



Economic Contribution of Standards in Ireland

A report for the National Standards Authority of Ireland

April 2016

Cebr

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Executive Summary

This report examines how standards – in diffusing technological progress and promoting efficiency in business – are contributing to Ireland’s economy, and how standards can play a pivotal role in the next stage of Ireland’s economic development. The report and underlying study were commissioned by NSAI – the National Standards Body (NSB) of Ireland.

The report is based on a desk-based review of the role of standards in Ireland and the economic contribution that they make. This was aided by a high-level meta-analysis of studies already carried out in the UK, Germany, France and Denmark, including an examination of how the structure of Ireland’s economy and its sectors differs to these ‘comparator’ economies. It was also aided by new evidence on the use of and attitudes towards standards in Irish industry, gathered through a survey of 250 company directors in December 2015, commissioned by NSAI from Behaviour & Attitudes (B&A), a Dublin-based market research company.

This facilitated the quantification of the economic contribution of standards to the Irish economy presented in this report. The key findings of the study are presented here.

- The national-level studies carried out in the comparator economies all find a statistically significant and positive relationship between standards and productivity growth. This leads naturally to the conclusion that **standards play an important role in determining the pace of long term economic growth** and job creation.
- These economic contributions are **attributed to a vital and often invisible role that standards play in boosting export and FDI activity by defining best practice, galvanising innovation and further catalysing it**, not only in production and manufacturing but increasingly in the services sector also.
- The B&A survey evidence would seem to confirm that, **throughout many Irish industries, the various channels and mechanisms through which standards generate these economic impacts are widespread** and that the perception of the roles and effects of standards in Ireland are consistent with the findings of the national-level studies.

The economic impact of standards in Ireland

- The analysis suggests that **standards supported at least 13.8% of annual labour productivity growth** in the Irish economy over the period 1964 to 2005, translating to **an estimated 9.7% of annual GDP growth**. To give an idea of the scale of these impacts in monetary terms, the 9.7% of annual GDP growth translates to **an annual average boost to GDP of €309 million**, expressed in 2014 prices. Cebr reckons **this is sufficient to have supported the creation of about 7,500 permanent full-time equivalent jobs in Ireland** by the end of the period 1964-2005.
- This is a rather **modest impact compared with the impact of standards in our ‘comparator’ economies**, such as the most recent finding that standards supported an estimated 37.4% of annual labour productivity growth in the UK over period 1921 to 2013 (Cebr, 2015). **Estimates vary between studies but overall the findings suggest that standards account for between 5% and 35% of productivity growth** in their respective countries.
- But the data for Ireland covers a period (1964-2005) of rapid ‘catch-up’ with the rest of Europe, in terms of industrial development, infrastructure investment and technological progress. Estimates of **the role of standards in this period** can be expected to be somewhat **drowned out** by the significant

labour and total factor productivity improvements catalysed by **rapid capital accumulation in Ireland**, as especially witnessed during the ‘Celtic Tiger’ years. **If this is the case**, although standards would have played the same role in business and the economy, the importance of their role in explaining productivity and economic growth would be expected to be smaller than in a period absent such seismic ‘catch up’ convergence.

- The extension of our analysis to 2013 suggests however that **today, standards are supporting a more substantial 17% share of GDP growth**, which equates to **approximately €335 million** of our real terms estimate of an average €1.95 billion in GDP expansion recorded over the period 2006-2013 (expressed in 2014 prices). Cebr estimates that this is sufficient to have supported the creation of **an additional 900 permanent full-time equivalent jobs** in Ireland by the end of the period 2006-2013 (making a **total jobs impact of ca. 8,400**).
- **The jump from the 9.7% estimated for the 1964-2005 period to 17% over the period 2006-2013 reflects economic growth that appears to be achieving relative stability.** In other words, **during 2006-2013, capital accumulation is likely to have been less dominant in accounting for productivity growth.** The increase can also be rationalised by **the recent pace of globalisation and of business R&D investment trends.** (See Section 5.1 in the main report.)
- **Although the estimate for 2013 is still mid-range relative to estimates for the comparator countries, the differences can be explained by the differing structure of Ireland’s economy and what this reveals about the intensity of use of standards.**
- But isolating and measuring the precise economic impacts of standards is not an exact science and, as noted in Cebr (2015), standards do not support productivity and economic growth independently. Rather, **standards play a symbiotic and complementary role with other factors like technological progress and educational improvements.** Standards **support productivity growth through a variety of mechanisms and intermediate effects within and between companies that enhance business performance, improve trust, stimulate trade and galvanise and catalyse further innovation.**
- **Enhanced productivity as a result of standards can increase profitability and is key to companies investing in new capacity, either through hiring new staff or undertaking new fixed capital investments or both.** Previous academic studies show that **the effect on employment is particularly strong in cases where companies are using quality management standards** to improve both management practices and production processes. The B&A survey evidence suggests that these are some of the most widely used categories of standards in Irish industry.

How the economic impact of standards transmits through business

- The academic literature argues that **standards play four important economic functions that help business and their industries overcome fundamental problems that can impede them maximising their productive potential.** The B&A survey evidence suggests that **these important economic functions are working well in Ireland** and that the perception of the roles and effects of standards in Ireland are consistent with the findings of the comparator economy studies. Each of the four economic functions of standards and the supporting evidence is explored in the following points.
- **Standards help businesses enhance the quality of their products and the efficiency of their processes:** European and international standards are identified with reducing the transaction costs involved in ensuring quality and compatibility, allowing companies to outsource more of their supply chain to the most competitive external contractors whilst avoiding the negative consequences of a ‘race to the bottom’. The strength of the European standards system internationally can also be expected to give

Irish companies a competitive advantage abroad. The B&A survey evidence suggests 71% of Irish companies agreeing that standardization has improved client-supplier relationships and 85% agreeing that multinational companies are more likely to do business with an Irish company that adheres to internationally-recognised standards. Considering the relatively small size of Ireland's domestic market, it is essential that companies are able to effectively sell into internationalised supply chains and standards can play an important role in this endeavour.

- ***Standards help industries efficiently reduce the variety of goods and services in order to minimise cost:*** Standards that ensure interoperability of complementary products are important in reducing variety where greater homogeneity is more efficient. Compatibility between products and processes articulated through standards can also boost confidence in suppliers, thus supporting the development of more efficient supply chains. B&A found that 85% of companies surveyed agreed that companies that use standards have stronger reputations and 66% agreeing that standardization has helped their business to achieve economies of scale.
- ***Standards facilitate inter-operability of products and processes:*** Standards have been instrumental in the creation of the European single market for goods, which has facilitated increased trade and market-based competition by helping to ensure the interoperability of complementary products across the continent. The role of standards is likely to increase in importance as European institutions take steps to remove the barriers that have impeded the development of an effective single market for services and as they seek to implement an effective digital single market. This economic function appears to be working well in Ireland, with 58% of companies surveyed by B&A agreeing that standardisation has increased compatibility or interoperability of products and systems, which has resulted in increased price competition in their markets.
- ***Standards support innovation by efficiently making available technical information, allowing an effective and less costly inter-firm exchange of information:*** Cebr (2015) summarises the literature and the findings of original UK survey evidence, both of which suggest that standards facilitate innovation by reducing the time to market for new products and by promoting the diffusion of new knowledge. This can level the playing field between large and small companies, facilitate inter-operability and create the conditions required for an environment conducive to continued innovation in goods and services delivery. Amongst the Irish companies surveyed by B&A, 66% agreed that standards help to speed up technology transfer by making innovation more accessible. 62% agreed that standards encourage innovation by disseminating new knowledge.

The benefits of standards to trade

- Previous studies suggest a **positive** and statistically significant **impact of standards in promoting trade**. This is **attributed to lower transaction and search costs**, which **reduces the need to adapt products** for foreign markets, and provides information about overseas markets that would otherwise be costly to obtain.
- Standards have, in the past, been viewed as restrictive of trade, particularly where national standards are used to restrict competition from imports in the domestic market. The **development of standards at the European and international level is seen as vital in ensuring the dismantling of international barriers to trade and overseas market entrants where they still exist and are unnecessarily restrictive**. Survey evidence from the UK, presented in Cebr (2015) suggests that 3 out of 4 businesses disagreed with the suggestion that standards had contributed to higher barriers to trade. Similarly, the B&A evidence suggests that 64% of Irish exporting companies agree that standardization has made it easier to enter new foreign markets.

- **Standards are a fundamental underlying driver of the success of the European single market and Ireland's membership in no small part explains the fact that exports from Ireland equate to 114% of the nation's GDP (compared to a 42.9% EU28 average).** Standards will only increase in importance as Ireland continues its journey towards an increasingly knowledge and service-based economy, which closely aligns with the objectives of the European institutions to deepen the single market in services and to develop the digital single market.
- **Using the findings of academic research** on the impact of standards use on international trade, we estimate that **between 1980 and 1995, at least 7.8% of Ireland's annual trade volume growth was supported by standards** and the wider innovation ecosystem of which they form part. This equates to about €631 million of annual recorded trade growth and **a €310 million contribution to recorded export growth per annum**, expressed in 2014 prices (see Table 11 in the main report).
- **Between 1996 and 2013, the share of trade growth attributable to standards is estimated to be higher at about 23%.** This equates to an **average €415 million contribution to recorded export growth per annum** due to standards over this more recent period.

The role of standards in galvanising and catalysing further innovation

- The existing national-level studies and the Irish survey evidence also suggest that standards play an important role in R&D and innovation. These impacts have been **reported as particularly evident in more mature medium technology sectors such as automotive manufacturing.** These sectors focus less on the development of proprietary knowledge (patents) and are more likely to be intensive standards users, given their more process-oriented, less R&D intensive nature, which is more conducive to enjoying the economies of scale that standards facilitate.
- **But, Ireland is relatively light in these medium technology sectors,** given the absence of any automotive manufacturing, shipbuilding, aircraft or locomotive manufacturing of any note. This is **consistent with relatively low observed demand from Irish manufacturers** for the subset of **more traditional standards** that are relevant to this study – from organisations like **ISO, IEC, ITU, CEN and CLC.** Whilst there is **heavy utilisation of these standards amongst food and beverage manufacturing in Ireland,** demand for these types of standards tends to be **concentrated** in NSAI's experience in the **construction, gas and electricity sectors.**
- Studies on the economic impact of standards in other countries suggest that **high levels of foreign direct investment (FDI) are associated with higher impacts of standards, all else being equal.** The **Irish economy outperforms most of Europe and the comparator countries** on this metric, with Ireland ranking third in Europe in terms of cumulative inward FDI as a percentage of GDP (at 168%).
- **But, Irish manufacturing is concentrated in high technology sectors** (59% of the total compared to 13% across the EU28 countries), as is **Ireland's inward FDI and exports. ICT and pharmaceuticals are dominant, but these sectors tend to use industry standardization consortia** rather than WTO standards bodies to which NSAI is aligned. For instance, in the ICT industries, international industry-led standards developers like ECMA, WC3, IEEE and 3GPP are prominent.¹ This is perhaps reflected in

¹ Data on these standards or the numbers adopted in Ireland are not readily available and, as such, the estimates of the economic impact of standards in Ireland presented in this report would not pick up their effect. Neither do the existing national-level studies include these types of standards, except IEEE standards in some cases.

B&A's evidence that suggests below average participation in the standards development process amongst the Irish manufacturing companies surveyed.

- This provides a **plausible explanation for the lower estimated impact of (the relevant subset of) standards in Ireland than has been found for the comparator countries**, particularly given that its exports and FDI are concentrated in the high technology sectors, which are not heavy users of these standards. Other important comparative metrics include the concentration of business R&D activity, in which Ireland appears to have underperformed relative to the comparator countries in the past.
- But **globalisation has intensified the internationalisation of companies with footloose FDI, particularly in R&D, attracted to locations where they are guaranteed a sufficient pool of highly-skilled labour. Ireland is one such location** and has succeeded in attracting major investments by multinationals in R&D activities. **Between 2004 and 2014, business R&D expenditure has increased by 61%** but is still far below the EU28 average in Ireland's manufacturing sector. Nevertheless, this **provides a plausible explanation for the greater contribution of standards in Ireland in the 2006-2013 period**.

Benefits of participation in the standards development process

- The existing evidence suggests that the **involvement of companies in the standards development process can produce tangible benefits** in terms of gaining **early awareness of emerging themes** in their sector through **prior access to information** not normally received. This **enables anticipation of future market rules** and the achievement of **first mover advantage**.
- For example, **survey evidence from Cebr's 2015 study on the economic impact of standards in the UK suggests that 71% of all firms participating in the standards development process benefitted from the ability to lead the progression of their market**, not only in setting standards but in developing new technological solutions. But reported participation is low at 10% of UK SMEs, as opposed to 26% for larger companies.
- This is not dissimilar to the recent B&A survey evidence from Ireland. Of the 250 companies surveyed, 16% report that they have contributed to the development of standards. But, amongst that 16%, there is broad consensus that being involved in standards development confers a number of benefits, including the chance to promote their firm's interests at the national level (73% of respondent companies) and at international level (63%), to achieve recognition through an official system (87%), to participate in a network of the most influential operators in their sector (90%), to gain access to information that would not normally be received about activities in their sector (80%), to gain early awareness of product compliance standards such as future market rules and emerging themes (83%), to tailor product design to standards to get them to market first (77%) and to lead the development of their market by influencing the development of standards or promoting new technological solutions (70%).
- **But this same evidence suggests that participation by SMEs remains a challenge**. Given the magnitude of investment required in time and the resulting demands on their limited staff resource, not to mention travel and other expenses, the cost of participation can be prohibitive.

Conclusions

- *Enterprise 2025* sets out the Government's latest 10-year jobs and enterprise strategy. Key policy objectives are to be aimed at delivering sustainable, enterprise-based growth, with a particular focus on job creation and productivity growth within Irish companies, not least by encouraging greater

exporting. Within this strategy, Ireland's National Standards Body NSAI has been tasked with the role of promoting the benefits of standards to the widest cross section of industry, raising awareness of the importance of standards in the context of research, development, and innovation (RD&I) and encouraging more companies to participate in the standards development process.

- According to policymakers, essential to the success of the *Enterprise 2025* strategy is the need to improve the resilience and global reach of Irish-owned companies, provide support for Irish-based subsidiaries of global companies to compete for investment within their own organisations, and make Ireland an even more attractive location for foreign companies to invest. Standards can be expected to play an important role in helping these companies reach critical mass in terms of access to foreign markets, thereby increasing the likelihood that they remain independent and Irish-owned.
- In the context of *Enterprise 2025*, the required role of NSAI therein, the unique characteristics of the Irish economy and the findings of the analysis presented in this report, Cebr would draw the following conclusions:
 - While Ireland has been extremely successful in attracting FDI, the domestically-owned export-oriented sector still tends to be subject to acquisition. Standards could play a role in helping these companies reach critical mass in terms of access to foreign markets, thereby increasing the likelihood that they remain independent and Irish-owned. Standardization could, therefore, represent one policy area where the need for action could be examined, aimed at achieving the policy objectives of the DJEI Enterprise 2025 Strategy.
 - Despite the dominance of high-tech manufacturing, low-tech manufacturing industries are also important for Ireland's economy, representing close to the EU28 average in terms of share of manufacturing. Most notable among these is food and beverage manufacturing, which together represent 22% of Ireland's manufacturing output - well above the EU28 average of 13%. Domestic ownership and SMEs are more concentrated in these sectors, as is NSAI standards development and sales activities. This is significant given the focus of Enterprise 2025 on supporting Irish companies to bolster Ireland's economic resilience. Efforts towards promoting the awareness of standards in Irish industry should, on this basis, be concentrated more heavily towards low and medium technology manufacturing companies, but also in specific services sectors where standards use is increasingly common, such as computer services. The construction sector is also an important user of standards and is crucial in terms of the domestically-owned business population. This, and the concentration of multi-national corporations in high-tech manufacturing leads us to conclude that on balance, Ireland's domestic sector is likely to benefit more from initiatives aimed at enhancing the benefits of standards.
 - Although the high-tech manufacturing sectors like ICT and pharmaceuticals use industry standardization consortia rather than WTO standards bodies to which NSAI is aligned, it might be worth exploring whether domestically owned SMEs in these sectors require the kind of support that NSAI already provides to the more long-established low-mid-tech sectors.
 - Evidence from Cebr's recent study for BSI in the UK² suggests that companies involved in the standards development process gained a competitive edge by being able to capitalise on the latest information first and by being at the forefront of their industry. The study also reveals that SMEs are far less likely to participate in the standards development process but that, when they do participate, they report substantial benefits. The B&A survey evidence paints a very similar picture

² Cebr, 2015, "The Economic Contribution of Standards to the UK Economy", BSI.

for Ireland. Assistance with participation in standards development could, therefore, be explored as another policy area in which the need for action could be explored. Such action could support Irish SMEs and larger businesses to perform to their maximum potential, thus furthering the objectives of *Enterprise 2025*.

- The Review of the European Standardization System³ is another relevant consideration in supporting the *Enterprise 2025* strategy. The recommendations include seeking out new or enhanced mechanisms for assisting with the standards development process, including enhanced levels of practical advice and support for new entrants. Participation in standards development places a disproportionate cost burden on SMEs and there is evidence to suggest that SMEs are less likely to be involved in standards development than larger companies. If standards are considered important for industrial development and supporting domestic companies, targeted support might be explored as an avenue for policy action. However, this would need to be provided in a manner that ensures the non-duplication of effort and the spreading of the cost burden. One approach might involve working through trade associations.
- Another reason for encouraging SME participation in standards development is the need for the national interest to be represented, particularly in sectors such as ICT where multinationals dominate the market but tend not to participate. This might provide further reason for exploring the need to promote and support involvement by domestically-owned SMEs in standards development.

³ EY, 2015, 'Independent Review of the European Standardisation System', European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs.

1 Introduction

This is a report by the Centre for Economics and Business Research (Cebr) on behalf of the National Standards Authority of Ireland (NSAI) on the contribution of standards to Ireland's economy. This section introduces the report, considering our understanding of how one might define standards and moving on to provide an overview of the study and an outline of the macroeconomic and policy context within which the report sits.

1.1 Standards and their role

Standardization is a voluntary process for the development of technical and other specifications based on consensus between a group of companies and/or other stakeholders, project managed by the National Standards Body (NSB). They specify the requirements for and characteristics of a product, process or service.

Standards are defined by the European Commission as “voluntary documents that define technical or quality requirements with which current or future products, production processes, services or methods may comply. Standards result from voluntary cooperation between industry, public authorities and other interested parties collaborating within a system founded on openness, transparency and consensus.”

In contrast to patents and trademarks, the development of standards involves an open and transparent process in which stakeholders build consensus on the standards required to enable their industries to flourish. Normally, standards are made available to anyone who wants to use them, either for free or for a nominal fee.

The use of standards can represent a cost to organisations in terms of purchase and certification costs, and the time and investment involved in implementation. Some smaller firms will inevitably find that the implementation of a standard consumes a higher proportion of available resources compared to larger firms. Typically, the decision of whether to implement or use a standard can be viewed as an investment, from which there must be a decent prospect of achieving a healthy rate of return. The implementation decision is however likely to differ between sectors. For some, the standard may be necessary in order to demonstrate that a product meets the minimum requirements of legislation and the alternative – demonstrating compliance without the standard – could be more costly.

The first standards were developed at the beginning of the 20th Century and have experienced a gradual evolution in scope and focus. Standards today cover a wide range of functions including defining testing methods and processes, technical specifications and, most recently, standards for good business practices. Standards also play an important role in protecting health, safety, security and the environment.

Prior to EU harmonisation, the majority of standards were developed at the national level and were often used to restrict competition from imports in domestic markets. Harmonisation of standards across the EU, however, has been a major catalyst for trade – allowing companies to sell their products and services without the need for adaptations across multiple markets. The development of standards at the European and international level is seen as vital in ensuring the dismantling of international barriers to trade and overseas market entrants where they still exist and are unnecessarily restrictive. But there are exceptions - national standards that have been shown to be superior to international standards.

The large majority of European standards remain industry-initiated, indicating that these standards mainly respond to the needs of enterprises and are usually private sector-driven. The EU has an active standardization policy that promotes standards as a way of better applying regulations and enhancing the competitiveness of European industry, as well as protecting the safety and standard of life of citizens.

The role of standards can be most clearly viewed through the lens of the single European market. Standardization has played a leading role in facilitating the single market for goods, ensuring interoperability of complementary products, thereby facilitating the market-based competition that is the foundation and primary source of the economic benefits of the common market. Standards are often used to support policy instruments that ensure the interoperability of networks and systems, a proper functioning of the single market, a high level of consumer and environmental protection, and more innovation and social inclusion. Their role is likely to grow ever more important as the single market for services develops, in which the European Parliament believes there is significant work to be done to lift barriers to trade across borders that still exist. European institutions are also seeking to implement an effective digital single market, in which standards are also likely to play an important role.

Due to the scale and importance of the EU market and the recent scale and pace of globalisation, European standards are in many instances adopted at the international level and used in local markets worldwide. Through Ireland's involvement in the EU standards system, Irish businesses can harness first mover advantage in international markets and enhance their competitiveness. This international influence is especially important in technological areas where Irish companies are driving innovation in the development of new types of goods, services and technologies.

Convergence of technologies, fierce global competition and the emergence of new global players has prompted a review of the European standardization system to identify a way forward for adapting to these new challenges. It has been identified that the system needs to be more responsive to the shorter innovation cycles of the hi-tech industries, particularly ICT. The review of the European standardization process⁴ completed in 2015 by EY provided recommendations on how to improve performance and effectiveness with the aim of meeting European strategic objectives on standardization.

The recommendations include improving the speed of standards development through a case-by-case scheme that addresses the specific requirements of sectors, developing a centralised information system to standardise documents and support broad participation, as well as exploiting the synergies between standardization and research for the timely start of standardization activities. The review also recommended that support should be given to SMEs to both take part in the standards development process and reap its benefits by using available standards.

1.2 Study overview

This study examines the contribution of standardization to Ireland's economy. The research considers the mechanisms through which standards impact businesses - by defining best practice, galvanising innovation, and driving productivity. Through an examination of these mechanisms, it is possible to arrive at broad estimates of the contribution of standardization to Ireland's wider economy, focussing on the impact on Ireland's GDP, employment and export activity.

Previous academic and national level studies have shown that in general standards can be associated with a substantial proportion of improvements in labour productivity and hence of economic growth. This is related to the role that standards play in distributing technical knowledge, but also their role in stimulating trade and innovation. Standards have another important trade-enhancing role in that they support trust in supply chains, make it easier for firms to sell their goods abroad and compete in foreign markets, and reduce the need for costly product adaptations for different country markets. Recent survey evidence

⁴ EY, 2015, 'Independent Review of the European Standardisation System', European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs.

(combined with what we know and have learned about the structure of the Irish economy) suggests equally positive associations between standards, productivity and economic growth in Ireland.

Prior to carrying out the study, there was little reason to believe that the contribution of standards to Ireland's economy could be anything but on a par with those estimated for other countries where national level studies have already been carried out. To test this hypothesis, the study team drew on two sources of evidence:

- *Data indicating the industrial structure of the Irish economy and how it compares to other countries for which evidence on the magnitudes of the economic impact of standards exists:* International export markets and global supply chains are more important to Ireland than to most other countries. Ireland has a small domestic market relative to larger countries which means Irish companies need to find markets abroad for their products in order to achieve growth. Exports of goods and services are equivalent to 114% of Ireland's GDP, ranking third in the EU only behind Malta and Luxembourg. Their exports are concentrated in, respectively, tourism and financial services, both sectors with relatively low standards input.
- *Recent survey evidence from Ireland on attitudes to and usage of standards:* NSAI commissioned a survey from Behaviour & Attitudes (B&A) (a Dublin-based market research company) of a sample of companies from sectors more likely to be utilising standards.⁵ The 250 company directors surveyed are responsible for standards in their organisation. The industrial profile of the sample is shown in Table 1 below. The sample sizes for sectors towards the bottom of this list were insufficiently large to draw statistically robust inferences.⁶

Table 1: Industrial structure of B&A's survey sample

Business Sector	
	%
Construction	29
Manufacturing Services	22
Business Services	15
Academic/Government	11
Food & Drink Manufacturing	9
Healthcare	5
Retail	3
Environmental & Clean Tech	2
ICT/Software/Internet/Telecoms/Data Centres	2
Engineering	2
Other	11

Source: B&A (2015)

⁵ Excluding companies in very low-tech areas (like small shops) and companies with less than or equal to 4 employees. Companies with 1-3 employees in food manufacturing were included because standards are more commonplace in this sector. The fieldwork was carried out in December 2015. B&A (2015), "Standards: Usage and Attitudes – Quantitative Research", Report for NSAI, December.

⁶ For this reason, specific results are provided for, in some cases, only Construction, Manufacturing, Business Services, Healthcare and Other, which includes all the rest. Sometimes, specific results are also provided for Academic/Government, Food & Drink Manufacturing and Pharmaceuticals. The 'other' category therefore includes, at a minimum, Retail, Environmental & Clean Tech, ICT/ Software/ Internet/ Telecoms/ Data Centres and Engineering. The 'other' category in Table 1 above was not specified in the B&A (2015) report, but would appear to include pharmaceuticals in this case.

Like any survey evidence, the B&A findings need to be interpreted with care. The sampling is somewhat restricted and the individual sectors do not appear to be represented in a balanced way. However, B&A, and therefore Cebr in this report, has only provided statistics on sector-level samples that could be considered broadly representative in size relative to the size of the population of businesses in those sectors. But, we also note that the survey evidence from other country-level studies, specifically Cebr (2015) on the economic contribution of standards to the UK economy (on which we also draw for the purposes of this report⁷), is similarly restricted to sectors in which standards are known to be of relatively greater importance.

An important theme for the report is participation by business in the standards development process and the advantages that this can confer. The aforementioned UK study produced evidence showing that participating companies gained a competitive edge by being able to capitalise on the latest information first and by being at the forefront of their industry. The study also reveals, however, that SMEs are far less likely to participate in the standards development process (with only 10% reporting that they are highly involved) but that, when they do participate, they report substantial benefits. In contrast, 26% of large companies (of 250+ employees) reported significant involvement in standards development.

This is not dissimilar to the evidence on Irish industry from the B&A survey. Of the 250 companies surveyed, 16% reported that they have contributed to the development of standards. This was higher for companies operating in the academic/government sector (32%) and in business services (24%), at the average level in construction (16%), but lower than average in manufacturing (13%) and healthcare (10%) and, rather surprisingly, lowest in food and drinks manufacturing (5%). This appears stark but is unsurprising given the prevalence of micro enterprises (0-9 employees) in the food and drinks manufacturing sector.

It is also relevant to note from the B&A survey evidence that, of those contributing to standards development, there is broad consensus that being involved provides the chance to improve business performance. There is little variation across the different sizes of business surveyed but, if anything, the smallest companies are more positive about the benefits of participation. This suggests that standards could be considered more closely as a potential policy tool with which the Irish Government could support micro, small and medium enterprises, as well as larger businesses if and when required, to perform to their maximum potential.

With this policy application in mind, the aim of the report is to examine the magnitude and channels through which standards contribute to the Irish economy, how this might differ from other countries given its unique attributes and to produce high-level estimates of what the likely impact of standards are. This is with a view to providing evidence on the potential areas where Irish Government policies could be applied to optimise the benefits of standards for the Irish economy.

The purpose of this study is to examine how standards are contributing to Ireland's economy and how standards can play a pivotal role in the next stage of Ireland's economic development. Underlying this are four main objectives:

- Present the evidence around the economic effects of standards;
- Establish how Ireland differs from other countries in terms of its size, FDI intensity, R&D activity, trade volumes and industrial structure, and make inferences on what this means for the relative contribution of standards to the Irish economy;

⁷ Cebr, 2015, "The Economic Contribution of Standards to the UK Economy", BSI.

- Provide high level estimates on the economic impact of standardization in Ireland in the following areas:
 - GDP;
 - Labour productivity and industrial performance;
 - Exports of goods and services;
 - Employment;
- Provide credible conclusions on the evidence and how it could be used to help formulate policies of the Irish Government to further enhance the contribution of standards.

1.3 Macroeconomic and policy context for the research

This study comes at an important time for the Irish economy, as it moves towards recovery from the most severe economic slump in modern times. Recent performance has been excellent – at the time of writing (April 2016), the economy is growing at an annual rate of 7.8%⁸, far outstripping the performance of any other European country. The jobs market has seen substantial improvements, with the unemployment rate currently at 8.6% and during calendar year 2015, 44,100 jobs being added.⁹ However, the long term success of Ireland's economy is by no means certain and will depend on appropriate economic policies to ensure Ireland remains competitive and on a steady growth trajectory.

In November 2015, the Department for Jobs, Enterprise and Innovation launched Enterprise 2025¹⁰ – a 10-year jobs and enterprise strategy - aimed at delivering sustainable, enterprise-based jobs growth. The Strategy aims for an additional 221,300 additional jobs over the next 5 years with several specific policy targets including:

- A 60 percent increase in Enterprise Ireland enterprises spending more than €1m on R&D and winning €3.6bn in R&D related FDI;
- Delivering 2% to 2.5% productivity growth per annum in Irish companies;
- A 50% increase in exports by Irish companies by 2020;
- An export sector to create 47% (105,000) of the new jobs to 2020 (including tourism). During the years of the construction boom, exporting companies accounted for only 19% of jobs.

A key focus of this strategy is the need to improve the resilience and global reach of Irish-owned companies, to provide support for Irish-based subsidiaries of global companies to compete for investment within their own organisations, and to make Ireland an even more attractive location for foreign companies to invest.

The Government is of the view that standards can play an important role in the goal of improving competitiveness of domestic and foreign owned companies in the international market and sustaining long-term productivity growth. This appears to be confirmed by the recent B&A survey evidence, which

⁸ Central Statistics Office website – annualised real GDP growth rate based on Q4 2015 National Accounts data. Available at: <http://www.cso.ie/en/releasesandpublications/er/na/quarterlynationalaccountsquarter42015/>

⁹ Central Statistics Office, Employment (ILO) statistics, available at: <http://www.cso.ie/multiquicktables/quickTables.aspx?id=qng03>

¹⁰ The strategy document is available at: <https://www.djei.ie/en/Publications/Publication-files/Enterprise-2025-Background-Report.pdf>

suggests, for example, a general perception amongst Irish companies that standards boost their acceptability as international business partners or exporters and that they reduce trepidation about dealing with unknown foreign partners. The Enterprise 2025 strategy also recognises the important role of standards and the National Standards Body (NSAI) in Ireland's innovation infrastructure.

The Irish Government and its agencies are supportive of the theory that standards can provide a competitive advantage to domestic and international firms located in Ireland – by making it easier for these companies to access more markets, by facilitating greater integration within global supply chains and by providing better access to the standards development process than might be the case in larger countries. Evidence from Cebr's 2015 study for BSI¹¹ in the UK shows that 70% of British companies surveyed stated that standards had contributed to more efficient supply chains by improving the quality of supplier goods and services.

The B&A survey evidence suggests a very similar percentage (71%) of Irish companies agreeing that standardization has improved client-supplier relationships and 85% agreeing that multinational companies are more likely to do business with an Irish company that adheres to internationally-recognised standards. Considering the relatively small size of Ireland's domestic market, it is essential that companies are able to effectively sell into internationalised supply chains and standards can play an important role in this endeavour.

Ireland has been extremely successful in attracting FDI, which has catalysed industrialisation, the expansion of exports and helped to diversify economic activity. More difficult has been the initiative to grow and scale the export-oriented domestically-owned sector, in which firms tend to be subject to acquisition (rather than raising development finance to grow through debt or equity issuance). Standards could play a role in helping these companies reach critical mass in terms of access to foreign markets, thereby increasing the likelihood that they remain independent and Irish-owned. This suggests that standardization could represent one policy area where action could be taken, aimed at achieving the objectives of the DJEI Enterprise 2025 Strategy.

1.4 Structure of the report

This report is organised into four further chapters as follows:

- **Chapter 2** introduces the prevalence and use of standards in Ireland;
- **Chapter 3** provides evidence from the academic literature and from Irish and UK survey evidence on the economic effects of standards and on the prevalence of the mechanisms and intermediate effects through which standards deliver economic impact;
- **Chapter 4** places standards in the context of the Irish economy by considering how Ireland's economic characteristics differ to those of other countries where national level studies on the impacts of standards have already been carried out;
- **Chapter 5** presents high-level estimates for the economic contribution of standards in Ireland with a view to understanding the magnitude of the impact;

¹¹ The study was commissioned by BSI Group with grant funding provided by the UK Department for Business, Innovation and Skills.

- **Chapter 6** presents credible conclusions on the evidence and how it could be used to help formulate policies of the Irish Government to further enhance the contribution of standards, thereby furthering Ireland's industrial development strategy.

2 The prevalence and use of standards in Ireland

This section provides an introduction to standards in Ireland. We consider how standards are viewed by policymakers in Ireland as reflected in the statutory role and objectives of NSAI, Ireland's National Standards Body (NSB). We move on to identify the range of standards bodies from which Ireland's businesses source their standards before examining the B&A survey and other evidence provided by NSAI on the awareness, use and impacts of standards across Irish industry.

2.1 The role of NSAI in supporting Government policy objectives

Formed under the National Standards Authority of Ireland Act in 1996, Ireland's National Standards Body NSAI, is tasked with the role of supporting economic growth and job creation, enabling trade and protecting consumers through greater awareness and the wider application of standards. NSAI supports economic activity in Ireland by ensuring a strong and secure trading infrastructure for products and services through the development and application of national and international standards. NSAI provides Ireland with a standards infrastructure via its programmes of standardization, scientific and industrial metrology, legal metrology and conformity assessment.

NSAI fulfils several strategically important roles within Ireland's enterprise support structure. NSAI:

- Leads the development of new international, European and national standards in areas of national interest;
- Facilitates indigenous industry and public participation in the development of relevant standards;
- Assists small and medium sized businesses to take full advantage of standards;
- Supports businesses, Government and public sector organisations through the provision of a measurement standards infrastructure;
- Provides businesses with a range of product and systems certification, leading to an independent and internationally recognised certificate of compliance;
- Provides advice and support to industry and university-based groups in the use of standards and standardization in basic and applied research.

In the 2015 Action Plan for Jobs, NSAI was assigned five specific actions under the headings of manufacturing and research and development, aimed at supporting the Government's objective of growing employment. In particular, NSAI was tasked with (and has now successfully achieved) the development of the competencies and retention of employment in Irish companies through the 'Excellence through People' programme; the promotion of the awareness of standards among the Local Enterprise Office network; the support of medical device innovation and research to reduce lead time to market; and the promotion of the advantages of Irish, European or International standards and certification.¹²

The DJEI Enterprise 2025 strategy has specified two new specific policy objectives for NSAI, to:

¹² 2015 Action Plan for Jobs, Department of Jobs, Enterprise and Innovation: [<https://www.djei.ie/en/Publications/Publication-files/Action-Plan-for-Jobs-2015-Table-of-Actions.pdf>]

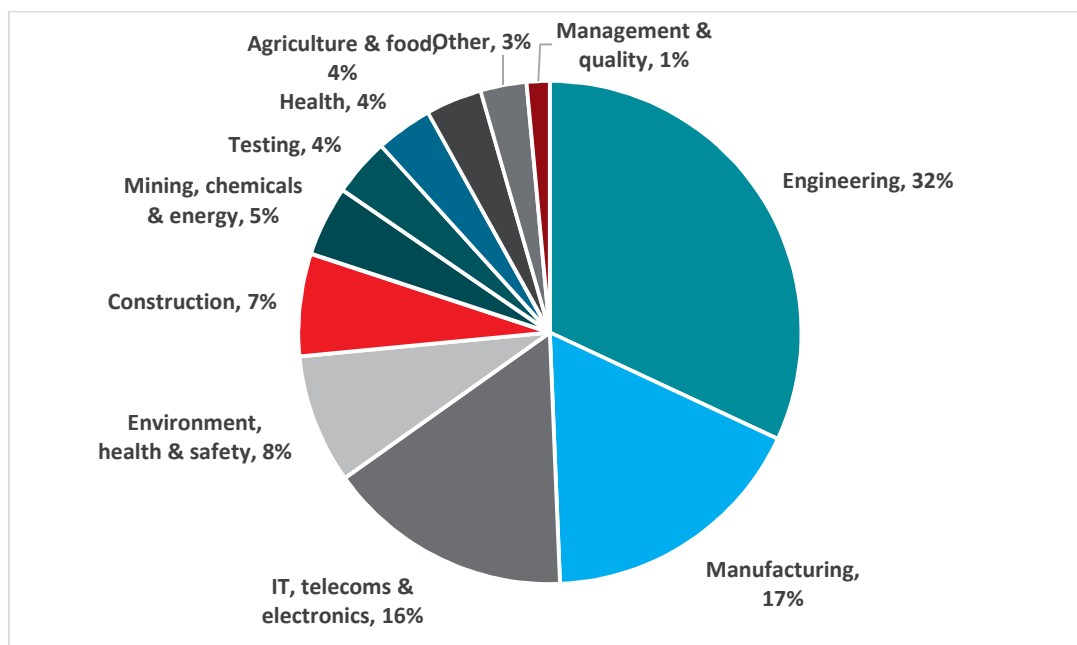
- Strengthen the role of NSAI as a crucial element of Ireland’s sectoral and innovation ecosystem, by promoting the benefits of standards to the widest cross section of industry and ensuring that its focus is aligned with the Enterprise 2025 policy and informed by the future needs of enterprises;
- Raise awareness of the importance of standards in the context of Research, Development and Innovation (RD&I) and encourage more companies to participate in the standards setting process.

Innovation 2020 sets out Ireland’s national strategy for public research in support of enterprise innovation and, therein, the Government articulates its intention to promote standards and regulations as a source of competitive advantage.¹³ As part of this, NSAI is noted as playing a key role in supporting firms by providing information on current and future standards that can assist in bringing products to market and improving organisational performance. As an example, the 2015 European Innovation Management standards published by NSAI are highlighted as an important development, providing guidance for organisations (public or private) seeking to manage innovation by moving from an *ad hoc* to a more rigorous approach.

2.2 NSAI’s standards catalogue and other sources of standards

Data on the harmonised EU standards adopted for NSAI’s standards catalogue gives a picture of where standards publication activity is concentrated at the sector level in Ireland (see Figure 1). Engineering and manufacturing represent the largest number of standards published but IT, telecoms & electronics also have a sizable share.

Figure 1: Published Standards in the NSAI catalogue, by industry



Source: NSAI Publication Catalogue, Cebr analysis

Standards used by Irish companies are normally either European (developed via the standards bodies of the European Standardization System CEN, CENELEC and ETSI), or international (WTO standards bodies such as ISO, ITU and IEC, to which NSAI is aligned). In its role as the National Standards Body, NSAI

¹³ This is available to view at <https://www.djei.ie/en/Publications/Innovation-2020.html>

published a total of 1,450 standards in 2014, contributing to a library in the region of 23,000 standards available for purchase online.

Most of these are adopted EU or international standards although a small number are indigenous Irish standards developed through NSAI to address specific national issues. For example, I.S. 813:2014 contains a unique code of practice for the installation of domestic gas boilers, which is required to be compliant with Ireland's Gas Safety Framework and to meet the requirements of the Building Regulations.

Irish companies, especially in high-tech sectors like ICT, also use industry-level international organisations that develop standards for specific technologies. These include IEEE (electro and information technologies), ECMA (consumer electronics), W3C (internet standards) and 3GPP (mobile broadband technologies).

2.3 Overview of awareness and use of standards in Ireland

The evidence from the B&A survey evidence of 250 Irish companies reveals important insights on the awareness and use of standards in Ireland. On average, 94% of businesses report that they are aware of standards in their sector. Food and drinks manufacturing businesses reported the lowest awareness, but this is still very high at 85%. The results at the sector level are illustrated in Table 2 below.

Table 2: Awareness of standards in own sector amongst Irish companies

Aware x Sector	
	%
Energy	100
Environmental & Clean Tech	100
Healthcare	100
ICT/Software/Internet/Telecoms/Data Centres	100
Pharmaceutical	100
Academic/Government	100
Construction	97
Business Services	95
Manufacturing Services	89
Food & Drink Manufacturing	85
Other	90

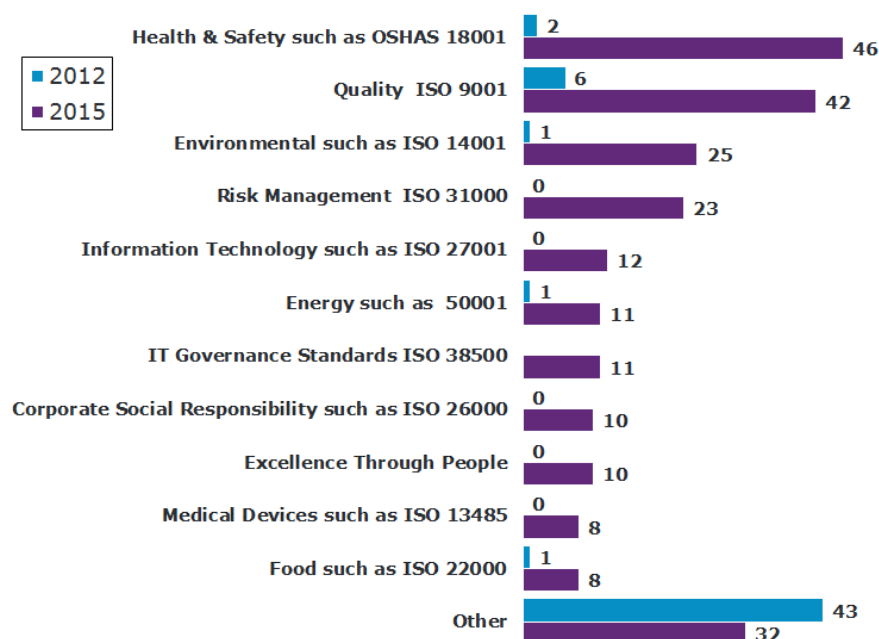
Source: B&A (2015)

Only a quarter of businesses surveyed report not being familiar with NSAI, while 74% report broad familiarity. The difference between awareness of standards themselves and of the NSAI most likely reflects the existence of other sources of standards, but could also be expected to reflect the situation for standards takers, as most small businesses can be expected to be. Larger companies report being a lot more likely to be aware of and have dealings with NSAI, which is consistent with involvement in standards development being more prevalent amongst larger companies relative to micro and small companies. Nevertheless, 7 out of 10 of the smallest companies are at least familiar with NSAI, even if they do not deal directly with them.

The survey found that 88% of businesses surveyed report using some standards, but B&A also probed companies on which standards they use in their business. Nearly half (46%) of those interviewed use a health & safety standard such as OSHAS 18001, while quality management ISO 9001 is the second most mentioned at 42%. This is illustrated below, along with the percentage of businesses reporting the use of

various other types of standards. (See Figure 2, which also shows the results from a similar 2012 survey but this is not comparable with the 2015 survey due to differences in approach).

Figure 2: Usage of standards in Ireland (11 most popular)



Source: B&A (2015)

Table 3 below expands out the 'other' category featured in Figure 2 above, along with the reported percentage of businesses surveyed that report using them.

Table 3: Usage of standards in Ireland (other standards)

Other Standards Used	%
Other construction materials and building standards/ certifications	4
British Retail Consortium standards	2
ISO 9000/9002	2
Quality & Qualifications Ireland standards	2
Product/ Factory Production Standards	2
Other unspecified standards/ guidelines	2
CE Mark	1
In-house standards	1
RIAI/ Architectural standards	1
EN1090 - Steel & aluminium	1
IS EN 206 -Concrete	1
IS 820 & IS 813 - Gas installation	1
Standards/ guidelines in education	1
PS 9000 - Pharmaceutical	1
ISO 22716 -Cosmetics	1
Other organisations' standards/ guidelines	5
Don't know/ None	4

Source: B&A (2015)

A total of 56% of the 88% of businesses surveyed by B&A that use standards report being independently certified to standards, which is more likely in larger companies and amongst those in the construction

sector, as illustrated in Table 4 below. We also note that 50% of companies in the 'other' category report being certified to standards. The 'other' category in this includes pharmaceuticals, non-food manufacturing, retail, environmental & clean tech, ICT/ software/ internet/ telecoms/ data centres and engineering.

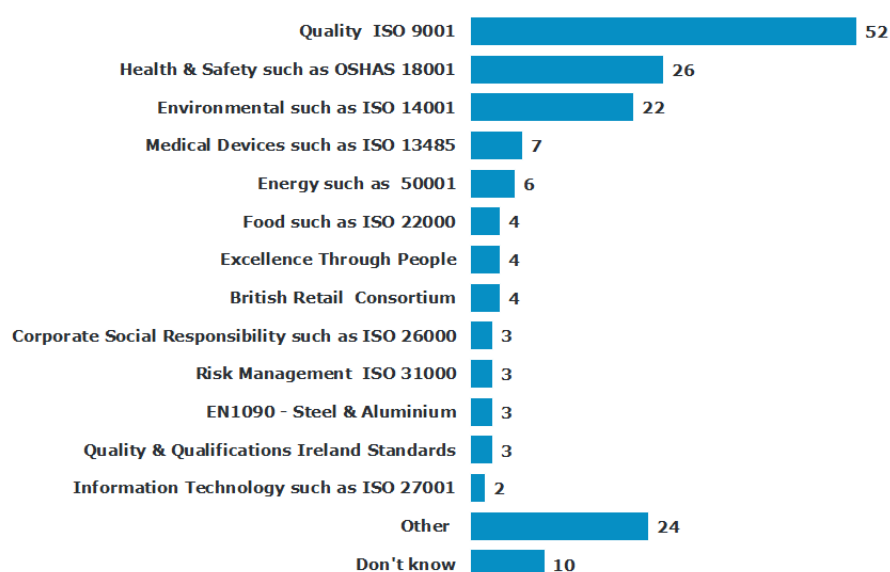
Table 4: Proportion of companies in different size bands and sectors that are certified to standards

Certified x Business Sector & Employee Size	
	%
Up to 9 employees	41
10-19 employees	52
20-49 employees	66
50+ employees	75
Construction	64
Academic/Gov	28
Business Services	21
Food & Drink Manufact.	20
Health-care	10
Others	50

Source: B&A (2015)

Figure 3 below shows the most popular standards to which Irish companies are certified and the proportion of all companies that report being certified to each. Over half claim to be certified to Quality ISO 9001, while health and safety and environmental certifications are also widely availed of.

Figure 3: Types of standards to which Irish companies are independently certified (13 most popular)



Source: B&A (2015)

Table 5 expands on the ‘other’ category featured in Figure 3 above, along with the reported percentage of businesses surveyed that are using them.

Table 5: Types of standards to which Irish companies are independently certified (other standards)

Other Standards Certified to	%
IT Governance Standards ISO 38500	1
RIAI/ Architectural standards	1
Council Directive 89/106/EEC- Construction Products	1
IS EN 206 -Concrete	1
IS 820 & IS 813 - Gas installation	1
Product/ Factory Production Standards	1
Standards/ guidelines in education	1
PS 9000 - Pharmaceutical	1
ISO 15489 - Records Management	1
AS 9100 - Aerospace	1
ISO 17065 - Conformity	1
Other unspecified standards/ guidelines	1

Source: B&A (2015)

This evidence points to very strong awareness of standards and of the National Standards Body (NSAI) amongst Irish companies of all sizes in the relevant sectors. The statistics on the usage of and certification to standards is also strong, which lends significant support to the proposition that standards play an important economic role in Ireland. It is the value of this role that this report seeks to explore.

2.4 The use of standards in Irish industry

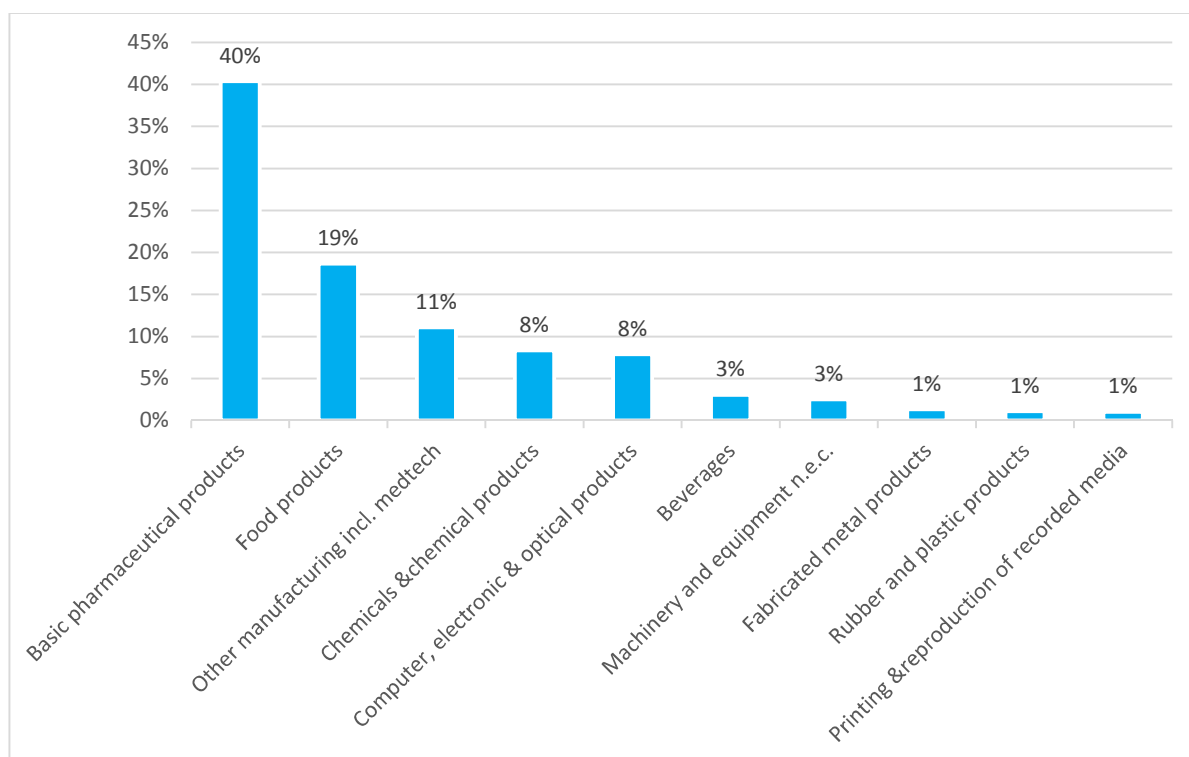
In 2014, Ireland’s manufacturing sector contributed almost one-quarter (23%) of the country’s total GVA.^{14,15} But the manufacturing sector consists of many different types of activities and products and there can be expected to be wide divergences between them in terms of the importance of standards.

¹⁴ Eurostat, Structural Business Survey

¹⁵ GVA or gross value added is a measure of the value from production in the national accounts and can be thought of as the value of industrial output less intermediate consumption. That is, the value of what is produced less the value of the intermediate goods and services used as inputs to produce it. GVA is also commonly known as income from production and is distributed in three directions – to employees, to shareholders and to government. GVA is linked as a measurement to GDP – both being a measure of economic output. That relationship is $(GVA + \text{ Taxes on products } - \text{ Subsidies on products } = \text{ GDP})$. Because taxes and subsidies on individual product categories are only available at the whole economy level (rather than at the sectoral or regional level), GVA tends to be used for measuring things like gross regional domestic product and other measures of economic output of entities that are smaller than the whole economy. GVA must be distinguished from turnover measures, which capture the entire value of sales. By contrast, GVA captures the value added to a set of inputs by a firm on their journey from raw materials to finished consumer products. Thus the value added of a firm that uses oil imports to make plastics is equal to the price that it sells the plastic for minus the cost of the oil it uses as inputs. Similarly the value added of a manufacturer that uses that plastic to make a bus shelter is equal to the price that it sells the bus shelter for minus the cost of the plastic it uses as an input. The concept of added value enables the avoidance of double counting when estimating the size of an economy.

Of the manufacturing sector's GVA contribution, almost two-fifths (40%) was contributed by the manufacture of pharmaceutical products, as illustrated by Figure 4. By comparison, almost one fifth (19%) of manufacturing GVA was generated by the food manufacturing sector, while 11% was contributed by other manufacturing (which encompasses the manufacture of medical devices).

Figure 4: Manufacturing value added (GVA) as a % of total, 10 largest sub-sectors (2012)

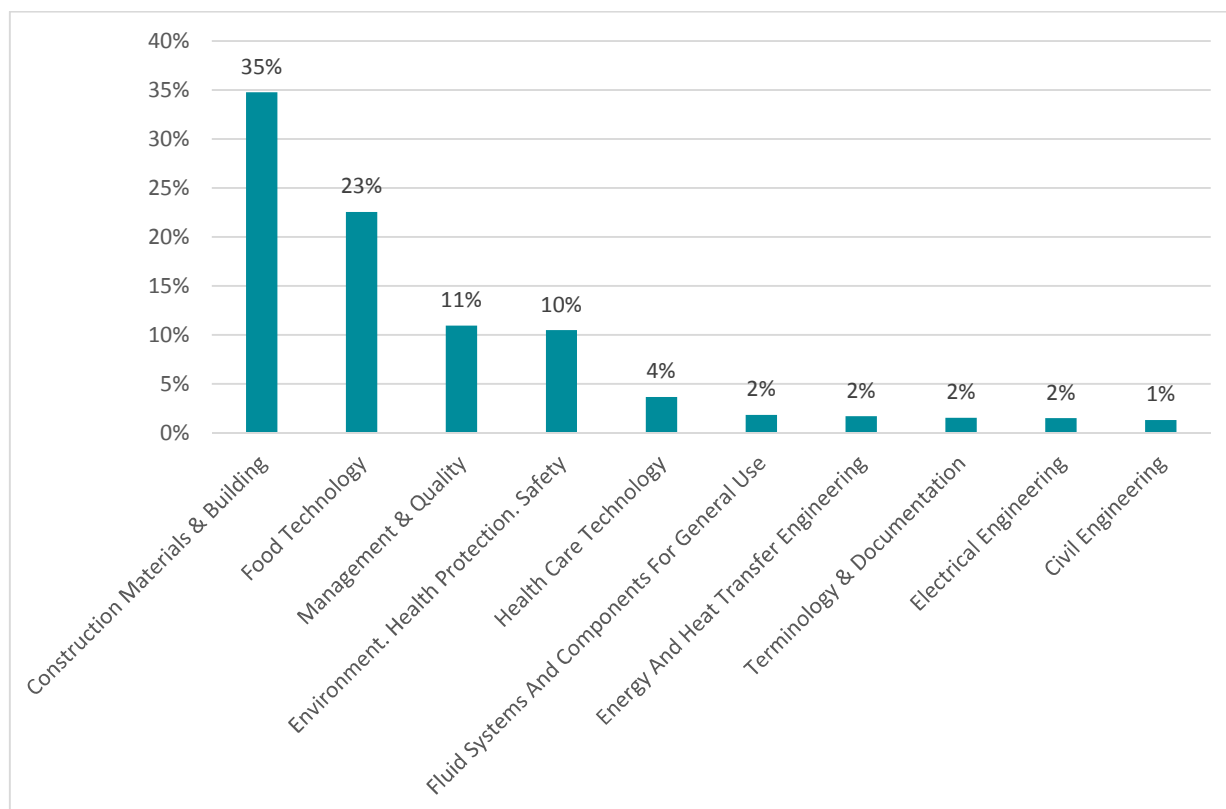


Source: Eurostat, Cebr analysis

Cebr has carefully examined NSAI's standards catalogue, matching the different standards available to the sectors in which they apply. Manufacturing accounts for an estimated 69% of all standards in the catalogue), while construction and ICT-related standards account for the next largest shares at 5.3% and 4.9% of standards in the catalogue, respectively. While these appear small relatively, neither of these sectors is constituted as such a diverse range of different economic activities as in manufacturing.

We also analysed NSAI's statistics on its sales of standards. As illustrated by Figure 5 below, construction and food technology standards make up the majority of standards sold by NSAI over the past eight years. NSAI is the largest vendor of standards in Ireland, although companies also purchase standards from foreign national standards bodies and other commercial entities. It is possible therefore that the pattern of usage of standards within Irish industry might differ if data on the adoption and use of such standards were also available.

Figure 5: NSAI's top-ranking standards sales, standards category as a percentage of total, 2008 to 2015



Source: NSAI, Cebr analysis

The picture painted by Figure 5 is, however, consistent with B&A's finding that, at the sector level, companies in construction (23%) are most likely to be aware of and have direct dealings with NSAI – Ireland's National Standards Body. This is lowest at 10% in food and drinks manufacturing but this sector reports much higher proportions of businesses that are familiar but have no direct dealings with NSAI (65%), as compared with construction (31%). This is most likely related to the prevalence of very small companies in this sector, who would have limited resources to have direct dealings with NSAI (through, for instance, the standards development process) and who are more likely to be 'standards takers' rather than 'standards makers'. This may well be manifest in B&A's finding that only 5% of food and drinks manufacturing businesses reported contributing to the development of standards (the lowest among the sectors considered), compared to 16% in construction, for instance.

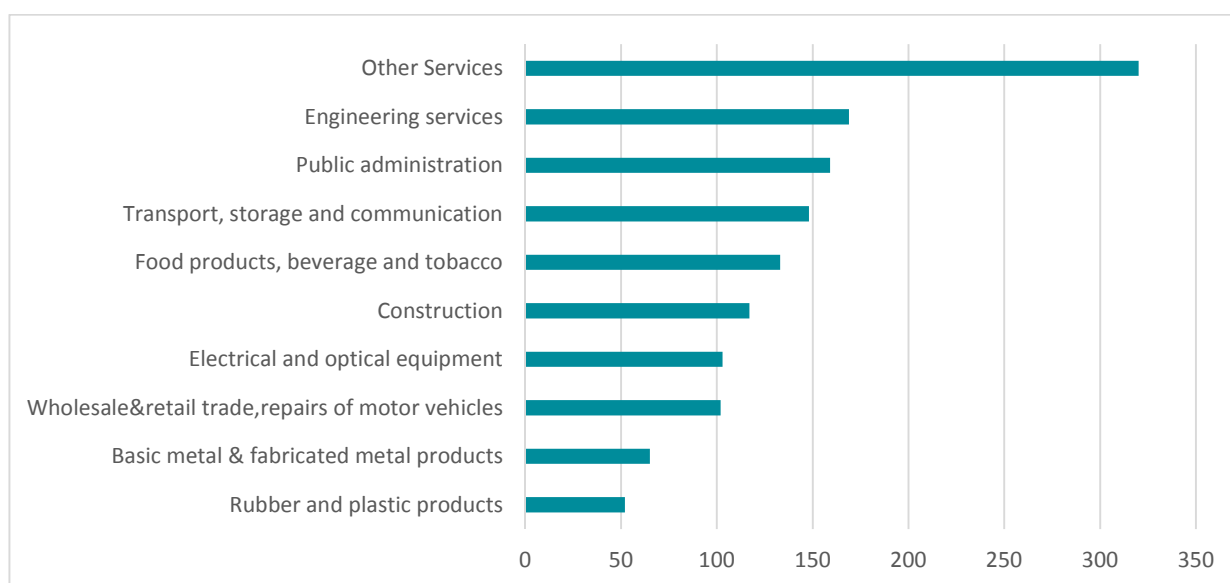
The evidence presented in Figure 5 also chimes somewhat with B&A's reported finding that 64% of construction businesses surveyed reported being independently certified to standards, compared to only 20% for food and drinks manufacturing and 10% in healthcare. This is likely to reflect a combination of the increasing importance of standards as a pre-requisite in tendering for large public sector civil engineering contracts but also of the smaller firms and tighter margins in food and drinks and healthcare and, thus, less resource to dedicate to the certification process.

There is other evidence on the industries that use quality management standards in Ireland. The ISO 9001 quality management system standard is used by businesses to improve their internal management and operational processes. It is one of the most widely used standards around the globe with 1.1 million certifications worldwide in 2014 alone. According to the annual ISO Survey, there were 1,844 certifications

in Ireland in 2014, concentrated in manufacturing, construction, public administration and ‘other services’, which includes professional services and software development.

The more recent B&A survey evidence is consistent with this picture, finding that 42% of all companies (the second highest) report using ISO 9001 and 52% of those companies that are certified to standards reporting being certified to this standard. Figure 6 shows that the services sector made up the largest number of ISO 9001 certifications in Ireland in 2014.

Figure 6: ISO 9001 Quality Management Certifications in Ireland, top 10 sectors by 2014 certifications



Source: NSAI, ISO Survey 2014

The service-based sectors represent the largest employer in all EU countries, including in Ireland. While the use of standards is currently concentrated in the production industries (incl. manufacturing), this situation has been starting to change in recent years, with many companies now using standardised processes as part of their service delivery. Interestingly, B&A (2015) found that companies in the business services sector (24%) are most likely to be aware of and have direct dealings with NSAI.

Growing the use of standards in the services sector is important, given the structural shift in the Irish economy, which has seen falling manufacturing employment. Since 2000, employment in the services sector has increased by 38%, while employment in the production industries (NACE rev. 2 sectors B to E) has decreased by 21%¹⁶.

Blind¹⁷ (2006) analysed standards publication data at the European level and found that development activity in standards for service-based industries is most focussed in the areas of data security, quality management and customer satisfaction. This use is clustered in five main areas: service management, employee knowledge and skills, service delivery, customer interaction, and data flows and security. This appears to be reflected in the survey evidence on use of different types of standards in Ireland (presented

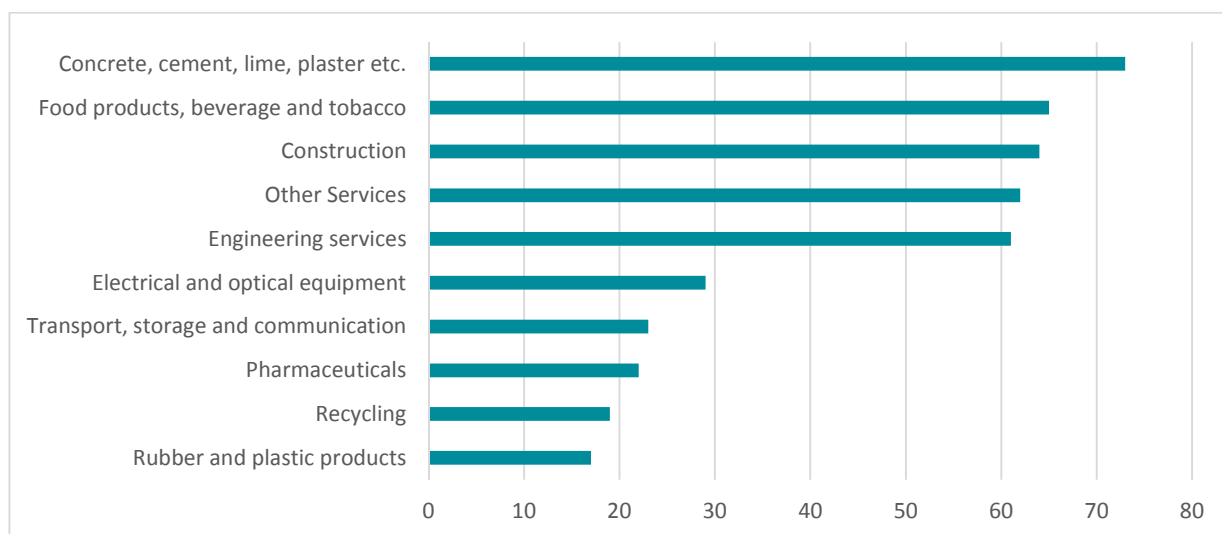
¹⁶ CSO Quarterly National Household Survey Main Results - Q2 2015

¹⁷ Blind, Knut, (2006), A taxonomy of standards in the service sector: Theoretical discussion and empirical test, The Service Industries Journal, 26, issue 4, p. 397-420

in Figure 2 above), with quality management, information technology, IT governance and risk management all featuring strongly.

Another important quality management standard is ISO 14001 which is used by companies to manage and control their environmental performance. The objective is to ensure efficient use of resources and the reduction of waste. According to the annual ISO Survey, there were 571 certifications in Ireland in 2014, concentrated in concrete manufacturing, food products and construction.

Figure 7: ISO 14001 Environmental Quality Management Certifications in Ireland, top 10 sectors by 2014 certifications



Source: NSAI, ISO Survey 2014

Again, this is reflected in the most recent survey evidence for Ireland, and illustrated in Figure 2 above, with 25% of all Irish businesses surveyed reporting use of this standard and 22% of all certified companies reporting being certified to this standard.

3 Evidence on the economic effects of standards

This chapter provides an overview of the evidence on the economic effects of standards, and interprets this evidence in the context of the Irish economy. We consider general evidence from the academic literature, including the findings of national-level studies carried out in different countries, as well as the recent evidence from B&A's survey of 250 Irish companies, which reveals that the mechanisms and intermediate effects through which standards deliver economic impact are working well in Ireland.

3.1 The economic roles of standards

Standards represent one element of the technical knowledge that is available to firms along with proprietary knowledge (patents) and technology licences (permissions to use, produce or sell new technologies). In advanced economies such as Ireland, economic growth depends on research and development (R&D) and the advances it delivers in technical knowledge. Continual product improvements and investment in R&D in new pharmaceutical drugs and new ICT technologies are essential to sustain the global competitiveness of Irish companies and the health of the Irish economy.

The degree to which knowledge is freely available depends on the investment costs involved in research and development. Depending on the optimal strategy of the firm and the development costs involved, companies choose to retain intellectual property for their own use (patents), make it available via licence or allow the knowledge to be made available freely. Apart from the nominal fees levied in some cases, standards fall largely into the last category and will generally be created when their use will help all to flourish.

This should become apparent through the description of the mechanisms through which standards contribute to economic growth that follows in Subsection 3.2. Once we understand the impact that standards can have on economic growth, we move on to examine the contribution of standards to other aspects of the macro economy. We consider the role of standards in boosting export activity, job creation and in galvanising innovation. From this, we evaluate the benefits to businesses of involvement in the standards development process, which completes our comprehensive picture of how standards impact business and the economy.

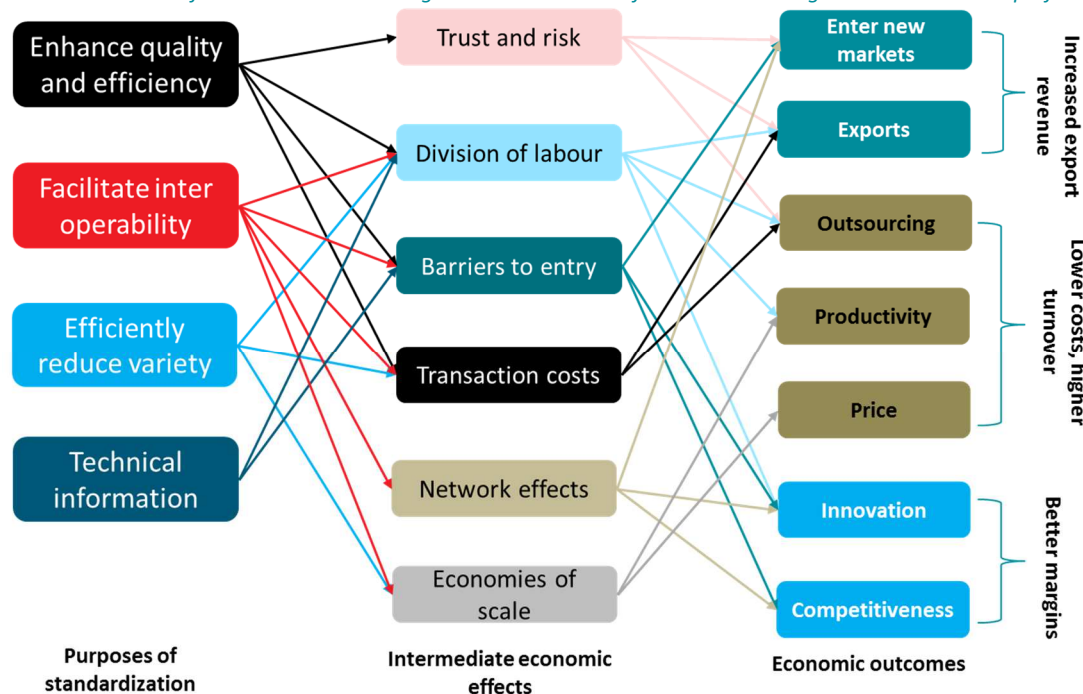
3.2 The mechanisms through which standards contribute to economic growth

Standards contribute to economic growth through a variety of mechanisms within companies that facilitate improved business performance. An overview of these mechanisms is presented in Figure 8 below. Standards are not homogenous but rather have a variety of uses. These uses are commonly classified into four areas: standards that help to reduce unnecessary variety in the marketplace, quality and performance standards, measurement standards for standardized testing and standards that facilitate compatibility and interoperability. Here we explore these primary mechanisms through which standards contribute to the economy.

Economies of scale

Standards are often used to reduce unnecessary variety in situations in which the exploitation of economies of scale is important, for example, when investment in operating capacity is lumpy and it is important to eliminate wasteful duplication of the fixed costs involved in getting set up. From reduced variety, producers also gain skills and experience by focusing on fewer product variations. If different versions of products need to be produced for each market, costs are likely to be higher for both consumers and producers.

Figure 8: An overview of the mechanisms through which standards influence economic growth and business performance



Source: Adapted from Swann 2010

A good example of variety reduction generating economies of scale is the development of a shipping container standard, which dramatically reduced the transaction costs of moving goods by sea (see Den Butter et al. 2007¹⁸). Thanks to the standard sizes specified in ISO 668, containers will fit on all appropriate ships and vessels, trains and trucks at any location in the world. Prior to this, goods were stored in bulk and items were unloaded individually, which was labour-intensive. Standardized containers have allowed fast efficient loading and can be moved seamlessly between ships, trucks and trains, releasing enormous efficiencies which have dramatically reduced the cost of shipping goods. With trade being such an integral part of the Irish economy, the benefits to Ireland of this particular standard are likely to have been significant.

Evidence of this effect of standards is strong in Ireland. The B&A (2015) survey suggests that 66% of the 250 Irish companies surveyed believe that standardization has helped their business to achieve economies of scale. This view is more pervasive in traditional sectors like construction (66%), manufacturing (71%) and healthcare (64%). Companies in the business services sector were least likely to agree that standards had produced the scope for economies of scale, but those that did are still in the majority at 51%. The view also received the greatest support amongst the larger companies surveyed (those with 50+ employees).

A more recent example of a standardized product is the USB connector, which was introduced by industry to provide a standardized way to supply power to cameras, mobile phones and other handheld devices and to allow such devices to communicate with each other.

¹⁸ Den Butter, Frank, Groot, Stefan P.T. and Lazrak, Farook, 2007, The Transaction Costs Perspective on Standards as a Source of Trade and Productivity Growth, No 07-090/3, Tinbergen Institute Discussion Papers, Tinbergen Institute.

The B&A (2015) survey evidence suggests that, in Ireland, these sentiments go well beyond just ship containers and USB connectors, with 58% of the Irish companies surveyed believing that standardization has served to reduce unnecessary variety and has thereby strengthened the basis for price competition in their sector.

Ensuring quality

Standards reduce the costs involved in ensuring quality and compatibility, allowing companies to outsource more of their supply chain to external contractors and generating a competitive advantage for certified firms (see Terlaak and King, 2006¹⁹). By outsourcing the manufacture of certain components and services, companies can specialise in the areas where they have a comparative advantage, potentially facilitating further economies of scale and cost savings.

Of the 250 Irish companies surveyed by B&A, 85% agree that multinational companies are more likely to do business with an Irish company that adheres to internationally-recognised standards, while 84% agreed that they themselves would be more likely to do business with other companies that use standards and are certified. Likewise, 71% of the companies surveyed agreed with the proposition that standardization had improved client-supplier relationships by increasing their confidence in suppliers.

Quality management system (QMS) standards, such as ISO 9001 are some of the most widely used standards worldwide. The popularity of QMS standards is a result of the extensive impacts they can have across a business. By integrating management system frameworks that enable continuous improvement and efficiency savings, QMS standards promote quality and boost efficiency. These frameworks comprise of processes that are constructed to identify the scope for potential time savings, and areas of error and defect reduction. Overall, these can lead to greater efficiency and cost savings.

QMS standards also contribute to solving the economic problems that arise from information asymmetry: where sellers have more information than buyers about the quality of their product. QMS can resolve this by enabling sellers to signal the quality of their product or service to buyers, thereby providing customers with certainty that they are purchasing a high-quality item.

Irish companies appear to agree that standards play this role and have this effect, with 85% agreeing that companies that use standards have stronger reputations. 46% of companies agreed with the view that standards had helped their industry avoid a 'race to the bottom'. While this is low relative to some of the other statistics, it may have been affected by strong views within a pharmaceutical sector that is witnessing a rapid increase in the market penetration of generic prescription medicines, but also by views within sectors that have been subject to severe public spending cuts since the Great Recession, such as Academic/Government and Healthcare.

Contractual agreements can also be simplified because the characteristics and functionalities of the product are clear as a result of standards. This is particularly important for Irish companies, given the concentration of foreign ownership, the emphasis on exports and the involvement in international manufacturing supply chains.

Standards also lead to better relations with suppliers and clients derived from increased safety for consumers, increased trust, reduced liability risk and wider choice of suppliers for the same reasons mentioned above.

¹⁹ Terlaak, A., & King, A. A. (2006). The effect of certification with the ISO 9000 Quality Management Standard: A signalling approach. *Journal of Economic Behavior & Organization*, 60(4), 579-602.

The B&A (2015) survey of Irish companies reveals that 76% of those surveyed believe (either strongly or slightly) that those who use standards and are certified provide higher quality goods and services. But there is less (but still strong) consensus on the extent to which this higher quality can introduce scope to increase prices, with 58% agreeing that companies with standards and certification can charge more for their goods and services. Only 16% strongly agreed with the proposition, which contrasts with 50% who strongly agree with the proposition that standards are associated with higher quality.

We suspect that this relates to different views on the role of standards in relation to quality in different contexts. On the one hand, 58% of the Irish companies surveyed agree that standardisation has strengthened the basis for price competition through homogenisation while, on the other, 81% believe that standards provide benchmarks enabling the differentiation of products according to quality or other characteristics. Depending on the particular role of a company being considered, either or both of these views could be relevant. The former view is however more likely to be associated with inputs and complementary products such as USB connector cables, whereas the latter view is more likely associated with final consumer goods and services and substitutable products, such as different types of software that perform the same function.

Facilitating interoperability and compatibility

Standards facilitate the interoperability of components, systems and products, enabling those made by different manufacturers to interact or communicate with each other. The literature (for example, Farrell & Klemperer, 2007) describes two economic phenomena that inter-operability standards affect: switching costs and network effects.

Switching costs arise when a customer chooses to change supplier. They have the effect of ‘locking in’ the customer to purchasing from a single firm, because it is costly to switch or purchase from multiple suppliers. This can limit the extent of competition within a market. Ensuring interoperability can reduce switching costs which can hence facilitate competition. Standards help to reduce switching costs by making it easier for customers to move between suppliers. In doing so, standards also improve buyers’ access to choice, which lowers the overall cost of investment for the customer.

‘Network effects’ – when users of a good derive benefit when additional users adopt it²⁰ - are promoted through the use of open standards. A good example of network effects in practice is the mobile phone. There is no benefit if only one person owns a mobile phone and is connected to the network. As more and more people are connected, the benefits increase exponentially because every user experiences the benefit of being able to call more and more people.

With a similar effect, the use of the same common set of standards allows many different types of mobile device to connect to the network, making it possible for communication to take place regardless of the device used. With network externalities making it so attractive to be connected, it is in the interests of communications providers to ensure interoperability between their networks and in the interests of mobile device manufacturers to ensure compatibility with current network technology. This serves to increase the size of the total market, allowing them to achieve a higher turnover. In addition, interoperability facilitates competition and ensures value-for-money to the consumer.

²⁰ Katz, M. L., & Shapiro, C. (1994). Systems competition and network effects. *The Journal of Economic Perspectives*, 93-115.

Users gain directly from more widespread registration on the network, and with more users the network becomes more attractive to non-users considering to join. This creates a positive feedback loop that aids the growth of different technologies.

The evidence on this effect of standards in Ireland is again relatively strong, with (as already noted) 58% of the 250 companies surveyed by B&A believing that standardization has increased compatibility or interoperability of products and systems, which has resulted in increased competition in their markets.

Diffusion of technical knowledge

Technical standards predominantly serve the purpose of providing information and product descriptions that align the expectations of suppliers and purchasers. Standards spread technical knowledge by allowing firms easy access to information. This facilitates an efficient, and cost effective mechanism for inter-firm exchange of information, by reducing the costs of each transaction. This translates into savings, achieved from a reduction in the costs of purchasing intermediate products from external suppliers.

Standardising components is vital in complex industries such as aerospace and manufacturing where large companies source their components from thousands of suppliers, often spanning a range of international markets. For instance, in aircraft manufacturing, each aircraft is composed of millions of separate parts sourced from thousands of intermediaries across a global supply chain. Manufacturers such as Boeing and Airbus will use standards to effectively communicate technical requirements to their suppliers, thereby diffusing information across the supply chain. This, in turn, enables those suppliers to specialise, achieve scale, reductions in unit cost and increased competitiveness.

Previous studies²¹ have shown that when technical knowledge is diffused widely, it can have more significant productivity impacts. For example, the software sector has seen a remarkable evolution from an industry dominated by proprietary software (e.g. Microsoft Office) towards open source software (e.g. Linux). With open source, new advances and improvements in software are shared, allowing other companies to adopt and add their own improvements. All parties benefit from the use of collaboratively developed software.

The same principles apply in other sectors, particularly where R&D expenditure as a percentage of turnover is relatively low. Standards codify technical knowledge and are made available at low cost to all companies. More companies are able to benefit from this technical knowledge because it is being disseminated more widely, resulting in an overall increase in productivity, ultimately boosting economic growth at the national level.

The B&A (2015) survey evidence suggests that the experience and attitudes of Irish companies align with this view of standards, with:

- 66% agreeing that standards help to speed up technology transfer by making innovations more accessible, a view that was strongest in the construction (71%), business services (76%) and healthcare (72%) sectors, but was lower in manufacturing (58%) and amongst the largest of the companies surveyed.
- 62% agreeing that standards encourage innovation by disseminating new knowledge, a view that was most prevalent in healthcare (72%) and manufacturing (67%).

²¹ For example: DIN, (2000). 'Economic Benefits of Standardization', DIN German Institute for Standardization.

Further, the fact that knowledge that is essential for production is codified in open standards helps to level the playing field between incumbent and entrant businesses, thus encouraging competition. Without open standards, incumbents have an informational advantage over entrants. As a result, this property of standards can help to reduce barriers to entry for smaller companies and start-ups. The B&A survey evidence suggests that this role and effect of standards is prevalent in Ireland, finding, of the 250 companies surveyed:

- 56% agreeing that standards have made their sector more competitive;
- 46% agreeing that international standardization has led to increased global competition in their sector;
- 45% agreeing with the proposition that standards have stimulated the development of new sectors of business within their industry;
- 61% agreeing that small firms grow faster when they apply standards;
- 81% agreeing that companies that apply standards have a higher probability of long term success; and
- 48% in agreement that standardization has enabled their firm to increase and consolidate market share.

Ensuring safety of consumers and the environment

The European standardization system requires all products sold in Ireland and throughout the EU to be subject to a conformity assessment, placing an obligation on producers to demonstrate that their products are safe and conform to the requirements of regulations.

Standards can also help businesses meet requirements and obligations under health and safety and environmental regulations. The evidence on usage of and certification to standards in Ireland (see Figure 2 and Figure 3 above), suggests that these are already playing an important role in Irish industry. Furthermore, 72% of companies surveyed agreed that those who use standards tend to be more environmentally friendly.

As businesses are increasingly encouraged to adopt more social responsibility, these types of standards are likely to play an increasingly important role in the economy and in society.

Conclusion

Ultimately, the various mechanisms through which standards contribute to growth do so by improving the productivity and competitiveness of companies, boosting exports, employment and investment in R&D to further innovate and maintain a competitive edge over rivals etc. Also, ultimately, consumers benefit from the lower prices delivered through increased competition and lower costs of production. We explore the evidence on these mechanisms and effects in the following subsections.

3.3 Effects of standards on economic growth and productivity

Various national-level studies have examined the link between technology diffusion (proxied in part by standards) and economic performance. Generally, these studies confirm that standards have a positive and significant relationship with productivity and GDP growth. The first of these studies was published by

DIN (Germany) in 2000²². Since then, studies have been carried out in six other countries including the UK, France, Denmark, Canada, Australia and New Zealand.

These studies follow a similar methodology, which involves using a growth accounting approach to econometrically estimate the size and significance of the effect of the stock of standards available to companies on economic growth.

Economic theory suggests that growth in the economy depends on the quantities of the factors of production employed (specifically labour and capital) and the efficiency with which they are utilised. Growth can be sustained by increasing the amounts of labour and/or capital that are used. But as additional units of these factors are added, the amount of additional output as a result tends to diminish. Only increases in the level of technological progress can offset the decline in growth that occurs as an economy matures and diminishing returns to labour and capital set in. Growth over the long run can be sustained by increasing the efficiency with which these factors are combined to produce output. This is known as total factor productivity (TFP). Improvements in TFP are driven by a number of factors including technological advancements and improved education that enhance the efficiency of processes and techniques.

The growth accounting approach statistically tests the significance of standards as a driver of productivity growth within an equation that includes capital, labour and TFP. A summary of the findings of the national level studies completed to date are presented in Table 6.

Table 6: Comparative summary of existing national level studies on the contribution of standards to economic growth (in chronological order)

Country	Organisation (year)	Time period	GDP growth rate	Contribution of standards to GDP growth (percentage points)
Germany	DIN (2000)	1960 - 1990	3.3%	0.9%
UK	DTI (2005)	1948 - 2002	2.5%	0.3%
Australia	Standards Australia (2006)	1962 - 2003	3.6%	0.8%
Canada	Standards Council of Canada (2007)	1981 - 2004	2.7%	0.2%
Denmark	Danish Enterprise and Construction Authority (2007)	1966 - 2003	2.4%	0.1%
France	AFNOR (2009)	1950 - 2007	3.4%	0.8%
New Zealand	Standards Council of New Zealand (2011)	1978 - 2009	2.5%	0.5%
Germany	DIN (2011)	1992 - 2006	1.1%	0.8%
UK	BSI Group (2015)	1921 - 2011	2.4%	0.7%

Source: Cebr literature review

Estimates vary between studies but overall the findings suggest that standards account for between 5% and 35% of productivity growth in their respective countries. For example, the findings of the recent study

²² DIN, 2000, Economic benefits of standardization, DIN German Institute for Standardization

for BSI, suggest that standards were a significant contributory factor in almost 30% of the UK's economic growth, averaged over a 90-year period.

While the studies listed in Table 6 present compelling evidence as to the contribution of standards to economic growth, the findings should be interpreted with some degree of caution for several reasons:

- Standards are used as a proxy for the dissemination of technical knowledge within the economy and should therefore be representative of a broader infrastructure supporting that process including human capital, patents and proprietary knowledge;
- The standards indicator used in these studies represents the number of active standards in that country – giving each standard equal weight. However, some standards have a disproportional contribution to economic growth which means that the effectiveness of such an indicator may be constrained in accurately representing the diffusion of standards across the economy.

The efficiency- and performance-enhancing roles and effects of standards appears to be well-recognised within Irish industry. For instance, of the 250 companies surveyed by B&A:

- 78% agree that the application of standards leads to more efficient use of resources;
- 77% agree that independent certification to standards provides a competitive edge; and
- 69% agree that the improvements brought about by standards/certification translate into higher sales.

Furthermore, 47% of Irish companies surveyed that use standards reported an increase in turnover as a result. This was higher (at 49%) amongst exporting businesses than non-exporting businesses (44%). Of those businesses reporting such increases:

- 37% of exporting businesses report an increase in turnover of 1-10%, with 31% reporting an increase in the region of 11-20%;
- 43% of non-exporting businesses report an increase of 1-10%, with a much lower 14% reporting increases of 11-20%.

At the sector level, business services companies and food and drinks manufacturers were most likely to report increases in turnover of 1-10% (54% and 45% respectively). Construction and manufacturing companies were most likely to report increases in turnover of 11-20% (28% and 33% respectively). Meanwhile, 21% of construction companies reported increases in turnover of 21-30% while 18% of food and drinks manufacturers report increases in turnover in excess of 30% as a result of the use of standards.

These impacts can be expected to constitute a gain to the efficiency and performance of business and a net gain to the economy as a whole to the extent that the improvements are not made at the expense of other companies (through a business-stealing effect as opposed to market expansion).

3.4 Role of standards in boosting export activity

Over the past 40 years, Ireland has enjoyed spectacular success in attracting foreign direct investment, which has led to the rapid expansion of exports and helped to diversify economic activity in Ireland away from agriculture. Exports of goods and services from Ireland now represent 114% of GDP, in no small part as a result of the export-oriented activities of foreign owned companies, but also of Ireland's membership of the European single market, the workings of which depend crucially on the system of European (and indeed international) standardization.

Global trade likewise relies on international standards. A literature review by Swann²³ (2010) shows that most academic studies find that international standards – which represent the bulk of standards used in Ireland – have in most cases a positive effect on a countries' export performance. This proposition is supported by the B&A (2015) survey evidence which reports 83% of Irish companies agreeing that the application of standards has enabled easier access to international markets.

According to the academic literature (see Blind and Jungmittag, 2005²⁴) standards have several important effects on international trade, including:

- Technical standards as an indicator of the competitive assets of a country. Countries where standards are used widely have a competitive advantage in export markets because they improve quality and reduce the cost of their goods. As already noted, 77% of Irish companies surveyed by B&A agree that independently certified standards have provided their business with a competitive edge in international markets;
- Standards help to reduce the transaction costs involved in ensuring quality and compatibility, allowing companies to outsource more of their supply chain to external contractors. The B&A survey evidence likewise supports this proposition, given the findings that, as already noted, 71% of Irish companies agreeing that standardization has improved client-supplier relationships and 85% believing that multinational companies are more likely to do business with an Irish company that adheres to internationally recognised standards.

Further evidence comes from a survey²⁵ of ICT companies involved in the standards development process and reveals that the cost-related impacts of standards are less relevant to stakeholders than various market-shaping aspects, such as defining best practice or galvanising innovation. This is reflected in the B&A survey evidence already noted in Subsection 3.1 above, but also by the fact that only 37% of companies surveyed by B&A associated lower costs with the use of standards. Stakeholders in the ICT study perceived the main positive impacts to be in the area of international trade and the ability with standards to efficiently increase product choice, and to develop new global outsourcing opportunities. Formal standards were seen to have major positive impacts on the globalization of markets and on market entry. Such perceptions are likewise reflected in the B&A evidence from the survey of Irish companies presented in Subsection 3.1 above.

A study by Blind and Jungmittag²⁶ (2005) using German and UK data examined the effect of innovative capacity on bilateral trade flows and trade with the rest of the world. The study found that the trade balance with the rest of the world is positively influenced by the stock of international standards and negatively by national ones. The results support the hypothesis that the entire national stock of standards (which in Ireland's case is predominantly EU and international standards) have a positive influence on the competitive advantage of the exporting country. This chimes with the predominant perception amongst Irish industry of the competitive edge conferred by certification to standards, as reflected in the B&A survey evidence.

²³ Swann, G. P. (2010). International standards and trade, OECD.

²⁴ Blind, K., & Jungmittag, A. (2005). Trade and the Impact of Innovations and Standards: The Case of Germany and the UK. *Applied Economics*, 37(12), 1385-1398.

²⁵ Blind, Knut & Gauch, Stephan & Hawkins, Richard, 2010. "How stakeholders view the impacts of international ICT standards," *Telecommunications Policy*, Elsevier, vol. 34(3), pages 162-174, April.

²⁶ Blind K, Jungmittag A (2005) Trade and the impact of innovations and standards: the case of Germany and the UK. *Appl Econ* 37: 1385–1398

3.5 How standards support employment generation

Academic research at the country level shows that technological progress (of which standards are a component) drives long-term economic growth, productivity and improved standards of living. One aspect that this research does not capture is the process of “creative destruction”. New technologies replace or remove jobs in some industries - for example office typist roles are now redundant as a result of personal computers - while creating jobs in new industries which require different sets of skills.

According to Aghion and Howitt (1994), technological progress has two opposing effects on employment. First, as technology substitutes for jobs, there is a destruction effect, requiring employees to change occupations. Second, there is the capitalisation effect, as more companies enter markets where business is performing well, leading employment in those sectors to expand.

These opposing effects on jobs are present in Ireland, where the trend has been towards creating high-value employment, raising productivity and the automation of routine and manual production occupations. The quest for productivity improvements has meant that many low value-added activities have transferred to countries with lower labour costs. In their place ‘high-value’ jobs have been created in activities such as research and development, high-tech manufacturing, precision engineering and computer & IT services. Jobs in these sectors tend to be highly productive i.e. the GVA generated per employee is substantial. Such trends mean that new ICT-related standards are likely to become equally important for traditional industries as for those operating in these R&D-led sectors like ICT.

The economic activity generated by these sectors has a multiplier effect created via purchases from their locally based supply chain – which induces output and creates additional jobs in other sectors of the Irish economy. Ireland’s Department of Finance has provided estimates of the magnitude of these impacts, which are presented in Table 7.²⁷ The lower values in the foreign-dominated sector reflects its concentration in high value R&D-led sectors like high-tech manufacturing (such as medical devices) and computer and IT services relative to the more labour-intensive low-mid-tech sectors in which domestic companies are concentrated.

Table 7: Type 1 multiplier and employment effect of foreign MNE dominated sectors and rest of economy

Sector	Output Multiplier	Employment effect
Foreign-dominated	1.2	3
Rest of economy	1.4	10

Source: Department of Finance - Economic Impact of the Foreign-Owned Sector in Ireland, 2012

Evidence from Cebr²⁸ (2015) shows that standards use tends to be focussed in sectors such as manufacturing, ICT and engineering where high value production jobs are concentrated. Ireland is an outlier amongst EU28 economies with disproportionately large manufacturing and ICT sectors. This suggests that Ireland could benefit more from standards use in terms of job creation relative to other countries.

The B&A evidence suggests that 63% of Irish companies surveyed believe that those who adopt standards are more likely to create new jobs. Interestingly, this view was most prevalent amongst food and drinks

²⁷ Department of Finance, (2014), Economic Impact of the Foreign-Owned Sector in Ireland, Department of Finance.

²⁸ Cebr, (2015), Economic Contribution of Standards to the UK Economy, BSI.

manufacturing and healthcare companies (both 81%), followed by construction and business services (both 66%) and manufacturing (54%).

A large scale study by Levine and Toffel²⁹ (2010) covering 1,000 Californian companies examined the effects of ISO 9001 Quality Management System standards adoption on organisational outcomes including employment. The study had several hypotheses including to test whether ISO 9001 improves management practices and production processes, and that these improvements translate into increased sales and employment.

In terms of employment, the study found that staff numbers were on average 6.1% higher after three years of adoption, and 33% higher after nine years. The study also found that employment growth was higher for larger firms compared to smaller firms. While the results of this study specifically relate to the use of ISO 9001 among companies, the findings point to an important role of standards in creating the conditions required to facilitate new job creation.

The study also tests the hypothesis that ISO 9001 certification is associated with a greater probability of firm survival, testing whether the success of businesses in remaining solvent stems from channels such as the ability to effectively reduce costs and to signal higher quality to customers. But businesses are often obliged to adopt ISO 9001 by important industrial buyers that require certification as part of participation in their supply chain. This can guarantee the survival of the business without necessarily coinciding with a reduction in costs or improvements in output. Without specifically determining the channels through which survival is achieved, the study found that over a period of nine years, only 0.5% of companies that adopted ISO 9001 went out of business while 7.1% of non-certified companies did not survive.

3.6 Role of standards in R&D and innovation

Blind and Jungmittag³⁰ (2008) show that in the more mature and less R&D intensive sectors, we observe higher impacts of standards, whereas the knowledge pool measured by patent applications is more relevant to those sectors with high R&D intensity and a stronger use of high technology. This originates from the fact that, in sectors where R&D is more costly, companies will tend towards retaining technical knowledge in-house so that they can maximise the return on their investment.

According to Blind and Jungmittag (2008), the globalisation of companies and trade in technologies reduces the duplication of R&D effort globally and consequently increases the efficiency of R&D activity, which further enhances growth. This has allowed businesses to consolidate their R&D activities in a smaller number of locations, often choosing countries where a skilled workforce is available and where the tax treatment of patent revenues is favourable. In recent years, Ireland has attracted large amounts of foreign investment in R&D facilities. In 2014, business R&D expenditure amounted to €2.1 billion³¹, an increase of 47% compared to 2007 levels. The main driver of Ireland's business expenditure in R&D continues to be the foreign-owned sector which contributes approximately 65 per cent of overall annual R&D investment.

Those involved directly in R&D are, of course, more likely to be aware of and adopt basic standards that are relevant to their activities. For most businesses, however, the standards themselves often represent

²⁹ Levine, David and Toffel, Michael, (2010), Quality Management and Job Quality: How the ISO 9001 Standard for Quality Management Systems Affects Employees and Employers, No 09-018, Harvard Business School Working Papers, Harvard Business School.

³⁰ Knut Blind & Andre Jungmittag, (2008), "The impact of patents and standards on macroeconomic growth: a panel approach covering four countries and 12 sectors," Journal of Productivity Analysis, Springer, vol. 29(1), pages 51-60, February.

³¹ Central Statistics Office, 2015, 'Business Expenditure on Research and Development 2013 – 2014', CSO.

the innovation of their sector and these are the businesses amongst which the greater use of standards could be usefully promoted.

Furthermore, traditional standards tend to be effective in serving traditional industries, but it is often these traditional industries that are developing innovative new technologies. For instance, the energy sector is leading the development of smart devices like smart meters and remote control heating devices etc.

Standards have several functions within the innovation process. Swann³² (2000) summarises the existing literature on the relationship between standards and innovation, which is presented alongside the survey evidence from Ireland that supports these propositions about the role of standards:

- Standardization helps to build focus, cohesion and critical mass in the emerging stages of technologies and markets. In Ireland, 81% of companies surveyed by B&A believe that standards provide benchmarks enabling the differentiation of products according to quality or other characteristics.
- Standards for measurements and testing help innovative companies to demonstrate to their customers that their products possess the features they claim to have, but that they also present acceptable levels of risks for health, safety and the environment. 85% of Irish companies surveyed by B&A agree that companies that use standards have stronger reputations, while 76% believe that those who use standards and are certified to them provide higher quality goods and services.
- Standards codify and diffuse the state of the art and best practice in science and technology. In Ireland, 66% of companies surveyed agree that standards help to speed up technology transfer by making innovations more accessible. Furthermore, 72% agree that the use standards is associated with greater environmental friendliness.
- Open standardization processes and standards enable a competition between and within technologies and contribute therefore to innovation-led growth. B&A found that 45% of Irish businesses agreed with the proposition that standards have stimulated the development of new sectors of business within their industry.

The latest Government Enterprise Policy for the period 2015 to 2025 emphasises how standards and the national standards body NSAI are crucial elements of Ireland's sectoral and innovation ecosystem³³. Since 2014, EC Horizon 2020 research funding is dependent on projects specifying technology readiness levels and the standards that will be used in the grant-funded research as part of the assessment of each application. This points to the recognition among policymakers at the national and EU level of the importance of standards for the commercialisation of applied research originating in universities and research institutes.

3.7 Benefits to companies from involvement in standards development

According to research from Cebr³⁴ (2015), companies that are highly involved in standards development are more likely to experience benefits from using standards than those that are not involved. The main routes through which businesses benefit are by gaining early awareness of emerging themes in their sector and by promoting firms' interests in order to gain first mover advantage. For example, survey evidence

³² Swann, G. P. (2000). The economics of standardization: final report for standards and technical regulations directorate, Department of Trade and Industry. Manchester Business School.

³³ Department for Jobs, Enterprise and Innovation, 2015, 'Enterprise 2025: Innovative, Agile, Connected', DJEI. Available at: <https://www.djei.ie/en/Publications/Enterprise-2025.html>

³⁴ Cebr, 2015, "The Economic Contribution of Standards to the UK Economy", BSI.

from Cebr's 2015 study on the economic impact of standards in the UK revealed that 71% of all firms participating in the standards development process benefitted from the ability to lead the progression of their market, not only in the setting of standards but in determining new technological solutions.

But, according to De Vries (2009), SMEs face a financial burden disproportionate to their size from sending staff to participate in standards development. The survey evidence from Cebr's UK study suggests that participation by SMEs remains a challenge. Given the magnitude of investment required in time and the resulting demands on their limited staff resource, not to mention travel and other expenses, the cost of participation can be prohibitive. SMEs also often lack the necessary expertise in standardization matters. This affects their ability or willingness to attend standards-setting committees. Cebr (2015) also suggests that SMEs are under-represented in the standardization process, with only 10% of UK SMEs reporting that they are highly involved in standards development compared to 26% of large companies (250+ employees).

This is not dissimilar to the recent B&A survey evidence from Ireland. Of the 250 companies surveyed, 16% report that they have contributed to the development of standards. This was higher for companies operating in the academic/government sector (32%) and in business services (24%), at the average level in construction (16%), but lower than average in manufacturing (13%) and healthcare (10%) and, rather surprisingly, lowest in food and drinks manufacturing (5%).

Amongst these participants in standards development, there is broad consensus that being involved in standards development provides the chance to:

- Promote their firm's interests at the national level (73% of respondent companies) and at international level (63%);
- Achieve recognition through an official system (87%);
- Participate in a network of the most influential operators in their sector (90%);
- Gain access to information that would not normally be received about activities in their sector (80%);
- Gain early awareness of product compliance standards such as future market rules and emerging themes (83%);
- Tailor product design to standards to get them to market first (77%); and
- Lead the development of their market by influencing the development of standards or promoting new technological solutions (70%).

There is little variation across the different sizes of business surveyed but, if anything, the smallest companies were more positive about the benefits of participation. This suggests that standards could be considered more closely as a potential policy tool with which the Irish Government could support micro, small and medium enterprises, as well as larger businesses if and when required, to perform to their maximum potential.

Given the benefits of participation by companies in the standards development process, and the desirability of achieving an adequate representation of SMEs on standards-setting committees, De Vries (2009) suggests that the solution may revolve around providing targeted resources to SMEs, for instance by compensating for their time, expenses or providing education on the standards development process so that they are better equipped to participate.

4 Standards in the context of the unique characteristics of the Irish economy

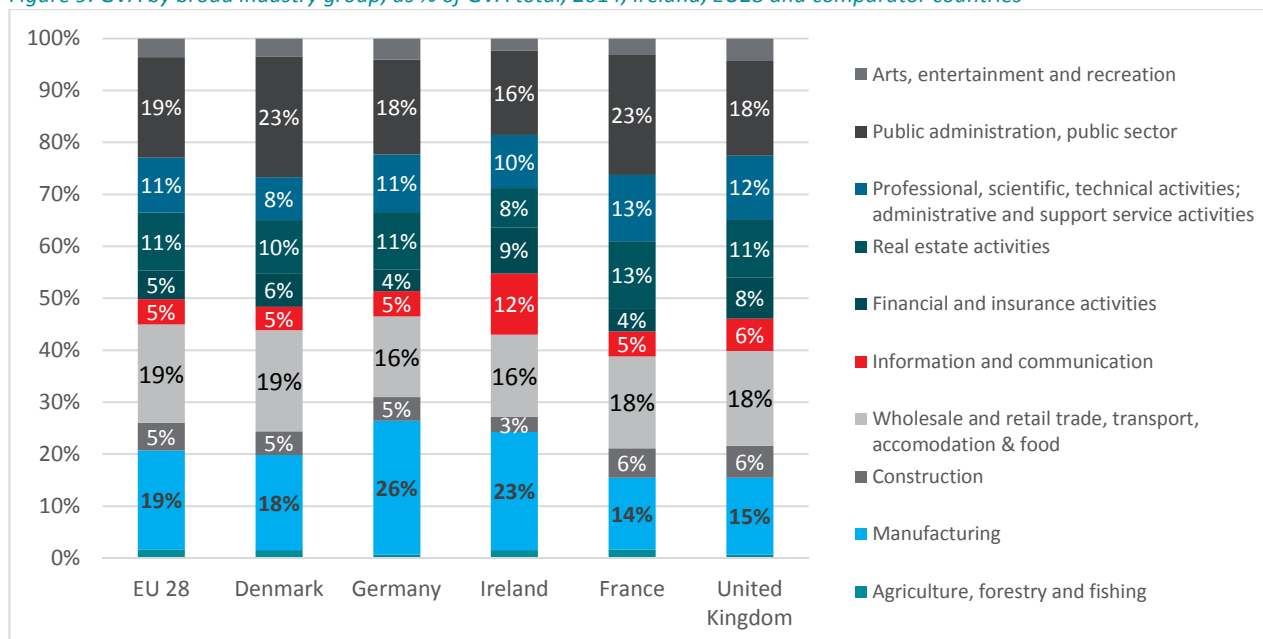
The evidence from existing government and academic research shows that standards make a positive and significant contribution towards economic growth, productivity, export activity, employment and innovation. The B&A survey evidence suggests that the channels and mechanisms through which these impacts of standards are generated are present in Irish industry. However, it does not provide any clues as to the magnitude of these impacts, and making direct inferences from the academic and government research is not always easy because the countries for which previous studies have been carried out are predominantly large economies (such as France, Germany and the UK).

But, while Ireland's economy is small, it is very open. Therefore, as already noted, there was little reason to believe that the contribution of standards could be anything but on a par with those estimated for other countries where national level studies have already been carried out, not least due to Ireland's relative openness to trade and the importance of FDI compared with some of the larger economies. In this section, a comparison is made between Ireland's economic characteristics and that of four comparator countries (Germany, France, the UK and Denmark) where studies have been carried out to quantify the economic contribution of standards. The aim is to ascertain the extent to which Ireland differs from those countries, and hence the degree to which the findings of previous national level studies can be applied to the case of Ireland.

4.1 Ireland's industrial structure

Ireland's industrial structure differs substantially from the EU28 average. The manufacturing and information & communications technology (ICT) sectors make up a far higher share of gross value added (a measure of economic output) than in the majority of EU countries (see Figure 9). Ireland ranks sixth amongst the EU28 countries in terms of GVA from manufacturing as a percentage of the total economy – exceeded only by the Czech Republic, Hungary, Slovenia, Germany and Slovakia.

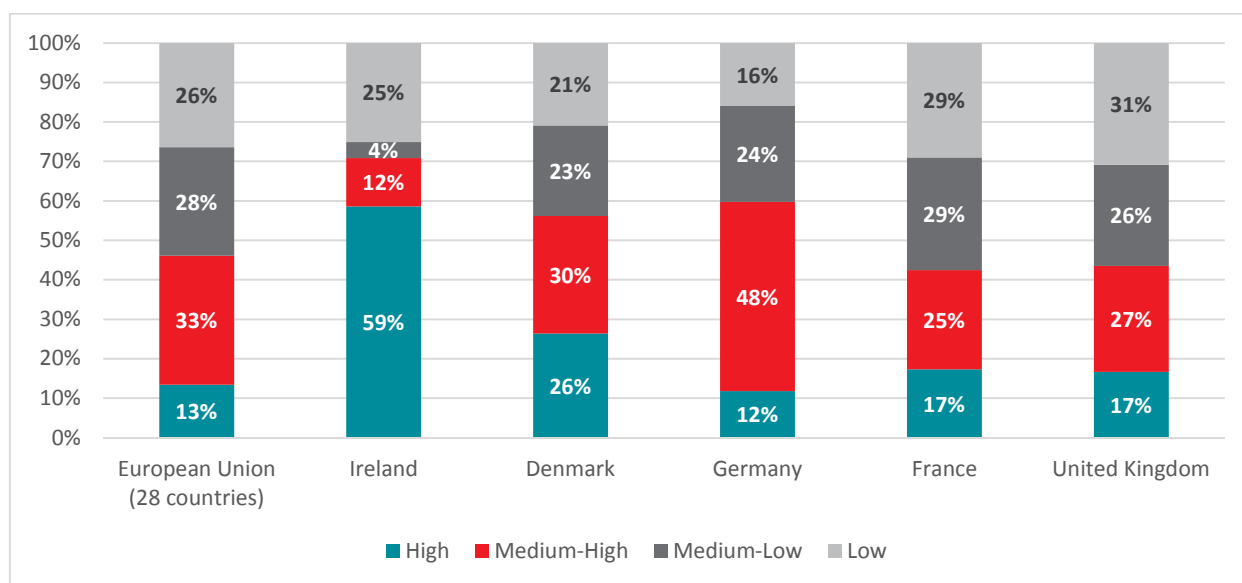
Figure 9: GVA by broad industry group, as % of GVA total, 2014, Ireland, EU28 and comparator countries



Source: Eurostat

Within Ireland's manufacturing sector, there are further important differences. The structure is concentrated in high-tech technology-intensive sectors³⁵ such as ICT equipment, medical devices and pharmaceuticals.³⁶ Figure 10 shows that 59% of Ireland's manufacturing activity is made up of high-tech sectors.³⁷ By comparison, the comparator countries boast greater shares of medium-tech, less R&D-intensive manufacturing sectors, capturing industries such as automotive and electrical machinery manufacturing.

Figure 10: Breakdown of manufacturing sector GVA at factor cost by technology-intensity level, 2012



Source: OECD ISIC Rev.3 technology intensity definition, Eurostat structural business statistics, Cebr calculations

Low-technology manufacturing sectors are also important for the Irish economy, representing close to the EU28 average in terms of share of aggregate manufacturing output. Most notable among these is food products and beverage manufacturing, which represent 22% of Ireland's manufacturing output - well above the EU28 average of 13%. Domestic ownership and SMEs are more concentrated in these sectors,³⁸ as is NSAI standards development and sales activities. This is significant given the focus of *Enterprise 2025* on supporting Irish companies to bolster Ireland's economic resilience. Given the purported benefits, there is clear potential to increase participation in the standards development process by companies in these sectors, as demonstrated by the fact that, as noted earlier, only 5% of Irish companies in the food and drinks manufacturing sector surveyed by B&A report having done so.

Greater impacts of formal standards are observed in more mature and less R&D-intensive sectors such as automotive manufacturing (see Subsection 3.6 above). In sectors with high R&D intensity, on the other hand, companies tend towards retaining more technical knowledge in-house so that they can maximise the return on investment in R&D (through licenses and patents). This suggests that, although

³⁵ In the latest version of the OECD ISIC REV.3 technology-intensity definition, "medical, precision and optical instruments" were moved to the high-technology group. It was previously classified as "medium - high technology".

³⁶ This definition, developed by Eurostat, groups manufacturing industries according to technological intensity, which is measured by R&D expenditure as a % of value added.

³⁷ See Appendix for a list of the full classification of 3-digit sectors by technology intensity level.

³⁸ For example, SMEs employ 68% of people working in the electrical equipment manufacturing industry compared to only 23% in the pharmaceuticals industry and 25% in computer & electronics manufacturing.

manufacturing is relatively more important in Ireland than in the comparator countries with the exception of Germany, the fact that the sector is skewed towards high-tech suggests that the subset of standards that are relevant to the analysis in this report might be of lesser importance to Ireland's manufacturing sector when taken as a whole. This would tend to dilute the greater economic impact of standards that would be expected to arise through a manufacturing sector that is larger as a share of the economy as a whole than in most of the comparator countries.

4.2 The importance of inward foreign direct investment (FDI)

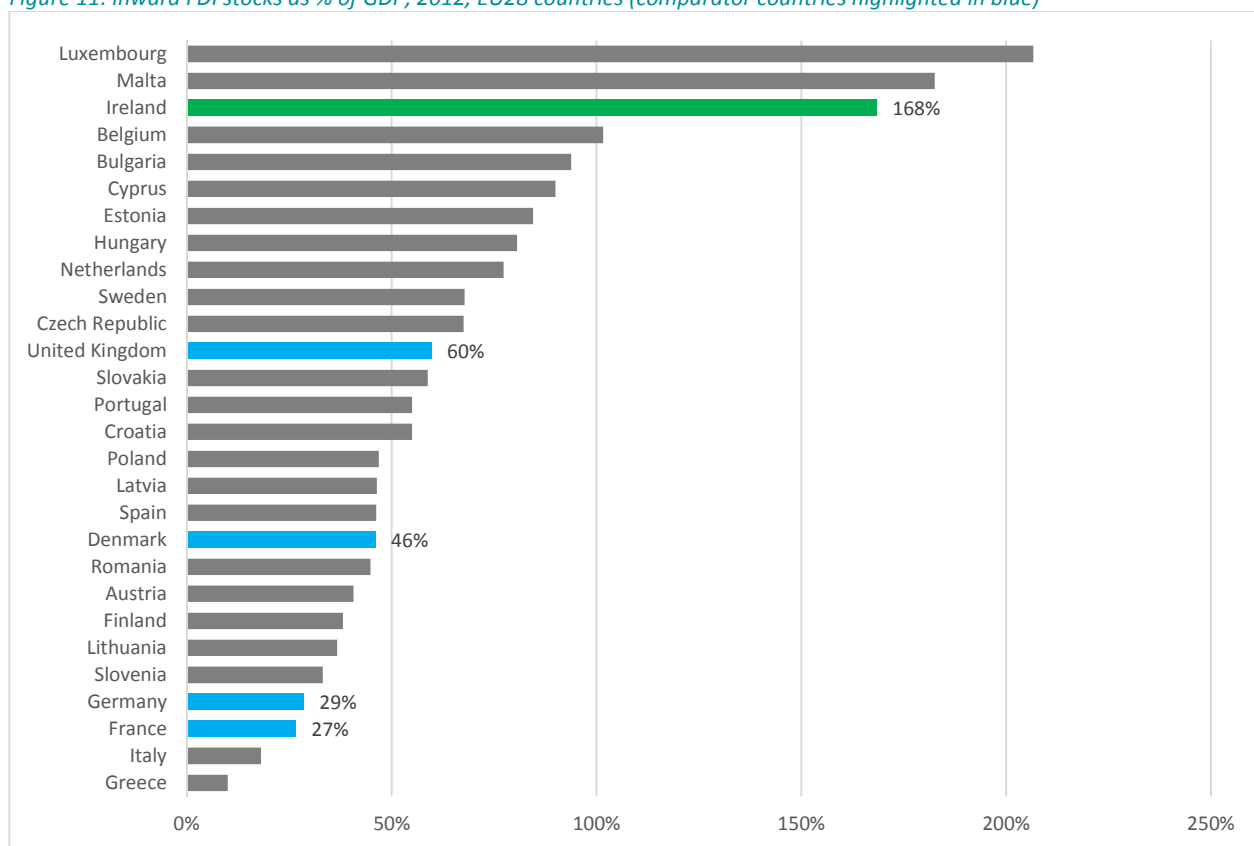
Ireland ranks as one of the most successful countries in the world at attracting foreign direct investment. Global multinationals such as Intel, Microsoft, Dell and Medtronic have each made significant investments in the country and employ thousands of staff. In 2012, Ireland was third amongst the EU28 in terms of its FDI stock as a share of GDP after Malta and Luxembourg (see Figure 11). As a result of prolonged inward investment, the share of economic activity from foreign-owned companies is high relative to other countries, representing an estimated 23.3% of employment and 58% of the value added of the entire business economy in 2012.³⁹

The nature of FDI means that investing companies normally have large networks of subsidiary companies and suppliers located around the world. Standardization can be important in the management of such complex global supply chains. Standards are also important when the product manufactured in Ireland is destined for European and other international export markets, some of which can necessitate product adaptations to meet minimum regulatory requirements, requiring the use of specific national or international standards in order to sell into those markets.

Evidence of this role of standards in Ireland is strong. As already noted, of the 250 Irish companies surveyed by B&A, 85% agree that multinational companies are more likely to do business with an Irish company that adheres to internationally recognised standards and 84% agreed that they themselves would be more likely to do business with other companies that use standards and are certified. Likewise, 71% of companies surveyed agreed with the proposition that standardization had improved client-supplier relationships by increasing their confidence in suppliers.

³⁹ Eurostat - Annual enterprise statistics for special aggregates of activities, 2015

Figure 11: Inward FDI stocks as % of GDP, 2012, EU28 countries (comparator countries highlighted in blue)

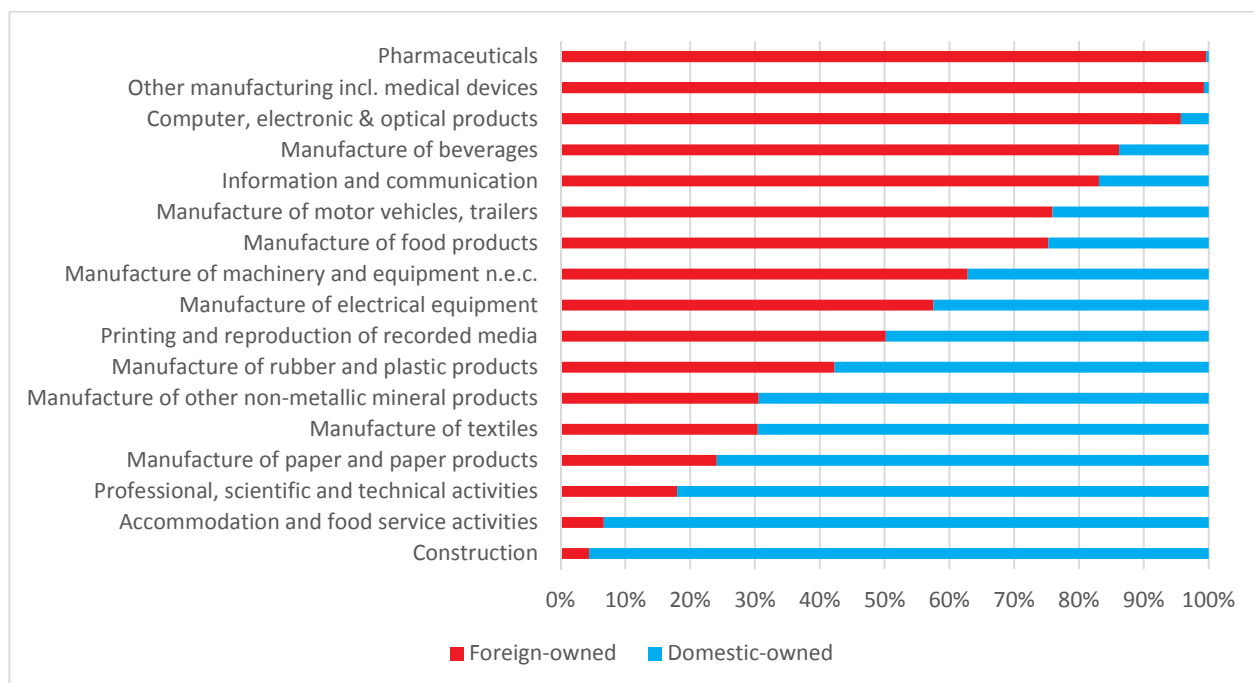


Source: Eurostat

These characteristics of FDI, combined with the evidence on the relative importance of FDI activity to Ireland's economy, suggest that standards probably play a more important role in Ireland *through the FDI route* than in the comparator countries.

However, Figure 12 depicts the share of businesses in several industries that are key to the Irish economy, broken down by the nationality of the business. It shows that foreign-owned companies tend to be clustered in high-tech, R&D-intensive sectors such as pharmaceuticals. Further high-tech industries such as 'other manufacturing (including medical devices)' and the 'manufacture of computer, electronic and optical products' are also heavily dominated by multinational companies. The lesser focus of such high-tech industries on the types of standards that are relevant to this report (subsection 4.1 above) might therefore dilute the expected greater impact of standards through the FDI route.

Figure 12: Proportion of total GVA by sector, breakdown by ownership status, 2012



Source: Eurostat, Cebr analysis

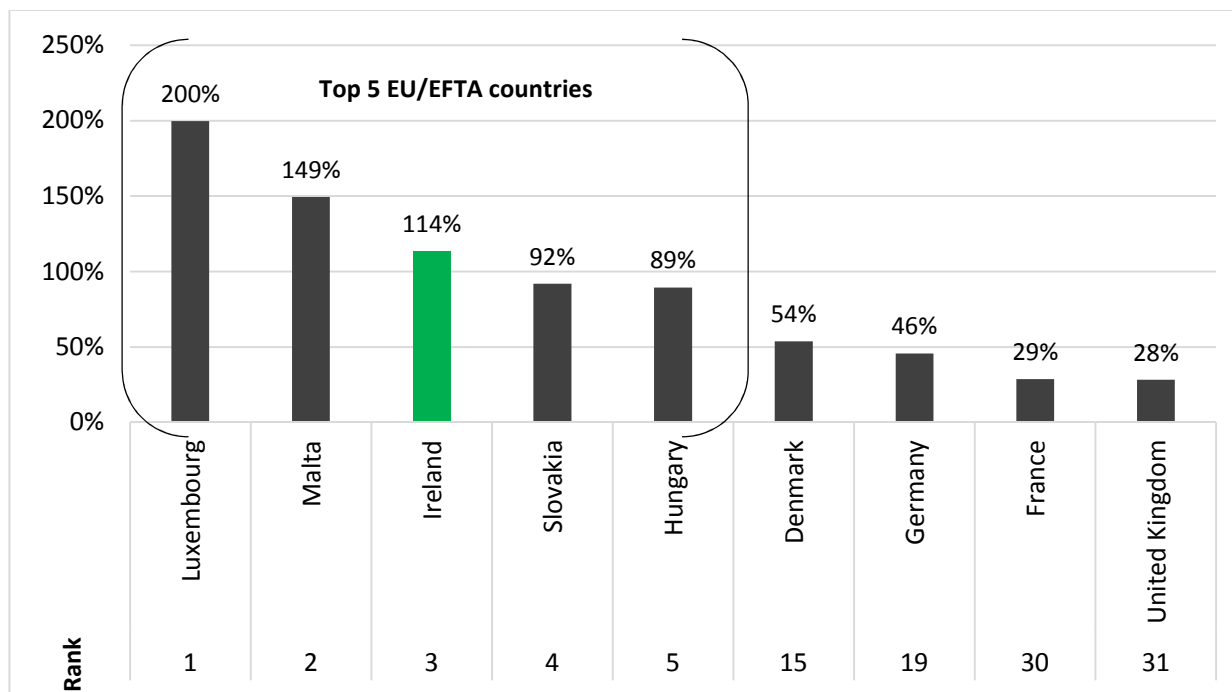
At the opposite end of the spectrum, domestic-owned businesses are more focussed in low-medium-tech manufacturing industries such as food products and in sectors like construction. As these sectors are generally characterised by greater standards-use intensities (see Section 3.6), the statistics implied by Figure 12 suggest that domestic businesses could have the most to gain from the benefits of standardization.

4.3 Scale of export activity relative to the size of Ireland's economy

From the evidence presented in section 3.4, it is established that the use of standards normally has a positive effect on export performance.

Large advanced economies such as France, Germany and the United Kingdom benefit from relatively large domestic markets which means that businesses located in those countries are less reliant on international trade and foreign markets to achieve growth and enhanced performance. In countries such as Ireland, the domestic market is much smaller, necessitating businesses to sell their goods and services outside the country in order to achieve scale. This is reflected in goods and services export statistics (see Figure 13), which show that exports as a share of GDP are far higher in Ireland (114% of GDP) than in our comparator countries. Only Luxembourg and Malta exceed Ireland but their exports are heavily concentrated in financial services and tourism, respectively – both sectors with relatively low standards input.

Figure 13: Exports of goods and services as a % of GDP, 2014, Top 5 EU/EFTA countries and comparator countries (rank out of 31 countries)



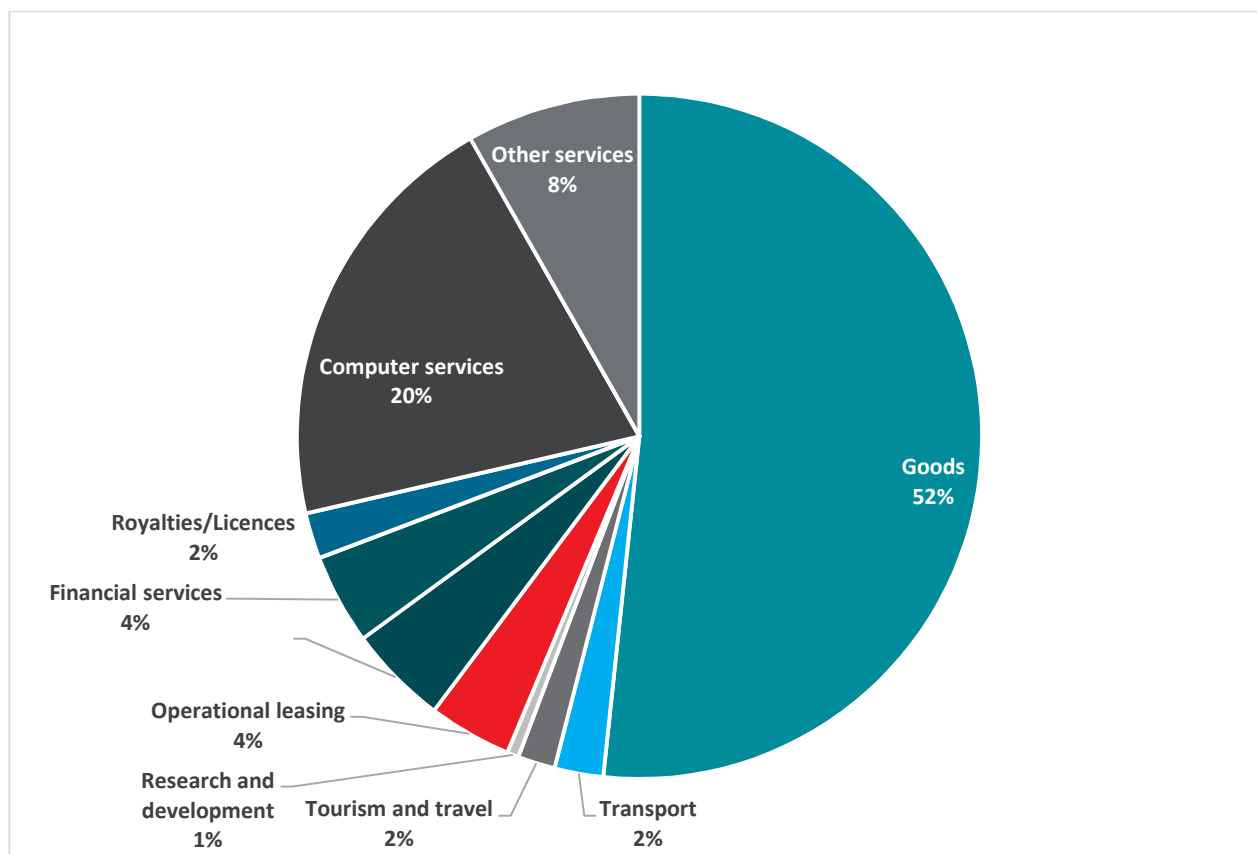
Source: Eurostat

Locating in Ireland is often a strategic corporate decision to gain access and proximity to the EU and EMEA markets. Ireland, with its domestic market of 4.6 million people and 186,000 businesses would not alone represent a sufficiently sizable market to warrant large-scale foreign investment. The nature of manufacturing in sectors such as the pharmaceutical industry means that, in order to be efficient, sites must produce at scale. It makes sense therefore that Irish manufacturing sites are often producing for the EU or EMEA regions or indeed further flung markets. Compatibility and quality standards are particularly beneficial for exporting manufacturers because they facilitate both participation in and outsourcing to suppliers located in other countries, allowing economies of scale in specialist large-scale sites located in Ireland.

Combined with the evidence on the relative importance of exporting to Ireland's economy, this suggests again that standards probably play a more important role in Ireland *through the exporting route* than in the comparator countries. However, as outlined in Subsection 4.1, Irish manufacturing is concentrated in high-tech sectors like pharmaceuticals, medical devices and ICT equipment, which would tend to dilute the greater economic impact of standards that would be expected due to a manufacturing sector that is larger as a share of the economy as a whole than in most of the comparator countries.

The importance of internationally traded services to the Irish economy has increased dramatically in recent years – from 14% of exports in 1990 to 48% of exports in 2014. A key driver of this growth has been the computer services industry, where multinationals such as Google, Microsoft and PayPal have all set up significant operations in Ireland. This has contributed to the Dublin region becoming one of the largest ICT clusters in Europe. As shown in Figure 14, computer services represented 20% of exports in 2013, and is expected to continue to grow over time.

Figure 14: Irish exports of goods and services – with detailed services sector breakdown, 2013⁴⁰



Source: CSO International Trade in Services 2013, CSO Goods Exports and Imports statistics Dec. 2013

Standards are now widely used by many services companies, particularly in the computer services sector. This points to a significant existing and growing impact of standards in terms of exporting activity in services.

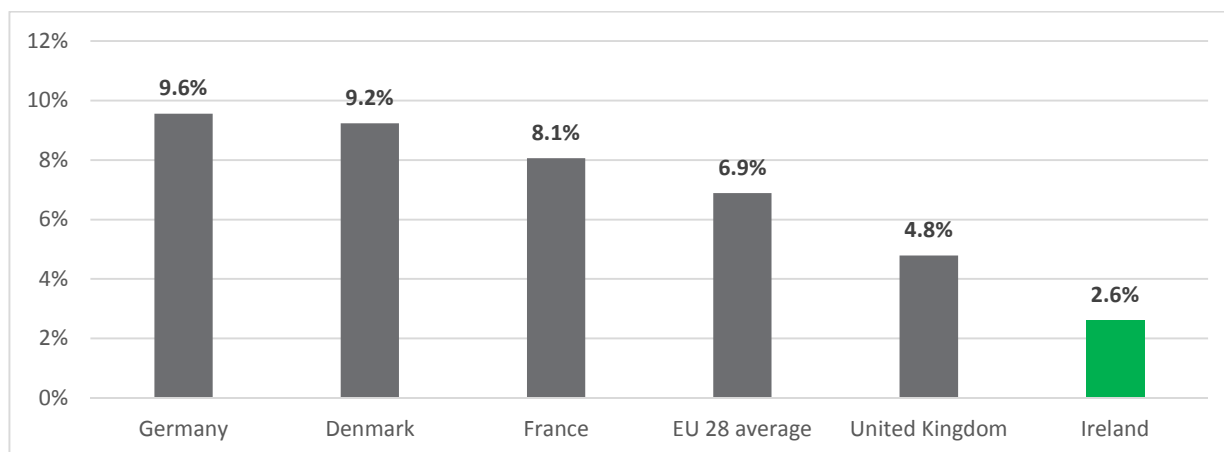
4.4 Low manufacturing business R&D in Ireland

Given the role of standards in the innovation process, overall levels of R&D expenditures can be indicative of the extent to which standards might be impacting on the economy. However, as illustrated by Figure 15, Ireland's manufacturing business R&D expenditure as a percentage of manufacturing GVA (2.6%) remains well below the EU28 average (6.9%) and well behind that of Denmark (9.2%) and Germany (9.6%).

Therefore, we might expect the economic benefits of standards *through the R&D and innovation route* to be lower in Ireland than in the comparator countries.

⁴⁰ Latest data available with detailed services sector export breakdown

Figure 15: Manufacturing business R&D expenditure as a percentage of manufacturing GVA, by country in 2013



Source: Eurostat, CSO, Cebr analysis

As described in Section 3.6, the globalisation of companies and trade in technologies has meant a reduction in the duplication of R&D effort globally and consequent increases in the efficiency of R&D activity. But Ireland appears to have benefited from this, reporting a substantial increase in the level of overall R&D expenditure in recent years, from €1.8 billion in 2004 to €2.9 billion in 2014 (a 61% increase). Given this, we would expect the impact of standards through this route to have increased in Ireland in response.

4.5 Summary: How the Irish economy differs to our comparators

The purpose of the analysis detailed in this section is to establish how Ireland's economy coincides with, and differs from the other countries for which the impact of standards has been examined. The focus is on key characteristics that make the Irish economy unique, including industrial structure, the importance of FDI and export activity and aggregate business-led R&D intensity levels. From this, we have sought to make inferences about the contribution of standards to the Irish economy and the extent to which the findings of previous national studies can be applied to the case of Ireland.

Table 8 summarises our findings on how Ireland's economy sits next to comparator European countries, and what this means in terms of what we can infer about the impact of standards in Ireland. Ireland has a far higher concentration of FDI investment and export activity relative to its European counterparts. Due to the significant role standards play in facilitating FDI and export activity, we can infer that in terms of these metrics, the contribution of standards to the Irish economy could be greater relative to comparator countries. However, we also noted how these expected greater impacts could be diluted due to:

- Ireland's industrial structure and the fact that manufacturing is skewed towards high-tech, meaning that standards are probably of lesser importance to Irish manufacturing and to Irish goods trade when taken as a whole relative to the comparator countries.
- The fact that the multinational companies that bring FDI to Ireland are heavily concentrated in high-tech industries.

We also find that, in terms of R&D activity, Ireland lags behind the comparator countries.

Table 8: Summary of characteristics important in understanding the impact of standards on the Irish economy relative to the comparator countries

Metric	Characteristic of the Irish economy	Expected impact of standards on Ireland (relative to comparators)
Industrial structure	Relatively important manufacturing sector but diluted by dominance of high-tech	Lower or equal
FDI	FDI of greater importance to the Irish economy than comparators but diluted by MNCs' concentration in high-tech	Equal or greater
Export activity	Exports of greater significance to the Irish economy than comparators but diluted by dominance of high-tech in manufacturing	Equal or greater
Business R&D expenditure	Below average business-led R&D activity than comparators	Lower

Source: Cebr analysis

Although Ireland boasts a manufacturing sector that is close to twice as important (in terms of GVA as a percentage of the economy) as in France and the UK, activities are heavily concentrated in high-tech manufacturing industries, such as pharmaceuticals and medical devices. These sectors tend to have lower standards-use intensity (with a higher concentration of proprietary knowledge through patents) relative to more mature and less R&D-intensive sectors (see section 3.6). In light of these characteristics, standards might be expected to make a lower contribution to Ireland's economy relative to the comparator countries. France and Germany, for example, have more well-developed medium technology⁴¹ manufacturing industries such as automotive and electrical machinery manufacturing, which tend to be more intensive users of the subset of standards that is relevant to this report.

While it is impossible to be definitive, this analysis suggests that, on balance, the role and importance of standards in Ireland should not be expected to be very different, at least in average terms, than in the comparator countries. This is explored in the following section, in which we produce estimates of the magnitude of the economic impact of standards in Ireland.

⁴¹ ISIC rev. 3 classification of manufacturing industries into categories based on technology intensity

5 Macroeconomic analysis of the impact of standards on Irish economy

This section presents high-level estimates of the economic impact of standardisation in Ireland. We examine the impact of standards on the country's output, labour productivity, employment and export activity, using a high-level meta-analysis of previous national level studies. The purpose of the analysis is to provide an understanding of the magnitude of the impact of standards in Ireland and to ascertain how this might differ from their estimated impacts in other countries.

5.1 Labour productivity and GDP growth

Long-established economic theory states that a country's economic growth is determined by the quantity of factors used in production (capital and labour), and the efficiency with which they are used. More specifically, theory suggests that economic growth can be achieved through increasing the amount of labour and capital used, and by increasing the level of technological progress in an economy, which improves the efficiency with which these factors are combined to produce output.

Technological progress, as reflected in total factor productivity (TFP) growth, is sustained through aspects such as improved education and technological advancements. These lead to innovations which enhance the efficiency of processes and techniques used in the deployment of capital and labour across the economy. The features of TFP are driven by a variety of components, including R&D, patents, and standards and it is only TFP growth that can offset the decline in growth that occurs as an economy matures and diminishing returns to additional labour and capital set in. As standards play a significant role in driving TFP, the academic literature suggests that, in the long-run, there is a causal relationship between standards, labour productivity and economic growth.

As a foundation to our analysis, we use a synthesis of studies from the body of existing empirical research on the impacts of standards in economic terms. In particular, we use research that evaluates the impact of standards in European countries, namely the UK, Germany, Denmark and France. Further, we focus on research that pertains to mature, developed economies that are at similar stages of economic development to Ireland. The comparison between the characteristics of these countries and Ireland presented in section 4 indicates that the expected contribution of standards should be broadly consistent, thereby warranting the use of a meta-analysis methodology. This allows us to identify the impact of the common variable across these countries, i.e. standards, and to apply this to Irish macroeconomic data.

The comparator country studies use a 'growth accounting' approach to the estimation of the role of standards in the economy, which involves, as the name suggests, accounting for the sources of economic growth in a given period of time. The starting point is a production function of the economy, expressed as a function of labour and capital inputs and TFP. This Cobb-Douglas equation can be transformed into a linear equation that expresses labour productivity as a function of the capital-employment ratio and of standards, along with specific national factors where relevant. The model expressed in this form is conducive to econometric estimation. The unexplained variation in labour productivity is captured by the residual of the model, representing the remaining portion of TFP.

Given their nature, economic theory suggests that standards should exhibit a causal relationship with labour productivity and that the effect is likely to exist only in the long run. The output of these models is the coefficient on the stock of standards, described as the elasticity of labour productivity growth to the stock of standards. The estimates from the various national studies are presented in Table 9 below.

Table 9: Comparison of summary results of national studies

Country	France	Canada	Germany	Germany	UK	UK
Organisation and publication year	AFNOR (2009)	Standards Council of Canada (2007)	DIN (2000)	DIN (2011) ⁴²	DTI (2005)	Cebr (2015)
Period of analysis	1950-2007	1981-2004	1961 - 1990	2002 - 2006	1948-2002	1921-2013
Estimated function	GDP Output	Labour Productivity	GDP Output	GDP Output	Labour productivity	Labour Productivity
Elasticity of labour productivity growth to the stock of standards	0.12	0.36	0.07	0.18	0.05	0.11
Share of labour productivity growth, %	27.1	17	30.1	-	13.0	37.4
Growth rate of GDP % p.a.	3.4	2.7	3.3	-	2.5	2.4
Share of GDP growth, %	23.5	9.2	27.4	-	11.0	28.4
Contribution of standards to GDP growth, % points	0.8	0.3	0.9	0.7	0.3	0.7

Source: AFNOR (2009), Standards Council of Canada (2007), DIN (2000), DTI (2005), Cebr analysis

The fourth row of this table shows the estimates for the elasticity of labour productivity growth with respect to growth in the stock of standards, and how these elasticities vary across the national studies. These can be interpreted as the percentage increase in labour productivity in response to a 1% increase in the stock of standards.

Neither the data nor resources available for the present study could support the development and application of the same growth accounting approach for Ireland. We use the analysis in Section 4, therefore, to draw inferences about the roles and impacts of standards in Ireland based on this evidence from other countries.

The next step in all of these studies is to apply the elasticity of labour productivity growth with respect to the growth rate in the stock of standards, which gives the percentage point contribution to labour productivity growth. Based on the analysis and conclusions of Section 4 above, we consider it appropriate to adopt for Ireland an average measure across the findings for these countries. The mean of the other

⁴² Detailed results were not reported in the study.

country-level results suggest a coefficient for Ireland of 0.11% labour productivity growth in response to a 1% increase in the stock of standards.

The next step is to apply this estimate of the coefficient, and in this we have not departed from the other national studies. The task is to multiply the coefficient by the percentage growth in the stock of standards to give a percentage point contribution to labour productivity growth. Adjusting for the differing time periods of each study, we estimate that annual average growth in the Irish stock of standards was 4.5% in the period 1964-2005.

Applying the elasticity (0.11) to this annual growth in the stock of standards, yields an estimation that, on average over the period 1964-2005, standards contributed 0.5 percentage points to annual labour productivity growth in Ireland.

With labour productivity growing on average by 3.6% each year over the relevant period, we apply the impact of standardization (0.5 percentage points) to estimate that standards supported at least 13.8% of annual average labour productivity growth in Ireland during the 1964-2005 time period (see Table 10).

Table 10: Modelled estimates of the impact of standards on labour productivity and GDP in Ireland, 1964 – 2005, 2014 prices

Metric	Value
Estimated elasticity of labour productivity to the stock of standards (ratio: % change in response to 1% increase in SoS)	0.11
Contribution of standards to labour productivity growth, % points	0.5
Share of labour productivity growth, %, average 1964-2005	13.8%
Share of GDP growth, %, average 1964-2005	9.7%
Estimated average annual contribution to economic growth, 1964-2005, 2014 prices	€309 million
Share of GDP growth, %, average 2006-2013	17.0%
Estimated contribution to economic growth, 2013	€335 million

Source: Existing research⁴³, Cebr analysis

This translates to 9.7% of annual GDP growth. To give an idea of the scale of these impacts in monetary terms, the 9.7% of annual GDP growth translates to an annual average boost to GDP of €309 million, expressed in 2014 prices.

These are rather modest impacts compared with the impact of standards in the other economies, such as the most recent finding that standards support an estimated 37.4% of annual labour productivity growth in the UK over period 1921 to 2013 (Cebr, 2015). Estimates vary between studies but overall the findings suggest that standards account for between 5% and 35% of productivity growth in their respective countries.

But the data for Ireland covers a period (1964-2005) of rapid ‘catch-up’ with the rest of Europe, in terms of industrial development, infrastructure investment and technological progress. During this period of rapid convergence, estimates of the role of standards can be expected to be ‘drowned out’ by the significant labour and total factor productivity improvements catalysed by rapid capital accumulation in

⁴³ See section 3.2 for a list of studies that contributed to our results.

Ireland, as especially witnessed during the ‘Celtic Tiger’ years. In other words, the pace of convergence during the 1964-2005 period can be expected to have been characterised by high levels of capital investment and labour input to GDP growth, and a lower contribution of technological progress (TFP, which includes standards). If this is the case, although standards would have played the same role in business and the economy, the importance of their role in explaining productivity and economic growth would be expected to be smaller than in a period absent such seismic ‘catch up’ convergence.

As Ireland’s economy has matured, TFP will have become a more important factor in sustaining economic growth, due to the decreasing returns to growth that come with adding more capital and labour inputs. Although the results of the analysis indicate that the contribution of standards to economic growth is lower than in some other countries, over time, this contribution is likely to have increased, as has also occurred in other countries, as employees become more productive and R&D becomes a more important element of industrial activity. This is consistent with the application of our analysis to data for the period 2006-2013.

The extension of our analysis to 2013 suggests that today, standards are supporting a more substantial 17% share of GDP growth, which equates to approximately €335 million of our real terms estimate of an average €1.95 billion in GDP expansion recorded over the period 2006-2013 (expressed in 2014 prices).

The jump from the 9.7% estimated for the 1964-2005 period to 17% over the period 2006-2013 reflects economic growth that appears to be achieving relative stability. In other words, during 2005-2014, capital accumulation is likely to have been less dominant in accounting for productivity growth. The increase can also be rationalised by the recent pace of globalisation and of business R&D investment trends.

Although the estimate for 2013 is still mid-range relative to estimates for the comparator countries, the differences can be explained by the differing structure of Ireland’s economy and what this reveals about the intensity of use of standards. The B&A survey evidence confirms the widespread workings of the various channels and mechanisms through which standards generate economic impact through Irish industry.

But isolating and measuring the precise economic impacts of standards is not an exact science and, as noted in Cebr (2015), standards do not support productivity and economic growth independently. Rather, standards play a symbiotic and complementary role with other factors like technological progress and educational improvements. Standards support productivity growth through a variety of mechanisms and intermediate effects within and between companies that enhance business performance, improve trust, stimulate trade and galvanise and catalyse further innovation.

5.2 Employment

As described in Section 3, standardization enables businesses to realise efficiency gains and achieve higher output as a result. Through this, businesses benefit from greater revenue, which in turn contributes to a boost in GDP growth at the national level. Productivity improvements tend to boost profit margins at the outset before being shared with customers through price reductions and with employees through increases in wages and salaries. But they can also boost retained earnings for new investment in capacity expansion, including the creation of new jobs.

Levine and Toffel (2010) use a differences-in-differences approach to estimate the employment impact of businesses adopting the ISO 9001 quality management standard. Comparing a sample of ISO-certified businesses with non-certified businesses, the study reveals that employment was around 10 percentage points higher in ISO-certified workplaces after they were certified, than in comparator, non-certified firms.

The authors attribute this growth in employment to businesses experiencing increased levels of sales, which occur due to the higher level of quality and lower costs, accrued across companies as a result of the ISO 9001 standard. To ensure higher output can be accommodated, businesses expand their productive capacity by employing more people.⁴⁴

We use the GDP impact estimates described in section 5.1 to estimate the employment impacts of standards in Ireland. Businesses need to increase employment to accommodate higher levels of business output. Based on the annual labour share of output between 1964 and 2005, we estimate the number of additional workers required to support the annual boost to GDP of €309 million.⁴⁵ Our estimates suggest that this equates to an additional 7,500 permanent jobs created over the period 1964-2005. This represents the number of jobs that might not otherwise have been created in the absence of standards. This increases to roughly 8,400 jobs based on the estimated impacts for the 2006-2013 period.

Standards are likely to play an increasingly important role in sectors in which the jobs of the future will be concentrated. Ireland already performs strongly and has a comparative advantage in sectors such as computer services, ICT and food products, where standards are widely used. Standards will also be essential in developing emerging sectors such as eHealth, green technologies and cloud computing, which are gaining ground in Ireland, and in which Ireland has the potential to be a market leader. This suggests that the contribution of standards in supporting employment is likely to continue into the future and to potentially grow over time.

5.3 Export activity

Due to the export-oriented nature of Irish industry, Ireland has benefitted from a trade surplus for the past 25 years. As outlined in Section 3.4, economic theory and existing evidence point to the significant role standards play in the operations of exporting and importing businesses. For example, Moenius (2004) examined the impact of shared standards between two countries on trade between them. The study reveals that shared standards between two countries have a statistically significant role in promoting trade, in particular, by lowering information costs.⁴⁶

Standards of the importing country provide valuable information to the exporting country on how to adapt goods and services to the foreign market. Standards offer a channel through which to acquire this information, where this would otherwise be costly to gather.

Over the time period 1980 to 1995, Moenius (2004) estimates that the average elasticity of trade volume with respect to standards is approximately 0.34. This suggests that a 10% increase in bilaterally shared standards between two countries is associated with a 3.4% rise in trade volume. Given this elasticity, and the estimated annual growth in the stock of standards in Ireland between 1980 and 1995 (3.7%), we estimate that on average standards supported 1.2 percentage points of trade volume growth in Ireland every year (see Table 11).

Standards are a fundamental underlying driver of the success of the European single market and Ireland's membership in no small part explains the fact that exports from Ireland equate to 114% of the nation's GDP (compared to a 42.9% EU28 average). Standards will only increase in importance as Ireland continues

⁴⁴ Levine, D., and Toffel, M., (2010) "Quality Management and Job Quality: How the ISO 9001 Standard for Quality Management Systems Affects Employees and Employers".

⁴⁵ We assume a simplified version of the established relationship between labour productivity and wages: workers are rewarded with a wage reflective of their marginal productivity. If we take total output and total wage as given, then the number of workers required to achieve the total output can be identified.

⁴⁶ Moenius, J., (2004), "Information versus product adaptation: the role of standards in trade".

its journey towards an increasingly knowledge and service-based economy, which closely aligns with the objectives of the European institutions to deepen the single market in services and to develop the digital single market.

Using the findings of academic research on the impact of standards use on international trade, we estimate that between 1980 and 1995, at least 7.8% of Ireland's annual trade volume growth was supported by standards and the wider innovation ecosystem of which they form part. This equates to about €631 million of annual recorded trade growth and a €310 million contribution to recorded export growth per annum, expressed in 2014 prices (see Table 11 below).

Between 1996 and 2013, the share of trade growth attributable to standards is estimated to be higher at approximately 23%. This would equate to an average €415 million contribution to recorded export growth per annum due to standards over this more recent period (in 2014 prices).

Table 11: Estimation of the impact of standards on export activity, 1980 – 1995, 2014 prices

Metric	Value
Elasticity of trade volume to standards	0.34
Contribution of standards to trade volume growth, % points	1.2
Share of trade volume growth %, 1980-1995	7.8%
Estimated average annual impact on exports p.a., 1980-1995	€310 million
Estimated average annual impact on exports, 1996-2013	€415 million

Source: Moenius (2004), Cebr analysis

6 Conclusions: standards and Ireland's next stage of industrial economic development

This report, and the study on which it was based, examines how standards are contributing to Ireland's economy and how they can play a pivotal role in the next stage of Ireland's economic development.

The economic impact of standards in Ireland

- The analysis suggests that **standards supported at least 13.8% of annual labour productivity growth in the Irish economy over the period 1964 to 2005**, translating to **an estimated 9.7% of annual GDP growth**. To give an idea of the scale of these impacts in monetary terms, the 9.7% of annual GDP growth translates to **an annual average boost to GDP of €309 million**, expressed in 2014 prices. Cebr reckons **this is sufficient to support the creation of about 7,500 permanent full-time equivalent jobs in Ireland** by the end of the period 1964-2005.
- This is a rather **modest impact compared with the impact of standards in our 'comparator' economies**, such as the most recent finding that standards support an estimated 37.4% of annual labour productivity growth in the UK over period 1921 to 2013 (Cebr, 2015). **Estimates vary between studies but overall the findings suggest that standards account for between 5% and 35% of productivity growth** in their respective countries.
- But the data for Ireland covers a period (1964-2005) of rapid 'catch-up' with the rest of Europe, in terms of industrial development, infrastructure investment and technological progress. Estimates of **the role of standards in this period** can be expected to be somewhat **drowned out** by the significant labour and total factor productivity improvements catalysed by **rapid capital accumulation in Ireland**, as especially witnessed during the 'Celtic Tiger' years. **If this is the case**, although standards would have played the same role in business and the economy, the importance of their role in explaining productivity and economic growth would be expected to be smaller than in a period absent such seismic 'catch up' convergence.
- The extension of our analysis to 2013 suggests however that **today, standards are supporting a more substantial 17% share of GDP growth**, which equates to **approximately €335 million** of our real terms estimate of an average €1.95 billion in GDP expansion recorded over the period 2006-2013 (expressed in 2014 prices). Cebr estimates that this is sufficient to have supported the creation of **an additional 900 permanent full-time equivalent jobs** in Ireland by the end of the period 2006-2013 (making a **total jobs impact of ca. 8,400**).
- **The jump from the 9.7% estimated for the 1964-2005 period to 17% over the period 2006-2013 reflects economic growth that appears to be achieving relative stability**. In other words, **during 2006-2013, capital accumulation is likely to have been less dominant in accounting for productivity growth**. The increase can also be rationalised by **the recent pace of globalisation** and of **business R&D investment trends**. (See Section 5.1 in the main report.)
- **Although the estimate for 2013 is still mid-range relative to estimates for the comparator countries, the differences can be explained by the differing structure of Ireland's economy and what this reveals about the intensity of use of standards**.
- But isolating and measuring the precise economic impacts of standards is not an exact science and, as noted in Cebr (2015), standards do not support productivity and economic growth independently.

Rather, **standards play a symbiotic and complementary role with other factors like technological progress and educational improvements**. Standards **support productivity growth** through a variety of mechanisms and intermediate effects within and between companies that **enhance business performance, improve trust, stimulate trade and galvanise and catalyse further innovation**.

- **Enhanced productivity as a result of standards can increase profitability and is key to companies investing in new capacity, either through hiring new staff or undertaking new fixed capital investments or both**. Previous academic studies show that **the effect on employment is particularly strong in cases where companies are using quality management standards** to improve both management practices and production processes. The B&A survey evidence suggests that these are some of the most widely used categories of standards in Irish industry.

The benefits of standards to trade

- Previous studies suggest a **positive** and statistically significant **impact of standards in promoting trade**. This is **attributed to lower transaction and search costs**, which **reduces the need to adapt products** for foreign markets, and provides information about overseas markets that would otherwise be costly to obtain.
- Standards have, in the past, been viewed as restrictive of trade, particularly where national standards are used to restrict competition from imports in the domestic market. The **development of standards at the European and international level is seen as vital in ensuring the dismantling of international barriers to trade and overseas market entrants where they still exist and are unnecessarily restrictive**. Survey evidence from the UK, presented in Cebr (2015) suggests that 3 out of 4 businesses disagreed with the suggestion that standards had contributed to higher barriers to trade. Similarly, the B&A evidence suggests that 64% of Irish exporting companies agree that standardization has made it easier to enter new foreign markets.
- **Standards are a fundamental underlying driver of the success of the European single market and Ireland's membership in no small part explains the fact that exports from Ireland equate to 114% of the nation's GDP (compared to a 42.9% EU28 average)**. Standards will only **increase in importance as Ireland continues its journey towards an increasingly knowledge and service-based economy**, which closely aligns with the objectives of the European institutions to deepen the single market in services and to develop the digital single market.
- **Using the findings of academic research** on the impact of standards use on international trade, **we estimate that between 1980 and 1995, at least 7.8% of Ireland's annual trade volume growth was supported by standards** and the wider innovation ecosystem of which they form part. This **equates to about €631 million of annual recorded trade growth and a €310 million contribution to recorded export growth per annum**, expressed in 2014 prices (see Table 11 in the main report).
- **Between 1996 and 2013, the share of trade growth attributable to standards is estimated to be higher at about 23%**. This equates to an **average €415 million contribution to recorded export growth per annum** due to standards **over this more recent period**.

The role of standards in galvanising and catalysing further innovation

- The existing national-level studies and the Irish survey evidence also suggest that standards play an important role in R&D and innovation. These impacts have been **reported as particularly evident in more mature medium technology sectors such as automotive manufacturing**. These sectors focus less on the development of proprietary knowledge (patents) and are more likely to be intensive standards users, given their more process-oriented, less R&D intensive nature, which is more conducive to enjoying the economies of scale that standards facilitate.
- **But, Ireland is relatively light in these medium technology sectors**, given the absence of any automotive manufacturing, shipbuilding, aircraft or locomotive manufacturing of any note. This is **consistent with relatively low observed demand from Irish manufacturers** for the subset of **more traditional standards** that are relevant to this study – from organisations like **ISO, IEC, ITU, CEN and CLC**. Whilst there is **heavy utilisation of these standards amongst food and beverage manufacturers in Ireland**, demand for these types of standards tends to be **concentrated** in NSAI’s experience in the **construction, gas and electricity sectors**.
- Studies on the economic impact of standards in other countries suggest that **high levels of foreign direct investment (FDI) are associated with higher impacts of standards, all else being equal**. The **Irish economy outperforms most of Europe and the comparator countries** on this metric, with Ireland **ranking third in Europe in terms of cumulative inward FDI as a percentage of GDP (at 168%)**.
- But, **Irish manufacturing is concentrated in high technology sectors** (59% of the total compared to 13% across the EU28 countries), **as is Ireland’s inward FDI and exports**. **ICT and pharmaceuticals are dominant, but these sectors tend to use industry standardization consortia** rather than WTO standards bodies to which NSAI is aligned. For instance, in the ICT industries, international industry-led standards developers like ECMA, WC3, IEEE and 3GPP are prominent.⁴⁷ This is perhaps reflected in B&A’s survey evidence that suggests below-average participation in the standards development process amongst the Irish manufacturing companies surveyed.
- This provides a **plausible explanation for the lower estimated impact of (the relevant subset of) standards in Ireland than has been found for the comparator countries**, particularly given that its exports and FDI are concentrated in the high technology sectors, which are not heavy users of these standards. Other important comparative metrics include the concentration of business R&D activity, in which Ireland appears to have underperformed relative to the comparator countries in the past.
- But **globalisation has intensified the internationalisation of companies with footloose FDI, particularly in R&D, attracted to locations where they are guaranteed a sufficient pool of highly-skilled labour**. **Ireland is one such location** and has succeeded in attracting major investments by multinationals in R&D activities. **Between 2004 and 2014, business R&D expenditure has increased by 61%** but is still far below the EU28 average in Ireland’s manufacturing sector. Nevertheless, this **provides a plausible explanation for the greater contribution of standards in Ireland in the 2006-2013 period**.

⁴⁷ Data on these standards or the numbers adopted in Ireland are not readily available and, as such, the estimates of the economic impact of standards in Ireland presented in this report would not pick up their effect. Neither do the existing national-level studies include these types of standards, except IEEE standards in some cases.

Benefits of participation in the standards development process

- The existing evidence suggests that the **involvement of companies in the standards development process can produce tangible benefits** in terms of gaining **early awareness of emerging themes** in their sector through **prior access to information** not normally received. This **enables anticipation of future market rules** and the achievement of **first mover advantage**.
- For example, **survey evidence from Cebr's 2015 study on the economic impact of standards in the UK suggests that 71% of all firms participating in the standards development process benefitted from the ability to lead the progression of their market**, not only in setting standards but in developing new technological solutions. But reported participation is low at 10% of UK SMEs, as opposed to 26% for larger companies.
- This is not dissimilar to the recent B&A survey evidence from Ireland. Of the 250 companies surveyed, 16% report that they have contributed to the development of standards. But, amongst that 16%, there is broad consensus that being involved in standards development confers a number of benefits, including the chance to promote their firm's interests at the national level (73% of respondent companies) and at international level (63%), to achieve recognition through an official system (87%), to participate in a network of the most influential operators in their sector (90%), to gain access to information that would not normally be received about activities in their sector (80%), to gain early awareness of product compliance standards such as future market rules and emerging themes (83%), to tailor product design to standards to get them to market first (77%) and to lead the development of their market by influencing the development of standards or promoting new technological solutions (70%).
- **But this same evidence suggests that participation by SMEs remains a challenge.** Given the magnitude of investment required in time and the resulting demands on their limited staff resource, not to mention travel and other expenses, the cost of participation can be prohibitive.

Conclusions

- *Enterprise 2025* sets out the Government's latest 10-year jobs and enterprise strategy. Key policy objectives are to be aimed at delivering sustainable, enterprise-based growth, with a particular focus on job creation and productivity growth within Irish companies, not least by encouraging greater exporting. Within this strategy, Ireland's National Standards Body NSAI has been tasked with the role of promoting the benefits of standards to the widest cross section of industry, raising awareness of the importance of standards in the context of research, development, and innovation (RD&I) and encouraging more companies to participate in the standards development process.
- According to policymakers, essential to the success of the *Enterprise 2025* strategy is the need to improve the resilience and global reach of Irish-owned companies, provide support for Irish-based subsidiaries of global companies to compete for investment within their own organisations, and make Ireland an even more attractive location for foreign companies to invest. Standards can be expected to play an important role in helping these companies reach critical mass in terms of access to foreign markets, thereby increasing the likelihood that they remain independent and Irish-owned.
- In the context of *Enterprise 2025*, the required role of NSAI therein, the unique characteristics of the Irish economy and the findings of the analysis presented in this report, Cebr would draw the following conclusions:

- While Ireland has been extremely successful in attracting FDI, the domestically-owned export-oriented sector still tends to be subject to acquisition. Standards could play a role in helping these companies reach critical mass in terms of access to foreign markets, thereby increasing the likelihood that they remain independent and Irish-owned. Standardization could, therefore, represent one policy area where the need for action could be examined, aimed at achieving the policy objectives of the DJEI Enterprise 2025 Strategy.
- Despite the dominance of high-tech manufacturing, low-tech manufacturing industries are also important for Ireland's economy, representing close to the EU28 average in terms of share of manufacturing. Most notable among these is food and beverage manufacturing, which together represent 22% of Ireland's manufacturing output - well above the EU28 average of 13%. Domestic ownership and SMEs are more concentrated in these sectors, as is NSAI standards development and sales activities. This is significant given the focus of Enterprise 2025 on supporting Irish companies to bolster Ireland's economic resilience. Efforts towards promoting the awareness of standards in Irish industry should, on this basis, be concentrated more heavily towards low and medium technology manufacturing companies, but also in specific services sectors where standards use is increasingly common, such as computer services. The construction sector is also an important user of standards and is crucial in terms of the domestically-owned business population. This, and the concentration of multi-national corporations in high-tech manufacturing leads us to conclude that on balance, Ireland's domestic sector is likely to benefit more from initiatives aimed at enhancing the benefits of standards.
- Although the high-tech manufacturing sectors like ICT and pharmaceuticals use industry standardization consortia rather than WTO standards bodies to which NSAI is aligned, it might be worth exploring whether domestically owned SMEs in these sectors require the kind of support that NSAI already provides to the more long-established low-mid-tech sectors.
- Evidence from Cebr's recent study for BSI in the UK⁴⁸ suggests that companies involved in the standards development process gained a competitive edge by being able to capitalise on the latest information first and by being at the forefront of their industry. The study also reveals that SMEs are less likely to participate in the standards development process but that, when they do participate, they report substantial benefits. The B&A survey evidence paints a very similar picture for Ireland. Assistance with participation in standards development could, therefore, be explored as another policy area in which the need for action could be explored. Such action could support Irish SMEs and larger businesses to perform to their maximum potential, thus furthering the objectives of *Enterprise 2025*.
- The Review of the European Standardization System⁴⁹ is another relevant consideration in supporting the *Enterprise 2025* strategy. The recommendations include seeking out new or enhanced mechanisms for assisting with the standards development process, including enhanced levels of practical advice and support for new entrants. Participation in standards development places a disproportionate cost burden on SMEs and there is evidence to suggest that SMEs are far less likely to be involved in standards development than larger companies. If standards are considered important for industrial development and supporting domestic companies, targeted support might be explored as an avenue for policy action. However, this would need to be provided

⁴⁸ Cebr, 2015, "The Economic Contribution of Standards to the UK Economy", BSI.

⁴⁹ EY, 2015, 'Independent Review of the European Standardisation System', European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs.

in a manner that ensures the non-duplication of effort and the spreading of the cost burden. One approach might involve working through trade associations.

- Another reason for encouraging SME participation in standards development is the need for the national interest to be represented, particularly in sectors such as ICT where multinationals dominate the market but tend not to participate. This might provide further reason for exploring the need to promote and support involvement by domestically-owned SMEs in standards development.

Appendix

Table 12: OECD technology intensity level classification, by SIC 3-digit level sector

Technology intensity level	SIC code	Sector, SIC 3-digit level, NACE rev. 3
High technology	21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
High technology	26	Manufacture of computer, electronic and optical products
High technology	32.5	Manufacture of medical and dental instruments and supplies
High technology	30.3	Manufacture of air and spacecraft and related machinery
Medium-high technology	20	Manufacture of chemicals and chemical products
Medium-high technology	27	Manufacture of electrical equipment
Medium-high technology	28	Manufacture of machinery and equipment n.e.c.
Medium-high technology	29	Manufacture of motor vehicles, trailers and semi-trailers
Medium-high technology	30.2	Manufacture of railway locomotives and rolling stock
Medium-high technology	30.4	Manufacture of military fighting vehicles
Medium-high technology	30.9	Manufacture of transport equipment n.e.c.
Medium-low technology	18.2	Reproduction of recording media
Medium-low technology	19	Manufacture of coke and refined petroleum products
Medium-low technology	22	Manufacture of rubber and plastic products
Medium-low technology	23	Manufacture of other non-metallic mineral products
Medium-low technology	24	Manufacture of basic metals
Medium-low technology	25	Manufacture of fabricated metal products, except machinery and equipment
Medium-low technology	25.4	Manufacture of weapons and ammunition
Medium-low technology	30.1	Building of ships and boats
Medium-low technology	33	Repair and installation of machinery and equipment
Low technology	10	Manufacture of food products
Low technology	11	Manufacture of beverages
Low technology	12	Manufacture of tobacco products
Low technology	13	Manufacture of textiles
Low technology	14	Manufacture of wearing apparel
Low technology	15	Manufacture of leather and related products
Low technology	16	Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
Low technology	17	Manufacture of paper and paper products
Low technology	18.1	Printing and service activities related to printing
Low technology	31	Manufacture of furniture
Low technology	32.1	Manufacture of jewellery, bijouterie and related articles
Low technology	32.2	Manufacture of musical instruments
Low technology	32.3	Manufacture of sports goods
Low technology	32.4	Manufacture of games and toys
Low technology	32.9	Manufacturing n.e.c.

Source: OECD ISIC REV. 3 Technology Intensity Definition