

ICEST 2020
**International Conference on Economic and Social Trends for Sustainability of
Modern Society**

**INFLUENCE OF PHYSICS-BASED SECTORS ON THE
ECONOMY**

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Abstract

This work is focused on industrial physics and its contribution toward economy. The work highlights how physics-based sectors play a vital role in generating economic growth and prosperity. The main comparison here will be the influence of industrial physics on economy. The article starts from explaining industrial physics and what goes into it and where it can be applicable. Literature review gives an idea of the influence of industrial physics or simply physics on chosen countries. The following four countries were chosen: the United States, the United Kingdom, Ireland and Italy. The following four countries were selected as there was available data on the influence of industrial physics on economy. The results illustrated that physics-based sectors have a tremendous effect on the selected countries economy. Physics based-sectors influenced a number of jobs, exports and thus have a positive effect on economy. The number of employees in physics-based sectors were analyzed. The results illustrated a similar path for the selected countries if perceiving the result in percentages. The values were in the range of 4% and 8.6 %. The exports of each country were also analyzed. The results showed that the US has the highest rate of exports and Ireland's exports are less than the others. The percentage difference in exports were high if compared with the percentage difference in employment. If looking at the revenue from exports, again, the US is in the leading place, followed by Italy, then, the UK and the last one is Ireland.

2357-1330 © 2020 Published by European Publisher.

Keywords: Economy, physical-based sector, the UK, the USA, Ireland, Italy.



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1. Introduction

It is hard to imagine for today's generation to live in a world without gadgets and devices that we are surrounded with. These scientific breakthroughs can be directly related to industrial physics. Not so many years ago, around the middle of the 20th century physics discoveries were transformed by the usage of industrial physics into today's known incredible products and services. Since then industrial physics has altered dramatically. Living in the present-day establishment of new products and services feels natural and integration goes as barely noted, but if to compare the starting point to the present state of industrial physics, it has gone through vast changes. The tendency of the non-stop growth of physics into industry is far from ending and is stepping further each coming year.

Industrial physics is not just well-trained physicists, but rather a combination of physics knowledge, principles to the design, manufacturing and services etc. These principles include understanding of cause and effect in the physical world; harnessing light, force, and energy productively; and creating materials from the nano-scale to the mega-scale (American Physical Society, 2019; Leveson, 2015). As was mentioned before physics in industry is used to create products and services. However, there is another side to it, which is profit. Industrial physics benefits to economy. Therefore, the need of improvement and future perspectives in this field is essential. However, this article will look into the economic prospects of industrial physics (Mentsiev & Guzueva, 2019; National Center for Science and Engineering Statistics and U.S. Census Bureau, 2017).

2. Problem Statement

In the last decades physics-based sectors proved to be profitable parts of the economy of some countries despite when other sectors went vulnerable physics-based sectors stayed steady. Therefore, it is important to understand that physics-based sectors have prosperous influence on the export, unemployment and etc.

3. Research Questions

After the analysis of the work the comparison of the results will take place and the following bullet points will be covered.

- The effect of physics-based sectors to the economy of chosen countries;
- To find out if there are any similar paths in physics-based sectors of chosen countries when compared the results of jobs and exports.

4. Purpose of the Study

The main aim of the work is to compare the influence on the physics-based sectors to the economy of the chosen countries. To understand the path of influence of physics-based sectors to the economy of the UK, the USA, Italy and Ireland.

5. Research Methods

The analysis done by Deloitte MCS (“Deloitte”) for the Institute of Physics (IOP) of the United Kingdom states “Physics is central to the economy of the UK”. When looking from perspective of direct jobs in physics-based sectors they found that the peak was in the year of 2008. However, the number is in excess of 1 million jobs. The decrease in year 2008 is directly related to the financial crisis at that period. The most dawn effect of the financial crisis was experienced by manufacturing activities, and it was evaluated to be around 50 % of total activities. While 50 % of other activities were in increase, such as architectural, engineering services, research and development (R&D), transport, electricity production and distribution and defence. Therefore, the listed sectors (activities) were identified as a crucial part to the economy recovery. They also found that from period between 2005 and 2010 direct jobs in physics-based sector were approximately 4% of all jobs in the United Kingdom. Direct jobs in physics-based sector exceeded the share of direct jobs in the banking, finance, insurance and also in the construction sector.

If physic-based sectors exceed the share of direct jobs compared to other sectors, there should be also another side of benefits, which can be related to exports. However, the analysis revealed that the exports of the United Kingdom deteriorated dramatically over the period of 2004-2009. It was also found that between the period of 2005 and 2009 the UK exports from physics-based sectors was 26% of total turnover in physics-based sectors. Physics-based sectors in 2009 in the UK exports of goods and services was worth around 100 billion pounds while the imports were worth around 125 billion, where the difference is quite contrast. However, if businesses in physics-based sectors to be compared with the businesses in the rest of the economy first mentioned will earn a greater share of turnover from exports. The gathered data illustrated that UK businesses in physics-based sectors export less than Germany, the United States, Japan, but more than France. The contribution of physics-based businesses to the UK’s economy outputs can be estimated around 8.5 % and one million people are employed. By considering an indirect effect such as supply chains for these businesses the value goes to 3.9 million and contributes 220 billion pounds to the UK economy (Deloitte, 2012).

Similarly, Deloitte did an analysis on the Italian economy on behalf Società Italiana di Fisica to understand, particularly, the contribution of physics-based sectors to the economy of Italy. In physics-based sectors of Italian economy have been diverse since 2008. The number of employees in physics-based sectors were clearly declined and the percentage of decline was marked 7% starting from 2008 and ending in 2011 at its peak. It was found that with the fall of the number of jobs in 2008 the number still exceeded one million jobs in the physics-based sectors, and it can be accounted to 1.5 million in 2011, 6.1% of all employment (in the year of 2008 the number of jobs in the physics-based sectors were around 6.4%). Similarly, as the UK most dawn effects on jobs lost in Italy were experienced by manufacturing sectors. Over the period of 2008-2011 dawn effect on jobs lost in the manufacturing sectors was evaluated to be around 80% (Mulvey & Pold, 2015).

The analysis was done on physics-based sectors of Italian economy to see the shifts in exports and imports. The analysis illustrated unsteady results of imports of products made and used by physics-based sectors in the period between 2008-2011 if to be compared over the same period with equivalent measures of exports. Exports from physics-based sectors accounted for 35% of total turnover in physics-based sectors between 2008 and 2011. The results also show that in the period of 2008-2009 the exports in physics-based

sectors declined by 25%. This might be due to the long-term contracts, which are tied with Italian exports or exports to area where effect of recession went unnoticed, for example China. Consequently, visible balance of trade in physics-based sectors turned negative due to the mentioned statements, the demand for imports increased faster than the demand for exports. It was estimated that physics-based exports were accounted around 134 billion euros (Deloitte, 2014).

The following paragraph will look into analysis of influence of physics-based sectors to economy of the United State. Industrial applications of physics have been a prime mover of the U.S (American Physical Society, 2014; U.S. Census Bureau, 2012). Similarly, as the UK and Italy the US was affected by the recession of 2008-2009. However, physics-based sectors of economy were unaffected by the recession than other sectors such as retail, services and construction. The data gathered in 2016 illustrated that around 11.5 million people were employed, which is 6% of total the US employment (Bureau of Economic Analysis, 2016; Leveson, 2015).

Physics-based sectors plays a big role in the economy of the United State. The data were gathered in 2016 and illustrates that the US exports in physics-based sectors are 1.1 trillion, which is approximately 20% of the value added (GDP) produced by those sectors (the illustrated percentage stayed almost constant in the period of 2010-2016). The highest mark in the exports can be given in the year of 2014 and the lowest at 2010 (meaning that the data were taken in the period 2010-2016) (Gordon, 2017; Henttu et al., 2012). High-value, physics-based exported products include semiconductor chips, medical imaging equipment, and advanced commercial and defense aircraft (American Physical Society, 2019; Freedonia Group, 2016).

Lastly data on Ireland physics-based sectors and their influence on economy are presented. Ireland is the smallest country that is presented in this work if to be compared with other countries which were discussed above. Results from 2014 illustrates that direct employment in physics-based sectors (industries) was about 160 thousand, which is 8.6% of total employment. It also was found that physics-based sectors share of aggregate employment exceeds that of both the construction and financial services sectors (Institute of Physics, 2017). Also, if to be compared with some parts of the UK for instance Scotland, Wales and Northern Ireland the comparison of employment was varied (in 2014). Employment by physics-based sectors in Ireland was lower than in Scotland, but higher in Wales and Northern Ireland. In terms of export Ireland in 2013 exported €37 billion of worth goods and services (American Physical Society, 2019).

6. Findings

The following paragraph will be dedicated to compare the different values in the physics-based sectors of beforementioned countries and effect on their economy. It is clear that the gathered results of influence physic-based sectors to economy of selected countries cannot be directly compered. It is due to the luck of the data from the same period, methods usage and number of samples taken (one country's population is higher than the other population therefore the average values were used). For instance, data used in Italian economy were mainly taken in period of 2008-2011, where for the UK data were taken from 2005 to 2010 and similarly for other two countries, which are the US and Ireland. However, in this section will be discussed tendency of results rather direct comparison.

As physics-based sectors has huge impact on economy and thus influence on employment. For example, it was stated that the UK peak of direct jobs in physics-based sectors was around 2008 before the

recession. Similarly, for other three country recession did influence on their economy. However, it was mentioned that recession slightly influenced physics-based sectors, whereas manufacturing, retail and services sectors were influenced most. It is fear to say that the US has 11.5 million people employed in physics-based sectors (which is the highest result), second one is Italy with the 1.5 million, then goes the UK with 1.1 million and Ireland with the number of 160 thousand. Of course, these numbers cannot be directly compared, as it was stated before, as these values were taken in different year and with the different sample numbers. However, by looking into percentage of physics-based job from total the tendency of the numbers stays almost the same for all four countries. Direct jobs in physics-based sector in the UK were around 4% of all total jobs, for Italy 6.1%, for Ireland 8.6% and for the US its accounted around 6%. By comparing the numbers of jobs provided by physics-based sectors it is clear that the difference is vast, but when looking at the percentage it seems that all four countries follows the same trend (path). The difference between these numbers is small. Hence one can assume that physics-based sectors produces around the same number of jobs (this is applicable just judging the results from this work, which were gathered by other researchers).

Exports and Imports were also discussed in this work (but only exports will be compared). It was evaluated that between period 2005 and 2009 UK exports from physics-based sectors was 26% of total turnover in physics-based sectors. Italy exports from physics-based sectors accounted for 35% of total turnover in physics-based sectors between 2008 and 2011. Similarly, the US in period of 2010-2016 exports 20% and Ireland in 2011-2014 14% of total turnover in physics-based sectors. The UK exports goods and services worth of 100 billion pounds, Italy 134 billion euros, Ireland 34 billion euros and the US 1.1 trillion dollars. By no means these values cannot be compared with each other (table 1), but it is obvious that the largest country earns from exports more than the three others and the smallest country Ireland exports goods and services lesser than the left three countries.

Table 01. Exports and jobs from directly related with physics-based sectors (data are collected from different periods)

Countries	Exports %	Jobs %
UK	26	4
Italy	35	6.1
US	20	6
Ireland	14	8.6

7. Conclusion

To conclude, the analysis of influence of physics-based sectors on economy of the UK, the US, Italy and Ireland was done. Instruction of the work gave brief understanding of physics-based sectors. In the section of literature review the effects of physics-based sectors on economy of the UK, the US, Italy and Ireland were given. The analysis illustrated that there is a path for the results gathered of physics-based sectors in terms of jobs. The range of difference in the jobs were small and therefore for all four countries the similar path is follows. Similarly, analysis was performed on exports of the selected countries and results illustrated the discrepancy in the outcome.

Future amendments can be taken into account when analysing this problem in the future. For instance, it would be better if comparing results are taken from the same period, in that way results shows real path of outcome. Similarly, for the number of samples taken when doing analysis.

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