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Integrated Indicators for Ireland: Adjusting Economic Progress for Environmental and Social Sustainability (I^3: AEPESS)

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Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
Department of Communications, Climate Action & Environment

www.epa.ie

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

The work of the EPA can be divided into three main areas:

Regulation: *We implement effective regulation and environmental compliance systems to deliver good environmental outcomes and target those who don't comply.*

Knowledge: *We provide high quality, targeted and timely environmental data, information and assessment to inform decision making at all levels.*

Advocacy: *We work with others to advocate for a clean, productive and well protected environment and for sustainable environmental behaviour.*

Our Responsibilities

Licensing

We regulate the following activities so that they do not endanger human health or harm the environment:

- waste facilities *(e.g. landfills, incinerators, waste transfer stations)*;
- large scale industrial activities (*e.g. pharmaceutical, cement manufacturing, power plants)*;
- intensive agriculture *(e.g. pigs, poultry)*;
- the contained use and controlled release of Genetically Modified Organisms *(GMOs)*;
- sources of ionising radiation *(e.g. x-ray and radiotherapy equipment, industrial sources)*;
- large petrol storage facilities;
- waste water discharges;
- dumping at sea activities.

National Environmental Enforcement

- Conducting an annual programme of audits and inspections of EPA licensed facilities.
- Overseeing local authorities' environmental protection responsibilities.
- Supervising the supply of drinking water by public water suppliers.
- Working with local authorities and other agencies to tackle environmental crime by co-ordinating a national enforcement network, targeting offenders and overseeing remediation.
- Enforcing Regulations such as Waste Electrical and Electronic Equipment (WEEE), Restriction of Hazardous Substances (RoHS) and substances that deplete the ozone layer.
- Prosecuting those who flout environmental law and damage the environment.

Water Management

- Monitoring and reporting on the quality of rivers, lakes, transitional and coastal waters of Ireland and groundwaters; measuring water levels and river flows.
- National coordination and oversight of the Water Framework Directive.
- Monitoring and reporting on Bathing Water Quality.

Monitoring, Analysing and Reporting on the Environment

- Monitoring air quality and implementing the EU Clean Air for Europe (CAFÉ) Directive.
- Independent reporting to inform decision making by national and local government *(e.g. periodic reporting on the State of Ireland's Environment and Indicator Reports)*.

Regulating Ireland's Greenhouse Gas Emissions

- Preparing Ireland's greenhouse gas inventories and projections.
- Implementing the Emissions Trading Directive, for over 100 of the largest producers of carbon dioxide in Ireland.

Environmental Research and Development

- Funding environmental research to identify pressures, inform policy and provide solutions in the areas of climate, water and sustainability.

Strategic Environmental Assessment

- Assessing the impact of proposed plans and programmes on the Irish environment *(e.g. major development plans)*.

Radiological Protection

- Monitoring radiation levels, assessing exposure of people in Ireland to ionising radiation.
- Assisting in developing national plans for emergencies arising from nuclear accidents.
- Monitoring developments abroad relating to nuclear installations and radiological safety.
- Providing, or overseeing the provision of, specialist radiation protection services.

Guidance, Accessible Information and Education

- Providing advice and guidance to industry and the public on environmental and radiological protection topics.
- Providing timely and easily accessible environmental information to encourage public participation in environmental decision-making *(e.g. My Local Environment, Radon Maps)*.
- Advising Government on matters relating to radiological safety and emergency response.
- Developing a National Hazardous Waste Management Plan to prevent and manage hazardous waste.

Awareness Raising and Behavioural Change

- Generating greater environmental awareness and influencing positive behavioural change by supporting businesses, communities and householders to become more resource efficient.
- Promoting radon testing in homes and workplaces and encouraging remediation where necessary.

Management and structure of the EPA

The EPA is managed by a full time Board, consisting of a Director General and five Directors. The work is carried out across five Offices:

- Office of Environmental Sustainability
- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet regularly to discuss issues of concern and provide advice to the Board.

EPA RESEARCH PROGRAMME 2014–2020

Integrated Indicators for Ireland: Adjusting Economic Progress for Environmental and Social Sustainability (I^3: AEPESS)

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EPA Research Report

Prepared for the Environmental Protection Agency

by

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The EPA Research Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

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Executive Summary

Effective metrics help steer transition to sustainability and promote the decoupling of economic performance from intensive use of resources. Sustainability refers to both ecological and social systems. This project applies *sustainable competitiveness,* a national-level concept, to measure the impact of economic performance on both environmental and social sustainability for Ireland (2005–2015) focusing on:

- measurement of the main economic, environmental and social features of a competitive economy;
- identification of the most important Irish competitiveness pillars in terms of key strengths and roadblocks to sustainable competitiveness;
- drivers of ecological innovation by firms (indigenous and multi-national) – such innovation plays a determining role in promoting economic growth that supports the decoupling of economic performance from intensive use of environmental resources.

Methods

The method used to apply the sustainable competitiveness concept follows the approach developed by the World Economic Forum (WEF) and leverages data collected in its Global Competitiveness Project. Scores generated for nations in the Global Competitiveness Index are adjusted for two aspects of sustainability: social and environmental. A range of additional data is used to estimate social and environmental sustainability.

The method used to assess drivers of ecological innovation follows a production function approach that relates innovation inputs to firms' eco-innovation output. Estimates of the probability of firms eco-innovating are computed across the range of driver categories.

Data Collection

A panel of data was assembled allowing analysis of Ireland's performance across a sample of 94 countries for the period 2005–2015. Economic competitiveness indicators were extracted from datasets developed by the WEF as part of its Global Competitiveness Project. Social and environmental indicators were collected for 2014–2015 by the WEF, and this project extended this back through the decade to 2005, identifying the most appropriate comparative data from international sources.

The data used to estimate the innovation production function are from the Community Innovation Survey (undertaken by the Central Statistics Office – CSO) for the years 2006–2008 – the only recent period when specific questions around eco-innovation were included in the survey. The 2006/2008 survey incorporated specific questions on nine separate types of eco-innovation including firms' expenditure on each type and the drivers underlying the expenditure, generating a rich dataset across a sample of over 2000 firms.

Estimations

The results confirm that there is no necessary trade-off between economic competitiveness and sustainability. Their trajectories follow similar patterns over time both for Ireland and in general across the sample of 94 countries, with some variations. For Ireland, the impact of the economic crisis beginning in 2007 is relatively more evident for sustainable competitiveness than for economic competitiveness, i.e. it declined more sharply.

Relatively better scores for Irish sustainable competitiveness, compared with economic competitiveness, resulted largely from strong performance in social sustainability. Strong performance was observed in access to basic services and social safety protection indicators (i.e. sanitation, water, health services and social safety). Lower scores were recorded for employment indicators, for both youth unemployment and vulnerable employment, with declining performance in youth unemployment.

Relative to the top 10 countries, a substantial gap exists in Ireland's performance. Despite its strong performance, Ireland's improvements in sustainable competitiveness were half those enjoyed by the

top 10 countries. Ireland exhibits lower scores for social sustainability for eight (of nine) indicators relative to the top 10 countries, i.e. other countries improved more.

Roadblocks

Direct impacts on sustainable competitiveness, and its components of social and environmental sustainability, could be achieved by improving performance across a set of specific indicators feeding into social and environmental sustainability, respectively. The specific areas where the largest gaps exist between Ireland and other advanced countries are identified for each sustainability component as:

- *Social sustainability:* access to health care services; and youth unemployment.
- *Environmental sustainability:* stringency and enforcement of environmental regulation; baseline water stress; waste-water treatment; carbon concentration; and changes in forest cover.

Measured pass-through effects indicate the nature and scale of the *indirect* impacts of economic competitiveness (i.e. pillars) feeding through to sustainability measures. The largest pass-through effects are found for innovation factors. Higher education and training, and technological readiness, also generate high pass-through impacts, with some variation observed in the impacts on social and environmental sustainability.

Eco-innovation

The range of ecological innovations conducted by firms in Ireland, and their drivers, provide business-level insight into firms' sustainable activities. Such innovation in products and processes reduces environmental impacts while promoting economic prosperity.

Firms in Ireland engage in a broad range of eco-innovations, with recycling waste being the main activity (for 34% of all firms) and many firms engaging in several eco-innovations. Existing and expected regulations are drivers of 30% of eco-innovations. Demand-side drivers feature in 34% of eco-innovations and supply-side drivers in 26% of eco-innovations.

The most significant drivers increase the probability of firms eco-innovating by between 52% and 21%. These drivers are (ranked from highest to lowest impact):

1. voluntary agreements (firms' strategies);
2. customer perception;
3. existing regulation;
4. government grants;
5. expected regulation.

Recommendations

- Attention should focus on all aspects of competitiveness – economic, social and environmental – to better understand their inter-relationships. Data collection for social sustainability and environmental sustainability indicators should be maintained and improved.
  - As data availability increases (e.g. Social Progress Index, SPI), performance relative to the Sustainable Competitiveness Index can be investigated. With SPI data available for two Irish regions, among other European regions, aggregate and intra-regional analysis of the interdependencies of economic, social and environmental aspects may also be conducted.
- Improvements in innovation and higher education pillars feed into economic competitiveness *and* sustainable competitiveness and are to be supported as fundamental elements of both social and environmental sustainability policies.
- The role of eco-innovation as an element in decoupling strategies requires greater research and more regular availability of data through, for example, the Community Innovation Survey. Availability of such data on a regular (for example, an annual) basis permits more timely analysis of eco-innovation in the context of firms' strategic decisions, as well as their expenditures.
- Firms' strategies and their customers' positive perceptions of eco-credentials are drivers of eco-innovation by Irish-based firms. The provision of government grants also increases the likelihood of eco-innovation. The potential to match regional SPI data with firm-level eco-innovation data could permit deeper consideration of the social and environmental impacts of eco-innovation, and more general innovation, decisions.

1 Introduction and Objectives

The EPA

The Environmental Protection Agency (EPA) was established to ensure that a proper balance is achieved between the need to protect the environment (and the cost of such protection) and the need for infrastructural, economic and social progress (EPA Act, 1992).

In addition to regulating and policing activities that might otherwise cause pollution and monitoring the state of the environment in Ireland, the EPA has a strong agenda on contributing to the development of the green economy by liaising with enterprises and industry to incorporate the principles of sustainable development into their practices.

One important feature of the EPA is its contribution to funding research and development under the pillars of Climate, Water and Sustainability and co-ordinating research on environmental (including air and water quality, climate change, biodiversity and environmental technologies) and socio-economic issues (EPA, 2012).

Transition towards a *smart economy*, defined as the combination of elements of the *enterprise* economy and the *innovation* or *ideas economy*, presents important opportunities for Ireland. In the context of this research, smart growth concerns the inter-related challenges of economic development, climate change and energy security. It involves the transition to a low-carbon economy and recognises the opportunities for investment and employment in a clean and green industry.

For Ireland, the green economy encompasses an ongoing focus on efficiency including energy-efficient products and services. Other areas include niches within sustainable food production, tourism and *green* financial services. Research and development (R&D) has a key role to play in developing the green economy (Government of Ireland, 2012).[1]

Effective metrics assist in steering the smart transition, highlighting the current status of goals achieved and areas for improvement. The Commission on the Measurement of Economic Performance and Social Progress (Stiglitz *et al*., 2009) identified that traditional indicators (i.e. gross domestic product, or GDP, and CO_2 emissions) present a narrow view of sustainable development, pointing to the need for more comprehensive, integrated and holistic approaches. A number of metrics on aspects of sustainable development compete for policy space and attention. While these have contributed much, it remains difficult to inter-relate different aspects of sustainable development without leading to information overload.

The need for better, synthetic metrics is emphasised in this project – *I³AEPESS: Integrated Indicators for Ireland: Adjusting Economic Progress for Environmental and Social Sustainability.* The project's objective is to understand the impact of economic performance on environmental and social sustainability for Ireland. A set of distinct elements of economic performance, i.e. "competitiveness pillars", as well as aggregated competitiveness measures, are used in the research.

In this project, Irish economic competitiveness is set in its international context and with focus on countries within Ireland's development neighbourhood, particularly those (like Ireland) with an innovation focus. Emphasis on competitiveness stems from understanding that economic performance is steered by a set of basic fundamentals *and* the relationships between these fundamentals and the enterprise (i.e. micro-economic) environment. The definition of

1 In June 2017, the Irish government received its first National Mitigation Plan, an important first step in enabling transition to a low-carbon, climate-resilient and environmentally sustainable economy by 2050. The plan is a whole-government approach to tackling greenhouse gas emissions, particularly in the key sectors of electricity generation, the built environment, transport and agriculture. The draft plan is available at http://www.dccae.gov.ie/en-ie/climate-action/consultations/Pages/National-Mitigation-Plan-.aspx (accessed 20 November 2017).

The EPA and the Green Economy

Since 2001, the EPA has been promoting more environmentally friendly work practices under the *Cleaner Greener Production Programme*. In 2013, the programme was re-named the *Green Enterprise Programme* to reflect its broader scope beyond production-based economic activities. The goal of the programme is to encourage the production of goods and the provision of services in more environmentally friendly ways and to minimise emissions through cleaner production methods (EPA, 2017).

Over eight phases, the EPA has supported 116 demonstration projects. The programme also presents strong synergies with other EPA initiatives, such as the *National Waste Prevention Programme*, forging a coherent path to resource efficiency in Ireland.

The philosophy driving EPA initiatives is that prevention is better than cure. This is also in line with Ireland's national effort to become a leading nation in the green economy sector. See:

http://www.epa.ie/researchandeducation/research/epafunding/greenenterprise/

and http://www.epa.ie/waste/nwpp/

economic competitiveness used in the project is "the set of institutions, policies, and factors that determine the level of productivity of a country" (following WEF, 2012, p. 4). The concept of *sustainable competitiveness* is defined as the set of institutions, policies and factors that make a nation productive over the longer term while ensuring social and environmental sustainability (WEF, 2015).

This research is novel in its study of the intersection between economic competitiveness and environmental and social sustainability. It leverages and extends data produced by the Global Competitiveness Project (GCP) of the World Economic Forum (WEF; www.weforum.org) with environmental and social data for Ireland, and its neighbours, from multiple sources from 2005 to 2015.[2]

This final report presents project findings across three key aspects:

- measurement of the main economic, environmental and social features of a competitive economy;
- examination of the most important Irish competitiveness pillars to identify key strengths and roadblocks to sustainable competitiveness;
- drivers of ecological innovation for firms operating in Ireland, both foreign and domestically owned – such innovation plays a determining role in promoting economic growth that supports the decoupling of economic performance from intensive use of environmental resources.

1.1 Report Structure

In Chapter 2 definition and measurement issues around sustainable competitiveness are outlined along with how eco-innovation fits into this context.[3] Despite general agreement on the limitations of traditional measures (i.e. GDP, CO_2 emissions) when focusing on sustainability, the literature reveals a substantial diversity of potential alternatives. In the context of potential measures of sustainable competitiveness, the approach selected here has the advantage of applicability to a broad range of countries for which reliable and comparable data can be brought together for the recent period, i.e. since 2005. The project integrates data from several sources on the social and environmental elements of competitiveness with data on economic competitiveness provided by the GCP of the WEF.

Results from analysing Irish sustainable competitiveness using this approach are presented in Chapter 3. Both environmental and social sustainability are considered, in addition to a combination that includes both aspects. Comparisons of Ireland's experience are made relative to the overall sample of 94 countries for which comparable data were available. As one of 37 countries at an advanced level of economic development, Ireland's sustainability

2 A list of the 94 countries included in the analysis are provided in Appendix 1.

3 The project website hosts an extensive review of related literature on which this section is based. See http://www.ucc.ie/en/eri/projects/i3aepess/

experience is also compared with that of the entire group of advanced economies. Comparisons relative to the top 10 and top 20 countries are also provided.

In section 3.4 results of analyses of the drivers of ecological innovations across businesses in Ireland are presented. Data from the Community Innovation Survey undertaken by the Central Statistics Office (CSO) are used to identify drivers of eco-innovation for Irish firms by firm size and ownership (i.e. indigenous and multinational). While such data are unavailable for the entire 2005–2015 period, and data for Ireland alone are examined here, significant trends in eco-innovation and the probability of Irish firms engaging in such activities are provided.

Chapter 4 provides a general discussion of the implications of the project's findings, outlining recommendations and further research opportunities.

2 Sustainable Competitiveness: Definition and Measurement

In 2015, the WEF extended its definition of competitiveness to encompass sustainability, defining sustainable competitiveness as the set of institutions, policies and factors that make a nation productive over the longer term while ensuring social and environmental sustainability (WEF, 2015). Within policy and research spaces, key related concepts of the "circular economy" and "inclusive growth" identify the need for consumption and production systems that are in harmony with society and the environment (Corrigan *et al*., 2014; Piketty and Goldhammer, 2014). A trade-off between environmental quality and economic growth no longer dominates research or policy narratives – now simultaneous targets are identified for growth, sustainability and societal development (Porter and van der Linde, 1995; Ambec *et al*., 2013).

Sustainable competitiveness includes several inter-related aspects of the concept of sustainable development. Environmental sustainability has received much attention within sustainability debates, and the general understanding is that economic development must be decoupled from intensive use of natural resources to avoid surpassing the carrying capacity of the natural environment (United Nations, 2002). Within economic growth research, increasing emphasis on human development, polarisation and inequality impacts prevails (Karabarbounis and Neiman, 2013; Piketty and Goldhammer, 2014). Much of this work focuses on developing nations, where economic growth is expected to significantly reduce poverty (Commission on Growth and Development, 2008). Coming out of deep recession, increased focus on social injustice and inequality was also evident in mainstream public policy in more advanced economies (WEF, 2015).

For policy, efforts are directed at decoupling economic growth from environmental degradation while leveraging innovation and skill upgrading to foster prosperity for all, especially the most vulnerable (e.g. European Commission, 2010). Thus, while the sustainability narrative binds the three key elements of sustainable development – economic, environmental and social – the environmental and social elements of sustainable development are often studied entirely separately from economic growth. Sustainable competitiveness as a concept (and as an approach) bridges this gap, acknowledging that social and environmental sustainability aspects are deeply embedded in each other.

2.1 Measuring Competitiveness

Measuring sustainable competitiveness requires focusing on the intersections between the factors that make an economy more productive and measures of environmental and social sustainability. A starting point is to look at what makes a nation competitive and how this is measured.

A productivity-based approach to competitiveness considers the fundamental factors enabling a location-focused generation of wealth and prosperity. Pioneered by Porter (1990), three key themes of research that map different levels of interlocking relationships driving productivity are identified. The first theme is the *macroeconomic environment*, which provides a broad context for growth. The second theme includes business sophistication and the quality of the business environment, labelled the *microeconomic environment* and outlined in Porter's *Diamond Model* (Porter,1990). The third theme considers the systemic and feedback relationships between these two themes.

Specific factors highlighted as drivers of productivity are presented in Table 2.1. They are categorised as traditional drivers, recently identified drivers and more complex drivers, which are not yet fully understood (Porter *et al*., 2008; Delgado *et al*., 2012; Ketels, 2016).

One productivity-based measure is the Global Competitiveness Index (GCI). In its current form, the GCI is comparable across annual publications since

Table 2.1. Drivers of competitiveness: a productivity-based approach

Traditional drivers	Recently identified drivers	Complex drivers
Rules and regulation	Company sophistication and firm heterogeneity	Individuals: culture and trust
Financial markets	Economic geography: urbanisation and clusters	Institutions: quality and capacity
Physical infrastructure	Economic composition: "economic complexity"	Social capital and linkages
Macroeconomic policy	(Creative) skills and locational attractiveness	
Institutions and geography	Different levels of geography (within a nation)	
Size of the economy		

Source: Compiled by the authors from Ketels (2016).

2005[4] and is the most recognised competitiveness index, covering 144 countries in its latest edition. It is devised in collaboration with international experts (e.g. Porter *et al*., 2009). The GCI identifies *12 competitiveness pillars,* separated into three sub-indexes, driving productivity, as outlined in Figure 2.1.

To generate the GCI, hard statistical data (66%) and data gathered through business surveys (34%) are used to measure 114 indicators feeding into the pillars. These are compiled into one competitiveness score for each country. The extent to which pillars (and sub-indexes, i.e. basic requirements/efficiency enhancers/ innovation and sophistication factors) contribute to productivity depends on the *stage of development* of an economy. Based on its living standards (GDP per capita), Ireland is identified as a country operating in the third, innovation-driven stage of economic development.[5]

Productivity-based approaches to competitiveness have evolved from an agreed theoretical background that views productivity as central to prosperity (Porter, 1990; Krugman, 1994; Delgado *et al*., 2012). It is increasingly recognised that, at different levels of development, locations face different competitiveness challenges in which the relative importance of different dimensions of microeconomic and macroeconomic competitiveness is changing (Porter, 1990; Porter *et al*., 2008). The GCI proposes a comprehensive representation of the key levers of productivity and how their relative importance changes with development stages (Delgado *et al*., 2012).[6]

The approach, while not without criticism (Lall, 2001; Fougner, 2008), is widely used and recognised as the most theoretically grounded approach available. The GCI allows the identification of vulnerabilities and strengths in national competitiveness from the aggregate index down to the 114 indicators feeding into its construction. Development debates focus on what *specific* policies are best applied to support productivity growth and to identify strategies to close gaps as they develop (Ketels, 2006).

2.1.1 Ireland's competitiveness framework

For Ireland, the National Competitiveness Council (NCC) includes a specific focus on productivity in its bespoke competitiveness framework, presented in Figure 2.2. The current approach was revised in 2016 to take account of research and best practice in conceptual and measurement understandings. The NCC uses a broad definition of competitiveness referring to the ability of the enterprise base (firms) in Ireland to compete in international markets.

At the pinnacle of the competitiveness pyramid in Figure 2.2 is the goal of sustainable growth, which relates to both sustainable improvements in living standards and quality of life. This goal is not directly within the control of policymakers, but it depends

4 The first GCI was published by the WEF in 1979; however, in its construction it differs from the substantially revised version in use since 2005.

5 Countries included in this stage of development are those with the highest levels of living standards, i.e. GDP per capita. The WEF identifies 37 countries at this stage, namely: Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Puerto Rico, Qatar, Republic of Korea, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, Taiwan (China), Trinidad and Tobago, UK and USA.

6 In measuring the GCI for countries at different stages of development, different weightings of the three sub-indexes are applied, with increased weighting towards sub-index three (innovation-related) for the most advanced countries.

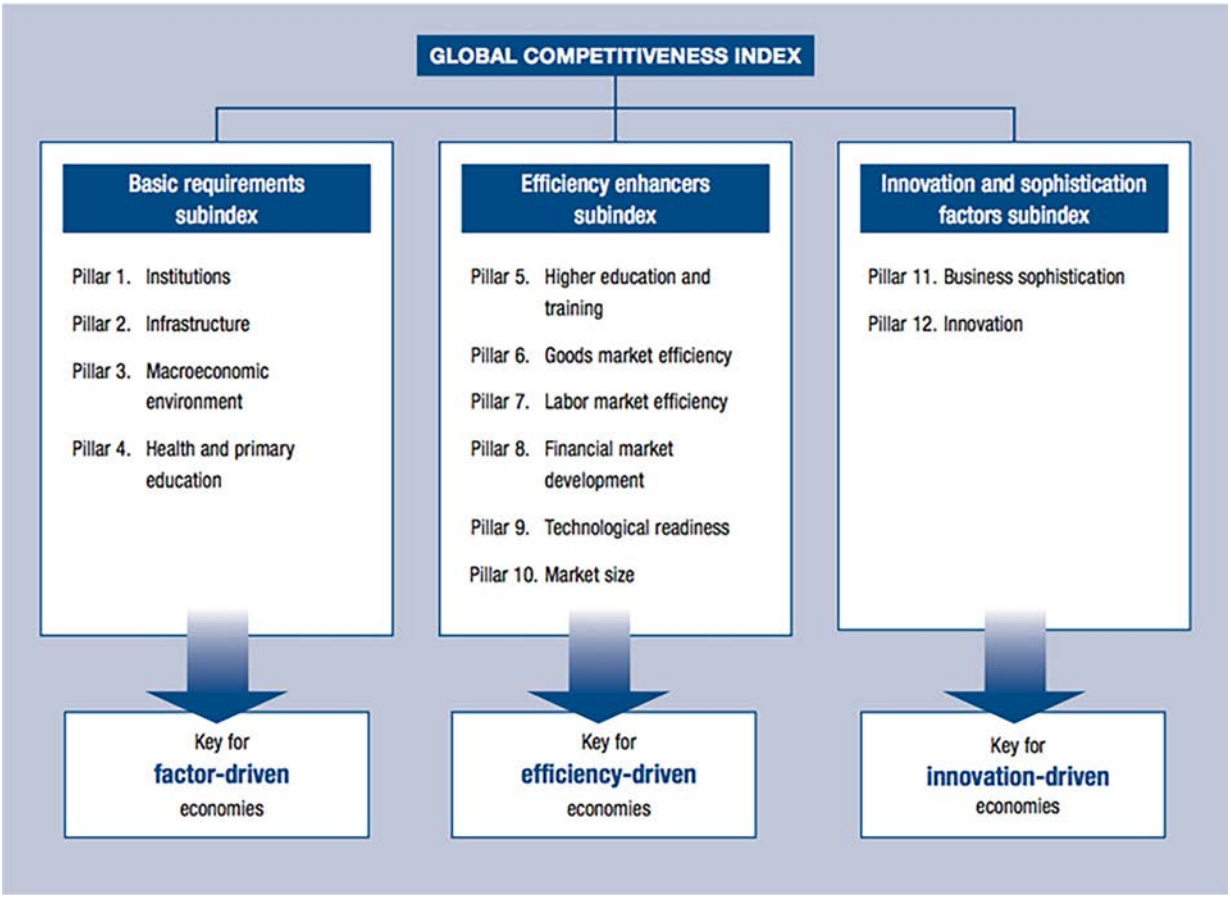

Figure 2.1. Competitiveness pillars. Reproduced from WEF (2016) with permission from the World Economic Forum.

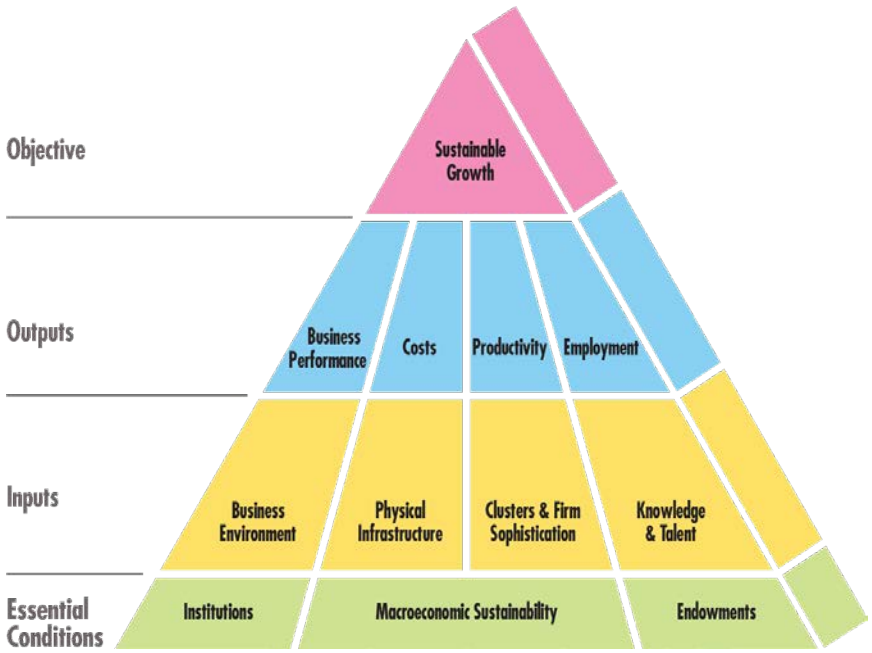

Figure 2.2. Irish competitiveness framework. Source: National Competitiveness Council (2016). Reproduced from NCC (2016) with permission from the National Competitiveness Council.

crucially on sets of underlying essential conditions and policy inputs. These policy levers impact through four channels of the business environment, the physical and knowledge infrastructures and cluster-based economic activity. At the intermediate level of the pyramid lie conditions reflecting the basis of competition for Irish firms: here business performance, productivity, costs and employment appear. Essential or fundamental conditions for achieving competitiveness, including institutions, macroeconomic sustainability and endowments, are required to generate the inputs leading to the outputs and objective in Figure 2.2.

Given the broad nature of the concept of competitiveness, the pyramid representation provides a structured set of logical relationships between the determinants of competitiveness. Definitions of competitiveness are either focused on (short-term) costs (i.e. market share, macro-imbalances, etc.) or on (medium- to long-term) productivity performance. The competitiveness pyramid represents a pragmatic approach that balances both definitions. The NCC's focus on sustainable growth is clearly anchored in the productivity-based definition of competitiveness. It also focuses on the cost-attractiveness of Ireland. The interaction between productivity and costs matters for the relative global attractiveness of a location and for macroeconomic sustainability. In a review of competitiveness frameworks, Ketels (2016) finds that the NCC applies a more structured approach (with regular revisions to reflect changing circumstances) to competitiveness than many of its peers, reflecting overall best practice in the field and consistency with core insights from the relevant academic literature.

The NCC regularly benchmarks Ireland's performance against peers based on selected indicators. The integrated pyramid is not used to generate a single synthetic "score" for competitiveness. The NCC produces Ireland's Competitiveness Scorecard, providing a comprehensive assessment of Ireland's performance using a range of statistical indicators drawn from data sources such as the Organisation for Economic Co-operation and Development (OECD), Eurostat and the CSO. The annual *Competitiveness Challenge* report focuses on the national competitiveness issues of greatest importance to the enterprise sector over the medium term and identifies policy recommendations.[7]

There are advantages and disadvantages of operating a bespoke model. The selection of features within the Irish framework relates to those most pertinent to the Irish experience. A potential limitation of productivity-based approaches is their focus on medium- to long-term dynamics. The importance of short-term conditions in achieving long-term productivity levels are often outlined as a precondition for productivity drivers, at least for countries with low productivity levels. Thus, while productivity is key for long-term prosperity, costs and prices are additional factors of importance in many policy contexts. The Irish framework addresses these issues with the explicit inclusion of costs and prices.[8]

The ability to use cross-country data in a more comprehensive manner is possible if the distinctively Irish model is replaced with one of those used on an international basis. For the purposes of this research, preference is given to using the internationally comparable and theoretically grounded approach found in the WEF's GCI. Its main features are:

- a productivity-based grounding enabling identification of potential bottlenecks and potential policy interventions;
- foundations in the literature of economic growth and competitiveness and, therefore, inclusion of the most commonly agreed competitiveness pillars;
- comparisons of nations across different development stages, indicating that, as economies develop, different sources of competitiveness play different roles in transition to higher levels of development;
- generation of an index of national competitiveness scores built up from 12 separate pillars (constructed from 114 indicators), allowing comparisons across broad and disaggregated levels.

7 These annual publications are available from: http://www.competitiveness.ie/Publications/

8 This has been addressed in extensions of the GCI approach (Delgado *et al*., 2012).

2.2 From Competitiveness to Sustainable Competitiveness

Sustainable competitiveness as a concept merges measures of environmental and social sustainability with competitiveness indicators into a synthetic competitiveness framework. The approach acknowledges that sustainability aspects of social and environmental development are deeply mutually embedded.

Ecologically speaking, environmental sustainability focuses on the natural environment's biogeophysical aspects, such as maintaining or improving the integrity of the Earth's life-supporting systems (Moldan *et al*., 2012). Assessing environmental sustainability should concern *what* is happening to the state of the environment; *why* it is happening; and *what we are doing* about it (Hammond *et al*., 1995). Questions such as *if* and *how* efforts for sustainable development are achieving decoupling, and the reciprocal effects between human influence on the natural environment and economic growth, have also been high on the research agenda (Patil and Rao, 1994).

The social domain is the least theorised and explored pillar of sustainable development and, to date, the most complex to operationalise (Littig and Grießler, 2005; Murphy, 2012). The most significant challenge for sustainable competitiveness research relates to this element and it demands further research. Although a range of analytical approaches to assess socio-economic development exist, before the 1990s they largely failed to align the social domain with sustainability (Omann and Spangenberg, 2002; Littig and Grießler, 2005; Colantonio, 2007; Magis, 2010).

Colantonio (2009) identifies three overarching categories for social sustainability research. The first views the natural environment as an enabler of social relations and dynamics. The second is environmentally oriented, i.e. focusing on social preconditions for achieving environmental sustainability. The third is people oriented, focusing on improving wellbeing, including distribution of resources, and reducing social exclusion and destructive conflict. Analytical frameworks for social sustainability are seldom applied at the national level with the majority of approaches focusing primarily on the regional or community levels (Omann and Spangenberg, 2002; Magee *et al*., 2012; Woodcraft, 2012). Social sustainability approaches at the national level largely use traditional criteria and themes from the literature on social development (i.e. income, inequality, etc.) and new themes emerging from sustainability concerns, such as quality of life, the environment as socially defining, and health of communities.

Research reveals a plethora of separate environmental and social sustainability approaches that have contributed much to each specific field but which make an *integrated* assessment of sustainability a challenging task. Similarly, the Commission on the Measurement of Economic Performance and Social Progress (Stiglitz *et al*., 2009) identifies that traditional indicators (i.e. GDP, CO_2 emissions) present a narrow view of what sustainable development should achieve, highlighting the need for more comprehensive, integrated and holistic approaches.

A related recent development is the redefinition of social progress. The Social Progress Index (SPI),[9] first published in 2013, is produced by a consortium of stakeholders, including academics, multilateral organisations and the private sector. The SPI is leading research in which social progress bridges traditional hard policy issues with soft policy priorities. Social progress is defined as "the capacity of a society to meet the basic human needs of its citizens, establish the building blocks that allow citizens and communities to enhance and sustain the quality of their lives, and create the conditions for all individuals to reach their full potential" (Porter *et al*., 2016, p. 4). This definition references three broad dimensions of social progress: basic human needs, foundations of wellbeing and opportunity. Each dimension is further broken down into four components, as presented in Table 2.2. In its 2016 edition, the SPI included 133 nations.

The SPI emphasises outcome, and not input, indicators. Achievement, irrespective of input or investment is its core focus. The SPI, therefore, allows individual countries to identify specific areas of strength, or weakness, in terms of its social

9 http://13i8vn49fibl3go3i12f59gh.wpengine.netdna-cdn.com/wp-content/uploads/2016/07/SPI-2016-Methodological-Report.pdf (accessed 18 November 2017).

Table 2.2. Dimensions of the SPI

Basic human needs	Foundations of wellbeing	Opportunity
Nutrition and basic medical care	Access to basic knowledge	Personal rights
Air, water and sanitation	Access to information and communications	Access to higher education
Shelter	Health and wellness	Personal freedom and choice
Personal safety	Ecosystem sustainability	Equity and inclusion

Source: Fehder and Stern, 2013, reproduced with permission from Social Progress Imperative.

Table 2.3. Indicators for social sustainability adjustment

Access to basic necessities	Vulnerability to shocks	Social cohesion
Access to sanitation	Vulnerable employment	Income Gini index
Access to improved drinking water	Extent of informal economy	Social mobility
Access to healthcare	Social safety net protection	Youth unemployment

Source: Bilbao-Osorio *et al.* (2013), reproduced with permission from World Economic Forum.

progress performance, and also allows countries to benchmark themselves against peers both at the level of individual indicators and at the aggregate level (Fehder and Stern, 2013). The approach has been well received in academic and policy circles, with several organisations operationalising findings of the SPI to aid policymaking. In Europe, the approach was adapted in late 2016 and applied at sub-national levels.[10]

For this project, we follow the WEF's research-grounded approach to add sustainability adjustments, for both social and environmental elements, to their competitiveness pillars. The adjustments were made by the WEF for 2014–2015 only. This project applies similar sustainability adjustments for both environmental and social sustainability elements for the period 2005–2015.

2.2.1 Adjusting for social sustainability

Social sustainability is defined as "institutions, policies and factors that enable all members of society to experience best possible health, participation, and security, and to maximise their potential to contribute and benefit from the economic prosperity of the country in which they live" (Bilbao-Osorio *et al.*, 2013, p. 59). The three elements comprising the social sustainability pillar are access to basic necessities, vulnerability to shocks and social cohesion – indicators are provided in Table 2.3. Because of the limited availability of appropriate quantitative data, survey data (from the Executive Opinion Survey of the WEF) are used for the following indicators: access to healthcare services; extent of informal economy; social safety net protection; and social mobility.

A social sustainability score is obtained using methods similar to those used in the GCI. That is, data are aggregated into the three elements and then averaged to obtain a national social sustainability score.

2.2.2 Adjusting for environmental sustainability

The WEF adjustment for environmental sustainability recognises that the state of the natural environment affects competitiveness both at national and at business (firm) level. Environmental sustainability is defined as a "set of institutions, policies, and factors that ensure an efficient management of resources to enable prosperity for present and future generations" (Bilbao-Osorio *et al.*, 2013, p. 58).

The environmental sustainability pillar consists of three elements: environmental policy, use of renewable resources and degradation of the environment. Table 2.4 lists the indicators included for each element. Survey data (from the Executive Opinion Survey of the

10 http://www.socialprogressimperative.org/custom-indexes-european-union-findings/ (accessed 27 November 2017). Results are available for two Irish regions (two NUTS 2 regions): the Border, Midlands and Western region, and the South and Eastern region.

Table 2.4. Indicators for environmental sustainability adjustment

Environmental policy	Use of renewable resources	Degradation of the environment
Environmental regulations (stringency and enforcement)	Agricultural water intensity	Level of particulate matter concentration
Number of ratified international environmental treaties	Forest cover change	CO_2 intensity
Terrestrial biome protection	Overexploitation of fish stocks	Quality of natural environment

Source: Bilbao-Osorio *et al.* (2013), reproduced with permission from World Economic Forum.

WEF) are used for the following indicators: stringency of environmental regulations and quality of the natural environment.

A similar aggregation approach is carried out to generate a national environmental sustainability score.

2.2.3 Combined adjustment for sustainability (social and environmental)

A sustainability score is obtained for each country from the average of its environmental sustainability and social sustainability adjustment scores (Corrigan *et al*., 2014). A sustainability-adjusted GCI, or *SGCI*, is constructed combining the economic and sustainability scores. The approach emphasises that economic competitiveness on its own does not necessarily lead to sustainable levels of prosperity, as illustrated in Figure 2.3 (Bilbao-Osorio *et al*., 2013).

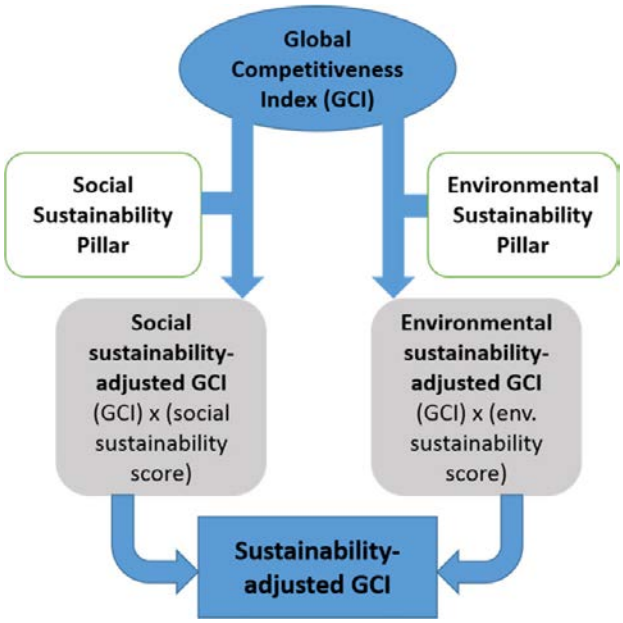

Figure 2.3. SGCI framework. Reproduced from Bilbao-Osorio *et al.* (2013) with permission from the World Economic Forum.

2.3 Sustainable Competitiveness and Eco-Innovation

Ecological innovation is innovation in products and processes that reduce impacts on the environment while promoting economic prosperity. Eco-innovation is increasingly identified as enabling sustainability (Kemp and Pearson, 2007). Current research acknowledges the circular economy perspective in which firms lessen their environmental footprint, and in doing so achieve positives for the planet (through increased resource efficiencies and absolute declines in resource use) and growth and development for the firm through new and renewed outputs.

Significant challenges exist when considering how environmental and eco-innovations contribute to enhancing sustainable competitiveness. Vallance *et al*. (2011) review how the *social* and the *environmental* domains of sustainable development interact in the context of environmentally friendly products and services. Three main research areas shed light on the dynamics around consumer demand for environmentally friendly products.

1. *Sustainability and basic needs.* Research has largely focused on developing nations and on how to meet their basic needs in an environmentally sustainable way (Commission on Growth and Development, 2008). Substantial barriers to the uptake of more sustainable technologies and products exist, and featuring large among them is poverty (Burningham and Thrush, 2003; Crabtree, 2005).
2. *Behavioural change*. Non-transformative changes, e.g. recycling schemes or cleaner energy, lead to stronger environmental ethics through the provision of information and services that do not impact heavily on everyday life (Vallance *et*

al. 2011). Transformative approaches require changes in how the environment and society are socially constructed. Consumer acceptance of non-transformative approaches tends to precede eco-innovation (Schrader, 1999).

3. *Preservation of socio-cultural characteristics.* Maintenance of social sustainability is founded on traditions, practices, preferences and places people would like to see sustained, e.g. low-density suburban living, the use of the private car and natural landscapes. This research (similar to transformative approaches) has identified mechanisms limiting encouragement of stronger environmental ethics, as they run contrary to socially constructed values and habits (Assefa and Frostell, 2007).

Changing behaviour to acknowledge social and environmental considerations has been identified as critical for both production and consumption (Mange *et al*., 2009). So far, research proposes that eco-innovations are driven by:

- inter-related factors external to the firm that put pressure on firms to increase their social and environmental performance;
- factors internal to firms that enable them to develop and adopt eco-innovations, with R&D and the technical resources of the firm featuring as the most important factors.

Figure 2.4 provides a synthesis of these factors. Further understanding of these drivers can enable policy to act as a catalyst for eco-innovation.

2.4 Implications

- Competitiveness can neither rely on intensive use of the environment and its ecological resources nor ignore human vulnerabilities or inequalities, i.e. social resources. Hence, *sustainable competitiveness* emphasises economic competitiveness as a driver of long-term growth – taking account of both environmental and social concerns.
- Understanding sustainable competitiveness requires a broad perspective drawing from both the social and natural sciences and investigating relationships between the economic, the social and the environment together.
- Firms must develop competitive advantages embodied in the concept of the circular economy

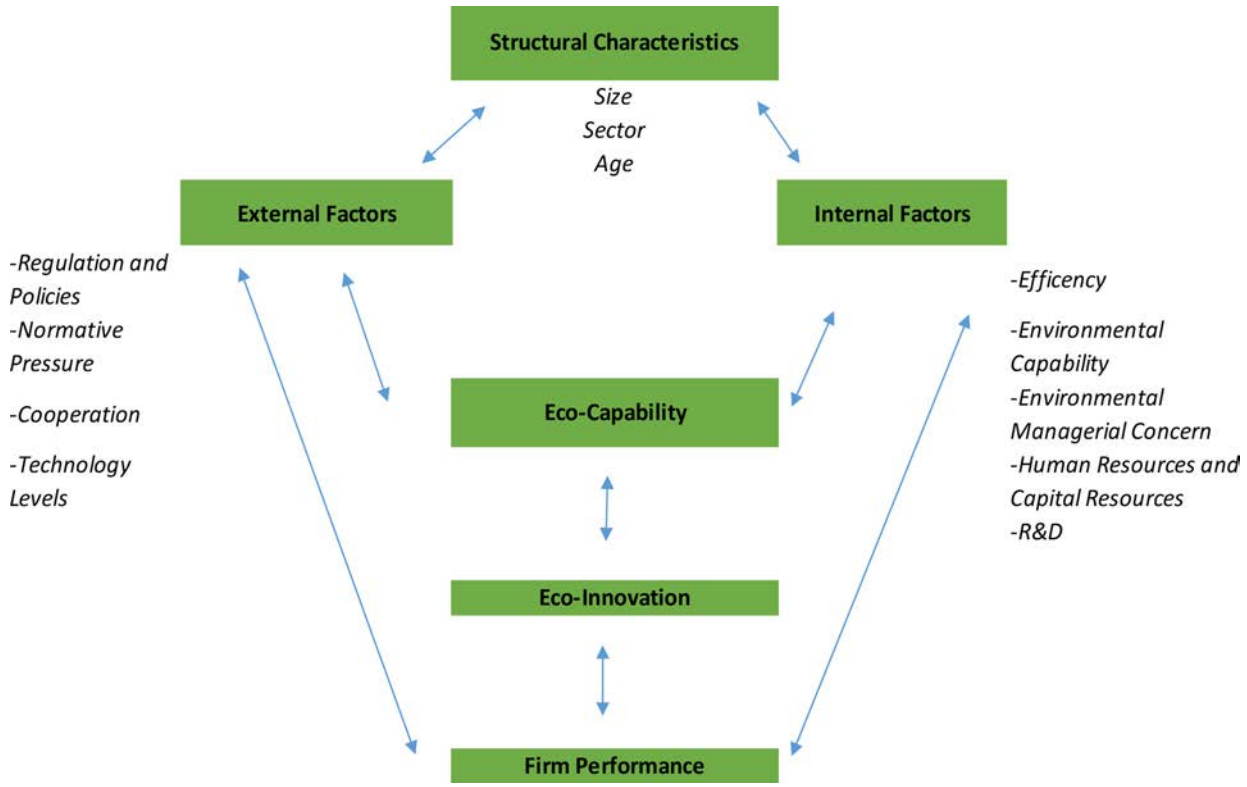

Figure 2.4. Drivers of eco-innovation.

to transition from a linear “take–make–dispose” system to one that encourages reuse and extraction of maximum value before returning resources to the biosphere. Eco-innovations are key to aiding this transition.

3 Sustainable Competitiveness: Competitiveness Pillars and Roadblocks

Trends in Ireland's competitiveness and sustainable competitiveness are presented in section 3.1. Performance relative to the overall sample of countries and to other advanced countries is considered in section 3.2. Sections 3.3 and 3.4 outline the impacts of three competitiveness sub-indexes and individual competitiveness pillars on SGCI, and its environmental and social components.

3.1 Ireland's Sustainable Competitiveness Performance

Ireland's competitiveness performance is set out for the period 2005–2015. Competitiveness is considered from four perspectives: (1) including only economic factors; (2) incorporating adjustments for social sustainability into economic competitiveness; (3) incorporating environmental sustainability into economic competitiveness; and (4) including both social and environmental adjustments to economic competitiveness.

Figure 3.1 illustrates Ireland's competitiveness including and excluding adjustments for sustainability. Adjusting economic competitiveness (GCI) for both environmental and social sustainability (SGCI) improves Ireland's overall competitiveness score by 0.35 points on average over the period (equivalent to an improvement of 6.5 percentage points).

Performance is highest for Ireland's social-adjusted competitiveness index. The gap between the social-adjusted measure and GCI remains large over the entire period, although a decline in the gap is evident. The initial difference was approximately 14 percentage points, which had reduced to 8 percentage points by 2015. This is due to both a deterioration of the social sustainability score, evident in the lower panel, and also an improvement in Ireland's economic competitiveness score (GCI).

Performance of the environment-adjusted competitiveness measure is substantially more muted, although it too results in a higher competitiveness score relative to the baseline GCI. Convergence towards the GCI measure is evident over the period, declining from a gap of 0.17 points in 2005 to 0.03 points in 2015 (from 3.4 to 0.6 percentage points).

In the period 2007–2010, coinciding with the economic crisis, the three adjusted indexes (see top panel) exhibited sharp declines, sharper than the decline in economic competitiveness evident in the GCI. In the years between 2005 and 2007 decline is also evident, albeit at a slower pace. From 2010 to 2015, steady increases in Irish competitiveness scores, both GCI and the adjusted SGCI, are observed, reflecting economic recovery.

The gap between the GCI and the SGCI declined from approximately 10 percentage points in 2005 to less than 6 percentage points by 2010. The difference widened once again after 2013. Gains in Irish competitiveness evident in the adjustments for social and environmental sustainability halved in the post-crisis period in comparison with pre-crisis years.

The bottom panel in Figure 3.1 presents the *pure* environmental sustainability and *pure* social sustainability pillars, i.e. when the economic component (GCI) is excluded. During the period 2007–2010, when both pillars declined, and the final 2 years considered here, when both were unchanged, different trends are exhibited. The social sustainability pillar appears to track the GCI more closely than the environmental pillar (the correlation coefficient measuring the relationship between GCI and the social pillar is 0.71, while the same measure for the environmental pillar is 0.4). This is not unexpected, as economic factors play a significant role in social sustainability aspects.

In considering the performance across the indicators included in the social sustainability pillar, Ireland scores highly in terms of access to basic services and social safety protection indicators (i.e. sanitation, water, health services and social safety). Lower scores are recorded in employment indicators, both for youth

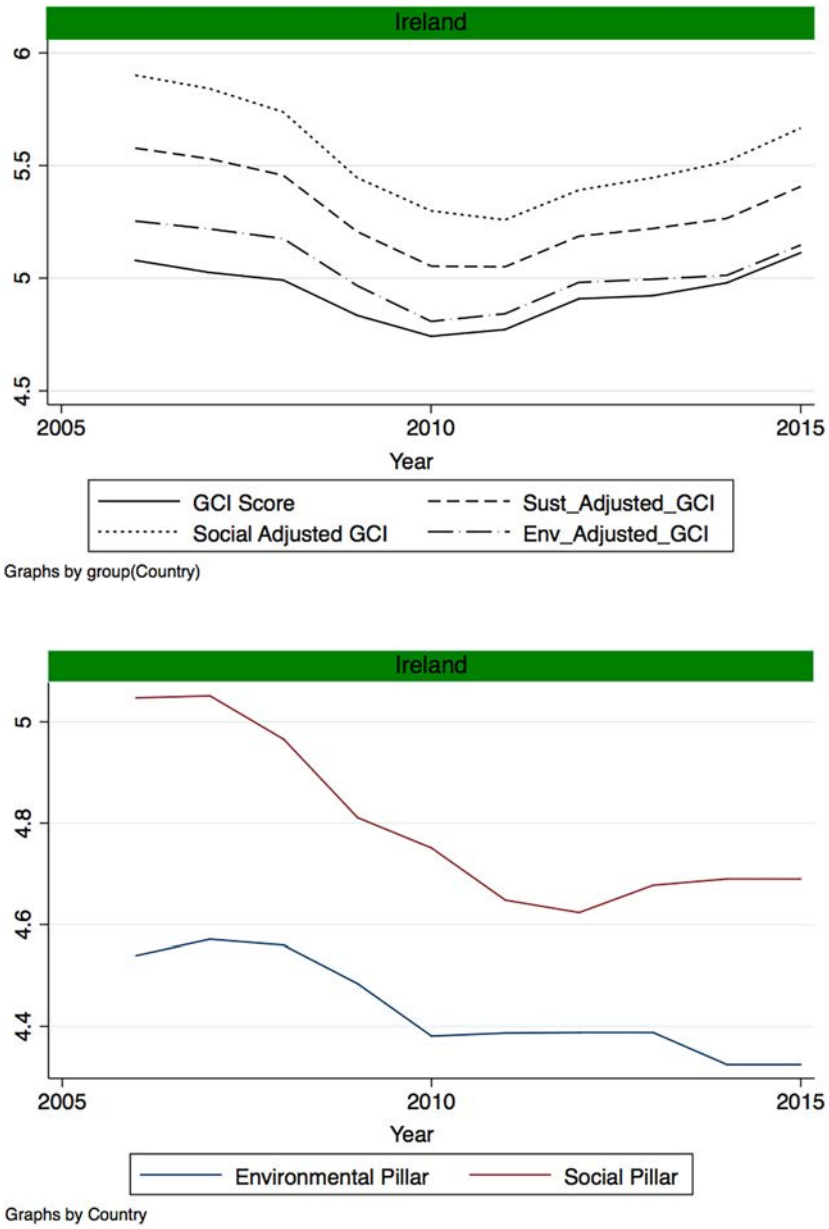

Figure 3.1. Ireland's sustainable competitiveness.

unemployment and vulnerable employment, with declining performance in youth unemployment. Little variation is observed for indicators denoting inequality (Gini index), extent of the informal economy and social mobility.

In the environmental sustainability pillar, indicators capturing the policy environment exhibit high, and steady, scores. These include ratified environmental treaties, regulatory stringency and enforcement. Indicators for air quality, overexploitation of fish stocks and baseline water stress score relatively lower. The score for waste-water treatment exhibits a decline, while that for particulate concentration improves over the period.

Ireland's sustainability-adjusted performance exhibits benefits from structural factors and a satisfactory institutional and policy environment, but performance of other social and environmental domains is mixed at best. Ireland's improved scores when the adjustments are applied to the GCI are derived largely from its performance in social sustainability indicators. However, deterioration since 2012 is evident here.

3.2 Ireland in Comparative Context

Adjusting economic competitiveness for social and environmental sustainability improves Ireland's competitiveness performance relative to other

countries. The 2005 GCI ranked Ireland 22nd among 114 economies: by 2015, Ireland ranked 24th. By comparison, using the sustainability adjusted SGCI, Ireland ranked 17th and 19th, respectively, for the same years.[11] Ireland's relative performance for environmental and social sustainability can be considered separately. Figure 3.2 plots Ireland's rankings over time for GCI, SGCI, environmental-adjusted GCI and social-adjusted GCI.

Relatively poor scores identified earlier for environmental sustainability can be placed in comparative context. Relative to other countries, Ireland displays improvement – Ireland's ranking remains higher for environment-adjusted competitiveness than for the GCI for the entire period.

Considering the social adjustment only, Ireland ranks highest in 2005 (across all four indexes) at 14th – and again in 2015 at 18th. The rankings are consistent with Ireland's higher social sustainability performance relative to environmental sustainability in the period up to 2010.

The lower panel (Figure 3.2) illustrates the difference in scores between GCI and SGCI in average terms

11 We calculated the ranking using our sample of $n = 94$.

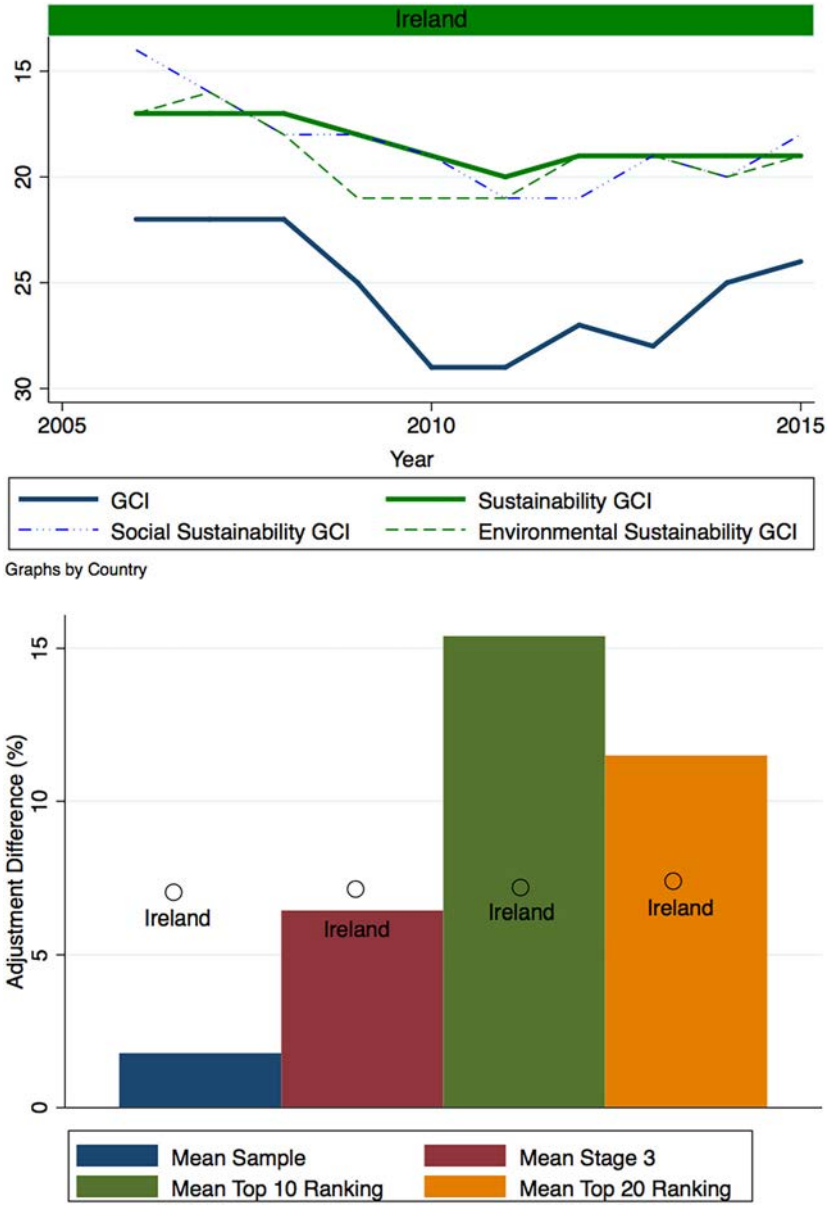

Figure 3.2. Ireland's rankings across competitiveness and sustainable competitiveness indexes.

over the 10-year period for Ireland compared with other country groups. The bars in the panel represent gains (or losses) in competitiveness when economic competitiveness (GCI) is adjusted for social and environmental sustainability. Ireland's gains can be interpreted relative to the mean of comparator countries.

The first bar in the lower panel illustrates that the average gain for Ireland (i.e. SGCI > GCI) is approximately 5 percentage points higher than the gain evident in the overall sample (of 94 countries). The second bar indicates that the difference for Ireland is also higher, albeit marginally, relative to countries at a similarly high stage of economic development (37 countries).

In comparison with top ranked countries, Ireland's gain in the SGCI ranking is on average 5 percentage points lower than countries in the top 20 of the SGCI and approximately 7.5 percentage points lower than countries in the top 10. Countries in the top 10 benefit almost twice as much from adjusting their competitiveness score for sustainability, relative to Ireland.

It is expected that the best countries are likely to feature similar environmental and social frameworks to Ireland, as most are EU Member States, or have a similar focus on social and environmental challenges. Thus, differences between these countries' competitiveness measures relative to Ireland may arise from performance in non-structural factors, i.e. beyond their similar strong institutions and strong regulatory oversight.

The economic crisis was not without impact on Ireland. While the post-2007 period has been accompanied by a declining trend in both the social and the environmental sustainability pillars for Ireland, other countries experienced relatively limited deterioration – or exhibited improvements – in these pillars. Ireland's relatively low performance in both social and environmental sustainability when compared with these top performing countries cannot be attributed to a simple set of key areas.

Closer assessment of relative scores across the indicators within the social pillar indicates that Ireland's scores are lower in eight of nine indicators relative to the top 10 countries ranked in the SGCI. Access to health care services exhibits the largest discrepancy for Ireland (approximately 27 percentage points lower than the top countries). Irish scores are 0.2 points higher for vulnerable employment than the average for top 10 countries.

Comparisons in the environmental domain reveal starker differences for Ireland. Ireland scores significantly lower than top performers in stringency and enforcement of environmental regulation, baseline water stress, waste-water treatment, carbon concentration and changes in forest cover. Ireland exhibits higher scores in number of ratified international treaties and particulate matter concentration.

3.2.1 Key results: SGCI – social and environmental adjustments

The SGCI reveals that Ireland has achieved significant social improvements, notwithstanding the negative effects of the recent crisis.[12] For environmental sustainability, improvement is also evident.

Both social and environmental sustainability outcomes are below those of countries in Ireland's development neighbourhood, and significantly so in relation to countries at the top of the SGCI ranking. Differences in the SGCI appear to arise from performance indicators in non-structural features, for which Ireland has relatively low scores.

Specifically, improving performance in the following areas would improve Ireland's measured sustainable competitiveness as captured in the social and environmental adjustments contained with the SGCI:

- access to health care services;
- youth unemployment;
- stringency and enforcement of environmental regulation;
- baseline water stress;
- waste-water treatment;

12 The longer context is worth noting, as Ireland's relative performance in the 1980s placed it significantly behind countries in its development neighbourhood in terms of living standards.

- carbon concentration; and
- changes in forest cover.

The first two of these indicators relate to social sustainability, while the remaining five refer to environmental sustainability.

3.3 Sub-indexes and Pillars of Economic Competitiveness: Sustainability Impacts

As Ireland targets transitioning to a green economy, identifying areas where progress has been made and areas that remain a challenge can aid policy recommendations. This section focuses on the relationship between the three sub-indexes and 12 economic elements, i.e. the pillars, of competitiveness and overall sustainable competitiveness as measured by the SGCI.

The nature of the panel of available data limits the analytical approaches that can be employed, since competitiveness, by its nature, arises from dynamic effects across systems of relationships and also because the starting point of analysis is related to (unobserved) historical conditions. In addition, the difference between competitiveness scores measured between Ireland and other countries (or groups of countries), as recorded in the SGCI, is quite narrow for robust statistical inferences to be drawn; there is limited variability in the SGCI score and its components over the 10-year period covered. The selected econometric approach takes these issues into account.[13]

Estimations were made of the impact on SGCI when each sub-index (or pillar) is increased by one point, holding the other sub-indexes (or pillars) unchanged. We consider how much of the change passes through to SGCI measures.

Results are reported relative to two baselines, i.e. the sample of 94 countries and the advanced countries group. Each impact for Ireland is compared with the average computed for these country groups to identify bottlenecks, i.e. where policy intervention can exert impact.

3.3.1 Sustainability impacts: sub-indexes

Ireland's ability to translate improvements in basic requirements (pillars 1–4) into sustainable competitiveness is significantly lower than that of the entire sample. Almost 40% of an improvement in the sub-index feeds into SGCI improvement for the overall sample, while for Ireland the estimated improvement is 19%, similar to other advanced countries.

Ireland exhibits a slightly lower pass-through than the overall sample for the efficiency enhancers (pillars 5–10). The pass-through estimate for Ireland is 49%, similar to other advanced countries, compared with 54% for the entire sample.

For the sub-index measuring innovation and sophistication factors (pillars 11–12) the pass-through estimate is 34%, as for other advanced countries, and is significantly higher than the estimate for the entire sample, at 12%.

Applying similar analyses separately to the social and environmental sustainability elements enables identification of potential dynamics that affect these aspects of sustainability. Pass-through results are similar to those outlined above.

Key results: three sub-indexes of the GCI

Sustainability-oriented policies for advanced innovation-driven economies, such as Ireland, are positively impacted not only through addressing innovation elements of the economy but also, and *substantially*, through targeting those factors included in the efficiency enhancing pillars of competitiveness. These include the six pillars of: (1) higher education and training; (2) goods market efficiency; (3) labour market efficiency; (4) financial market development; (5) technological readiness; and (6) market size.

3.3.2 Sustainability impacts: pillar-level estimates

Similar analysis was conducted to estimate the impacts of each economic competitiveness pillar on sustainable competitiveness, i.e. SGCI. Statistical tests

13 The Arellano and Bond generalised method of moments dynamic panel estimator approach was applied (Arellano and Bond, 1991).

revealed that pillars 11 and 12 could not be examined separately (owing to their collinearity) and, therefore, they were combined in analysis.

In terms of general results, for the total sample we found that the most influential pillars for sustainable competitiveness, in order of their impacts, are:

- innovation and business sophistication (P11 and P12);
- goods market efficiency (P6);
- health and primary education (P4);
- financial market development (P8); and
- macroeconomic environment (P3).

The least influential pillars are institutional environment (P1) and labour market efficiency[14] (P7).

Among the most advanced economies, the innovation and business sophistication pillar is not only the most influential but also significantly increases in importance (the impact more than doubled compared with the total sample, i.e. 0.14 to 0.33). Other significant pillars, in order of impact, for this country group are:

- higher education and training (P5);
- technological readiness (P9);
- institutions (P1).

The pillars of infrastructure, health and primary education, market size and goods market efficiency appear to have no influence on determining advanced countries' sustainable competitiveness, i.e. for those countries that have *already* achieved a relatively high level of economic development.

These results are consistent with the view that, as economies develop, gains in competitiveness and sustainability are derived from gains in efficiency, technology and innovation, rather than from further improvements in the basic factors of economic development.[15] Basic factors (pillars 1–4), however, are required for developing further competitiveness pillars.

Key results: competitiveness pillars

Innovation and sophistication factors, higher education and training, and technological readiness are the most influential pillars in sustainable competitiveness for more advanced economies.

Results for the separate measures of environmental-adjusted sustainability and social-adjusted sustainability indicate that:

- Innovation and business sophistication factors (P11 and 12) are equally important for both environment and social sustainability in more advanced economies (they influence social sustainability *only* in the larger sample). The magnitude of the coefficients indicates that changes generate the largest pass-through impacts on sustainable competitiveness for advanced economies. The innovation and business sophistication factors (P11 and 12) have high impacts (coefficients of 0.3) for both environment-adjusted and social-adjusted sustainability for advanced economies.
- Higher education and training (P5) has a relatively higher impact on environment-adjusted sustainability than on social-adjusted sustainability of 0.15 and 0.8, respectively.
- Institutional environment[16] (P1) plays an important role in the overall SGCI and the social-adjusted SGCI, but plays no role in the environmental-adjusted SGCI in both the total and the advanced economy samples.
- Quality of the macroeconomic environment (P3) is significant for both the total and the advanced economy samples, except for the environment-adjustment value for more advanced economies. The size of the impact is relatively low for

14 Ten indicators feed into measurement of this pillar. Redundancy costs and female participation are measured using quantitative data, and the remaining eight indicators are based on survey responses covering, for example, co-operation in employment relations, flexibility of wage determination, hiring and firing practices, and the relation between pay and productivity.

15 To examine if the weighting used in the index was driving these results, the research team undertook similar analysis using an unweighted SGCI. The magnitude of the coefficients was affected, but results remained generally unchanged.

16 The quality of institutions is measured using 21 separate indicators, all of which (with one exception) are based on survey responses to questions on property rights protections, intellectual property protection, public trust in politicians, judicial independence, favouritism in government decisions, burden of regulation, business costs of terrorism, ethical behaviour of firms, auditing and reporting standards, and transparency.

advanced economies (0.04 for SGCI and 0.05 for social-adjusted sustainability).
- Labour market efficiency (P7) is significant for SGCI and the social sustainability adjustment, but it has no impact on the environmental index of sustainable competitiveness.

Analysis of Ireland's performance relative to other advanced countries was conducted by comparing the mean effects for each pillar to estimate whether or not any significant differences were evident. For competitiveness pillars 1–4, i.e. those included in the basic requirements sub-index, the impact on SGCI is higher for Ireland than for other countries at similar stages of development for two of the pillars, i.e. institutions, and health and primary education. In contrast, the impact of the pillar quality of the macroeconomic environment on Irish SGCI is on average 0.6 points lower for Ireland than for the advanced countries' average.

For pillars 5–10, corresponding to the efficiency enhancers sub-index, the impact on SGCI of the pillars of goods market efficiency, labour market efficiency and technological readiness, are between 0.3 and 0.5 points higher for Ireland than for the advanced countries' average. Lower impacts relative to other advanced economies are estimated for the pillars higher education and training, and financial market development.

For pillars 11 and 12, corresponding to business sophistication and innovation factors, Ireland's mean score is similar to that of the advanced economies.

Among advanced countries, including Ireland:

- the most important pillars impacting the *environmental sustainability component* of SCGI in order of their estimated impacts are:
  - innovation and sophistication (P11 and 12);
  - higher education and training (P5);
  - technological readiness (P9);
  - financial market development (P8);
  - infrastructure (P2).
- the most important pillars impacting the *social sustainability component* of SCGI include some of the same pillars (pillars in italics are *not* among the most important factors impacting the environmental sustainability component) and are:
  - innovation and sophistication (P11 and 12);
  - *labour market efficiency (P7);*
  - higher education and training (P5);
  - financial market development (P8);
  - *institutions (P1);*
  - technological readiness (P9);
  - *macroeconomic environment (P3).*

Separating impacts for environment and social adjustments, respectively, reveals the different mechanisms in operation for the competitiveness pillars feeding into each component.

3.4.3 Macroeconomic environment

Macroeconomic disarray harms the economy, as evidenced by Porter *et al*. (2008). Results suggest that the macroeconomic environment in Ireland (P3) has detracted from Ireland's sustainable competitiveness relative to it peers. Of all the statistically significant impacts on SGCI among advanced countries, the macroeconomic environment coefficient is smallest. Changes to this pillar feed through to the social-sustainability adjustment only, i.e. not environmental sustainability.

By focusing on the main indicators within the macroeconomic stability pillar, areas where Ireland performs well and areas where performance may be improved are identified. Of the five indicators comprising the macroeconomic environment pillar, four focus primarily on public finances. These are:

- *government debt* as a percentage of GDP;
- *total government spending* as a percentage of GDP;
- *gross national saving* as a percentage of GDP; and
- *annual inflation rate* (annual percentage change in consumer prices).

The remaining indicator in this pillar is a perception-based score of businesses' trust in politicians, a proxy for the overall extent of public trust. The contribution of each element to the overall score for pillar 3 was estimated. Irish scores (SGCI) relative to the full sample and most advanced countries were compared.

The main results are detailed below.

- Ireland underperforms relative to the whole sample for government spending and inflation indicators. More spending is expected to trigger competitiveness *if* it is well targeted and does

not significantly affect the level of government debt. Too much inflation hinders competitiveness (as may too little – if businesses see prices as unchanging or falling).

- No effect is found in relation to trust in politicians for the whole sample. For Ireland, however, respondents to the survey reported less trust in their political environment than respondents in other countries. This difference was statistically significant.[17]
- Ireland performs better than the whole sample in the level of saving as percentage of GDP. Results for Ireland are similar to those of the sample of advanced economies.

3.4 Eco-innovation by Irish Firms

Ecological innovations matter for sustainable competitiveness, as they present opportunities to decouple economic development from the intensive use of resources and may permit exploitation of new market opportunities by firms. Drivers of eco-innovations at the firm level are at the heart of where productivity improvement is generated in an economy, i.e. in business-level activities. Research indicates that eco-innovations are driven by several factors that can be classified under three broad categories: (1) factors external to the firm, (2) factors internal to the firm and (3) interactions between external and internal factors.

Results from research into the drivers of sustainable competitiveness highlight the importance of innovation more broadly.

3.4.1 Drivers of eco-innovation

Drivers of eco-innovation by private firms in Ireland, and what drives these firms to eco-innovate, can be identified using data from the Community Innovation Survey (CIS) for the years 2006–2008 when specific questions around eco-innovation were included in the surveys. The CIS is carried out every 3 years by the CSO[18] in accordance with European Commission Regulation No 1450/2004.[19]

The 2006–2008 CIS incorporated specific questions on eco-innovation. All firms[20] were asked if they had introduced an eco-innovation that:

1. reduced material use per unit of output;
2. reduced energy use per unit of output;
3. reduced CO_2 "footprint" (total CO_2 production);
4. replaced materials with less polluting or hazardous substitutes;
5. reduced soil, water, noise or air pollution;
6. recycled waste, water or materials;
7. reduced energy use for end user;
8. reduced air, water, soil or noise pollution for end user; or
9. improved recycling of products after use.

Firms were asked to declare expenditure associated with these innovations and the main drivers that encouraged their eco-innovation. Firms' performance data were also collected. A total of 2181 firms completed the surveys (2127 completed the survey in full), equivalent to a response rate of 46%. To date (2017), no more recent data have yet been made available at the firm level for eco-innovation in Ireland.

Table 3.1 presents a description of the types of eco-innovations undertaken by Irish firms. Regulation, whether existing or expected, appears to be the most important driver of eco-innovation reported by firms with 16.8% and 12.61% of firms citing these factors as the main drivers, respectively. The existence of government grants is a driver for 5.9% of firms.

From the demand and supply sides, consumer perception and voluntary agreements appear to have similar influences in encouraging firms to eco-innovate. Backward linkages (to supply chain partners,

17 The importance of public trust for economic development and competitiveness has been widely documented and is the focus of ongoing reporting, e.g. by the OECD (OECD, 2015).

18 http://www.cso.ie/en/index.html

19 http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32004R1450

20 Firms included in the CIS are derived from a sample of the full business register in Ireland with more than 10 employees.

Table 3.1. Types of eco-innovations and main drivers

	Mean
Eco-innovation types (%)	
Eco1. Reduced material use per unit of output	18.62
Eco2. Reduced energy use per unit of output	22.19
Eco3. Reduced CO_2 "footprint" (total CO_2 production)	21.64
Eco4. Replaced materials with less polluting or hazardous substitutes	19.12
Eco5. Reduced soil, water, noise or air pollution	17.29
Eco6. Recycled waste, water or materials	33.70
Environmental benefits from the after sales use of a good or service by the end user	
Eco7. Reduced energy use	20.17
Eco8. Reduced air, water, soil or noise pollution	14.53
Eco9. Improved recycling of product after use	22.01
Eco-innovation drivers (%)	
Regulations	
Existing regulation	16.87
Expected regulation	12.61
Government grants	5.96
Demand side (%)	
Customer perceptions	16.23
Voluntary agreements	17.88
Supply side (%)	
Forward linkages	7.48
Backward linkages	9.87
Horizontal linkages	3.06
Public linkages (i.e. to public agencies)	6.44
R&D expenditure (standard deviation in parentheses)	
Intramural R&D (€)	2054 (10,253)
Extramural R&D (€)	460 (5064)
Firm-specific factors (standard deviation in parentheses)	
Employment	89 (246)
Irish owned (Yes) (%)	76
Capital (€)	3606 (36,718)
Sectoral composition of firms surveyed (%)	
High-tech manufacturing	30.03
All other manufacturing	9.54
Wholesale, transport, storage and communication	35.12
Financial intermediation	10.82
Computer, architecture and engineering services	14.49

The data source is the Irish CIS 2006–2008. Sectoral definitions are based on NACE Rev2. Adapted from tables in Doran and Ryan (2016).

for example) are the most important supply side factor with 9.9% of firms declaring this as a driver of eco-innovation while 7.5% declare forward linkages as the main driver. The role of *leading* firms in encouraging suppliers to upgrade their eco-innovative base through demonstration-type effects is evident in the literature, with other firms perceiving eco-innovations as an opportunity for product differentiation. The CIS data suggest that demand side motivations exhibit the greatest influences on firms' eco-innovation.

The largest proportion of firms completing the CIS operate in wholesale, transport, storage and communications sectors (35% of firms), followed by

the high-technology manufacturing sector (30%). Other sectors include computer, architecture and engineering services, financial intermediation and all other manufacturing. Around three-quarters of all firms completing the CIS, over the period here and more generally, are Irish owned and employ 89 people on average.

To identify the factors driving the nine types of eco-innovation, an innovation production function was estimated, which relates innovation inputs and conditioning factors to firms' innovation output.[21] Table 3.2 presents the main results, which are interpreted as the probability of firms eco-innovating across the different driver categories. Differentiating the respondents into small and medium-sized enterprises (SMEs) and Irish-owned firms is interesting, given the profile of firms in the Irish business landscape.

21 Examples of applying such an approach include Roper *et al*., 2008; Hall *et al*., 2009; Doran and O'Leary, 2011.

Table 3.2. Drivers of eco-innovation for Irish firms

	Eco-innovation			
	1: All firms	2: 10–49 employees	3: 50–249 employees	4: >250 employees
Existing regulation	1.530***	1.630***	1.365***	3.636*
	(–0.255)	(0.318)	(0.499)	(1.938)
Expected regulation	0.906***	0.9687***	1.901*	–1.07
	(0.354)	(0.432)	(1.117)	(1.819)
Government grants	1.443***	1.202*	--^	2.400
	(0.507)	(0.653)	–	(1.812)
Customer perception	2.589***	1.971***	--^	3.203*
	(0.325)	(0.367)	–	(1.716)
Voluntary agreements	2.703***	2.666***	2.912***	--^
	(0.274)	(0.311)	(0.678)	–
Forward linkages	–0.199***	0.1787	–0.384	–5.156**
	(0.340)	(0.449)	(0.725)	(1.918)
Backward linkages	1.379***	1.064**	2.383***	2.555*
	(0.328)	(0.455)	(0.720)	(1.195)
Horizontal linkages	–0.482	–0.564	–1.283	2.424
	(0.3751)	(0.528)	(0.823)	(1.737)
Public linkages	0.218	0.0438	1.432	–3.20*
	(0.371)	(0.522)	(0.851)	(1.498)
Intramural R&D	0.130***	0.126***	0.091**	0.318
	(0.022)	(0.029)	(0.039)	(0.127)
Extramural R&D	0.049	0.022	0.0915	0.478*
	(0.036)	(0.050)	(0.063)	(0.254)
Irish ownership	0.131	–0.2342	–0.115	1.76**
	(0.145)	(0.233)	(0.250)	(0.736)
Observations	2181	1418	448	91
LR χ^2 (20)	1161.02	609.18	150.82	57.34
Probability > χ^2	0.000	0.000	0.000	0.000
Log likelihood	–904.15	–598.22	–227.57	–33.96

Standard errors in parentheses.

*** *p*<0.10; ** *p*<0.05; *** *p*<0.01.**

Note: --^ denotes where *all* firms in the category responded that the driver impacted their eco-innovation; therefore, there is no variation in the variables to explain eco-innovation and it is dropped from the model.

LR, likelihood ratio.

In terms of factors affecting supply, existing environmental regulations have a significant impact on the probability of firms' eco-innovation across all sizes of firm. Expected changes in regulations also drive SMEs, but not the largest firms, to eco-innovate.

For the full sample, government grants is an important driver of eco-innovation; however, it is smaller firms *only* that are driven to eco-innovate by this factor (see column 2). It is likely that grants are also important drivers of eco-innovation in medium-sized enterprises, as all firms that received a government grant in this size category introduced an eco-innovation (see note for column 3). These results are consistent with studies of potential catalysts and barriers for SMEs to eco-innovate in Europe and beyond (e.g. Triguero *et al*., 2016). Grants offer a means for firms to overcome technological lock-in, which can hinder their ability to eco-innovate.

Demand-side drivers affecting the likelihood of firms eco-innovating are customer perception and voluntary agreements. Results here suggest that consumer perception (i.e. eco-credentials in the eyes of the consumer) is an important driver of eco-innovation in Ireland across all firm sizes (again we assume that this is the case for medium-sized firms – all firms in this category that reported consumer perception have eco-innovated). Similar results are exhibited for voluntary agreements, i.e. firms agreeing on a given green standard (for large firms this effect is also assumed, as all large firms that engaged in voluntary agreements have introduced eco-innovations). This finding indicates the important role of firms' strategic, i.e. self-imposed, decisions in addition to imposed regulations on their eco-innovation behaviour.

For smaller firms, developing eco-innovations may open new opportunities if they bring new technologies to market. Or firms may simply eco-innovate by adopting technologies developed by others, i.e. eco-innovations may be *pushed* by suppliers. The results suggest that firms are more likely to be driven to eco-innovate by backward linkages (with suppliers) than forward linkages (with consumers). These results may suggest that firms are likely to be eco-innovation adopters rather than developers. We find no significant effect of horizontal linkages (with competitors) on the likelihood of firms to eco-innovate.

The existence of public linkages (with universities or research centres) exhibits no effect on the likelihood of eco-innovating for SMEs. In the case of larger firms (250 employees and above), public linkages appear to have a negative effect on their likelihood of eco-innovating. This may also relate to how R&D activities are carried out, with results suggesting that firms are more likely to eco-innovate when they carry out their R&D in house relative to collaborating with other firms or groups of firms (intra- vs extramural R&D).

Further estimates based on the innovation production function for Irish firms highlight the impacts of the five main drivers on eco-innovation. Table 3.3 provides the results of the impact of a driver on the probability of firms eco-innovating.

Key results: drivers of eco-innovation

Across the full sample of firms, those that have entered voluntary agreements are 52% more likely to eco-innovate (Table 3.3, column 1) – the highest impact estimated. The next highest impact is observed

Table 3.3. Marginal effects of drivers of eco-innovation for Irish firms

	Eco-innovation			
	1: All firms	2: 10–49 employees	3: 50–249 employees	4: >250 employees
Existing regulation	0.34***	0.38***	0.31***	0.14*
Expected regulation	0.21***	0.23***	0.39*	–0.10
Government grants	0.31***	0.29*	--^	0.08
Customer perception	0.50***	0.45***	--^	0.11*
Voluntary agreements	0.52***	0.56***	0.52***	--^

*** $p<0.10$; ** $p<0.05$; *** $p<0.01$.**
Note: --^ denotes where *all* firms in the category responded that the driver impacted their eco-innovation; therefore, there is no variation in the variables to explain eco-innovation and it is dropped from the model.

for customer perception at 50%. Firms that respond to existing regulation are 34% more likely to eco-innovate. Firms that receive government grants are 31% more likely to innovate. Those firms that expect regulation to be introduced are 21% more likely to eco-innovate.

Among all drivers of eco-innovation, voluntary agreements exhibit the strongest positive effect (excluding large firms, where this effect was not estimable). This is followed by customer perceptions in terms of importance but not for the largest firms. Regulation appears to have the effect of increasing the likelihood of eco-innovation from 14% (large firms) to 38% (small firms). Smaller firms' likelihood of eco-innovating is similar in size to the effects observed for the entire sample of firms, while effects for larger firms are either smaller, insignificant or inestimable.

4 Conclusions and Recommendations

In the competition to find measures for the separate fields of social and environmental sustainability, no clear consensus has yet emerged on the most appropriate measures. However, there is agreement on the need to extend traditional indicators to more accurately encompass integrated economic, social and environmental aspects of sustainability. This project addresses this challenge for social and environmental measures of competitiveness using the concept of *sustainable competitiveness* as introduced by the WEF. This fosters understanding of the relationships among productivity and social and environmental sustainability.

While it is noted by the WEF (2015) that small movements in sustainability scores are expected from year to year, trends in Irish environmental and social sustainability over the decade considered here both display change, particularly for social sustainability. Better scores for Irish sustainable competitiveness (SGCI) than for economic competitiveness (GCI) were observed, largely because of relatively strong performance in social sustainability. The improvement observed in Irish sustainable competitiveness (SGCI), relative to economic competitiveness (GCI), was twice as large pre-crisis than for the post-crisis period.

Trends in Irish SGCI and GCI can be compared with other countries to put Irish performance in an international context. Relative to the top 10 countries (SGCI measure) a substantial gap in Ireland's performance is evident. Ireland's improvements in sustainable competitiveness were half those enjoyed by the top 10 countries. Although its social sustainability performance is responsible for a strong performance in sustainable competitiveness, Ireland exhibited lower scores in eight of the nine indicators of social sustainability than the top 10 countries.

The approach allowed for identification of the relationship between sub-indexes, pillars and indicators of competitiveness and sustainable competitiveness (SGCI), and its two components, social sustainability and environmental sustainability. Results confirm that there is no necessary trade-off between economic competitiveness and sustainability.

Those countries most appropriate for comparison with Ireland are included in the group of most advanced "innovation-driven" economies. For advanced economies (including Ireland), the measure of sustainable competitiveness (SGCI) exhibits statistically significant levels of pass-through of between 0.33 and 0.04 (equivalent to 33 and 4 percentage points, respectively) from changes in the following pillars (from greatest pass-through to smallest, respectively):

- innovation and business sophistication (P11 and P12);
- higher education and training (P5);
- technological readiness (P9);
- institutions (P1);
- labour market efficiency (P7);
- financial market development (P8); and
- macroeconomic environment (P3).

For all pillars listed above (except P8 and P3), the size of the pass-through effects were greater for advanced countries than for the entire panel, indicating advanced countries' ability to benefit more from improvements in these pillars. Owing to the systemic effects between economic and sustainable competitiveness, improvements in the above pillars have pass-through effects on sustainable competitiveness.

For environmental sustainability, the estimated pass-through effects were significant (between 0.3 and 0.07, i.e. 30 and 7 percentage points, respectively) for five pillars:

1. innovation and business sophistication (P11 and P12);
2. higher education and training (P5);
3. technological readiness (P9);
4. financial market development (P8); and
5. infrastructure (P2).

For social sustainability, estimated pass-through effects (between 0.3 and 0.02, i.e. 30 and 2

percentage points, respectively) were estimated for the following seven pillars:

1. innovation and business sophistication (P11 and P12);
2. *institutions* (P1);
3. technological readiness (P9);
4. *labour market efficiency* (P7);
5. higher education and training (P5);
6. financial market development (P8); and
7. *macroeconomic environment* (P3).

Pillars in italic text display pass-through effects for social sustainability only (not environmental sustainability). Estimated pass-through effects are similar (within 2–3 percentage points) to estimates for environmental sustainability with the exception of higher education (P5). In this case a lower impact is observed for social relative to environmental sustainability (0.8 compared with 0.15, or 80 compared with 15 percentage points).

The structured approach to the construction of competitiveness indexes by the WEF indicates that social and environmental competitiveness may be impacted jointly by changes in the economic pillars. As economic competitiveness and sustainability can work in mutually supporting ways, some policy interventions serve as generalised mechanisms to generate positive effects for all three aspects: economic, social and environmental. For example, the measured pass-through effects indicate the joint impacts of innovation and higher education on economic competitiveness and sustainability.

In addition, roadblocks to sustainable competitiveness can be identified. The specific areas where the largest gaps exist between Ireland and other advanced countries are identified for each sustainability adjustment as follows:

- *Social sustainability* – access to health care services; and youth unemployment.
- *Environmental sustainability* – stringency and enforcement of environmental regulation; baseline water stress; waste-water treatment; carbon concentration; and changes in forest cover.

These specific indicators have direct impacts on sustainable competitiveness. Measured pass-through effects indicate the nature and scale of *indirect* impacts of economic competitiveness (i.e. pillars) feeding through to sustainability measures.

To complement the above research, which highlights the importance to sustainable competitiveness of innovation more broadly, drivers of firm-level innovation were considered. The final aspect of the analysis concerns the drivers of ecological innovations by firms operating in Ireland. These innovations play a determining role in promoting economic growth that supports decoupling economic performance from intensive use of environmental resources. The most recent data available to consider this issue relate to 2006–2008, and the generation of such data on a more regular basis is recommended as necessary to follow trends and changes over time.

Engagement across a range of eco-innovations is evident by Irish firms, with recycling waste the main activity (for 34% of all firms) and many firms involved in several eco-innovations. Existing and expected regulations are drivers of 30% of eco-innovations with demand-side drivers featuring in 34% of eco-innovations and supply-side drivers in 26%. Estimations of the impact of specific drivers on the probability of eco-innovation reveal that the most significant increases in the probability of firms eco-innovating are through voluntary agreements (firms' strategies); customer perception; existing regulation; government grants; and expected regulation, with effects of between 52% and 21%.

Firms' strategic decisions – their self-selected agreements and their selected responses to customer perceptions – exert the largest impact on the probability of eco-innovation. Nevertheless, policy influence, through both current and expected regulation, and government influence through grants also generate substantial impact on the likelihood of firms' eco-innovation. Encouraging further eco-innovation through the policy levers of regulation and grants can be recommended with such impacts expected to systematically impact further on customer demands and tastes, and firms' recognition of market development opportunities worth addressing.

4.1 Recommendations

In the context of the results generated in this report, a number of recommendations are made.

- Attention should focus on all aspects of competitiveness – economic, social and environmental – to better understand their inter-relationships. Data collection for social sustainability and environmental sustainability indicators should be maintained and improved relative to best practice and analysis.
    - As data availability increases (e.g. SPI), performance relative to the Sustainable Competitiveness Index can be investigated. With SPI data available for two Irish regions, among other European regions, aggregate and intra-regional analysis of the interdependencies of economic, social and environmental aspects may also be conducted.
- Improvements in the innovation and higher education pillars feed into economic competitiveness *and* sustainable competitiveness and are to be supported as fundamental elements of both social and environmental sustainability policies.
- The role of eco-innovation as an element in decoupling strategies requires greater research and more regular availability of data through, for example, the CIS. The availability of such data on, for example, an annual basis permits more timely analysis of eco-innovation in the context of firms' strategic decisions, as well as their expenditures.
- Firms' strategies and their customers' positive perceptions of eco-credentials are drivers of eco-innovation by Irish-based firms. The provision of government grants also increases the likelihood of eco-innovation. The potential to match regional SPI data with firm-level eco-innovation data could permit deeper consideration of social and environmental impacts from eco-innovation, and more general innovation, decisions.

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Abbreviations

CIS	Community Innovation Survey
CSO	Central Statistics Office
EPA	Environmental Protection Agency
GCI	Global Competitiveness Index
GCP	Global Competitiveness Project
NCC	National Competitiveness Council
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
SGCI	Sustainability-adjusted Global Competitiveness Index
SME	Small and medium-sized enterprises
SPI	Social Progress Index
WEF	World Economic Forum

Appendix 1 Countries Included in Analysis

Albania	Guatemala	Panama
Algeria	Guyana	Paraguay
Argentina	Honduras	Peru
Armenia	Hungary	Philippines
Australia	Iceland	Poland
Austria	India	Portugal
Azerbaijan	Indonesia	Romania
Bangladesh	Ireland	Russian Federation
Belgium	Italy	Saudi Arabia
Bolivia	Jamaica	Senegal
Brazil	Japan	Serbia
Bulgaria	Kazakhstan	Slovakia
Cambodia	Kenya	Slovenia
Cameroon	Kyrgyz Republic	South Africa
Canada	Latvia	Spain
Chile	Libya	Sri Lanka
China	Lithuania	Sweden
Colombia	Luxembourg	Switzerland
Costa Rica	Malaysia	Tanzania
Croatia	Mauritius	Thailand
Cyprus	Mexico	Trinidad and Tobago
Czech Republic	Mongolia	Turkey
Denmark	Morocco	Ukraine
Dominican Republic	Mozambique	United Arab Emirates
El Salvador	Namibia	United Kingdom
Estonia	Nepal	United States of America
Ethiopia	Netherlands	Uruguay
Finland	New Zealand	Vietnam
France	Nicaragua	Zambia
Georgia	Nigeria	Zimbabwe
Germany	Norway	
Greece	Pakistan	

Note: dark blue indicates countries at the top stage of development.

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL
Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú
Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola *(m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola)*;
- gníomhaíochtaí tionsclaíocha ar scála mór *(m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta)*;
- an diantalmhaíocht *(m.sh. muca, éanlaith)*;
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe *(OGM)*;
- foinsí radaíochta ianúcháin *(m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha)*;
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil
- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce
- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol
- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil *(m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí)*.

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn
- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn.

Taighde agus Forbairt Comhshaoil
- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta
- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn *(m.sh. mórphleananna forbartha)*.

Cosaint Raideolaíoch
- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas
- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol *(m.sh. Timpeall an Tí, léarscáileanna radóin)*.
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta
- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil
Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:
- An Oifig um Inmharthanacht Comhshaoil
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Fianaise is Measúnú
- Oifig um Chosaint Radaíochta agus Monatóireachta Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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Integrated Indicators for Ireland: Adjusting Economic Progress for Environmental and Social Sustainability (I^3: AEPESS)

Authors: Eleanor Doyle and Mauricio Perez-Alaniz

Decoupling economic growth from environmental quality is an imperative for Ireland, as with other modern developed economies. Not only has economic growth been linked with environmental sustainability impacts, but more recently social sustainability has also been highlighted in terms of its relationship to, and impacts from, the economy. The "Integrated Indicators for Ireland" project considers the systemic nature of relationships between economic indicators and measures of sustainability, both environmental and social.

Identifying Pressures

A key environmental pressure is adopting a narrow focus rather than holistic and systemic considerations of society's relationships to the economy and the environment. The measure of 'sustainable competitiveness' developed by the World Economic Forum (WEF) is used for a sample of 94 countries over a decade to measure relationships between the economy and sustainability. A further pressure addressed is identification of specific levers of greatest impact for environmental and social sustainability for Ireland, based on advances in international data collection and current understandings of appropriate measures of economic, social and environmental indicators. Achieving decoupling for businesses is also informed by examining the range of ecological innovations by firms in Ireland, and their drivers, generating insight into firms' sustainable activities.

Informing Policy

A broad range of measures exist globally for economic growth and sustainability that policymakers may use to track and monitor economic, environmental and social progress. Few measures allow for consideration of all three aspects; none over an extended period such as the decade addressed in this project. The selected measure of 'sustainable competitiveness' points to areas where greatest impacts on sustainability can be achieved. Broadly, the results confirm there is no necessary trade-off between economic performance and sustainability. Better scores for Irish sustainable competitiveness, compared with economic competitiveness, resulted from strong performance in social sustainability. Sustainability-oriented policies can use the findings that improved innovation indicators exert large impacts on both environmental and social sustainability, to target policy. Substantial indirect impacts on sustainability measures were also estimated for indicators of higher education and training; goods market efficiency; labour market efficiency; financial market development; technological readiness; and internationalisation. For targeting business-oriented policies the project identified the most important drivers of eco-innovation as firms' strategies; customer perceptions; existing regulation; government grants, and expected regulation.

Develop Solutions

Solutions proposed to improve environmental sustainability impact on the economy and society. In this project's estimations, the direct impacts on sustainable competitiveness, and its components of social and environmental sustainability were identified. The research found improved sustainability performance could be generated from a set of specific indicators. For social sustainability, the areas where the largest gaps exist between Ireland and other advanced countries relate to health care services and youth unemployment. For environmental sustainability: the areas are stringency and enforcement of environmental regulation; baseline water stress; waste-water treatment; carbon concentration; and changes in forest cover. The project exploited data available from the WEF. As data availability increases over time (e.g. Social Progress Index), performance relative to the sustainable competitiveness measures of this project can be further investigated. Both aggregate and intra-regional analysis of the interdependencies of economic, social and environmental aspects may also be conducted. Potential to match regional SPI data with firm-level eco-innovation data could also support deeper consideration of the social and environmental impacts of eco-innovation, and more general innovation, decisions.

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