production

- **M1-Uncertainty and Expectations**

Expecting increase in energy prices in the future would affect consumer confidence and decisions about the postponing of the current consumption in the fear of job loss and income drop (Berndt and Wood, 1986).

- **M2-Adjustment Costs**

Increase in energy prices affects the productive capacity by forcing firms to shift the productive techniques and technologies and encounter higher costs of structural modification into energy efficient ones that conserve energy (Hamilton, 1983; Gilbert and Mork, 1986).

How energy prices affect productivity?

Multiplier Effect

- **M3-Labour's Marginal productivity**

The long established complementarity between energy and capital would transfer an increase in energy prices into reduced capital utilisation that decreases marginal productivity of labour and consequently reducing wages (Finn, 2000; Rotemberg and Woodford, 1996).

- **M4- Employment**

Davis and Haltiwanger (2001) find that the adverse effect of increase in energy prices on job depletion to be ten times higher than the effect of employment creation of the decrease in the energy prices due to job loss and labour reallocation mechanism.

What is the future of energy?

Energy Return on Investment (EROI)

EROI is the ratio of energy produced to the energy used in the production process which generally reflects the amount of energy surplus.

Recent energy studies show the magnitude (the strength) of relationship between energy prices and productivity would depend mainly on the ability of the economy to quickly respond to changes in Energy Return on Investment (EROI) (Murphy et al., 2014).

Murphy and Hall (2011a and 2011b) found that energy prices are negatively associated with EROI which implies that as the cost of oil increases due to exploiting the unconventional reserves this would lead to significant decline in EROIs of different sources of energy which would raise the price of energy.

The sustained decline in growth and productivity is an adjustment process for the market to put up with the declining EROIs and the upward trend of the increase in energy prices that is a result of the interaction of declining fossil energy supplies and the exponential increase in energy consumption.

What is the future of energy?

“Growth Paradox”

Enhanced economic growth requires new innovation and technology that needs to be supported by further energy supply contributing to the increased demand on energy raising its prices that in itself would deter further productivity growth (Hall et al., 2008; Murphy, 2014). Therefore, the oil industry is faced with high costs of production due to the low EROI of the less explored sources of oil (for example oil extraction from ultra-deep-water areas and oil shale) that makes it difficult to sustain lower prices.

The demand side of Energy-Productivity Nexus

Worldwide demand for energy services has witnessed a significant growth as reported by the International Energy Agency which reports a global energy demand growth of 2.3 percent in 2018, the highest growth rate in a decade, and 1.7 percent growth in energy-related CO_2 emissions driven by the industrial consumption and the heating and cooling requirements of the household sector (International Energy Agency, 2019).

Decoupling

Better standards of livings and lifestyle has its own tax of energy consumption where the wealthiest most developed countries with only 25 percent of the world's population consume more than 75 percent of the total world's supply of energy (Stambouli, 2011).

There is little evidence of this decoupling (Hu et al., 2018; Barrett et al., 2013; Brockway et al., 2015).

At the global side, the relationship between the country's income level and the demand on energy is very strong and little is known about the effect of policies that aim to reduce the energy demand from the consumption side on the economic productivity (Sorrell, 2015).

Consumer-Behaviour

Short-term repetitive behaviours towards energy (for example checking appliances and energy use, commuting by walking or cycling) can sustain long-term changes in the attitudes and behaviour of energy consumption and hence energy demand (Dwyer et al., 1993; Geller, 2002).

Some others argue that the long-term strategic energy efficiency behaviours (for example buying energy saving cars, building house insulations and having bigger double-glazing windows that preserve energy and allow for maximum lighting) are more significant in reducing the energy demand (Garling et al., 2002; Abrahamse et al. 2005).

The most effective attitudes towards energy are achieved under routine feedback on energy consumption and savings with its cost reductions and environmental impact that can significantly affect energy behaviours and reduce bad energy habits and instigate new attitudes and behaviours towards energy demand (Martiskainen, 2007).

Consumer Behaviour: Rationality

Although this theory has been the main driver of information campaigns and awareness wave for benefits of energy saving and energy conservation that mobilised the public opinion in the late 1970s, it did not show neither evidence of effectiveness nor impact on habits, perceptions, notions and attitudes toward energy demand (Martiskainen, 2007).

The Ecological Value Theory posits that the most conscious energy attitudes emanate from pro-environmental behaviours and pro-social values. Yet, Jackson (2005) and Druckman and Jackson (2008) argue that demographically those who embrace pro-environmental stances do belong to the higher income and social classes who exhibit the highest level of domestic energy consumption.

Consumer Behaviour: Rebound effect

The direct effect on energy demand of increased efficiency of some energy services (and the relative decline of their relative prices) suggests a more relaxed attitude towards more energy consumption and basically higher energy demand that could overwhelm the initial energy efficiency effects (Sorrell et al., 2009).

The indirect rebound effect entails that energy savings of higher efficiency and improved technology that results in higher real income would instigate other forms of spending which are either consumption of other goods and services with energy requirements or investment that could be energy-intensive in nature (Chitnis et al., 2014; Jackson,2005).

Economic Structure

There is an academic consensus on the strong linkage between energy demand and the economic structure (Hu et al., 2018; Chunbo and David, 2008; Feng et al., 2009).

The latest McKinsey & Company reports of Nyquist (2016) and Sharma et al (2019) predict that the increase in global energy demand will persist, yet the rate of growth would be reduced by an average 0.7 percent through 2050 due to the world-wide trend of the economic transition from the manufacturing sector to the services with its less-intensive energy production endowments.

The supply side of Energy-Productivity Nexus

Productivity growth from the perspective of productive efficiency would be producing more goods and services given the same quantity of labour, capital and energy while keeping factor prices constant. The second type of productivity growth emanates from the allocative efficiency which is attained when the market for goods and services reaches an equilibrium in which the supply that reflects the marginal cost of producing one extra unit of a product is equal to the demand.

Social Efficiency

Social Efficiency reflects the optimum resource distribution in which the marginal social benefit is equated with the marginal social cost of any economic activity. This is a situation which indicates the Pareto efficiency where the negative externalities of any economic activity or economic production is controlled for. In another words, if we don’t control for the negative externalities of energy production and consumption and if we could not integrate the social cost of energy in the analysis of productivity growth, we end up in a situation with a total deadweight loss in the welfare of the whole society that is equal to the price paid by the free market equilibrium.

A social equilibrium at higher price and lower quantity would attain that Pareto efficiency in which it is impossible to make anybody in the economy better off.

Social Efficiency

According to the social efficiency perspective, the only mean of enhancing productivity growth and efficiency is innovation and technological advancement that can push the supply curve outward while keeping the same price that reflects the social marginal cost. Here, we can talk about the dynamic efficiency which develops by the state of innovation, R&D activities, new ideas and new techniques and methods that improve the state of living and quality of life over time.

Technological Development

There is no doubt of the relevance of extensive R&D activities and learning process in changing an existing technology would change, yet, the outcome of these activities that results in the widespread of these technologies and its implementation on an industrial or sectoral scale is central to the necessary technological evolution in the energy sector.

Recent studies have showed that R&D spending in the energy sector in major industrialised countries are not necessarily associated with significant changes in energy efficiency or carbon reduction (McDonald, Schrattenholzer, 2001; Sagar and Holdren, 2002; Sagar and van der Zwaan, 2006).

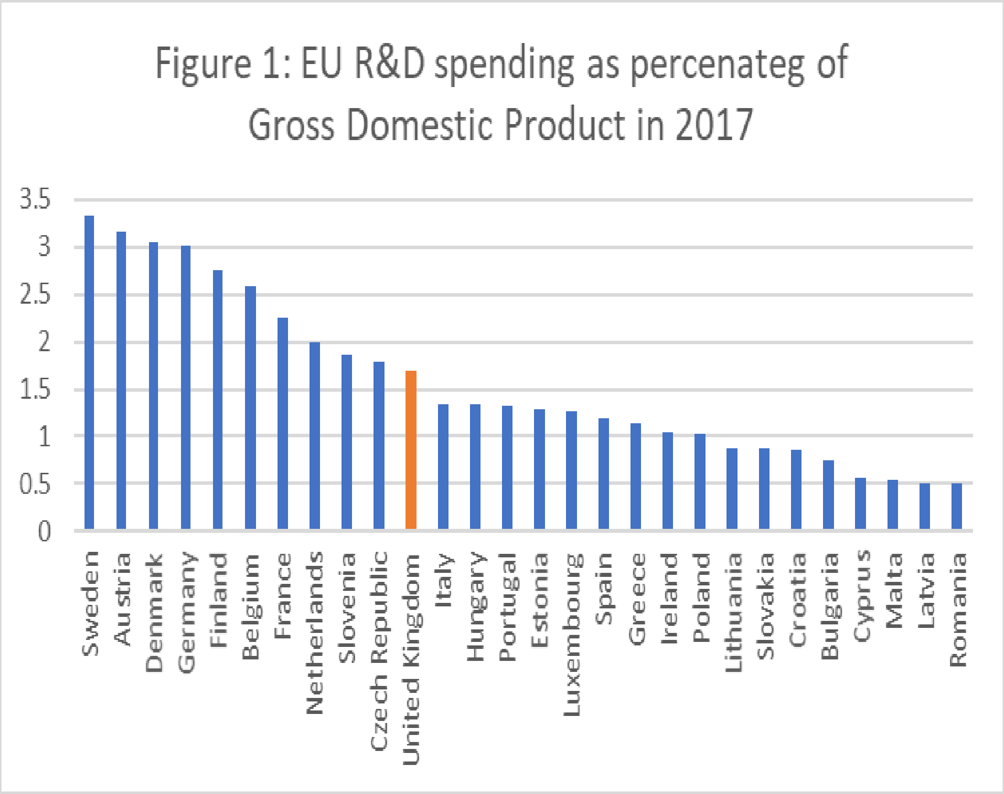
This could be explained by the long-term nature of returns of public R&D expenditures in under-developed energy domain or a strategic energy source like nuclear energy regardless of the contribution of this energy source to the national energy supply.

For example, Japan spends more than 70 percent of its public R&D expenditure on nuclear energy that constitutes less than 15 percent of its primary energy supply (International Energy Association, 2019).

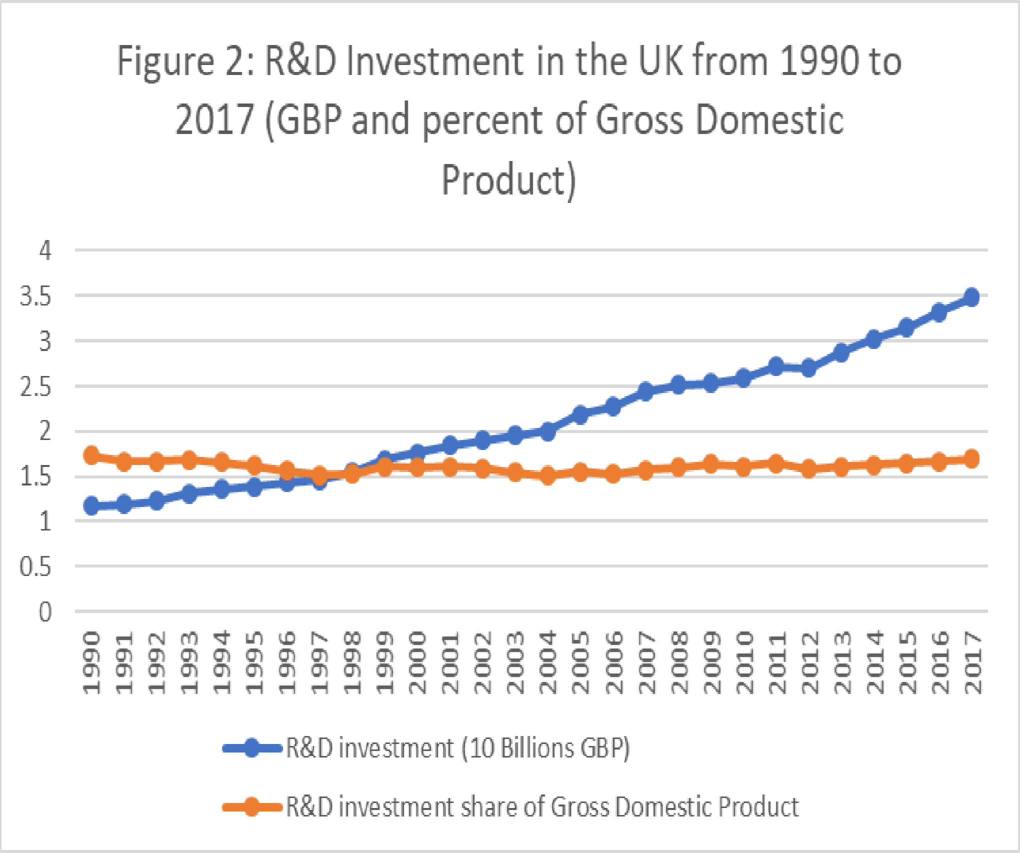
Policy-perspective of energy

- In particular, we need to understand the relationship between the productivity of major energy sectors -that has witnessed average drop of 40 percent since 2007 (for example the productivity of the UK's oil and gas extraction sector has been falling for more than a decade) and the economy's productive capacity (Patterson, 2012).
- Energy sectors like oil and gas extraction are capital-intensive and this generally translates into high productivity. However, cuts in capital spending (including innovation and R&D activities) and slow replacement of worn out and obsolete machines and equipment with high levels of uncertainty against the background of economic slowdown expectations adversely affect productivity growth.

Policy-perspective of energy



Source: Author's work based on [Eurostat]



Source: Author's work based on [Office for National Statistics database]

Policy-perspective of energy

In 2017 based on the Office of National Statistics, UK's R&D spending reached £34.8 billion accounting for 1.69 percent of Gross Domestic Product with 1.6 billion increase since 2016. This 4.8 percent increase in R&D spending in 2017 is above the annual average increase of 4.1 percent since 1990. However, this remains significantly lower than the average R&D investment in the 28 countries of the European union (with an estimate of 2.07 percent of Gross Domestic Product) which has placed the UK as the 11th country in the EU in R&D investment as a percentage of Gross Domestic Product.

The European union has already set a target of 3 percent for R&D investments as a share of Gross Domestic Product by 2020 which has been already reached by Sweden (3.33 percent), Austria (3.16 percent), Denmark (3.06 percent) and Germany (3.02 percent).

Conclusion

While the UK economy has grown by nearly 70 percent since 1990 and energy emissions have dropped by more than 40 percent, there is very little effort to capture the effects of enhanced quality of life and better state of welfare created by lower energy emissions in productivity measurements.

Accounting for the negative externalities of energy use in national accounts and measuring the improvement of the greenhouse gases would help to capture more comprehensive indicator of productivity.

It is very relevant in terms of policy-making to capture the real value a better quality of life and how this could impact productivity in the long-run. All activities that aim to create sustainable economy with balanced supply of different energy sources and rational consumption of this energy are barely reflected in any of the current measurements of productivity.

The future capacity to sustain growth and well-being is not fully reflected in the concept of productivity which is an output measurement. The global economy is merely depending on some indicators of economic thriving that depends on quantifying output based on market prices, yet, there is very little effort to measure economic performance by outcome-based indices that is focused on the quality of life, sustainability of performance (skills and resources) and well-being of its constituents in terms of physical and health capacity.