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# 2017 COMPETITIVENESS REPORT

## The new competitiveness scoreboard

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

Observatoire de la compétitivité

# 2017 COMPETITIVENESS REPORT

The new competitiveness scoreboard

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**Ministère de l'Économie**
**Observatoire de la compétitivité**

19-21 Boulevard Royal
L-2449 Luxembourg

observatoire@eco.etat.lu

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# 2017 Competitiveness Report

The following persons contributed to this publication:

**Serge ALLEGREZZA**
Ministry of the Economy/STATEC

**Marc FERRING**
**Martine HILDGEN**
**Max JENTGEN**
**Giulia SPALLETTI**
**Pierre THIELEN**
Ministry of the Economy

**Claude LAMBORAY**
STATEC

**Chiara PERONI**
**Charles-Henri DIMARIA**
**Xi CHEN**
STATEC/ANEC

# Introduction


The economy of the European Union is now well on the way towards recovery and is showing its resilience. Improved prospects in the European community have played in our favour. Luxembourg is now enjoying its fifth consecutive year of growth. Several short-term indicators are showing positive results for 2017 and 2018, continuing the positive trend in place since 2016. Statec is predicting increases in GDP of +3.4% for 2017 and +4.4% in 2018. Domestic employment is set to increase by over 3% and the unemployment rate continues to fall to its lowest level for the past five years (close to 6% in 2017). The government believes its medium-term budget targets will be achieved and that public debt will remain well below the 60% benchmark set by the EU Stability Pact. This fiscal stability is regularly confirmed by the Triple A ratings given to our country by ratings agencies. Luxembourg's performance is far better than most other EU countries, so we certainly have reason to be optimistic about our current situation.

These strong results could encourage Luxembourg to rest on its laurels and simply pat itself on the back for the good work it has done, but for our country, a small, open economy integrated into a large cross-border area, this development is in fact a challenge to which we need to rise. Our current growth model actually produces a number of negative externalities, such as the challenges in the domain of mobility and housing. We must not become complacent as we did in the 'good old days'. In late 2016, the government organised a series of events on qualitative growth and presented the commissioned strategic study entitled 'The Third Industrial Revolution Luxembourg' by Jeremy Rifkin. The aim of this study was to develop a long-term vision to prepare the country to operate in a constantly changing environment. New legislative, regulatory and technical measures, as well as potential flagship projects, are now being discussed in various arenas. A strategic monitoring committee was set up at the beginning of 2017 to coordinate the implementation of such measures, some of which have already been approved by the government.

Throughout the year, the Observatoire de la compétitivité monitors dozens of international rankings. It has become vitally important to closely monitor these results, which are key to shaping our country's territorial promotion strategy. These results contribute strongly to shaping our country's image abroad, revealing what Luxembourg is capable of achieving. A good rating acts an important marker of trust, demonstrating how attractive our country is for investors. We must therefore do our utmost to ensure that Luxembourg achieves good results in these international benchmarks.

At the request of the Tripartite Coordination Committee, a national competitiveness scoreboard was established in 2003 to shed more light on the specific features of our country, which international benchmarks often fail to do. The Economic and Social Council paved the way for a revised national scoreboard after adopting an opinion on the national indicators grid in July 2016. The Observatoire de la compétitivité has therefore developed an updated and reorganised national scoreboard. According to the results of this latest edition, Luxembourg is the 4th best-performing country in the EU and thus is clearly one of the front-runners.

Luxembourg has been seeking to diversify its economy for many years now as it recognises the risks of depending too heavily on the financial sector. This is a crucial issue in the long term. The Observatoire has therefore estimated the economic impact of the new priority sectors which the government is actively promoting as drivers of growth, to replace our sovereignty niches with skills niches, with a view to making us less dependent and vulnerable. These sectors are ICT, logistics, space technologies, health technologies and eco-technologies.

R&D and innovation are essential for these sectors, which are highly technology- and skills-intensive. When we look towards the future, we must not lose sight of what we are aiming for. Our record in terms of start-ups in these sectors has been particularly positive. A few years ago, Luxembourg's ecosystem was only just beginning to flourish and key measures still needed to be put in place to attract investors. Today, most of these challenges have been tackled effectively. The environment now has more than enough critical mass to ensure the sector continues to be dynamic and achieves international recognition. This proves that the government's decisions have been legitimate and well-founded.

In addition to its three main categories of analysis, the Report also includes a newly updated analysis of productivity, which is a key factor of economic growth and well-being. The government deemed this indicator highly important and therefore asked the Economic and Social Council to develop an opinion and a productivity report looking at the factors which contribute to productivity and its results in an international context. These analyses should all feed into the discussion pertaining to the establishment of a National Productivity Board in Luxembourg, a measure which stems from a recommendation of the Council of Ministers of the EU aiming to complete the Economic and Monetary Union.

Finally, I hope that this Report will also feed into in the social dialogue discussions between the government and the social partners, as well as the debates on the key topic of qualitative growth.

**Francine Closener**
Secretary of State for the Economy

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# 1 The Observatoire de la compétitivité


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# 1.1 The Observatoire de la compétitivité: Role and missions

The role of the Observatoire de la compétitivité is to assist the Government and the social partners in providing guidelines and formulating policies that promote and/or are suited to the concept of long-term competitiveness, which is the source of growth and well-being.

As such, it is a tool for documenting, observing and analysing evolution in the country's competitive position. It is a monitoring unit, responsible for leading a constructive debate between the social partners.

The main tasks of the Observatoire de la compétitivité are as follows:

- Collect, analyse and compare existing data on the national, regional and international levels that relate to economic competitiveness;
- Accurately target the dissemination of selected and processed information, which is useful for strategic decision-making;
- Undertake or commission studies and research on competitiveness, its factors, etc.;
- Contribute to the works and to the analyses of international organizations dealing with competitiveness (EU Council, OECD, etc.);
- Coordinate the work and the drafting of the Luxembourg's National Reform Programme (NRP) within the framework of the European Strategy for Growth and Jobs (Lisbon strategy and Europe 2020 strategy).

## 1.2 From the Lisbon strategy to the Europe 2020 strategy

Within the Government, the Minister of the Economy is responsible for coordinating the implementation of the European strategy for growth and jobs on the national level. The Observatoire de la compétitivité was commissioned in the autumn of 2005 to prepare the National Plan for Innovation and Full employment, which was submitted to the European Commission within the framework of the Lisbon strategy. In order to optimize government coordination, to ensure consultation procedures and to guarantee assimilation of reforms nationally, an ad hoc structure was set up at the inter-ministerial level in 2005, whose structure is coordinated by the Observatoire de la compétitivité. This network brings together Lisbon strategy coordinators within each of the relevant ministerial departments and administrations concerned. The Government then submitted annual implementation reports to the Commission, until the Lisbon strategy expired in 2010.

At the end of 2009, the European Commission began the works to define a new strategy for the next decade: the Europe 2020 strategy[1]. Based on European Commission proposals, the June 2010 European Council decided upon the development of this new strategy, the governance of which will take place at three integrated levels:

- A level of macroeconomic monitoring to focus on macroeconomic and structural policies;
- A thematic coordination level, covering the five major European objectives and their national implementation;
- A simultaneous monitoring level, taking place within the framework of the Stability and Growth Pact (SGP).

In November 2010 each Member State had to submit to the European Commission a first draft of the National Reform Programme (NRP), developed in the framework of the Europe 2020 strategy. In November 2010 Luxembourg submitted its interim NRP draft to the Commission, and the Government finally decided on the finalized NRP for Luxembourg in April 2011 which was then submitted to the European Commission, along with the SGP. The seventh update of Luxembourg's finalized NRP was sent to the European Commission in April 2017, along with the SGP 2017-2021[2]. Based on the NRP and the SGP, the Council issued in July 2017 country-specific recommendations for Luxembourg, for consideration during the national discussions to be conducted about the 2018 draft budget.

[1] For additional details: https://ec.europa.eu/info/strategy/european-semester_en

[2] For additional details: http://www.mf.public.lu

## 1.3 Agency for standardization and the knowledge economy (ANEC)

Through the creation of the economic interest group ANEC (2012), the government wanted to promote and support advocacy, awareness, training and monitoring in the field of standardization in order to support the competitiveness of companies in Luxembourg while developing a centre of excellence in research, development and innovation.

Research projects from the 'Knowledge Economy Department' are followed among others by the Observatoire de la compétitivité, in collaboration with STATEC. For 2017, the work program plans to deepen the activities undertaken to fulfil the foremost mission of ANEC, which consists in valuing STATEC's available statistical data through applied research.

## 1.4 Events and publications in 2016-2017

The Observatoire de la compétitivité aims to inform both the economic agents and the general public on competitiveness issues. To achieve this, multiple communication channels are used, such as organising public events (seminars, conferences, etc.) and publishing analytical documents on competitiveness. All information concerning events organized by the Observatoire de la compétitivité and its publications can be downloaded.

### 1.4.1 Seminars and conferences

The communication strategy of the Observatoire de la compétitivité is consistent with its 'competitiveness monitoring' mission and is in particular useful for initiating public debate on the major axes that define the competitiveness of the Luxembourg economy and the Europe 2020 strategy. The organization of public events is a part of this mission.

### Economy Day 2017[3]

In March 2017, the Ministry of the Economy, the Chamber of Commerce and Fedil joined forces with PwC to organise the Economy Day focussing on *'The Company of the Future'*.

### Conference: 'On the way to extreme inequalities: how income and wealth research highlights the challenges for the 21st century'[4]

In June 2017, the Observatoire de la compétitivité and the LIS Cross-National Data Center organised the conference *'On the way to extreme inequalities: how income and wealth research highlights the challenges for the 21st century'* with Professor Louis Chauvel.

## 1.4.2 *Perspectives de Politique économique*

Through the publication *'Perspectives de Politique économique'*, the Observatoire de la compétitivité disseminates the findings of studies and/or commissioned research from academics or consultants, as well as papers written by members of the Observatoire de la compétitivité. This publication is also intended to publicize the reports of lectures, seminars or conferences that the Ministry of the Economy organizes on issues of economic policy. Finally, its goal is also to clarify the possible policy options, to assess the effectiveness of certain measures, and so to foster the public debate on economic policy.

## 1.4.3 The Observatoire de la compétitivité website

The Observatoire de la compétitivité has a website that gathers all the information and publications regarding the competitiveness of the national economy: http://www.odc.public.lu. In particular this site provides information on Luxembourg's competitiveness in foreign publications. It acts as a communication platform for all those involved in the implementation of the Europe 2020 strategy in Luxembourg and enables to make the Competitiveness Scoreboard data available. The website announces upcoming events and publications. Documents relating to conferences and seminars, as well as the publications, can be downloaded for free from this site.

[3] For additional details: http://www.jecolux.lu//events/economyday/index.html

[4] For additional details: http://www.lisdatacenter.org/wp-content/uploads/chauvel-lecture.pdf

## 1.5 An overview of the 2017 Competitiveness Report

**Chapter 2** presents the performance of Luxembourg according to major international composite indicators (IMD, WEF, etc.) and also looks at various rankings less known by the general public.

**Chapter 3** analyses how Luxembourg's competitiveness has developed over the course of the past year in comparison with other EU Member States based on the national Competitiveness Scoreboard indicators. This scoreboard was initially introduced at the request of the Tripartite Coordination Committee in 2003 to provide a clearer overview of the specific information pertaining to Luxembourg. It has since been revised by the Economic and Social Council which unanimously adopted an opinion in 2016 on the set of national indicators to be included in the updated and restructured version of the scoreboard.

**Chapter 4** aims to present the priorities as well as the European an national objectives of the Europe 2020 strategy in the context of the European Semester and make an intermediate appraisal of Luxembourg's position for the indicators in the EU macroeconomic surveillance scoreboard, before the publication of the new edition by the end of 2017 by the European Commission.

**Chapter 5** aims to provide an overview and monitoring of the five priority economic sectors in Luxembourg, whose development is being promoted actively by the Ministry for the Economy: ICT, logistics, health technologies, eco-technologies and space technologies.

**Chapter 6** provides a summary of the recent study entitled 'Assessing the impact of sectoral interaction on wage development in Luxembourg and neighbouring countries' commissioned by the Observatoire de la compétitivité and penned by the University of Luxembourg. This study aims to analyse the sectoral discussions on wages in Luxembourg and its three neighbouring countries (Germany, Belgium and France), with a specific focus on wage dynamics in the private and public sector.

Finally, **Chapter 7** presents the results of studies carried out by ANEC-STATEC researchers pursuant to the framework agreement on research into productivity, which was concluded by ANEC, STATEC and the Observatoire de la compétitivité. The updated 'Luxklems' project forms one part of this, as does an analysis of the effects of Luxembourg's international trade activities on the domestic labour market.

# 2 Benchmarks and comparative competitiveness analysis


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# 2.1 Introduction

The debate on 'territorial competitiveness' is re-launched when international comparative benchmarks and territory rankings are published. Composite indices enable comparisons as they draw together multiple sets of information under a single numerical value[1], thus covering a variety of characteristics to provide an approximate summary of complex issues such as competitiveness, attractiveness, innovation or quality of life (albeit one which is by no means devoid of methodological limitations).

This chapter seeks on one hand to provide an overview of a raft of international benchmarks which have been published since the last edition of this Report in Autumn 2016, and on the other hand to analyse more specifically Luxembourg's position and to compare it to those of other EU Member States[2].

# 2.2 Luxembourg's rankings

In the debate about the determinant factors of regional competitiveness, the best-known benchmarks and rankings published annually are those of the World Economic Forum (WEF), the International Institute for Management Development (IMD), the Heritage Foundation and the European Commission. In addition to these four rankings, there are a multitude of other reports, some of which we will look at in this chapter.

## 2.2.1 WEF, IMD, Heritage Foundation and European Commission

### a. Growth Competitiveness Index[3]

End of September 2017 the World Economic Forum (WEF) published a new edition of its comparative study regarding the competitiveness of 137 countries around the world. The objective of this study, called 'Global Competitiveness Report', is to assess the world economies' potential to achieve sustainable growth in both the medium and long term. In the context of this study competitiveness is defined as 'the set of institutions, policies and factors that determine the level of productivity of a country.' This study takes into account that all countries are not at the same level of economic development. The relative importance of the various factors of competitiveness is thus dependent on initial conditions.

[1] For more information on composite indicators, see the European Commission's Joint Research Centre website: http://composite-indicators.jrc.ec.europa.eu/

[2] A list of more benchmarks may also be found on the website of the Observatoire de la compétitivité: https://odc.gouvernement.lu/fr/statistiques/benchmarks-internationaux.html

[3] For more information: https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018

The competitiveness level is measured through 114 indicators spread among three pillars:

- The basic requirements of competitiveness (institutions, infrastructure, macroeconomic environment, health and primary education);
- Efficiency enhancers (higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, market size);
- Innovation and sophistication factors (business sophistication and innovation).

Based on these indicators the authors calculate a composite index in order to rank countries on a scale from 1 (the least competitive) to 7 (the most competitive). This index is constructed by a combination of statistical data and information from an annual survey of economic decision-makers and business leaders. This survey is carried out in collaboration with a network of partner institutes, including Luxembourg Chamber of Commerce.

The global rankings for 2017 are headed by Switzerland (5.86/7), the USA (5.85) and Singapore (5.71). Luxembourg is in 19th place overall (5.23). The Netherlands are in 4th place (5.66), Germany is in 5th place (5.65), Belgium is 20th (5.23) and France 22nd (5.18). The Netherlands are the highest-ranked European Union country, with Luxembourg in 8th place among EU countries.

Table 1
**Luxembourg's position according to the GCI (2017-2018)**

| | Economy | Score | Prev. | Trend |
|---|---|---|---|---|
| 1 | Switzerland | 5.86 | 1 | |
| 2 | United States | 5.85 | 3 | |
| 3 | Singapore | 5.71 | 2 | |
| 4 | Netherlands | 5.66 | 4 | |
| 5 | Germany | 5.65 | 5 | |
| 6 | Hong Kong SAR | 5.53 | 9 | |
| 7 | Sweden | 5.52 | 6 | |
| 8 | United Kingdom | 5.51 | 7 | |
| 9 | Japan | 5.49 | 8 | |
| 10 | Finland | 5.49 | 10 | |
| 11 | Norway | 5.40 | 11 | |
| 12 | Denmark | 5.39 | 12 | |
| 13 | New Zealand | 5.37 | 13 | |
| 14 | Canada | 5.35 | 15 | |
| 15 | Taiwan, China | 5.33 | 14 | |
| 16 | Israel | 5.31 | 24 | |
| 17 | United Arab Emirates | 5.30 | 16 | |
| 18 | Austria | 5.25 | 19 | |
| **19** | **Luxembourg** | **5.23** | **20** | |
| 20 | Belgium | 5.23 | 17 | |

Source: WEF

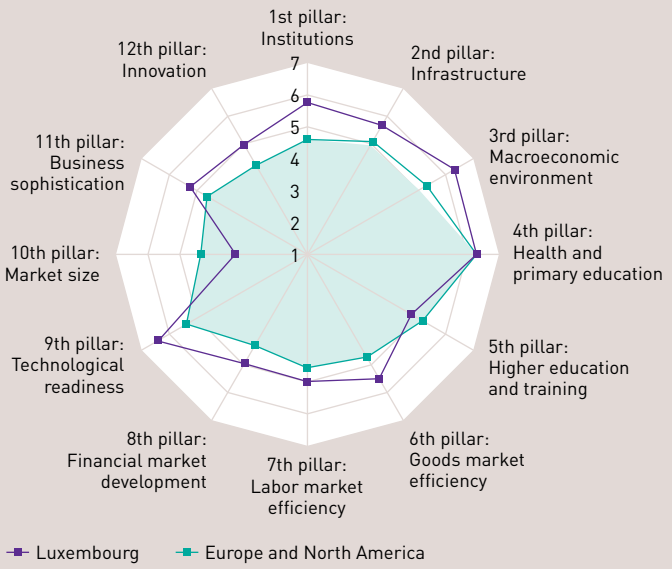
Luxembourg scored as follows under the three main pillars of the study:

- Luxembourg is in 10th place overall (6.0) for basic competitiveness requirements: it is ranked 8th for institutions, 17th for infrastructure, 7th for the macroeconomic environment and 41st for health and primary education;

- Luxembourg is in 23rd place overall (5.1) for efficiency indicators: 50th for higher education and training, 4th for goods market efficiency, 16th for labour market efficiency, 15th for financial market development, 1st for technological readiness and 88th for market size;

- Luxembourg is in 16th place overall (5.1) for innovation and sophistication indicators, with a 17th place for business sophistication and 15th for innovation.

Chart 1
**Luxembourg's performance within the different pillars**



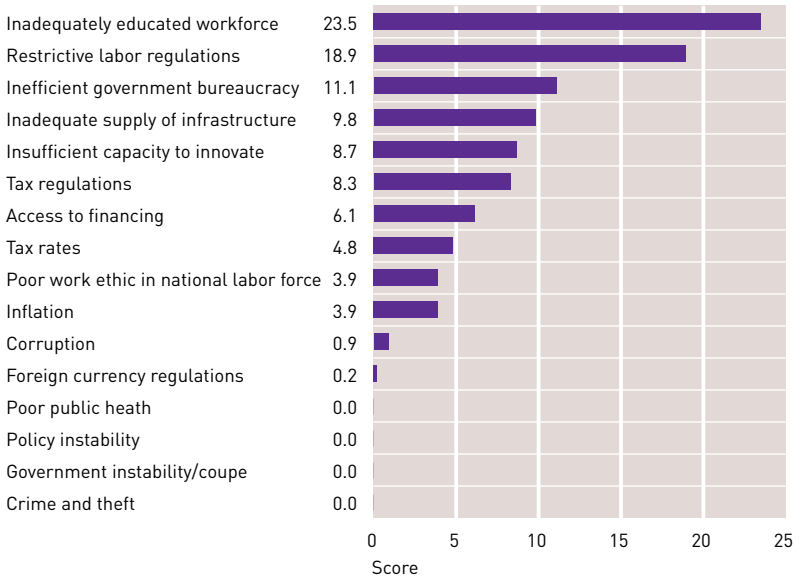

Source: WEF

Frame 1
**Results of the survey carried out in Luxembourg (WEF poll)**

The WEF annual survey, which is carried out among business leaders, makes it also possible to identify main factors hindering national business environment.

The survey shows the three main problems for doing business in Luxembourg result from an inadequately educated workforce, a too restrictive labour regulation and inefficient government bureaucracy.

**Most problematic factors for doing business**



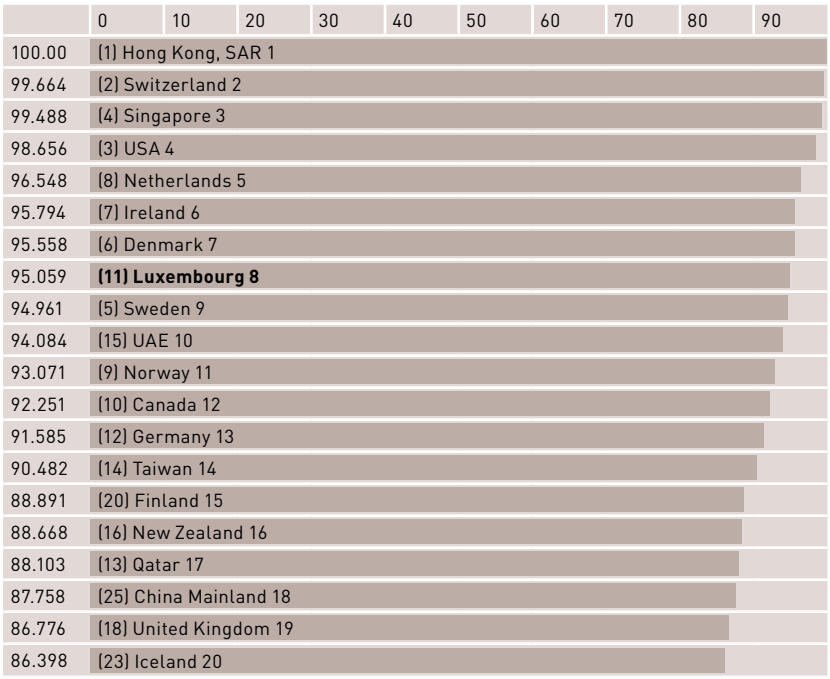

Note: Respondents are invited to select the 5 most problematic factors for doing business in their country from a list of 15, and to rank them from 1 (most problematic) to 5. Figures in this chart show the resulting answers weighted by their ranking.

## b. Global Competitiveness Index[4]

The Swiss Institute IMD published in May 2017 the latest version of its annual report on competitiveness, the 'World Competitiveness Yearbook'. This report is published yearly since 1989. In this new edition, 63 countries are analysed through 260 criteria. These criteria are both quantitative and qualitative (survey of business leaders), split into four subcategories: economic performance, government efficiency, business environment and infrastructure.

The 2017 global ranking is led by Hong Kong (scoring 100/100), Switzerland (99.664) and Singapore (99.488). Luxembourg is ranked 8th (95.059). The Netherlands finish 5th (96.548), Germany 13th (91.585), Belgium 23th (83.905) and France 31st (77.677). Luxembourg was 6th in 2015 and 11th in 2016. The Netherlands are the best-performing EU country in 2017, followed by Ireland (95.794) and Denmark (95.558). Luxembourg is the 4th highest-ranked EU country.

Chart 2
**IMD Top 20 global ranking**




Source: IMD

[4] For more information: http://www.imd.org/wcc/

Luxembourg is ranked as follows under the four sub-categories of the global ranking:

- For the 'economic performance' category, Luxembourg places 3rd, with strong results in international trade (4th), international investment (2nd) and domestic economy, but lower results in employment (18th) and prices (32nd);

- For the 'government efficiency' category, Luxembourg places 15th, finishing 9th for public finances, 44th for tax policy, 8th for overall institutional framework, 16th for business legislation and 10th for societal framework;

- For the 'business environment' pillar Luxembourg placed 6th, with strong results for finance (3rd), productivity (3rd) and management practices (10th), but lower results for attitudes and values (21st) and labour market (19th);

- The 'infrastructure' category is the area where Luxembourg records its poorest results, placing 22nd. For example, Luxembourg finishes 9th for basic infrastructure, 23rd for technological infrastructure, 23rd for scientific infrastructure, 21st for environment and health, and 26th for education.

## c. Index of Economic Freedom[5]

In February 2017, the American Heritage Foundation published the 23rd edition of its annual study 'Index of Economic Freedom' (IEF), launched in 1995. Economic freedom, which is analysed in 180 countries around the world, is defined as the absence of any government coercion or constraint on production, supply or consumption of goods and services beyond the extent necessary to protect and maintain the liberty of citizens. Economic freedom is supposed to favour productivity and economic growth by supporting entrepreneurship and creation of value added. It is measured through indicators spread among four categories, which are split into twelve equally-weighted sub-categories: Rule of law (property rights, judicial effectiveness, government integrity); Government size (tax burden, government spending, fiscal health); Regulatory efficiency (business freedom, labour freedom, monetary freedom); Market openness (trade freedom, investment freedom, financial freedom). The more open an economy is (composite index close to 100), the better a country ranks in the study.

[5] For more information: http://www.heritage.org/index/

The global ranking for 2017 is led by Hong Kong (89.8), followed by Singapore (88.6) and New Zealand (83.7). Luxembourg is listed in 14th place (75.9) and is in the category of countries deemed 'mostly free'. The Netherlands are 15th (75.8), Germany 26th (73.8), Belgium 49th (67.8) and France 72nd (63.3) in the global rankings. Luxembourg is the fourth best-performing EU country after Estonia (79.1), Ireland (76.7) and the United Kingdom (76.4). Switzerland is the best-performing European country, with Luxembourg coming 6th.

Table 2
**Top 30 of the European ranking**

| World Rank | Regional Rank | Country | Overall Score | Change from 2016 | Property Rights | Judicial Effectiveness | Government Integrity | Tax Burden | Government Spending | Fiscal Health | Business Freedom | Labor Freedom | Monetary Freedom | Trade Freedom | Investment Freedom | Financial Freedom |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 1 | Switzerland | 81.5 | 0.5 | 86.9 | 77.6 | 80.3 | 70.9 | 67.5 | 95.8 | 76.8 | 72.2 | 84.4 | 90.0 | 85 | 90 |
| 6 | 2 | Estonia | 79.1 | 1.9 | 82.6 | 82.8 | 69.9 | 81.2 | 55.8 | 99.8 | 77.0 | 56.9 | 85.7 | 87.0 | 90 | 80 |
| 9 | 3 | Ireland | 76.7 | -0.6 | 85.8 | 78.3 | 78.3 | 72.7 | 57.1 | 60.3 | 80.3 | 73.6 | 87.6 | 87.0 | 90 | 70 |
| 12 | 4 | United Kingdom | 76.4 | 0.0 | 93.8 | 93.0 | 78.3 | 65.1 | 41.9 | 40.4 | 89.9 | 72.8 | 85.0 | 87.0 | 90 | 80 |
| 13 | 5 | Georgia | 76.0 | 3.4 | 55.1 | 66.5 | 65.0 | 87.3 | 74.4 | 93.5 | 87.2 | 75.9 | 78.2 | 88.6 | 80 | 60 |
| **14** | **6** | **Luxembourg** | **75.9** | **2.0** | **85.8** | **77.0** | **78.3** | **64.5** | **46.0** | **99.0** | **68.6** | **43.8** | **86.2** | **87.0** | **95** | **80** |
| 15 | 7 | Netherlands | 75.8 | 1.2 | 87.4 | 69.9 | 85.7 | 53.2 | 37.0 | 83.0 | 80.2 | 70.5 | 85.8 | 87.0 | 90 | 80 |
| 16 | 8 | Lithuania | 75.8 | 0.6 | 73.0 | 62.4 | 69.7 | 86.9 | 64.1 | 93.6 | 79.1 | 63.6 | 90.0 | 87.0 | 70 | 70 |
| 18 | 9 | Denmark | 75.1 | -0.2 | 86.7 | 68.5 | 84.9 | 37.2 | 5.7 | 95.4 | 93.9 | 85.8 | 85.5 | 87.0 | 90 | 80 |
| 19 | 10 | Sweden | 74.9 | 2.9 | 88.6 | 82.2 | 87.4 | 44.4 | 21.7 | 93.4 | 90.8 | 53.2 | 85.3 | 87.0 | 85 | 80 |
| 20 | 11 | Latvia | 74.8 | 4.4 | 72.6 | 59.7 | 67.3 | 84.7 | 57.4 | 95.0 | 79.8 | 72.0 | 86.5 | 87.0 | 75 | 60 |
| 22 | 12 | Iceland | 74.4 | 1.1 | 85.0 | 71.5 | 71.5 | 70.9 | 41.1 | 90.6 | 90.2 | 62.6 | 81.2 | 88.0 | 80 | 60 |
| 24 | 13 | Finland | 74.0 | 1.4 | 90.6 | 82.7 | 90.0 | 66.6 | 0.0 | 77.3 | 90.2 | 53.4 | 85.1 | 87.0 | 85 | 80 |
| 25 | 14 | Norway | 74.0 | 3.2 | 86.7 | 83.3 | 88.3 | 55.6 | 38.5 | 98.4 | 89.5 | 48.8 | 75.8 | 87.7 | 75 | 60 |
| 26 | 15 | Germany | 73.8 | -0.6 | 82.9 | 79.5 | 77.7 | 61.9 | 41.4 | 89.9 | 86.6 | 42.8 | 85.9 | 87.0 | 80 | 70 |
| 28 | 16 | Czech Republic | 73.3 | 0.1 | 70.3 | 55.9 | 55.9 | 82.9 | 45.3 | 92.0 | 67.2 | 77.7 | 85.8 | 87.0 | 80 | 80 |
| 30 | 17 | Austria | 72.3 | 0.6 | 86.0 | 81.8 | 75.2 | 50.3 | 19.3 | 79.7 | 76.9 | 67.6 | 83.4 | 87.0 | 90 | 70 |
| 31 | 18 | Macedonia | 70.7 | 3.2 | 67.0 | 61.4 | 52.0 | 91.9 | 68.9 | 72.6 | 81.5 | 66.7 | 80.8 | 86.1 | 60 | 60 |
| 33 | 19 | Armenia | 70.3 | 3.3 | 55.5 | 42.5 | 43.4 | 83.7 | 81.7 | 82.9 | 78.5 | 72.4 | 72.8 | 80.2 | 80 | 70 |
| 39 | 20 | Romania | 69.7 | 4.1 | 63.9 | 58.5 | 45.9 | 87.4 | 65.3 | 90.9 | 65.9 | 62.5 | 83.6 | 87.0 | 75 | 50 |
| 45 | 21 | Poland | 68.3 | -1.0 | 60.8 | 58.0 | 55.5 | 76.0 | 46.9 | 76.1 | 67.8 | 61.5 | 84.7 | 87.0 | 75 | 70 |
| 46 | 22 | Kosovo | 67.9 | 6.5 | 70.3 | 58.0 | 45.9 | 93.5 | 77.8 | 88.9 | 68.8 | 65.3 | 80.0 | 70.8 | 65 | 30 |
| 47 | 23 | Bulgaria | 67.9 | 2.0 | 62.5 | 38.9 | 41.8 | 91.0 | 58.4 | 86.4 | 66.7 | 68.3 | 83.3 | 87.0 | 70 | 60 |
| 48 | 24 | Cyprus | 67.9 | -0.8 | 75.4 | 60.7 | 53.6 | 73.0 | 48.8 | 72.9 | 75.8 | 58.6 | 83.3 | 87.0 | 75 | 50 |
| 49 | 25 | Belgium | 67.8 | -0.6 | 83.3 | 69.3 | 71.5 | 44.1 | 9.6 | 66.3 | 82.0 | 61.1 | 84.9 | 87.0 | 85 | 70 |
| 50 | 26 | Malta | 67.7 | 1.0 | 67.7 | 62.9 | 53.6 | 62.8 | 44.9 | 85.1 | 62.5 | 57.2 | 83.5 | 87.0 | 85 | 60 |
| 56 | 27 | Hungary | 65.8 | -0.2 | 60.1 | 51.8 | 41.5 | 79.3 | 25.3 | 79.3 | 64.0 | 64.4 | 91.7 | 87.0 | 75 | 70 |
| 57 | 28 | Slovak Republic | 65.7 | -0.9 | 69.0 | 38.0 | 39.6 | 79.7 | 47.2 | 82.9 | 64.9 | 54.4 | 81.1 | 87.0 | 75 | 70 |
| 60 | 29 | Turkey | 65.2 | 3.1 | 61.3 | 52.5 | 40.7 | 75.5 | 57.7 | 95.7 | 64.3 | 48.5 | 72.2 | 79.4 | 75 | 60 |
| 65 | 30 | Albania | 64.4 | -1.5 | 54.0 | 28.5 | 39.7 | 86.9 | 72.5 | 51.5 | 79.3 | 50.17 | 81.4 | 87.7 | 70 | 70 |

Source: The Heritage Foundation

The report reveals Luxembourg's strong results in the domains of rule of law, market openness and monetary stability. The country's scores for labour freedom, government spending and tax burden give more cause for concern. Luxembourg records the following results in the twelve sub-categories:

- Rule of law: property rights (15th world rank; 85.8), judicial effectiveness (17th; 77.0), government integrity (12th, 78.3);

- Government size: tax burden (159th; 64.5), government spending (146th; 46.0), fiscal health (13th; 99.0);

- Regulatory efficiency: business freedom (71st; 68.6), labour freedom (160th; 43.8), monetary freedom (11th; 86.2);

- Market openness: trade freedom (20th; 87.0), investment freedom (1st; 95.0), financial freedom (4th; 80.0).

In conclusion, the authors of the study make the following observation with regard to Luxembourg: *'Luxembourg's economic competitiveness is sustained by solid institutional foundations for an open-market system. The judiciary, independent and free of corruption, protects property rights and upholds the rule of law. The economy is open to global trade and investment, and high levels of regulatory transparency and efficiency encourage vibrant entrepreneurial activity. The fiscal environment remains characterized by high public spending on social programs. Relatively stringent employment protection tends to undercut job mobility and dynamic employment growth. Fiscal consolidation and enhancement of Luxembourg's status as a global financial center are among the coalition government's main policy objectives. The recent tax reform package has lowered the top corporate tax rate.'*

## d. European innovation scoreboard[6]

In June 2017, the European Commission published the latest edition of its annual European Innovation Scoreboard (EIS), the first version of which was initially issued in 2001. This scoreboard enables the relative innovation performance of the different countries to be measured and compared and provides an analysis of the strengths and weaknesses of national research and innovation systems.

The new measurement framework used for the 2017 edition of the scoreboard includes 27 indicators separated into 4 categories and 10 areas:

- 'Tools' covers the main drivers of innovation external to companies: human resources, attractive research systems, innovation-friendly environment;
- 'Investments' covers private and public investments in R&D: finance and support, firm investments;
- 'Innovation activities' includes the efforts made to innovate within companies: innovators, linkages and intellectual assets;
- 'Results' describes the effect of company activity to promote innovation: employment impacts and sales impacts.

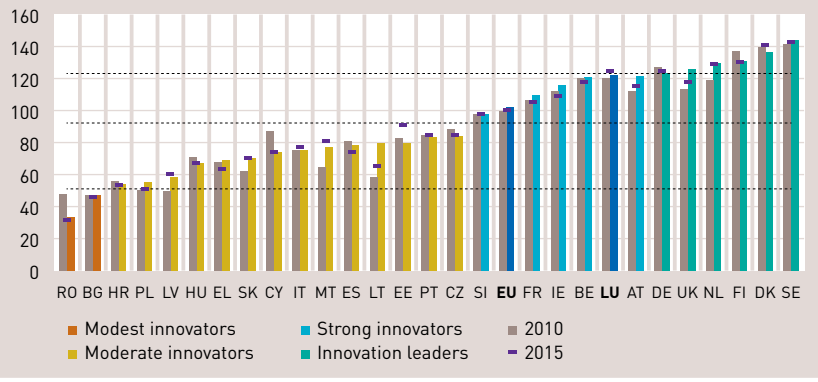
On the basis of the average innovation results, calculated using a composite indicator entitled 'Summary Innovation Index' (SII) and ranging from 0 (poor performance) to 1 (best performance), countries are placed into four different groups:

- 'Innovation Leaders', whose results in terms of innovation are well above the EU average (score at least 20% above the EU average);
- 'Strong innovators', whose results are above or close to the EU average (score of between 90% and 120% of EU average);
- 'Moderate Innovators', whose results are below the EU average (score of between 50% and 90% of the EU average);
- 'Modest Innovators', whose results are well below the EU average (score of <50% of the EU average).

[6] For more information: http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/index_en.htm

Sweden is the top-ranking EU country (average score of 0.708/1), followed by Denmark (0.675) and Finland (0.646). Luxembourg places 8th (0.599) and is therefore deemed a 'Strong Innovator'. The Netherlands come 4th (0.639) and Germany 6th (0.609), giving them the title of 'Innovation Leaders'. Belgium comes 9th (0.597) and France 11th (0.539), placing them both in the 'Strong Innovators' category along with Luxembourg.

Chart 3
**EIS rankings of EU Member States**




Coloured columns show Member States' performance in 2016, using the most recent data for 27 indicators, relative to that of the EU in 2010. The horizontal hyphens show performance in 2015, using the next most recent data for 27 indicators, relative to that of the EU in 2010. Grey columns show Member States' performance in 2010 relative to that of the EU in 2010. For all years the same measurement methodology has been used. The purple lines show the threshold values between the performance groups in 2016, comparing Member States' performance in 2016 relative to that in 2016.
Source: European Commission

Luxembourg records the following results for the ten areas of innovation:

- 'Tools': human resources (0.585), attractive research systems (0.868), innovation-friendly environment (0.752);
- 'Investments': finance and support (0.391), firm investments (0.341);
- 'Innovation activities': innovators (0.683), linkages (0.222) and intellectual assets (0.819);
- 'Results': employment impacts (0.751), sales impacts (0.609).

Based on this analysis, the Commission notes the following regarding Luxembourg: *'Relative strengths of the innovation system are in Attractive research systems, Innovation-friendly environment, and Intellectual assets. Relative weaknesses are in Linkages, Finance and support, and Sales impacts'.*

Chart 4
**Performance of Luxembourg (2017)**

| Luxembourg | Performance relative to EU 2010 in | | Change 2010-2016 |
|---|---|---|---|
| | 2010 | 2016 | |
| **SUMMARY INNOVATION INDEX** | **120.0** | **121.4** | **1.4** |
| **Human Resources** | **128.3** | **147.0** | **18.7** |
| New doctorate graduates | 46.2 | 62.4 | 16.3 |
| Population with tertiary education | 171.7 | 219.7 | 48.0 |
| Lifelong learning | 176.8 | 164.2 | -12.6 |
| **Attractive research systems** | **161.2** | **215.1** | **54.0** |
| International scientific co-publications | 280.5 | 572.4 | 291.9 |
| Most cited publications | 83.2 | 115.8 | 32.6 |
| Foreign doctorates students | 251.4 | 231.4 | 0.0 |
| **Innovation-friendly environment** | **174.7** | **172.9** | **-1.9** |
| Broadband penetration | 144.4 | 233.3 | 88.9 |
| Opportunity-driven entrepreneurship | 196.1 | 130.2 | -65.9 |
| **Finance and support** | **114.5** | **69.3** | **-45.3** |
| R&D expenditure in the public sector | 46.7 | 85.8 | 39.1 |
| Venture capital expenditures | 200.2 | 48.5 | -151.7 |
| **Firm investments** | **68.4** | **81.5** | **13.1** |
| R&D expenditure in the business sector | 58.8 | 55.4 | -3.4 |
| Non-R&D innovation expenditures | 24.5 | 4.9 | -19.6 |
| Enterprises providing ICT training | 114.3 | 171.4 | 57.1 |
| **Innovators** | **135.2** | **122.6** | **-12.6** |
| SMEs product/process innovations | 127.3 | 107.8 | -19.5 |
| SMEs marketing/organizational innovations | 145.2 | 150.1 | 4.9 |
| SMEs innovating in-house | 132.6 | 109.1 | -23.5 |
| **Linkages** | **69.7** | **44.2** | **-25.4** |
| Innovative SMEs collaborating with others | 111.7 | 80.0 | -31.6 |
| Public-private co-publications | 92.8 | 42.4 | -50.4 |
| Private co-funding of public R&D exp. | 15.4 | 16.5 | 1.1 |
| **Intellectual assets** | **141.0** | **166.8** | **25.8** |
| PCT patent applications | 67.3 | 71.8 | 4.4 |
| Trademark applications | 275.8 | 275.8 | 0.0 |
| Design applications | 137.0 | 211.3 | 74.3 |
| **Employment impacts** | **126.1** | **139.8** | **13.6** |
| Employment in knowledge-intenisve activities | 220.5 | 217.9 | -2.6 |
| Employment fast-growing enterprises | 57.2 | 82.7 | 25.5 |
| **Sales impacts** | **108.0** | **94.4** | **-13.7** |
| Medium and high tech product exports | 114.3 | 91.7 | -22.5 |
| Knowledge-intensive services exports | 145.5 | 149.0 | 3.4 |
| Sales of new-to-market/firm innovations | 56.6 | 33.6 | -23.0 |

Dark green: normalised performance above 120% of EU; light green: normalised performance between 90% and 120% of EU; yellow: normalised performance between 50% and 90% of EU; orange: normalised performance below 50% of EU. Normalised performance uses the data after a possible imputation of missing data and transformation of the data.
Change highlighted in green is positive, change highlighted in light red is negative.
Source: European Commission

## e. Ranking comparison and correlation analysis

The table below shows an extract of the rankings of the four major annual composite indicators that had been reviewed above, in which Luxembourg is appearing[7].

Table 3
**Top 25 of the four major rankings (reports published in 2017)**

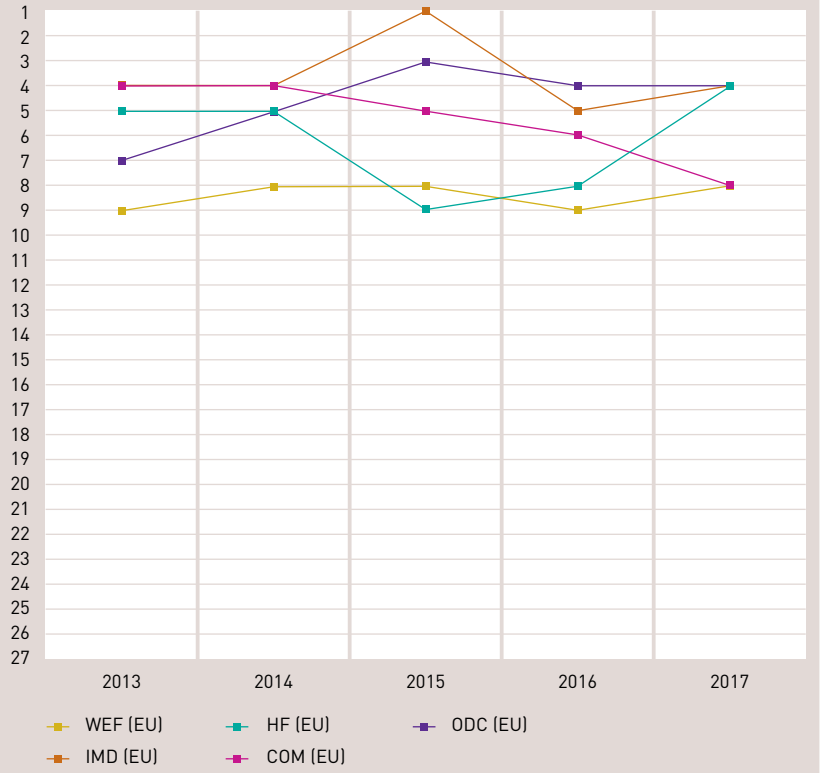
| | N° | World Economic Forum | IMD | Heritage Foundation | Commission européenne |
|---|---|---|---|---|---|
| | | ***GCI*** | ***GCI*** | ***Economic Freedom*** | ***SII*** |
| + | 1 | Switzerland | Hong Kong | Hong Kong | Sweden |
| | 2 | United States | Switzerland | Singapore | Denmark |
| | 3 | Singapore | Singapore | New Zealand | Finland |
| | 4 | Netherlands | United States | Switzerland | Netherlands |
| | 5 | Germany | Netherlands | Australia | United Kingdom |
| | 6 | Hong Kong | Ireland | Estonia | Germany |
| | 7 | Sweden | Denmark | Canada | Austria |
| | 8 | United Kingdom | **Luxembourg** | United Arab Emirates | **Luxembourg** |
| | 9 | Japan | Sweden | Ireland | Belgium |
| | 10 | Finland | United Arab Emirates | Chile | Ireland |
| | 11 | Norway | Norway | Taiwan | France |
| | 12 | Denmark | Canada | United Kingdom | Slovenia |
| | 13 | New Zealand | Germany | Georgia | Czech Republic |
| | 14 | Canada | Taiwan | **Luxembourg** | Portugal |
| | 15 | Taiwan | Finland | Netherlands | Estonia |
| | 16 | Israel | New Zealand | Lithuania | Lithuania |
| | 17 | United Arab Emirates | Qatar | United States | Spain |
| | 18 | Austria | China | Denmark | Malta |
| | 19 | **Luxembourg** | United Kingdom | Sweden | Italy |
| | 20 | Belgium | Iceland | Latvia | Cyprus |
| | 21 | Australia | Australia | Mauritius | Slovakia |
| | 22 | France | Israel | Iceland | Greece |
| | 23 | Malaysia | Belgium | South Korea | Hungary |
| | 24 | Ireland | Malaysia | Finland | Latvia |
| - | 25 | Qatar | Austria | Norway | Poland |

Luxembourg's neighbouring countries (Germany, Belgium, France), and the Netherlands as a Member State of the Benelux, are highlighted in green when their ranking is better than Luxembourg's and otherwise in red.

[7] Annual changes in country rankings should be consulted with a certain caution, because over the years methodological changes in the calculation of the index may have occurred without a recalculation of the ranks for all the years.

When we consider all the reports published in 2017, we can observe that Luxembourg places between 4th (IMD, Heritage Foundation) and 8th (WEF and European Commission) position in the list of EU countries. Luxembourg also falls within this range in the 2017 rankings produced by the Observatoire de la compétitivité[8] (4th place).

Chart 5
**Evolution of Luxembourg in the EU-28 rankings (2013-2017)**




Note: The time axis refers to the report's year of publication. Time series should be consulted with caution, because methodological changes might have occurred without the ranks for all prior years being recalculated.

In general, it is useful to analyse the correlation between these four major benchmarks. Kendall's coefficient is suitable for this type of analysis as it measures the degree of agreement. This correlation has been calculated on the basis of the EU countries[9]. The coefficient takes a value between 0 (no relation) and 1 (a perfect agreement between rankings and judges). In each of the previous years' Competitiveness Reports, there has been a strong correlation between the four rankings. On the basis of the four annual rankings previously described and the national scoreboard that is annually published by the Observatoire de la compétitivité, the Kendall's coefficient equates to 0.79 in 2017. Therefore, as in previous years, there is a strong correlation between the different EU rankings[10].

[8] Please refer to Chapter 3 of this Report for more information on the ODC ranking.

[9] EU-28 excluding Malta. The list of countries used for making this calculation has changed over the years. Since the publication of the 2011 Report, only EU Member States are taken into account. Since the 2014 edition, Croatia has been added as new EU Member State. Since 2017 Cyprus could be added in the calculation.

[10] Kendall's coefficient for the same countries was 0.86 in 2006, 0.83 in 2007, 0.86 in 2008, 0.87 in 2009, 0.84 in 2010, 0.83 in 2011, 0.83 in 2012, 0.83 in 2013 and 0.85 in 2014. Comparability between results before 2011 and after 2011 is limited. Another list of countries was used from 2011 (only countries being part of the EU). In the 2014 report, Croatia was added as new Member State. The 2015 Report was the first to include the ODC national rankings in calculating the Kendall coefficient (0.82). The SII indicator calculated by the European Commission is taken from the European Innovation Union Scoreboard (EIU) since 2011 and from the new European Innovation Scoreboard (EIS) since 2016. From 2017 Cyprus has been added in the calculation.

Table 4
**Adjustment of the EU-27 rankings (2017)**

| Country | WEF | IMD | HF | EC | ODC |
|---|---|---|---|---|---|
| Germany | 2 | 6 | 11 | 6 | 11 |
| Austria | 7 | 10 | 13 | 7 | 9 |
| Belgium | 9 | 9 | 18 | 9 | 13 |
| Bulgaria | 20 | 22 | 16 | 26 | 27 |
| Cyprus | 24 | 16 | 17 | 19 | 24 |
| Croatia | 26 | 27 | 25 | 25 | 19 |
| Denmark | 6 | 3 | 7 | 2 | 1 |
| Spain | 14 | 15 | 21 | 17 | 23 |
| Estonia | 12 | 12 | 1 | 15 | 15 |
| Finland | 5 | 7 | 10 | 3 | 5 |
| France | 10 | 13 | 22 | 11 | 14 |
| Greece | 27 | 26 | 27 | 21 | 26 |
| Hungary | 23 | 25 | 19 | 22 | 16 |
| Ireland | 11 | 2 | 2 | 10 | 3 |
| Italy | 18 | 21 | 24 | 18 | 21 |
| Latvia | 21 | 19 | 9 | 23 | 18 |
| Lithuania | 16 | 14 | 5 | 16 | 12 |
| **Luxembourg** | **8** | **4** | **4** | **8** | **4** |
| Netherlands | 1 | 1 | 6 | 4 | 7 |
| Poland | 15 | 17 | 15 | 24 | 20 |
| Portugal | 17 | 18 | 23 | 14 | 22 |
| Slovak Republic | 22 | 24 | 20 | 20 | 17 |
| Czech Republic | 13 | 11 | 12 | 13 | 6 |
| Romania | 25 | 23 | 14 | 27 | 25 |
| United Kingdom | 4 | 8 | 3 | 5 | 10 |
| Slovenia | 19 | 20 | 26 | 12 | 8 |
| Sweden | 3 | 5 | 8 | 1 | 2 |

Note: Excluding Malta
Source: Observatoire de la compétitivité

## 2.2.2 Other international benchmarks

Besides the four composite indicators and rankings analysed in the previous chapter, a multitude of other ones can be found. Some of these will be considered below.

### a. General indicators of competitiveness

#### a.1 Euro plus monitor[11]

Germany's Berenberg Bank and the Brussels-based think tank The Lisbon Council have just published the 6th edition of a study on the adjustment progress and the overall economic health of EU-28 economies: 'Euro plus monitor 2016'. This study analyses and rates countries, per sub-categories and indicators, on a scale from 0 (poor performance) to 10 (best performance). The analysis is based on two composite indices:

- Adjustment Progress Indicator (API): external adjustment (change in exports, export ratio, etc.), fiscal adjustment (change in balance), unit labour cost adjustment (real and nominal), reform drive. This first composite indicator assesses how capable the country is of tackling the challenges of globalisation, technological change and crisis via the implementation of internal measures;

- Fundamental Health Indicator (FHI): growth potential (recent growth, human capital, employment, consumption), competitiveness (export ratio in the economy, labour costs, etc.), fiscal sustainability (government outlays, structural deficit, public debt, etc.), resilience (current account, public debt held abroad, household savings rate, etc.). This second indicator provides an assessment of the overall health of the national economy, regardless of whether the country has introduced reforms.

According to the 2016 edition, Luxembourg has once again made much more significant advances in terms of fundamental health (FHI of 7.5/10, i.e. 2nd place) than in adjustment progress (API of 3.4, i.e. 19th place). Luxembourg's neighbouring countries are all performing less well in comparison under these two composite indicators. According to the authors, most of the countries with above-average results for the fundamental health indicator (FHI) are making less effort to improve, therefore resulting in lowers scores for the adjustment progress indicator (API) as well. However, the authors also claim that a lower score for this adjustment indicator can also mean that a country simply does not need to reform due to the robust health of its economy. This seems to be the case notably for Luxembourg, the Netherlands and Germany.

[11] For more information: http://www.lisboncouncil.net/

Table 5
**Country rankings according to API and FHI**

| Adjustment Progress Indicator | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rank** | | **Country** | **Total Score** | | | **External adjustment** | | | **Fiscal adjustment** | | | **Labour cost adjustment** | | | **Reform drive** | | |
| **2016** | **2015** | **Country** | **2016** | ***Change*** | **2015** | **2016** | ***Change*** | **2015** | **2016** | ***Change*** | **2015** | **2016** | ***Change*** | **2015** | **2016** | ***Change*** | **2015** |
| 1 | 1 | Greece | 7.9 | *-0.6* | 8.5 | 7.5 | *0.1* | 7.4 | 9.0 | *0.1* | 8.9 | 7.3 | *-0.3* | 7.6 | 7.7 | *-2.3* | 10.0 |
| 2 | 2 | Ireland | 7.3 | *-0.5* | 7.8 | 7.0 | *0.2* | 6.9 | 6.9 | *-0.2* | 7.1 | 9.2 | *0.0* | 9.2 | 6.0 | *-2.0* | 7.9 |
| 3 | 4 | Latvia | 6.8 | *-0.2* | 7.0 | 9.4 | *0.0* | 9.4 | 6.9 | *0.1* | 6.8 | 4.1 | *-0.7* | 4.8 | n.a. | *n.a.* | n.a. |
| 4 | 3 | Romania | 6.4 | *-0.8* | 7.2 | 7.1 | *-0.4* | 7.5 | 7.0 | *-1.9* | 8.9 | 5.0 | *-0.1* | 5.1 | n.a. | *n.a.* | n.a. |
| 5 | 6 | Portugal | 6.1 | *-0.4* | 6.6 | 6.2 | *0.3* | 5.9 | 6.3 | *-0.2* | 6.6 | 5.8 | *0.0* | 5.8 | 6.3 | *-1.8* | 8.0 |
| 6 | 5 | Spain | 6.1 | *-0.7* | 6.9 | 7.2 | *0.2* | 7.0 | 5.4 | *-1.0* | 6.4 | 5.4 | *-0.4* | 5.7 | 6.5 | *-1.9* | 8.3 |
| 7 | 8 | Cyprus | 6.0 | *0.0* | 6.1 | 4.8 | *0.5* | 4.3 | 6.3 | *-1.2* | 7.5 | 6.9 | *0.5* | 6.4 | n.a. | *n.a.* | n.a. |
| 8 | 7 | Lithuania | 5.5 | *-0.8* | 6.2 | 7.8 | *0.4* | 7.5 | 6.3 | *-0.3* | 6.5 | 2.3 | *-2.4* | 4.6 | n.a. | *n.a.* | n.a. |
| 9 | 10 | Slovenia | 5.0 | *-0.4* | 5.3 | 7.1 | *0.4* | 6.7 | 4.8 | *-0.4* | 5.1 | 4.6 | *-0.2* | 4.8 | 3.4 | *-1.4* | 4.8 |
| 10 | 11 | Slovakia | 4.9 | *-0.2* | 5.1 | 7.1 | *0.9* | 6.2 | 6.4 | *0.1* | 6.3 | 2.1 | *-0.7* | 2.8 | 4.3 | *-0.8* | 5.1 |
| 11 | 12 | Croatia | 4.9 | *0.0* | 4.9 | 6.4 | *0.1* | 6.3 | 4.0 | *0.2* | 3.8 | 4.2 | *-0.3* | 4.6 | n.a. | *n.a.* | n.a. |
| 12 | 9 | Estonia | 4.8 | *-0.6* | 5.4 | 6.9 | *-0.7* | 7.6 | 2.5 | *0.5* | 2.0 | 4.3 | *-0.6* | 4.9 | 5.6 | *-1.5* | 7.1 |
| 13 | 13 | Czech Republic | 4.8 | *0.1* | 4.7 | 6.1 | *0.4* | 5.7 | 7.3 | *0.1* | 7.2 | 1.1 | *-0.9* | 2.0 | 4.6 | *0.9* | 3.8 |
| 14 | 14 | Poland | 4.3 | *0.0* | 4.3 | 5.1 | *0.4* | 4.8 | 6.1 | *-0.7* | 6.8 | 0.8 | *0.4* | 0.4 | 5.3 | *0.0* | 5.3 |
| 15 | 16 | Italy | 3.9 | *0.1* | 3.8 | 4.0 | *0.0* | 4.0 | 3.3 | *-0.9* | 4.2 | 3.5 | *0.2* | 3.3 | 4.8 | *1.1* | 3.8 |
| 16 | 18 | Bulgaria | 3.9 | *0.3* | 3.6 | 8.1 | *0.5* | 7.6 | 3.6 | *0.4* | 3.1 | 0.0 | *0.0* | 0.0 | n.a. | *n.a.* | n.a. |
| | | **Euro 19** | **3.7** | ***-0.3*** | **4.0** | **4.2** | ***-0.1*** | **4.3** | **3.7** | ***-0.4*** | **4.2** | **2.5** | ***0.1*** | **2.4** | **4.4** | ***-0.7*** | **5.0** |
| 17 | 15 | United Kingdom | 3.7 | *-0.5* | 4.2 | 2.5 | *0.0* | 2.4 | 5.7 | *0.6* | 5.1 | 2.3 | *-1.1* | 3.4 | 4.1 | *-1.6* | 5.7 |
| 18 | 17 | Hungary | 3.4 | *-0.3* | 3.7 | 6.9 | *0.1* | 6.7 | 0.2 | *-0.4* | 0.6 | 2.5 | *-0.3* | 2.8 | 4.2 | *-0.5* | 4.8 |
| **19** | **19** | **Luxembourg** | **3.4** | ***0.1*** | **3.3** | **4.5** | ***0.2*** | **4.3** | **1.6** | ***-0.2*** | **1.8** | **6.1** | ***0.2*** | **5.9** | **1.4** | ***0.4*** | **1.1** |
| 20 | 20 | Netherlands | 3.4 | *0.2* | 3.2 | 5.1 | *0.1* | 5.0 | 3.4 | *0.5* | 2.9 | 1.7 | *-0.5* | 2.2 | 3.1 | *0.5* | 2.6 |
| 21 | 24 | France | 3.0 | *0.0* | 3.0 | 2.5 | *-0.3* | 2.9 | 3.8 | *0.0* | 3.8 | 1.6 | *0.0* | 1.6 | 4.0 | *0.4* | 3.6 |
| 22 | 21 | Malta | 3.0 | *-0.1* | 3.1 | 4.2 | *-0.1* | 4.3 | 2.5 | *0.5* | 2.0 | 2.1 | *-0.8* | 2.9 | n.a. | *n.a.* | n.a. |
| 23 | 22 | Denmark | 2.7 | *-0.4* | 3.1 | 3.5 | *0.2* | 3.3 | 0.7 | *0.6* | 0.1 | 2.4 | *-0.6* | 2.9 | 4.0 | *-2.0* | 6.0 |
| 24 | 23 | Austria | 2.7 | *-0.4* | 3.0 | 3.4 | *0.0* | 3.4 | 1.7 | *-1.3* | 3.0 | 1.2 | *0.3* | 0.9 | 4.3 | *-0.5* | 4.8 |
| 25 | 26 | Belgium | 2.4 | *0.2* | 2.3 | 4.3 | *0.4* | 3.9 | 0.7 | *-0.4* | 1.0 | 2.2 | *0.1* | 2.2 | 2.6 | *0.5* | 2.1 |
| 26 | 25 | Germany | 2.0 | *-0.3* | 2.4 | 3.3 | *-0.1* | 3.4 | 1.7 | *-1.6* | 3.3 | 0.7 | *0.0* | 0.7 | 2.4 | *0.4* | 2.0 |
| 27 | 27 | Finland | 1.9 | *-0.3* | 2.1 | 1.0 | *-0.1* | 1.1 | 0.0 | *0.0* | 0.0 | 2.5 | *0.2* | 2.2 | 3.9 | *-1.3* | 5.2 |
| 28 | 28 | Sweden | 1.6 | *-0.3* | -1.9 | 2.2 | *-0.2* | 2.4 | 0.0 | *0.0* | 0.0 | 1.1 | *0.3* | 0.8 | 3.2 | *-1.3* | 4.5 |

Continuing on next page

Table 5
**Continued**

| Fundamental Health Indicator | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rank** | | | **Total Score** | | | **Growth** | | | **Competitiveness** | | | **Fiscal sustainability** | | | **Resilience** | | |
| **2016** | **2015** | **Country** | **2016** | ***Change*** | **2015** | **2016** | ***Change*** | **2015** | **2016** | ***Change*** | **2015** | **2016** | ***Change*** | **2015** | **2016** | ***Change*** | **2015** |
| 1 | 2 | Czech Republic | 7.6 | *0.1* | 7.5 | 7.2 | *0.1* | 7.1 | 7.4 | *0.1* | 7.3 | 8.1 | *0.1* | 8.0 | 7.7 | *0.1* | 7.7 |
| **2** | **3** | **Luxembourg** | **7.5** | *0.0* | **7.5** | **6.5** | *-0.1* | **6.7** | **7.7** | *0.2* | **7.4** | **9.7** | *0.0* | **9.7** | **6.2** | *0.0* | **6.2** |
| 3 | 4 | Estonia | 7.5 | *0.1* | 7.3 | 6.9 | *0.2* | 6.8 | 5.6 | *0.0* | 5.6 | 9.2 | *0.2* | 9.0 | 8.1 | *0.2* | 7.9 |
| 4 | 1 | Germany | 7.4 | *-0.1* | 7.5 | 6.3 | *-0.2* | 6.5 | 7.9 | *0.0* | 7.9 | 7.8 | *0.0* | 7.9 | 7.7 | *-0.1* | 7.8 |
| 5 | 5 | Slovakia | 7.0 | *0.0* | 7.0 | 5.9 | *-0.1* | 6.0 | 7.1 | *0.0* | 7.0 | 7.7 | *-0.1* | 7.8 | 7.3 | *0.2* | 7.1 |
| 6 | 6 | Netherlands | 6.9 | *0.0* | 6.9 | 7.1 | *-0.2* | 7.2 | 7.6 | *-0.2* | 7.8 | 6.8 | *0.3* | 6.6 | 6.1 | *0.1* | 6.0 |
| 7 | 8 | Malta | 6.8 | *0.1* | 6.7 | 7.0 | *0.0* | 7.0 | 6.7 | *-0.1* | 6.8 | 7.2 | *0.3* | 6.8 | 6.4 | *0.3* | 6.1 |
| 8 | 7 | Lithuania | 6.8 | *0.0* | 6.8 | 6.1 | *0.2* | 5.9 | 6.5 | *-0.3* | 6.7 | 8.1 | *-0.1* | 8.1 | 6.5 | *0.3* | 6.3 |
| 9 | 11 | Ireland | 6.8 | *0.2* | 6.6 | 7.2 | *0.5* | 6.8 | 8.4 | *0.1* | 8.3 | 7.0 | *0.0* | 7.0 | 4.5 | *0.2* | 4.3 |
| 10 | 10 | Latvia | 6.6 | *0.0* | 6.6 | 6.3 | *0.0* | 6.3 | 4.9 | *-0.2* | 5.2 | 8.5 | *0.0* | 8.5 | 6.6 | *0.2* | 6.4 |
| 11 | 9 | Poland | 6.6 | *0.0* | 6.6 | 6.2 | *-0.1* | 6.3 | 6.9 | *0.1* | 6.8 | 6.5 | *-0.2* | 6.7 | 6.6 | *0.0* | 6.5 |
| 12 | 12 | Sweden | 6.5 | *0.0* | 6.5 | 7.4 | *0.4* | 7.0 | 4.2 | *-0.1* | 4.3 | 7.1 | *-0.2* | 7.3 | 7.3 | *0.0* | 7.3 |
| 13 | 14 | Slovenia | 6.3 | *0.1* | 6.2 | 6.0 | *0.0* | 6.0 | 5.8 | *0.1* | 5.8 | 5.8 | *-0.1* | 5.9 | 7.7 | *0.5* | 7.2 |
| 14 | 16 | Denmark | 6.3 | *0.2* | 6.1 | 6.1 | *0.1* | 6.0 | 5.0 | *-0.2* | 5.2 | 7.5 | *0.8* | 6.7 | 6.5 | *0.0* | 6.5 |
| 15 | 13 | Hungary | 6.2 | *-0.1* | 6.3 | 5.5 | *0.1* | 5.4 | 7.6 | *-0.2* | 7.8 | 5.3 | *-0.4* | 5.7 | 6.5 | *0.0* | 6.5 |
| 16 | 17 | Bulgaria | 6.2 | *0.1* | 6.1 | 5.1 | *-0.2* | 5.3 | 5.3 | *0.1* | 5.2 | 7.7 | *0.2* | 7.5 | 6.7 | *0.3* | 6.4 |
| 17 | 15 | Romania | 5.9 | *-0.3* | 6.1 | 4.9 | *-0.2* | 5.1 | 4.5 | *0.2* | 4.3 | 7.6 | *-0.9* | 8.5 | 6.5 | *-0.1* | 6.6 |
| | | **Euro 19** | **5.9** | ***-0.1*** | **5.9** | **5.1** | ***0.0*** | **5.1** | **6.0** | ***-0.2*** | **6.2** | **6.1** | ***-0.1*** | **6.3** | **6.1** | *0.1* | **6.1** |
| 18 | 19 | United Kingdom | 5.6 | *0.1* | 5.5 | 5.7 | *0.4* | 5.3 | 5.4 | *-0.4* | 5.8 | 6.2 | *0.3* | 5.8 | 5.2 | *0.0* | 5.2 |
| 19 | 18 | Austria | 5.5 | *-0.2* | 5.8 | 5.9 | *-0.3* | 6.2 | 4.6 | *-0.2* | 4.7 | 5.4 | *-0.4* | 5.8 | 6.2 | *-0.1* | 6.3 |
| 20 | 20 | Belgium | 5.3 | *-0.1* | 5.4 | 5.4 | *-0.1* | 5.5 | 6.7 | *-0.1* | 6.8 | 3.8 | *-0.2* | 4.0 | 5.4 | *0.1* | 5.2 |
| 21 | 21 | Croatia | 5.0 | *-0.1* | 5.1 | 3.6 | *-0.2* | 3.8 | 4.3 | *-0.2* | 4.5 | 5.0 | *0.2* | 4.8 | 7.2 | *-0.2* | 7.3 |
| 22 | 22 | Spain | 4.9 | *0.0* | 4.9 | 4.2 | *0.3* | 4.0 | 4.9 | *0.0* | 4.9 | 5.3 | *-0.5* | 5.8 | 5.2 | *0.2* | 5.0 |
| 23 | 24 | France | 4.9 | *0.0* | 4.8 | 5.1 | *0.1* | 5.0 | 4.7 | *0.0* | 4.7 | 4.4 | *0.0* | 4.4 | 5.3 | *0.0* | 5.3 |
| 24 | 23 | Finland | 4.8 | *-0.1* | 4.9 | 5.4 | *-0.3* | 5.7 | 2.3 | *0.0* | 2.3 | 5.9 | *-0.1* | 6.0 | 5.4 | *-0.1* | 5.6 |
| 25 | 25 | Italy | 4.5 | *0.0* | 4.5 | 3.3 | *-0.1* | 3.4 | 3.9 | *0.1* | 3.9 | 5.2 | *-0.2* | 5.4 | 5.6 | *0.1* | 5.5 |
| 26 | 26 | Portugal | 4.4 | *-0.1* | 4.5 | 3.5 | *0.0* | 3.5 | 5.6 | *-0.3* | 5.9 | 4.5 | *-0.1* | 4.6 | 4.1 | *0.2* | 3.9 |
| 27 | 27 | Cyprus | 3.9 | *-0.2* | 4.1 | 3.0 | *-0.2* | 3.2 | 3.2 | *-0.1* | 3.3 | 7.0 | *-0.2* | 7.2 | 2.3 | *-0.4* | 2.7 |
| 28 | 28 | Greece | 3.8 | *-0.2* | 4.0 | 1.5 | *-0.8* | 2.3 | 4.8 | *-0.1* | 4.9 | 4.3 | *0.0* | 4.3 | 4.5 | *0.0* | 4.4 |

**Scores** : For the scores, we rank all sub-indicators on a linear scale of 10 (best) to 0 (worst). Having calculated the results of the sub-indicators, we aggregate them into an overall score for each country, separately for the Adjustment Progress Indicator and the Fundamental Health Indicator.
**Change** refers to the change in score relative to last year. Note that our scores and ranks for 2015 can differ slightly for some countries from those published in *The 2015 Euro Plus Monitor* due to subsequent revisions of back data for labour costs, net exports and some other parameters.
**Ranks**: Based on the scores, we calculate the relative ranking of each country, with the No. 1 rank assigned to the country with the highest and the No. 28 rank to the one with the lowest score.
Source: Berenberg Bank / The Lisbon Council

The results for each individual category under the Adjustment Progress Indicator are as follows (average score 3.4/10, 19th):

- Luxembourg is 18th in the external adjustment category (4.5);
- Luxembourg is 23rd in the fiscal adjustment category (1.6);
- Luxembourg is 4th in the labour cost adjustment category (6.1);
- Luxembourg is 21st in the reform drive category (1.4).

The results for each individual category under the Fundamental Health Indicator are as follows (average score 7.5/10, 2nd):

- Luxembourg comes 18th in the growth potential category (6.5);
- Luxembourg comes 3rd in the competitiveness category (7.7);
- Luxembourg comes 1st in the fiscal sustainability category (9.7);
- Luxembourg comes 16th in the resilience category (6.2).

### a.2 Best countries for business[12]

The American economic and financial journal FORBES published an updated version of its *Best Countries for Business* rankings at the end of 2016, analysing which countries in the world are most attractive for investors and capital. This was the 11th edition of the study, the previous edition having been published in December 2015. The study analysed 139 countries according to around a dozen (equally-weighted) criteria including intellectual property rights, innovation, taxation, technology, corruption, freedoms, administrative burden, investor protection and stock market performance. The writers drew information from several international source publications including the Global Economic Forum, World Bank etc.

Sweden is at the top of the global ranking for 2017, followed by New Zealand and Hong Kong. Luxembourg comes 14th. The Netherlands places 7th, Belgium 17th, Germany 21st and France 26th.

[12] For more information: https://www.forbes.com/best-countries-for-business/list/3/#tab:overall

Table 6
**Top 15 of the ranking**

| | |
|---|---|
| 1 | Sweden |
| 2 | New Zealand |
| 3 | Hong Kong |
| 4 | Ireland |
| 5 | United Kingdom |
| 6 | Denmark |
| 7 | Netherlands |
| 8 | Finland |
| 9 | Norway |
| 10 | Canada |
| 11 | Australia |
| 12 | Singapore |
| 13 | Estonia |
| **14** | **Luxembourg** |
| 15 | Lithuania |

Source: Forbes

Finally, the authors note the following regarding Luxembourg: *'This small, stable, high-income economy has historically featured solid growth, low inflation, and low unemployment. The industrial sector, initially dominated by steel, has become increasingly diversified to include chemicals, machinery and equipment, rubber, automotive components, and other products. The financial sector, which accounts for about 36% of GDP, is the leading sector in the economy. The economy depends on foreign and cross-border workers for about 39% of its labour force. Luxembourg experienced uneven economic growth in the aftermath of the global economic crisis that began in late 2008. Luxembourg's GDP contracted 3.6% in 2009, rebounded in 2010-12, fell again in 2013-14, but recovered in 2015. Unemployment has remained below the EU average despite having increased from a historically low rate of 4% in the 2000s to 7.1% in 2014. The country continues to enjoy an extraordinarily high standard of living - GDP per capita ranks among the highest in the world and is the highest in the euro zone. Luxembourg has one of the highest current account surpluses as a share of GDP in the euro zone, and it maintains a healthy budgetary position and the lowest public debt level in the region. Luxembourg has lost some of its advantage as a favourable tax location because of OECD and EU pressure. In 2015, the government's compliance with EU requirements to implement automatic exchange of tax information on savings accounts - thus ending banking secrecy - has depressed banking activity and dampened GDP growth. Likewise, changes to the way EU members collect taxes from e-commerce has cut Luxembourg's tax revenues, requiring the government to raise additional levies and to reduce some direct social benefits.'*

### a.3 Länder-Index[13]

German research institute ZEW published the sixth edition of its composite index *Länder-index* at the beginning of January 2017, commissioned by the Familienunternehmen Foundation. This composite index has been updated every 2 years since 2006, and analyses how appealing 18 OECD countries are to investments made by family businesses (particularly in the industrial sector) with an annual turnover of at least EUR 100 million. The composite *Länder-index* results in a value between 0 (the poorest performance) and 100 (best performance) and is based on six sub-categories: taxation (20% weighting), labour costs, productivity and human capital (17.5%), regulation (17.5%), funding capacity (15%), infrastructures and institutions (15%) and energy (15%).

The overall classification for 2016 is headed by Luxembourg (score of 65.39/100), followed by the United Kingdom (65.12) and Switzerland (64.63). The Netherlands are in 5th place (61.24), Germany is 12th (53.07), Belgium 15th (46.15) and France 16th (45.91). Luxembourg therefore improves its result compared to the previous version of the report (score of 62.87 in 2014), moving up two places.

Luxembourg's results in the six sub-categories of the overall classification are as follows:

- Taxation: Luxembourg places 4th (73.83), mainly due to its competitive (average) effective tax rate, its attractive fiscal environment for national and cross-border business, company succession issues and the simplicity of its national tax system in comparison with other countries;

- Labour costs, productivity and human capital: Luxembourg is in 1st place (62.68) with average results for labour cost per hour, 1st place for labour productivity per hour and 1st for workforce education level, but posts lower scores for training expenditure (in % of GDP) as well as for PISA test results;

- Regulation: Luxembourg is in 8th place, with a 6th position for labour market, 8th for wage-setting, 14th for goods market regulation, 10th for business administrative environment and 15th for operational co-management in companies;

- Funding capacity: Luxembourg comes in 13th, with good results in credit markets (4th), public and private debt (5th) and sovereign ratings from the main ratings agencies (1st). Results were less impressive for legal protection of lenders (14th) and availability of information on the financial situation of applicants for loans (18th);

- Infrastructures and institutions: Luxembourg comes 1st (85.41). More specifically, the country comes 7th for transport infrastructure, 1st in ICT infrastructure, 3rd in legal security, 5th in corruption management and 2nd in crime and political stability;

- Energy: Luxembourg comes 1st (75.00), with a 2nd place in the category of electricity prices, 4th for gas and fuel prices, 1st for stability of electricity supply, 7th for risks linked to energy imports, and 13th for national climate change targets.

[13] For more information: http://www.familienunternehmen.de/de/pressebereich/meldungen/2017/2017-01-02/laenderindex-familienunternehmen

The authors of the report clarify that for some of the indicators used in this study, including productivity per hour of labour or human capital, Luxembourg's performance may be overestimated at least to some extent as the high number of cross-border workers in Luxembourg is not sufficiently taken into account in the study: *'Aufgrund seiner geringen Größe und seiner stark dienstleistungsorientierten Struktur ist das Großherzogtum als Standort für gewerblich ausgerichtete Familienunternehmen nur schwer mit größeren EU-Mitgliedstaaten vergleichbar. Bei den Indikatoren im Bereich „Arbeitskosten, Produktivität, Humankapital" dürften Dienstleistungsorientierung und Hochlohnbeschäftigung im Finanzsektor die guten Bewertungen beeinflussen, so dass dieser statistische Befund nicht ohne weiteres auf die gewerblichen Standortqualitäten übertragbar wäre. Auch profitiert Luxemburg stark von qualifizierten Einpendlern, die hohe Qualifizierung und Produktivität der Arbeitnehmer geht somit nur mit vergleichsweise geringen eigenen Bildungsanstrengungen einher.'*

Table 7
**Länder-Index ranking**

| Land | Punktwert 2016 | Rang 2016 | Punktwert 2014 | Rang 2014 |
|---|---|---|---|---|
| **Luxemburg** | **65,39** | **1** | **62,87** | **3** |
| Ver. Königreich | 65,12 | 2 | 66,87 | 1 |
| Schweiz | 64,63 | 3 | 65,95 | 2 |
| USA | 62,14 | 4 | 61,92 | 4 |
| Niederlande | 61,24 | 5 | 60,05 | 7 |
| Dänemark | 60,93 | 6 | 60,86 | 6 |
| Finnland | 58,04 | 7 | 60,91 | 5 |
| Irland | 57,99 | 8 | 55,47 | 9 |
| Schweden | 57,76 | 9 | 57,39 | 8 |
| Österreich | 53,89 | 10 | 54,07 | 10 |
| Tschechien | 53,75 | 11 | 52,01 | 12 |
| Deutschland | 53,07 | 12 | 53,03 | 11 |
| Polen | 49,10 | 13 | 49,54 | 13 |
| Slowakei | 47,00 | 14 | 46,33 | 16 |
| Belgien | 46,15 | 15 | 46,86 | 15 |
| Frankreich | 45,91 | 16 | 47,72 | 14 |
| Spanien | 43,02 | 17 | 41,57 | 17 |
| Italien | 35,09 | 18 | 34,55 | 18 |

Source: Berechnungen von ZEW und Calculus Consult

## b. Financial sector attractiveness and competitiveness indicators

### b.1 Global Financial Centres Index[14]

In September 2017, the Z/Yen consultancy bureau published the 22th edition of the bi-annual competitiveness index of 92 financial centres around the world, the 'Global financial centres index' (GFCI), which was initially issued in 2007. In a world that is becoming increasingly globalised and interdependent through information and communication technologies (ICT), financial centres are facing a greater competition than other sectors. In fact, financial services are at the heart of the global economy, acting as facilitators of international trade and foreign investments. The GFCI study is based on two types of sources to assess the competitiveness of financial centres (scale from 1 to 1,000). The study uses on the one hand 102 quantitative determinants and on the other hand a barometer of appreciation produced from online surveys among professionals of the sector. As defined in this study, competitiveness consists of five categories of indicators:

- Business environment (political stability, regulation, etc.);
- Human resources (training, flexibility, etc.);
- Infrastructure (cost and availability of offices, ICT, transports, etc.);
- Development of the financial sector (volumes, capital availability, etc.);
- Reputation (perception of cities as desirable places to live, degree of innovation, etc.).

In the latest edition of the GFCI study from September 2017, London (with a score of 780/1,000), New York (756) and Hong Kong (744) top the global rankings. Luxembourg is in 14th place worldwide (695), thus rising 4 places since March 2017, despite its individual competitiveness indicator falling by 13 points (708). In At European level, Luxembourg is 4th behind London, Zurich (9th/704) and Frankfurt (11th/701). In the EU, Luxembourg is the 3rd highest-ranking after London and Frankfurt, and 2nd in the euro area after Frankfurt. Some other examples of scores in the global rankings for European financial centres include: Geneva (15th/694), Paris (26th/680), Dublin (30th/672), Amsterdam (33th/667), Brussels (57th/638).

[14] For more information: http://www.longfinance.net/images/gfci/gfci_22.pdf

Table 8
**Top 20 of global financial centres**

| Centre | GFCI 22 | | GFCI 21 | | Change in Rank | Change in Rating |
|---|---|---|---|---|---|---|
| | Rank | Rating | Rank | Rating | | |
| London | 1 | 780 | 1 | 782 | 0 | ↓ 2 |
| New York | 2 | 756 | 2 | 780 | 0 | ↓ 24 |
| Hong Kong | 3 | 744 | 4 | 755 | ↑ 1 | ↓ 11 |
| Singapore | 4 | 742 | 3 | 760 | ↓ 1 | ↓ 18 |
| Tokyo | 5 | 725 | 5 | 740 | 0 | ↓ 15 |
| Shangai | 6 | 711 | 13 | 715 | ↑ 7 | ↓ 4 |
| Toronto | 7 | 710 | 10 | 719 | ↑ 3 | ↓ 9 |
| Sydney | 8 | 707 | 8 | 721 | 0 | ↓ 14 |
| Zurich | 9 | 704 | 11 | 718 | ↑ 2 | ↓ 14 |
| Beijing | 10 | 703 | 16 | 710 | ↑ 6 | ↓ 7 |
| Frankfurt | 11 | 701 | 23 | 698 | ↑ 12 | ↑ 3 |
| Montreal | 12 | 697 | 14 | 713 | ↑ 2 | ↓ 16 |
| Melbourne | 13 | 696 | 21 | 702 | ↑ 7 | ↓ 6 |
| **Luxembourg** | **14** | **695** | **18** | **708** | ↑ **4** | ↓ **13** |
| Geneva | 15 | 694 | 20 | 704 | ↑ 5 | ↓ 10 |
| San Francisco | 16 | 693 | 6 | 724 | ↓ 10 | ↓ 31 |
| Vancouver | 17 | 692 | 17 | 709 | 0 | ↓ 17 |
| Dubai | 18 | 691 | 25 | 696 | ↑ 7 | ↓ 5 |
| Boston | 19 | 690 | 9 | 720 | ↓ 10 | ↓ 30 |
| Shenzhen | 20 | 689 | 22 | 701 | ↑ 2 | ↓ 12 |

Source: Long Finance and Z/Yen

Luxembourg's results in the overall global rankings are particularly strong in the human resources category (10th place).

In the online assessment poll sent to professional operators, Luxembourg is among the top 15 financial centres perceived as having increasing significance in the next few years. Luxembourg comes in 13th place worldwide, and 3rd in the EU after Dublin (4th) and Frankfurt (7th). This category is dominated by the Asian financial centres.

The authors of the study rank Luxembourg in the 'Global specialists' financial centre category, which are regarded as 'global' and 'relatively deep specialist'.

Finally, according to an analyse of the volatility of the performance of the financial centres, Luxembourg ranks among 'dynamic' financial centres, placed between 'stable' and 'unpredictable' financial centres. This means that Luxembourg as a financial centre has the potential to evolve in either direction.

## c. Innovation and technology indicators

### c.1 Global innovation index[15]

In January 2017, Bloomberg published a composite index called the 'Global Innovation Index' (GII), which aims to gauge the innovation capacity of 78 countries worldwide. The statistical information for this index is sourced from several international organisations including the ILO, IMF, World Bank and OECD, to produce a report based on a range of equally-weighted criteria with results separated into the following seven categories: R&D intensity, manufacturing value-added, productivity, high-tech density, higher education, researcher concentration and patent activity.

The 2017 global GII rankings are topped by South Korea (score of 89.00), followed by Sweden (83.98) and Germany (83.92). Luxembourg is in 34th position (59.20). France places 11th (80.99), Belgium 13th (77.78) and the Netherlands 15th (75.23). In the overall GII listings for EU countries in 2017, Luxembourg places 20th.

Luxembourg performs as follows in the seven main categories of the GII (global rankings):

- R&D intensity: 28th (16th in the EU);
- Manufacturing value-added: 41st (24th in the EU);
- Productivity: 4th (1st in the EU);
- High-tech density: data not available;
- Higher education: 49th (26th in the EU);
- Researcher concentration: 11th (5th in the EU);
- Patent activity: 13th (6th in the EU).

[15] For more information: https://www.bloomberg.com/news/articles/2017-01-17/sweden-gains-south-korea-reigns-as-world-s-most-innovative-economies

Table 9
**Top 20 of the ranking**

| 2017 rank | 2016 rank | YoY change | Economy | Total score | R&D intensity | Manufacturing value-added | Productivity | Hign-tech density | Tertiary efficiency | Researcher concentration | Patent activity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | S. Korea | 89.00 | 1 | 1 | 32 | 4 | 2 | 4 | 1 |
| 2 | 3 | +1 | Sweden | 83.98 | 5 | 11 | 15 | 7 | 18 | 5 | 6 |
| 3 | 2 | -1 | Germany | 83.92 | 9 | 3 | 16 | 5 | 12 | 16 | 9 |
| 4 | 5 | +1 | Switzerland | 83.64 | 8 | 6 | 2 | 11 | 16 | 14 | 4 |
| 5 | 7 | +2 | Finland | 83.26 | 4 | 13 | 20 | 15 | 5 | 3 | 5 |
| 6 | 6 | 0 | Singapore | 83.22 | 14 | 5 | 12 | 17 | 1 | 6 | 12 |
| 7 | 4 | -3 | Japan | 82.64 | 3 | 9 | 28 | 8 | 27 | 9 | 3 |
| 8 | 9 | +1 | Denmark | 81.93 | 6 | 17 | 5 | 13 | 22 | 2 | 11 |
| 9 | 8 | -1 | U.S. | 81.44 | 10 | 22 | 10 | 1 | 34 | 20 | 2 |
| 10 | 11 | +1 | Israel | 81.23 | 2 | 30 | 30 | 3 | 20 | 1 | 18 |
| 11 | 10 | -1 | France | 80.99 | 12 | 34 | 18 | 2 | 10 | 18 | 10 |
| 12 | 13 | +1 | Austria | 80.46 | 7 | 7 | 11 | 23 | 6 | 10 | 17 |
| 13 | 16 | +3 | Belgium | 77.18 | 11 | 21 | 9 | 10 | 19 | 19 | 25 |
| 14 | 14 | 0 | Norway | 76.89 | 19 | 36 | 3 | 12 | 25 | 8 | 15 |
| 15 | 18 | +3 | Netherlands | 75.23 | 17 | 24 | 19 | 6 | 44 | 15 | 19 |
| 16 | 15 | -1 | Ireland | 74.94 | 22 | 2 | 6 | 16 | 13 | 22 | 31 |
| 17 | 17 | 0 | U.K. | 74.52 | 20 | 38 | 21 | 14 | 7 | 17 | 14 |
| 18 | 20 | +2 | Australia | 73.33 | 13 | 44 | 1 | 20 | 21 | 12 | 21 |
| 19 | 22 | +3 | New Zealand | 71.63 | 32 | 37 | 8 | 19 | 24 | 21 | 7 |
| 20 | 19 | -1 | Canada | 71.58 | 21 | 32 | 14 | 26 | 30 | 13 | 20 |
| 21 | 21 | 0 | China | 68.89 | 15 | 19 | 43 | 9 | 43 | 43 | 7 |
| 22 | 23 | +1 | Poland | 67.47 | 35 | 16 | 35 | 22 | 15 | 35 | 24 |
| 23 | 25 | +2 | Malaysia | 66.98 | 27 | 12 | 37 | 21 | 26 | 34 | 33 |
| 24 | 26 | +2 | Italy | 65.57 | 25 | 20 | 29 | 18 | 37 | 36 | 37 |
| 25 | 28 | +3 | Iceland | 65.27 | 18 | 23 | 7 | - | 36 | 7 | 22 |
| 26 | 12 | -14 | Russia | 65.24 | 31 | 48 | 42 | 24 | 3 | 27 | 16 |
| 27 | 30 | +3 | Hungary | 63.15 | 24 | 8 | 40 | 28 | 41 | 31 | 34 |
| 28 | 31 | +3 | Czech Rep. | 62.72 | 16 | 4 | 33 | - | 38 | 24 | 26 |
| 29 | 27 | -2 | Spain | 62.51 | 30 | 29 | 22 | 36 | 9 | 32 | 29 |
| 30 | 33 | +3 | Greece | 61.80 | 38 | 45 | 13 | 29 | 11 | 30 | 38 |
| 31 | 29 | -2 | Portugal | 60.65 | 26 | 33 | 26 | 37 | 17 | 23 | 39 |
| 32 | 32 | 0 | Lithuania | 60.50 | 33 | 15 | 26 | - | 8 | 28 | 42 |
| 33 | 34 | +1 | Estonia | 59.80 | 23 | 27 | 23 | - | 14 | 25 | 43 |
| **34** | **35** | **+1** | **Luxembourg** | **59.20** | **28** | **41** | **4** | **-** | **49** | **11** | **13** |
| 35 | 37 | +2 | Hong Kong | 57.49 | 41 | 50 | 17 | 27 | 29 | 26 | 30 |
| 36 | 39 | +3 | Slovakia | 57.17 | 36 | 10 | 24 | - | 40 | 29 | 44 |
| 37 | 36 | -1 | Turkey | 57.11 | 34 | 26 | 39 | 35 | 32 | 42 | 32 |
| 38 | - | - | Romania | 57.06 | 49 | 14 | 41 | 25 | 31 | 46 | 35 |
| 39 | 40 | +1 | Latvia | 54.40 | 43 | 40 | 36 | 38 | 33 | 37 | 23 |
| 40 | 43 | +3 | Malta | 54.06 | 37 | 25 | 25 | - | 45 | 33 | 36 |
| 41 | 38 | -3 | Croatia | 53.65 | 39 | 35 | 31 | 41 | 28 | 40 | 40 |
| 42 | 41 | -1 | Ukraine | 50.78 | 44 | 47 | 50 | 34 | 4 | 44 | 27 |
| 43 | 44 | +1 | Serbia | 49.77 | 40 | 31 | 46 | 40 | 39 | 39 | 45 |
| 44 | 47 | +3 | Thailand | 47.06 | 47 | 18 | 47 | 32 | 46 | 45 | 50 |
| 45 | 46 | +1 | Tunisia | 46.79 | 45 | 39 | 49 | 39 | 35 | 38 | 46 |
| 46 | - | - | Brazil | 46.40 | 29 | 46 | 45 | 30 | 50 | 50 | 47 |
| 47 | - | - | Cyprus | 46.39 | 48 | 49 | 38 | 31 | 42 | 48 | 41 |
| 48 | 50 | +2 | Kazakhstan | 45.56 | 50 | 42 | 34 | - | 23 | 49 | 28 |
| 49 | 49 | 0 | Argentina | 44.62 | 46 | 28 | 44 | - | 47 | 41 | 48 |
| 50 | 48 | -2 | Morocco | 43.99 | 42 | 43 | 48 | 33 | 48 | 47 | 49 |

NOTES: **1. R&D intensity**: Research and development expenditure, as % GDP **2. Manufacturing value-added**: MVA, as % GDP and per capita ($PPP) **3. Productivity**: GDP and GNI per employed person age 15+ an 3Y improvement **4. High-tech density**: Number of domestically domicilied high-tech public companies - such as aerospace and defense, biotechnology, hardware, software, semiconductors, Internet software and services, and renewable energy companies - as % domestic publicly listed companies and as a share of world's total public high-tech companies **5. Tertiary efficiency**: Total enrollment in tertiary education, regardless of age, as % the post-secondary cohort; minimum share of labor force with at least tertiary degrees; annual new science and engineering graduates as % total tertiary graduates and as % the labor force **6. Researcher concentration**: Professionals, including postgraduates PhD students, engaged in R&D per million population **7. Patent activity**: Resident patent fillings, total patent grants and patent in force, per million population; fillings per $100 billion GDP and total grants by country as a share of world total. All metrics are equally weighted. Metrics consisting of multiple factors were rescaled for countries void of some but not all data points. Most recent data available used. Of the more than 200 economies evaluated, 78 had data available for at least six of the seven factors and were ranked. The top 50 and the metric ranks among them are displayed.
Source: Bloomberg

### c.2 Global innovation index[16]

In June 2017, Cornell University, INSEAD and the World Intellectual Property Organisation (WIPO) published the 10th edition of the Global Innovation Index (GII). The GII composite index has been published every year since 2007 and is a comparative tool enabling business leaders, decision makers and other interested parties to better understand the innovation state of play across the world. The report contains a ranking of countries' innovation capacities and performance. Given the vital role that innovation plays in economic growth and prosperity, the GII index features indicators which go beyond those traditionally used, such as R&D expenditure. This new edition assesses 127 countries and is based on dozens of indicators.

The GII composite index represents the average of the following sub-indices:

- The 'Resources invested in innovation' sub-index ('Inputs') evaluates national economic measures in favour of innovative business activities on the basis of five pillars: 1) institutions, 2) human capital and research, 3) infrastructure, 4) market sophistication, 5) business sophistication;

- 'Outputs' sub-index assesses tangible evidence of innovation on the basis of two pillars: 6) knowledge and technology outputs, 7) creativity.

The GII composite index is then calculated on the basis of the simple average of these two sub-indices, with scores ranging from 0 (poor) to 100 (excellent).

Switzerland leads the global scoreboard (score of 67.69/100), followed by Sweden (63.82) and the Netherlands (63.36). Luxembourg comes in 12th position overall with a score of 56.40. The Netherlands are 3rd (63.36), Germany 9th (58.39), France 15th (54.18) and Belgium 27th (49.85). Luxembourg is 8th if only the EU-28 are considered.

[16] For more information: http://www.wipo.int/pressroom/fr/articles/2017/article_0006.html#about#about

Table 10
**Top 20 of the ranking**

| Country/Economy | Score (0–100) | Rank | Income | Rank | Region | Rank | Efficiency Ratio | Rank | Median: 0.62 |
|---|---|---|---|---|---|---|---|---|---|
| Switzerland | 67.69 | 1 | HI | 1 | EUR | 1 | 0.95 | 2 | |
| Sweden | 63.82 | 2 | HI | 2 | EUR | 2 | 0.83 | 12 | |
| Netherlands | 63.36 | 3 | HI | 3 | EUR | 3 | 0.93 | 4 | |
| United States of America | 61.40 | 4 | HI | 4 | NAC | 1 | 0.78 | 21 | |
| United Kingdom | 60.89 | 5 | HI | 5 | EUR | 4 | 0.78 | 20 | |
| Denmark | 58.70 | 6 | HI | 6 | EUR | 5 | 0.71 | 34 | |
| Singapore | 58.69 | 7 | HI | 7 | SEAO | 1 | 0.62 | 63 | |
| Finland | 58.49 | 8 | HI | 8 | EUR | 6 | 0.70 | 37 | |
| Germany | 58.39 | 9 | HI | 9 | EUR | 7 | 0.84 | 7 | |
| Ireland | 58.13 | 10 | HI | 10 | EUR | 8 | 0.85 | 6 | |
| Korea, Rep. | 57.70 | 11 | HI | 11 | SEAO | 2 | 0.82 | 14 | |
| **Luxembourg** | **56.40** | **12** | **HI** | **12** | **EUR** | **9** | **0.97** | **1** | |
| Iceland | 55.76 | 13 | HI | 13 | EUR | 10 | 0.86 | 5 | |
| Japan | 54.72 | 14 | HI | 14 | SEAO | 3 | 0.67 | 49 | |
| France | 54.18 | 15 | HI | 15 | EUR | 11 | 0.71 | 35 | |
| Hong Kong (China) | 53.88 | 16 | HI | 16 | SEAO | 4 | 0.61 | 73 | |
| Israel | 53.88 | 17 | HI | 17 | NAWA | 1 | 0.77 | 23 | |
| Canada | 53.65 | 18 | HI | 18 | NAC | 2 | 0.64 | 59 | |
| Norway | 53.14 | 19 | HI | 19 | EUR | 12 | 0.66 | 51 | |
| Austria | 53.10 | 20 | HI | 20 | EUR | 13 | 0.69 | 41 | |

Source: INSEAD/Cornell/OMPI

Luxembourg scores as follows for the two sub-indices:

- 24th place overall for the inputs category, with a score of 57.36 (institutions: 19th place overall, human capital and research: 33rd, infrastructure: 24th, market sophistication: 78th, business sophistication: 7th);

- 4th place overall for the outputs category, with a score of 55.43 (knowledge and technology outputs: 15th, creativity: 1st).

The authors also calculated an outputs/inputs index by cross-referencing these two sub-indices to assess the effectiveness of innovation systems and policies which have been implemented. For this indicator Luxembourg comes 1st place overall with a score of 0.97, followed by Switzerland (0.95) and China (0.94).

Finally, the authors note the following regarding Luxembourg: *'Luxembourg ranks 4th in the Innovation Output Sub-Index in 2017 and 12th in the overall GII. On the output side, Luxembourg loses four positions in Knowledge and technology outputs (15th), while gaining 1st place in Creative outputs. In this pillar, it maintains its strengths in cultural and creative services exports, national feature films, and generic top-level domains (TLDs) and improves in industrial designs by origin and ICT and organizational model creation. Luxembourg also keeps the top position in the Innovation Efficiency Ratio rankings.'*

## c.3 Measuring information society[17]

The International Telecommunications Union (ITU) published the latest edition of its *Measuring Information Society* report in late 2016, analysing the use of information and communication technologies (ICT) in 175 countries. It also gauges the development potential stemming from ICT use. Direct effects related to he development and diffusion of ICT can result in particular in productivity gains. The report uses a composite index entitled the 'ICT Development Index' (IDI), which assesses both the level and progress of ICT development over time. This composite index is made up of 11 base indicators split into three sub-categories:

- Access to ICTs (40% weighting): fixed-telephone subscriptions, mobile phone subscriptions, international Internet bandwidth per Internet user, households with a computer, and households with Internet access;
- ICT use (40%): individuals using the Internet, fixed broadband subscriptions, and mobile-broadband subscriptions;
- ICT skills (20%): mean years of schooling, gross secondary enrolment, and gross tertiary enrolment.

South Korea emerges at the head of the global IDI rankings for 2016 (score of 8.84/10), followed by Iceland (8.84) and Denmark (8.74). Luxembourg comes 11th overall (8.36). The Netherlands come 8th (8.43), Germany 12th (8.31), France 16th (8.11) and Belgium 22nd (7.83). Luxembourg is the 8th highest-scoring country in Europe and 5th among the EU-28.

Table 11
**Top 20 of the ranking**

| Economy | Rank 2016 | IDI 2016 | Rank 2015 | IDI 2015 |
|---|---|---|---|---|
| Korea (Rep.) | 1 | 8.84 | 1 | 8.78 |
| Iceland | 2 | 8.83 | 3 | 8.66 |
| Denmark | 3 | 8.74 | 2 | 8.77 |
| Switzerland | 4 | 8.68 | 5 | 8.50 |
| United Kingdom | 5 | 8.57 | 4 | 8.54 |
| Hong Kong, China | 6 | 8.46 | 7 | 8.40 |
| Sweden | 7 | 8.45 | 6 | 8.47 |
| Netherlands | 8 | 8.43 | 8 | 8.36 |
| Norway | 9 | 8.42 | 9 | 8.35 |
| Japan | 10 | 8.37 | 11 | 8.28 |
| **Luxembourg** | **11** | **8.36** | **10** | **8.34** |
| Germany | 12 | 8.31 | 13 | 8.13 |
| New Zealand | 13 | 8.29 | 16 | 8.05 |
| Australia | 14 | 8.19 | 12 | 8.18 |
| United States | 15 | 8.17 | 15 | 8.06 |
| France | 16 | 8.11 | 17 | 7.95 |
| Finland | 17 | 8.08 | 14 | 8.11 |
| Estonia | 18 | 8.07 | 18 | 7.95 |
| Monaco | 19 | 7.96 | 20 | 7.86 |
| Singapore | 20 | 7.95 | 19 | 7.88 |

Source: ITU

[17] For more information: http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2016.aspx

Luxembourg scores as follows in the three sub-categories of the global composite indicator:

- 1st position overall for access to ICT (score of 9.54)
- 10th position overall for ICT use (score of 8.05)
- 70th position overall for ICT skills (score of 6.59)[18].

### c.4 Digital transformation scoreboard[19]

Digital technologies have created new markets and unprecedented business opportunities. The European Union has a major challenge on its hands to ensure these opportunities are taken up by companies in the industrial and services sectors, so that digitalisation can drive growth and job creation. For this reason, the European Commission published a new *European Digital Transformation Scoreboard* in January 2017. The main aim of this new scoreboard is to assess how much progress has been made towards the digitalisation of the economy. The scoreboard is based on two broad categories, encompassing a total of thirty or so indicators:

- The 'enablers' category: digital infrastructures (20% weighting of the overall DTEI), Investment and access to finance (30%), Supply and demand of digital skills (30%), E-leadership (10%) and Entrepreneurial culture (10%);
- The 'output' category: integration of digital technology into traditional business models and ICT start-ups.

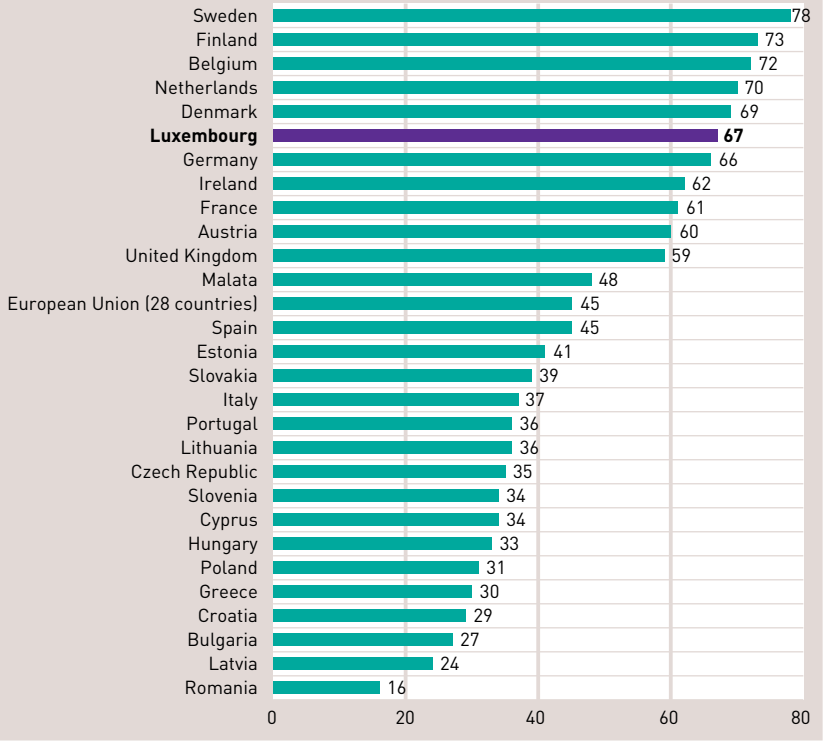
Using the indicators in the first 'enablers' category, the European Commission has then calculated a 'Digital Transformation Enablers Index' (DTEI), a composite index which gives a score between 0 (worst performance) and 100 (best performance).

The 2017 DTEI is headed by Sweden (78/100), followed by Finland (73) and Belgium (72). Luxembourg is in 6th place among the EU-28 (67). The Netherlands come 4th (70), Germany 7th (66) and France 9th (61).

[18] This relatively poor score for the third sub-category is however due to one of Luxembourg's unique features, which is not sufficiently taken into account in this report. The report gives very low scores to Luxembourg for the number of Luxembourg students in tertiary education (a tertiary gross enrolment ratio of 19.7%, placing Luxembourg far behind our nearest neighbours which all have ratios of over 60%). However, the report only takes into consideration students studying in the country itself and does not account for the fact that the majority of Luxembourg students study abroad. This means that Luxembourg's performance for this third sub-category is largely underestimated, resulting in a negative impact on Luxembourg's position in the overall IDI ranking (11th place in 2016).

[19] For more information: http://ec.europa.eu/Docs-Room/documents/21501

Chart 6
**EU ranking**



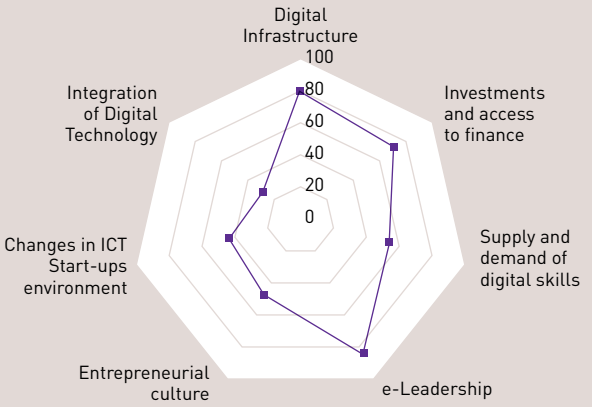

Source: European Commission (2017)

Luxembourg records the following results for the five 'enablers' indicators:

- Digital infrastructures: Luxembourg comes 4th (79) with scores well above the EU average (49);
- Investment and access to finance: Luxembourg comes 4th (72) with scores well above the EU average (44);
- Supply and demand of digital skills: Luxembourg comes 10th (55) with scores above the EU average (40);
- E-leadership: Luxembourg comes 4th (87) with scores well above the EU average (55);
- Entrepreneurial culture: Luxembourg comes 18th (47) with scores equal to the EU average (47).

Luxembourg therefore achieves high scores in several key areas of the 2017 DTEI ranking. Luxembourg boasts high-quality digital infrastructure but is also strong in the areas of investment, access to financing and e-Leadership. Luxembourg companies also benefit from a favourable environment for investment and a good ratio of supply and demand of digital skills. Entrepreneurial culture is quite strong in Luxembourg. Overall, Luxembourg is therefore considered to be among the best enabling countries in the EU along with Sweden, Finland, Belgium, the Netherlands, Denmark and Germany. The low levels of digital technology integration and the failure to adapt the business environment to ICT start-ups working as part of the digital transformation remain the country's main weaknesses.

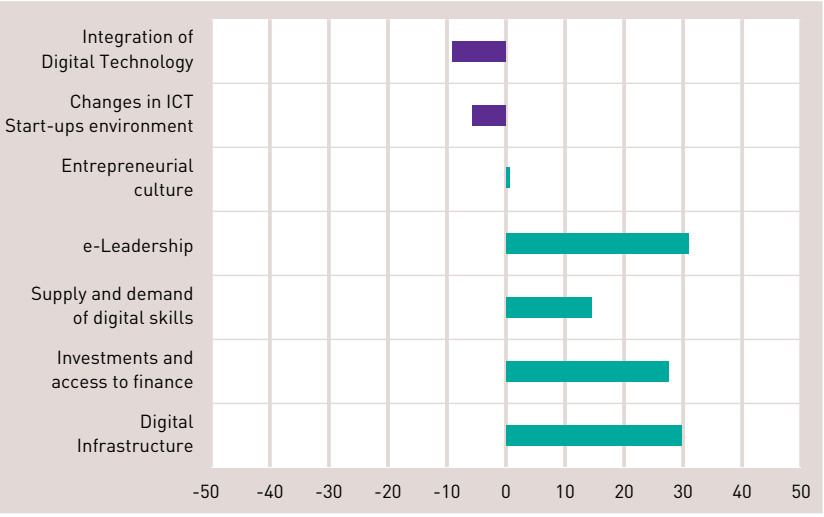
Chart 7
**Performance of Luxembourg**




Note: Based on the average of the latest imputed values. Where no data available, the EU average was used.
Source: European Commission (2017)

In comparison with the other EU Member States, Luxembourg scores highly in 4 of the 7 areas analysed. Luxembourg is one of the best-performing countries in the fields of e-Leadership, digital infrastructures and investment and access to finance (respectively scoring +31%, +30% and +28% higher than the EU average). Luxembourg is also ahead of other European countries in supply and demand of digital skills. However, the country does not meet the standards of other Member States in the domains of digital technology integration and ICT start-ups (scoring respectively 5% and 8% below the EU average).

Chart 8
**Performance of Luxembourg**




Note: Based on the average of the difference of the latest imputed values.
Where no data available, the EU average was used.
Source: European Commission (2017)

In conclusion, European Commission's report notes the following regarding Luxembourg: *'Luxembourg is today one of the EU leaders in digital transformation. The country's high quality digital infrastructure represents the main driving force behind its strong performance. Luxembourg offers overall an advantageous environment that incentivises companies to engage in digital business and technology. Despite these excellent achievements, further efforts should be made to tap the full potential of ICT start-ups in the country. Taking stock of these limitations, the government of Luxembourg recently launched policies to support the development of ICT companies and improve digital skills among students.'*

### c.5 Digital economy and society index[20]

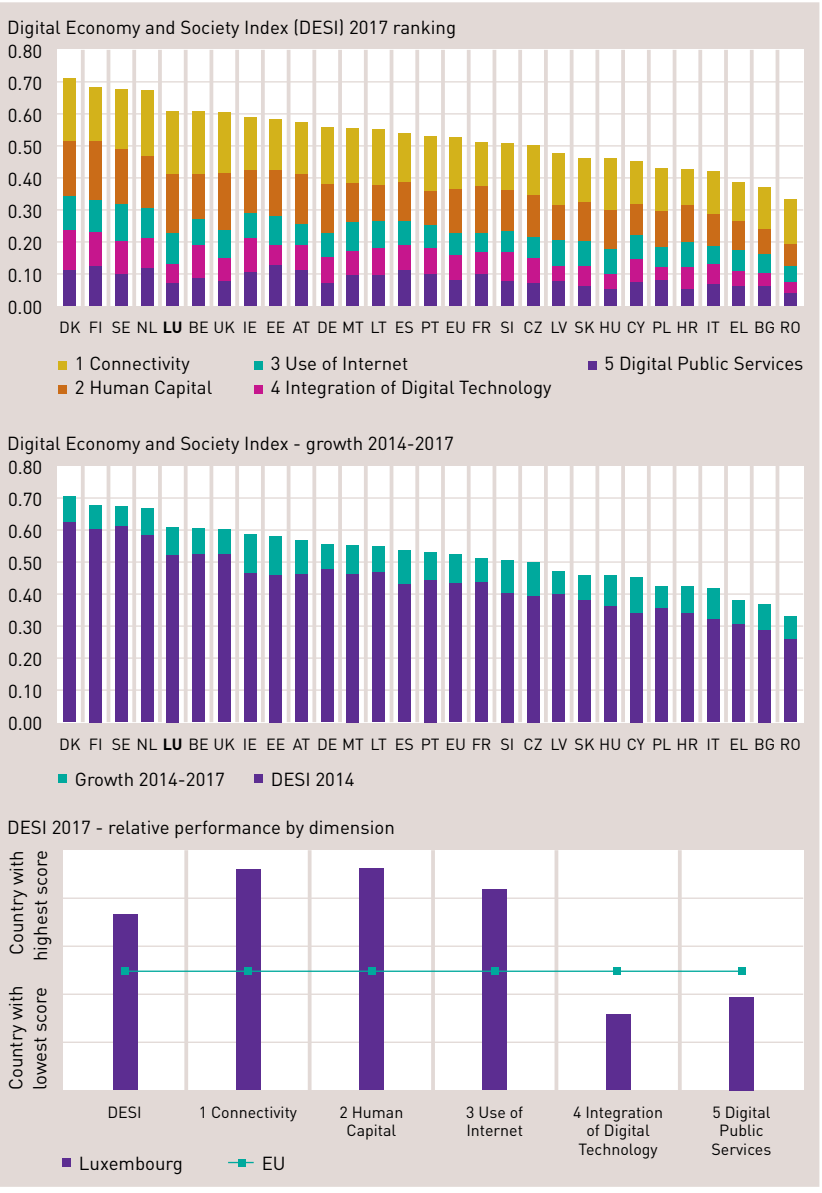
The European Commission has just published the new 2017 edition of its 'Digital Economy & Society Index'. The DESI is a composite index which assesses the progress made by EU countries towards having a digital economy and society, with scores ranging from 0 (worst performance) to 1 (best performance). The index is made up of 30 indicators separated into five interlinked categories:

- Connectivity (fixed broadband, mobile broadband, connection speed and affordability): 25% weighting;
- Human capital (use of internet, advanced and basic digital skills): 25% weighting;
- Use of internet (content, communication and transactions): 15% weighting;
- Integration of digital technology (business digitisation, e-commerce): 20% weighting;
- Digital public services (e-government): 15% weighting.

[20] For more information: https://ec.europa.eu/digital-single-market/en/desi

Denmark (with a score of 0.71), Finland (0.68) and Sweden (0.67) top the rankings for the 2017 DESI. Luxembourg is in 5th place (0.61). The Netherlands are 4th (0.67), Belgium 6th (0.61), Germany 11th (0.56) and France 16th (0.51). Luxembourg is therefore one of nine countries deemed 'High performing' by the European Commission along with Denmark, Finland, Sweden, Netherlands, Belgium, the United Kingdom, Ireland and Estonia.

Chart 9
**EU ranking and performance of Luxembourg**




Source: European Commission

Luxembourg is one of the leading countries in terms of connectivity, digital skills and use of internet, but fares less well in the integration of digital technology in the business sector and digital public services:

- Connectivity (2nd / 0.79): Luxembourg has achieved a very high level of coverage both for fixed high-speed broadband and 4G mobile broadband. There are still radio spectrum frequencies which have not been assigned due to insufficient demand;

- Human capital (2nd / 0.73): Luxembourg has high levels of digital skills, is the leader in terms of numbers of internet users and people with at least basic digital skills, and has a considerable number of ICT specialists;

- Use of internet (3rd / 0.64): Luxembourg's internet users consult a broad range of content (info, music, videos) and carry out numerous transactions (banking, online shopping). Social networks on the other hand are not especially popular;

- Digital technology integration (22nd / 0.30): companies in Luxembourg have an average level of digital technology integration (information-sharing, e-invoicing and cloud computing). However, SMEs are not very active in e-commerce, including across borders;

- Digital public services (19th / 0.49): Luxembourg has made progress over the last year, notably in the fields of open data and provision of pre-filled forms. However, the scores for number of e-government users and online service completion have regressed.

## d. Globalization and openness indicators

### d.1 Index of Globalization[21]

The Federal Institute of Technology in Zurich (ETH Zurich) recently published the 2017 edition of its composite globalisation index (known as the KOF) which appeared for the first time in 2002. It assesses the level of globalisation of 187 countries around the world, based on 23 variables split into 3 sub-categories: economic globalisation (with a 36% weighting in the KOF composite index), social globalisation (37% weighting) and political globalisation (27% weighting). The KOF index measures globalisation on a scale of 1 (least globalised) to 100 (most globalised). Most of the data in the 2017 edition of the survey date from 2014.

Overall, the Netherlands are ranked as the most globalised country in the world (scoring 92.84/100), closely followed by Ireland (92.15) and Belgium (91.75). Luxembourg is in 19th position overall (84.21), France 9th (87.19) and Germany 16th (84.57).

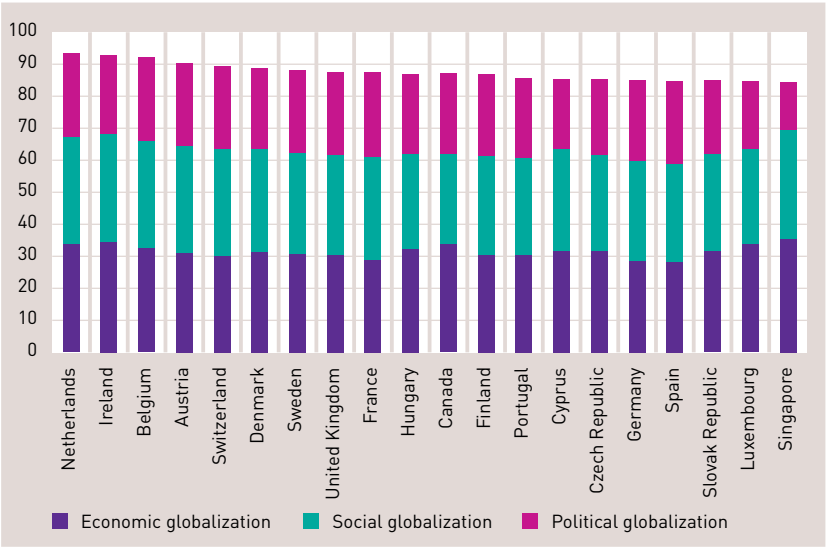
[21] For more information: http://globalization.kof.ethz.ch/

The indicators for the economic dimension of globalisation take into account both the actual international flows of goods, investments and profits in relation to Gross Domestic Product (GDP) and the effect of any restrictions on the movement of goods and capital. Singapore is the leader of the economic globalisation category (97.77), followed by Ireland (94.65) and Luxembourg (94.06).

The social dimension of globalisation is separated into three categories. The first covers personal international contacts in the form of letters and phone calls. Tourism flows and the number of foreign residents are also factored in. The second includes information flows via the internet, television and international press agencies. The third and final category attempts to assess cultural proximity to major global trends, beginning with the number of McDonalds' restaurants and Ikea outlets, as well as book imports and exports, in relation to GDP. Singapore tops the rankings (91.61) followed by Switzerland (91.13) and Ireland (90.99) in 3rd place. Luxembourg is in 28th place (79.39).

Finally, the political dimension is assessed based on the number of embassies abroad, international organisations of which the country is a member, UN peace missions which the country has participated in and the number of bilateral and multilateral agreements signed since 1945. In this category France is 1st (97.29), Italy 2nd (97.25) and Belgium 3rd (95.79). Luxembourg ranks 63rd (77.98).

Chart 10
**The 20 most globalised countries in the world**




Source: ETH

### d.2 Open markers index[22]

The International Chamber of Commerce (ICC) published an updated version of its 'Open Markets Index' (OMI) in 2017. The aim of this survey is to act as a tool for measuring the level of openness to international trade of 75 countries around the world. An open market is defined as a market without imposed barriers which restrict the free movement of products, services, capital and labour.

The composite index and OMI ranking are based on 23 indicators split into 4 sections:

- Observed trade openness (35% weighting);
- Trade policy (35% weighting);
- Openness to foreign direct investment (15% weighting);
- Trade-enabling infrastructure (15% weighting).

Countries are categorised according to their level of market openness, category 1 being the most open (scores of 5-6) and category 5 being the least open (scores of 1-2).

The 2017 OMI ranking is headed by Singapore (5.6/6), followed by Hong Kong (5.5) and Luxembourg (5.0). These three countries all achieve 'excellent' scores in terms of global openness (>5/6) and thus belong in category 1. The Netherlands place 4th (4.8) and Belgium 9th (4.6), ending up in category 2 (above average openness), whereas Germany comes 22nd (3.9) and France 35th (3.7), placing them in category 3 (average openness).

[22] For more information: https://iccwbo.org/publication/icc-open-markets-index-2017/

Table 12
**OMI 2017 ranking**

| Economy scores and rankings | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Category** | | **Rank** | **Score** | **Category** | | **Rank** | **Score** |
| **1 Most Open** | Singapore | 1 | 5.6 | **3 Average Openness** | Korea, Rep. | 39 | 3.7 |
| | Hong Kong SAR | 2 | 5.5 | | United States | 40 | 3.6 |
| | Luxembourg | 3 | 5.0 | | Saudi Arabia | 41 | 3.6 |
| **2 Above Average Openness** | Netherlands | 4 | 4.8 | | Spain | 42 | 3.6 |
| | Ireland | 5 | 4.8 | | Romania | 43 | 3.6 |
| | Switzerland | 6 | 4.7 | | Cyprus | 44 | 3.6 |
| | Malta | 7 | 4.7 | | Italy | 45 | 3.5 |
| | United Arab Emirates | 8 | 4.7 | | Mexico | 46 | 3.5 |
| | Belgium | 9 | 4.6 | | Jordan | 47 | 3.4 |
| | Iceland | 10 | 4.3 | | Thailand | 48 | 3.4 |
| | Norway | 11 | 4.2 | | South Africa | 49 | 3.3 |
| | Slovak Republic | 12 | 4.2 | | Greece | 50 | 3.3 |
| | Hungary | 13 | 4.1 | | Colombia | 51 | 3.3 |
| | Czech Republic | 14 | 4.1 | | Uruguay | 52 | 3.3 |
| | Estonia | 15 | 4.1 | | Turkey | 53 | 3.3 |
| | Lithuania | 16 | 4.1 | | Morocco | 54 | 3.2 |
| | Canada | 17 | 4.1 | | Kazakhstan | 55 | 3.2 |
| | Sweden | 18 | 4.1 | | China | 56 | 3.2 |
| | Austria | 19 | 4.1 | | Ukraine | 57 | 3.2 |
| | Denmark | 20 | 4.0 | | Russian Federation | 58 | 3.1 |
| | New Zealand | 21 | 4.0 | | Sri Lanka | 59 | 3.1 |
| **3 Average Openness** | Germany | 22 | 3.9 | | Egypt | 60 | 3.0 |
| | Chinese Taipei | 23 | 3.9 | | Tunisia | 61 | 3.0 |
| | Chile | 24 | 3.9 | | Philippines | 62 | 3.0 |
| | Latvia | 25 | 3.9 | | Indonesia | 63 | 3.0 |
| | Slovenia | 26 | 3.9 | **4 Below Average Openness** | India | 64 | 2.9 |
| | Israel | 27 | 3.9 | | Uganda | 65 | 2.8 |
| | United Kingdom | 28 | 3.9 | | Kenya | 66 | 2.7 |
| | Finland | 29 | 3.9 | | Algeria | 67 | 2.6 |
| | Australia | 30 | 3.8 | | Argentina | 68 | 2.6 |
| | Malaysia | 31 | 3.8 | | Brazil | 69 | 2.4 |
| | Poland | 32 | 3.8 | | Bangladesh | 70 | 2.3 |
| | Vietnam | 33 | 3.8 | | Nigeria | 71 | 2.3 |
| | Peru | 34 | 3.7 | | Pakistan | 72 | 2.1 |
| | France | 35 | 3.7 | | Ethiopia | 73 | 2.1 |
| | Portugal | 36 | 3.7 | | Sudan | 74 | 2.1 |
| | Japan | 37 | 3.7 | | Venezuela | 75 | 2.0 |
| | Bulgaria | 38 | 3.7 | | | | |

Source: ICC

Luxembourg scores as follows in the four sections:

- Observed trade openness (4.9/6);
- Trade policy (4.8);
- Openness to foreign direct investment (5.3);
- Trade-enabling infrastructure (5.6).

## e. Quality of life and cost of living indicators

### e.1 Quality of living survey[23]

In March 2017 the consultancy firm MERCER published the 19th edition of its annual study on the quality of living for expatriates through their host cities around the world: the Quality of living survey. This survey is conducted to help multinational companies and governments to establish the amount of compensation for their staff abroad. In this new edition, 231 cities were analysed. The survey is based on factors that expatriates consider as having a major impact on their quality of life abroad. Indicators used to assess the level of quality of living are grouped into ten categories: political and social environment, economic environment, sociocultural environment, health system, education system, public services and transport, leisure, consumer products, housing, and finally, the natural environment. Data for the current edition were collected in September-November 2016.

Once again, Vienna, Zurich and Auckland are ranked by MERCER as the three best cities in the world in terms of quality of living for expats in 2017. The City of Luxembourg comes 21st in the global rankings. Vienna, Zurich and Munich are the top three European cities. Luxembourg comes 14th among European cities and 10th among cities in the EU. Luxembourg outscores several neighbouring cities on quality of living, including Stuttgart (26th), Brussels (27th) and Paris (38th), but is beaten by Düsseldorf (6th), Frankfurt (7th) and Amsterdam (12nd). Dublin places 34th in the world and London 40th.

[23] For more information: https://www.mercer.com/newsroom/2017-quality-of-living-survey.html

Table 13
**Top 25 of the ranking**

| Rank | City | Country |
|---|---|---|
| 1 | Vienna | Austria |
| 2 | Zurich | Switzerland |
| 3 | Auckland | New Zealand |
| 4 | Munich | Germany |
| 5 | Vancouver | Canada |
| 6 | Dusseldorf | Germany |
| 7 | Frankfurt | Germany |
| 8 | Geneva | Switzerland |
| 9 | Copenhagen | Denmark |
| 10 | Basel | Switzerland |
| 10 | Sydney | Australia |
| 12 | Amsterdam | Netherlands |
| 13 | Berlin | Germany |
| 14 | Bern | Switzerland |
| 15 | Wellington | New Zealand |
| 16 | Melbourne | Australia |
| 16 | Toronto | Canada |
| 18 | Ottawa | Canada |
| 19 | Hamburg | Germany |
| 20 | Stockholm | Sweden |
| **21** | **Luxembourg** | **Luxembourg** |
| 22 | Perth | Australia |
| 23 | Montreal | Canada |
| 24 | Nurnberg | Germany |
| 25 | Singapore | Singapore |

Source: Mercer

## e.2 Global liveability ranking[24]

In April 2017 ECA International, a provider of solutions and information for professionals in the international human resources sector, published the latest edition of its *Global Liveability Ranking* on the most liveable cities in the world for European expats. Using ratings provided by expats as well as other indicators, this survey assesses several factors to generate an estimate of quality of life in 470 cities around the world. Cities are rated on several criteria including weather conditions, availability of healthcare, accommodation, social networks and free time activities, infrastructures, personal safety, political tension, air quality, etc. These data are mainly used by human resources professionals to calculate living costs allowances for expats.

The 2017 global rankings are led by Copenhagen, followed by Bern and The Hague. The City of Luxembourg is in 9th position worldwide in 2017, falling 6 places in comparison to 2013. Some of the other cities close to Luxembourg fare as follows: Amsterdam (7th), Antwerp (11th), Frankfurt (17th), Brussels (25th), Paris (36th) and London (47th).

[24] For more information: https://www.eca-international.com/news/april-2017/european-global-liveability-rankings

Table 14
**Top 20 of the ranking**

| Locations | Global Rank | | |
|---|---|---|---|
| | 2017 rank | 2016 rank | 2013 rank |
| Copenhagen | 1 | 1 | 1 |
| Bern | 1 | 1 | 1 |
| The Hague | 3 | 3 | 4 |
| Stavanger | 4 | 5 | 9 |
| Geneva | 4 | 4 | 5 |
| Basel | 6 | 5 | 5 |
| Amsterdam | 7 | 8 | 12 |
| Eindhoven | 7 | 8 | 9 |
| **Luxembourg City** | **9** | **5** | **3** |
| Gothenburg | 9 | 12 | 12 |
| Antwerp | 11 | 8 | 5 |
| Dublin | 11 | 8 | 12 |
| Rotterdam | 11 | 15 | 19 |
| Zurich | 14 | 18 | 23 |
| Bonn | 15 | 12 | 12 |
| Munich | 15 | 12 | 12 |
| Vienna | 17 | 21 | 23 |
| Frankfurt | 17 | 15 | 12 |
| Hamburg | 17 | 15 | 20 |
| Stockholm | 20 | 22 | 29 |
| Edinburgh | 20 | 26 | 27 |

Source: ECA (2017)

## e.3 Global 150 cities index[25]

Despite the forces currently working against globalisation, companies continue to employ staff from beyond national borders. Skill levels in human resources have become a key competitiveness factor. Both finding and recruiting talented personnel is now a global issue for companies. AIRINC, an American firm specialising in international mobility and payments for human resources staff, therefore compiles information on over 400 cities of the world in a database which is then used to calculate a composite index of the most attractive cities for talented personnel: the 'Global 150 cities index' (GCI). This composite index is based on 2 categories of indicators: financial indicators (wages, taxes, cost of living etc.) which have a 60% weighting in the GCI, and quality of living indicators (crime rates, health, climate, availability of housing, leisure options etc.) which have a 40% weighting in the GCI.

The overall GCI for 2017 is headed by Zurich, (1st), Geneva (2nd) and Luxembourg City (3rd). Elsewhere in Europe, Dublin placed 22nd, Amsterdam 23rd, Brussels 29th, London 31st and Paris 32nd.

[25] For more information: http://airshare.air-inc.com/airinc-global-150

Table 15
**Top 20 of the ranking**

| **Overall Attractiveness** | |
|---|---|
| 1 | Zurich, Switzerland |
| 2 | Geneva, Switzerland |
| **3** | **Luxembourg** |
| 4 | Munich, Germany |
| 5 | Vienna, Austria |
| 6 | New York NY, U.S.A. |
| 7 | Berlin, Germany |
| 8 | Toronto ON, Canada |
| 9 | Calgary AB, Canada |
| 10 | San Francisco CA, U.S.A. |
| 11 | Seattle WA, U.S.A. |
| 12 | Denver CO, U.S.A. |
| 13 | Chicago IL, U.S.A. |
| 14 | Singapore |
| 15 | Houston TX, U.S.A. |
| 16 | Melbourne, Australia |
| 17 | Boston MA, U.S.A. |
| 18 | Los Angeles CA, U.S.A. |
| 19 | Vancouver BC, Canada |
| 20 | Brisbane, Australia |

Source: AIRINC

The City of Luxembourg recorded particularly good scores compared to other cities worldwide in financial aspects (7th) and came 29th overall for quality of life.

Table 16
**Ranking's determinants**

| **Lifestyle Rank** | | **Financial Rank** | |
|---|---|---|---|
| 21 | New York NY, U.S.A. | 1 | Manama, Bahrain |
| 22 | Calgary AB, Canada | 2 | Georgetown, Cayman Islands |
| 23 | Vancouver BC, Canada | 3 | Zurich, Switzerland |
| 24 | Barcelona, Spain | 4 | Geneva, Switzerland |
| 25 | Auckland, N.Z. | 5 | Riyadh, Saudi Arabia |
| 26 | Madrid, Spain | 6 | Kuwait City, Kuwait |
| 27 | Brussels, Belgium | 7 | Luxembourg |
| 28 | Oslo, Norway | 8 | Macau |
| **29** | **Luxembourg** | 9 | Amman, Jordan |
| 30 | San Francisco CA, U.S.A. | 10 | Seattle WA, U.S.A. |
| 31 | Hong Kong | 11 | Houston TX, U.S.A. |
| 32 | Edinburgh, U.K. | 12 | Doha, Qatar |
| 33 | Lisbon, Portugal | 13 | Denver CO, U.S.A. |
| 34 | Rome, Italy | 14 | Abu Dhabi, U.A.E. |
| 35 | Denver CO, U.S.A. | 15 | Chicago IL, U.S.A. |
| 36 | Chicago IL, U.S.A. | 16 | Dubai, U.A.E. |
| 37 | Seoul, Korea | 17 | Boston MA, U.S.A. |
| 38 | Seattle WA, U.S.A. | 18 | Muscat, Oman |
| 39 | Houston TX, U.S.A. | 19 | Guatemala City, Guatemala |

Source: AIRINC

## e.4 Expat insider[26]

InterNations, a worldwide expatriates network, published in 2017 the 4th edition of its annual report on host countries for expatriates. The report is based on a (qualitative) survey of around 12,500 expatriates in 65 destinations across the world. They scored different aspects of expatriate life in their host country: quality of life, easy insertion, work, family life, financial situation and cost of living abroad. The authors draw up a classification of the best destinations for expatriates across the world on the basis of the responses submitted. The 2017 rankings of the best destinations for expats are topped by Bahrain, Costa Rica and Mexico. Luxembourg is in 14th place. The Netherlands comes 13th, Germany 23rd, Belgium 32nd and France 38th.

Table 17
**Top 20 of the ranking**

| Rank | Country |
|---|---|
| 1 | Bahrain |
| 2 | Costa Rica |
| 3 | Mexico |
| 4 | Taiwan |
| 5 | Portugal |
| 6 | New Zealand |
| 7 | Malta |
| 8 | Colombia |
| 9 | Singapore |
| 10 | Spain |
| 11 | Czech Republic |
| 12 | Vietnam |
| 13 | Netherlands |
| **14** | **Luxembourg** |
| 15 | Malaysia |
| 16 | Canada |
| 17 | Oman |
| 18 | Thailand |
| 19 | Romania |
| 20 | Norway |

Source: InterNations

[26] For more information: https://www.internations.org/expat-insider/

Luxembourg scores as follows in the 5 sub-categories on which the overall classification is based:

- Quality of life: Luxembourg comes 11th, just behind Germany (10th). The Netherlands (17th), France (21st) and Belgium (37th) are further down the list. For the sub-indicators in this category, Luxembourg comes 55th for Leisure Options, 18th for Personal happiness, 19th for Travel & Transport, 14th for Health & Well-being and 5th for Safety & Security (including an 8th position for peace of mind and a 1st for political stability);

- Ease of settling in: Luxembourg comes 40th, ahead of Belgium (45th), France (53rd) and Germany (56th). The Netherlands outperforme Luxembourg, coming in 36th place. For the sub-indicators in this category, Luxembourg comes 33rd for Feeling Welcome, 47th for Friendliness, 46th for Making Friends and 29th for Language;

- Working Abroad: Luxembourg comes 4th, ahead of the Netherlands (6th), Germany (7th), Belgium (20th) and France (40th). For the sub-indicators in this category, Luxembourg comes 17th for Job & Career, 28th for Work-Life Balance, and 1st for Job Security;

- Family Life: Luxembourg comes 20th and is outperformed by the Netherlands (9th), France (15th) and Belgium (16th). Germany is behind Luxembourg (22nd). For the sub-indicators in this category, Luxembourg comes 27th for Availability of Childcare and Education, 24th for Costs of Childcare and Education, 22nd for Quality of Education and 17th for Family Well-being;

- Personal Finance and Cost of Living: Luxembourg comes 17th for personal finance, outstripping Belgium (23rd), the Netherlands (31st), Germany (33rd) and France (52nd). Luxembourg comes 60th for cost of living and is beaten by Germany (27th) France (35th) the Netherlands (38th) and Belgium (40th).

### e.5 Cost of living[27]

In June 2017, MERCER published the 23rd edition of its annual Cost of living survey for expatriates across the world. The survey measures the cost of living in 400 cities on five different continents and uses 200 products and services to estimate the cost of living (housing, transport, food, clothing, leisure, etc.). Among other things, human resources professionals use these data to calculate allowances for expatriates.

Luanda, Hong Kong and Tokyo have the highest living costs for expats in the world. The City of Luxembourg is ranked 107th. Other European cities fare as follows: Zurich (4th), Geneva (7th), London (30th), Paris (62nd), Dublin (66th), Amsterdam (85th), Brussels (104th) and Frankfurt (117th).

## f. Human resources

### f.1 Global talent competitiveness index[28]

In a globalised world, human capital is a key factor for territorial competitiveness. Countries are competing in developing this human capital, but also in attracting and retaining it on the national territory. In this context, the business school INSEAD, in association with the Human Capital Leadership Institute and Adecco, published early 2017 a new edition of the 'Global Talent Competitiveness Index' (GTCI), initially issued in 2013. In order to compare the performance of 118 countries around the world, the report uses a composite index based on an input-output model, which allows evaluating:

- The measures, policies and resources implemented to develop human capital (inputs), based on four sub-categories: enable, attract, grow and retain talents;

- The performance of the measures implemented (outputs), based on two categories of competence: mid-level/technical skills of labour force (LV skills) and high-level skills needed for innovation and entrepreneurship (GK skills).

The GTCI global composite index, calculated through a simple average of these six categories, is made up of 65 indicators. It uses a score between 0 (worst performance) and 100 (best performance).

The GTCI global classification is led by Switzerland (74.55), followed by Singapore (74.09) and the United Kingdom (69.40). Luxembourg places 7th in the overall ranking (68.66). The Netherlands are in 11th place (67.80), Belgium 16th (65.24), Germany 17th (64.94) and France 24th (59.93). Luxembourg is the 3rd highest EU country after the United Kingdom and Sweden.

[27] For more information: https://mobilityexchange.mercer.com/cost-of-living-rankings

[28] For more information: http://global-indices.insead.edu/gtci/

In the inputs sub-category, Luxembourg comes 21st for Enable (73.02), 2nd for Attract (84.40), 17th for Grow (62.70) and 3rd for Retain. In the outputs sub-category, Luxembourg comes 24th (59.51) for mid-level/technical skills of the labour force (LV skills) and 12th (55.26) for high-level skills needed for innovation and entrepreneurship (GK skills). Overall, Luxembourg's scores are higher than the average scores of other high-income developed countries.

In conclusion the authors of the report note that Luxembourg *'(...) remains a top country in the Attract pillar (2nd), the result of combining strong External Openness (3rd) with good Internal Openness (5th). As a small country that has built an international reputation as a centre of finance and industry, it also excels at retaining its domestic talent (3rd in this pillar). Despite the strong attraction of knowledge workers, the business environment could progress in Labour Market Flexibility (Business and Labour Landscape is 60th), reflecting the fact that over half its native population works for the state. As is often the case in a small country, Formal Education (46th) does not figure at the top, particularly in terms of the top global universities.'*

Table 18
**Top 20 of the human capital ranking**

| Country | Score | Overall Rank | Income Group |
|---|---|---|---|
| Switzerland | 74.55 | 1 | High income |
| Singapore | 74.09 | 2 | High income |
| United Kingdom | 69.40 | 3 | High income |
| United States of America | 69.34 | 4 | High income |
| Sweden | 69.14 | 5 | High income |
| Australia | 69.06 | 6 | High income |
| **Luxembourg** | **68.66** | **7** | **High income** |
| Denmark | 68.59 | 8 | High income |
| Finland | 68.56 | 9 | High income |
| Norway | 68.01 | 10 | High income |
| Netherlands | 67.80 | 11 | High income |
| Ireland | 67.58 | 12 | High income |
| Canada | 67.16 | 13 | High income |
| New Zealand | 67.15 | 14 | High income |
| Iceland | 65.79 | 15 | High income |
| Belgium | 65.24 | 16 | High income |
| Germany | 64.94 | 17 | High income |
| Austria | 63.70 | 18 | High income |
| United Arab Emirates | 62.49 | 19 | High income |
| Estonia | 61.72 | 20 | High income |

Source: INSEAD

## f.2 World talent report[29]

The Swiss IMD institute published the 2016 edition of its *World Talent Report* in late November. The authors analysed how successfully 61 countries around the world are developing, attracting and retaining the talent needed by the economy and businesses to make progress and create lasting, long-term added value. The survey uses both quantitative and qualitative indicators which are split into three sub-categories:

- Investment and development of local talent (expenditure on education, quality of national education, apprenticeships, employee training etc.);
- Attracting talent from abroad (quality of life, cost of living, brain drain etc.);
- Availability of qualified and skilled workforce (labour force growth, skills, student mobility, PISA test results etc.).

This information is then used to calculate a composite index which ranks the countries in order (with a value of between 1 and 100). The 2016 rankings are led by Sweden (scoring 100), followed by Denmark (90.7) and Belgium (85.8). Luxembourg comes in 9th place overall (81.7). The Netherlands comes 5th (82.8), Germany 11th (80.8) and France 28th (67.8).

Chart 11
**Top 20 of the ranking**

| | | | |
|---|---|---|---|
| 1 | Switzerland | - | 100.0 |
| 2 | Denmark | - | 90.7 |
| 3 | Belgium | +6 | 85.8 |
| 4 | Sweden | +7 | 84.6 |
| 5 | Netherlands | - | 82.8 |
| 6 | Finland | - | 82.5 |
| 7 | Norway | -3 | 82.5 |
| 8 | Austria | +11 | 82.5 |
| 9 | Luxembourg | -6 | 81.7 |
| 10 | China Hong Kong | +2 | 81.4 |
| 11 | Germany | -4 | 80.8 |
| 12 | Canada | -4 | 79.9 |
| 13 | New Zealand | +5 | 79.7 |
| 14 | USA | - | 79.3 |
| 15 | Singapore | -5 | 78.8 |
| 16 | Iceland | +1 | 77.8 |
| 17 | Australia | -4 | 77.6 |
| 18 | Ireland | -2 | 77.5 |
| 19 | Malaysia | -4 | 72.7 |
| 20 | United Kingdom | +1 | 71.9 |

Source: IMD

[29] For more information: http://www.imd.org/wcc/world-competitiveness-center-rankings/talent-rankings/

### f.3 Human capital report[30]

In the 21st century, expertise and talent are essential factors linking innovation, competitiveness and growth. The level and the quality of human capital available to a country are considered as key factors for long-term economic success in an increasingly digitalised world. In September 2017, the World Economic Forum (WEF) published the latest edition of its Human Capital Report, which assesses the ability of 130 countries to develop human capital. The report analyses four sub-categories under the heading of human capital:

- Capacity, which is assessed mainly by calculating the investments made in formal education (e.g. literacy and numeracy rates, school attainment rate);
- Deployment, i.e. the application and development of skills at work (e.g. labour force participation rate, gender gap, unemployment rate);
- Development, including formal education of the workforce of the next generation and lifelong training of the current staff (e.g. school attainment rate, vocational education);
- Know-how, i.e. the breadth and depth of specialist skills in the workplace (e.g. high-skilled employment share, medium-skilled employment share, availability of skilled employees).

One of the basic principles of this report is that skills development does not stop when formal education comes to an end, and that the ongoing use and development of skills in the workplace are a crucial part of developing human capital. The analysis employs 21 quantitative and qualitative indicators, which the WEF then uses to calculate the composite 'Human capital index' (HCI), assessing how countries develop their human capital in a globalised and digitalised economy. The value for the HCI composite index ranges from 0 (worst score) to 100 (best score).

Norway leads the overall classification (77.12/100), followed by Finland (77.07) and Switzerland (76.48). With a HCI score of 69.61 in 2017, Luxembourg is 30th in the world and 16th in the EU. Germany is ranked 6th (74.30), the Netherlands 13th (73.07), Belgium 15th (72.46) and France 26th (69.94).

[30] For more information: https://www.weforum.org/reports/the-global-human-capital-report-2017

Table 19
**Top 30 of HCI ranking**

| | Overall index | | Capacity subindex | | Deployment subindex | | Development subindex | | Know-how subindex | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **Score** | **Rank** | **Score** | **Rank** | **Score** | **Rank** | **Score** | **Rank** | **Score** | **Rank** |
| Norway | 77.12 | 1 | 80.46 | 13 | 73.18 | 24 | 82.63 | 6 | 72.22 | 6 |
| Finland | 77.07 | 2 | 81.05 | 8 | 65.09 | 68 | 88.51 | 1 | 73.62 | 2 |
| Switzerland | 76.48 | 3 | 76.36 | 28 | 69.12 | 42 | 84.87 | 2 | 75.57 | 1 |
| United States | 74.84 | 4 | 78.18 | 22 | 68.72 | 43 | 83.45 | 4 | 68.99 | 13 |
| Denmark | 74.40 | 5 | 79.37 | 16 | 71.41 | 34 | 78.65 | 14 | 68.18 | 17 |
| Germany | 74.30 | 6 | 76.33 | 29 | 69.52 | 40 | 79.38 | 12 | 71.96 | 7 |
| New Zealand | 74.14 | 7 | 78.92 | 18 | 72.76 | 27 | 80.38 | 8 | 64.50 | 22 |
| Sweden | 73.95 | 8 | 76.21 | 31 | 69.60 | 39 | 77.10 | 16 | 72.89 | 3 |
| Slovenia | 73.33 | 9 | 81.10 | 7 | 65.90 | 64 | 79.21 | 13 | 67.10 | 18 |
| Austria | 73.29 | 10 | 73.71 | 45 | 68.00 | 44 | 81.53 | 7 | 69.92 | 11 |
| Singapore | 73.28 | 11 | 76.45 | 27 | 70.52 | 36 | 73.62 | 25 | 72.52 | 4 |
| Estonia | 73.13 | 12 | 80.94 | 10 | 72.70 | 28 | 76.20 | 18 | 62.68 | 26 |
| Netherlands | 73.07 | 13 | 74.09 | 43 | 65.37 | 67 | 83.60 | 3 | 69.22 | 12 |
| Canada | 73.06 | 14 | 80.38 | 15 | 71.96 | 32 | 74.06 | 22 | 65.85 | 20 |
| Belgium | 72.46 | 15 | 75.14 | 35 | 63.39 | 75 | 82.84 | 5 | 68.47 | 16 |
| Russian Federation | 72.16 | 16 | 83.19 | 4 | 74.33 | 18 | 72.97 | 33 | 58.14 | 42 |
| Japan | 72.05 | 17 | 80.96 | 9 | 66.32 | 62 | 73.92 | 23 | 67.00 | 19 |
| Israel | 71.75 | 18 | 70.70 | 58 | 70.56 | 35 | 74.69 | 21 | 71.03 | 8 |
| Ireland | 71.67 | 19 | 75.47 | 34 | 62.33 | 78 | 80.04 | 10 | 68.84 | 15 |
| Australia | 71.56 | 20 | 78.44 | 20 | 66.20 | 63 | 80.24 | 9 | 61.36 | 29 |
| Iceland | 71.44 | 21 | 58.39 | 96 | 75.55 | 14 | 79.50 | 11 | 72.33 | 5 |
| Czech Republic | 71.41 | 22 | 69.20 | 67 | 73.74 | 22 | 78.13 | 15 | 64.58 | 21 |
| United Kingdom | 71.31 | 23 | 71.59 | 54 | 67.40 | 51 | 76.23 | 17 | 70.02 | 10 |
| Ukraine | 71.27 | 24 | 81.70 | 5 | 72.65 | 31 | 71.47 | 38 | 59.26 | 38 |
| Lithuania | 70.81 | 25 | 80.42 | 14 | 70.28 | 37 | 73.05 | 31 | 59.50 | 37 |
| France | 69.94 | 26 | 74.68 | 39 | 60.90 | 86 | 75.34 | 20 | 68.86 | 14 |
| Korea, Rep. | 69.88 | 27 | 76.59 | 26 | 66.73 | 58 | 73.34 | 26 | 62.87 | 25 |
| Latvia | 69.85 | 28 | 81.57 | 6 | 67.23 | 52 | 72.07 | 35 | 58.52 | 41 |
| Kazakhstan | 69.78 | 29 | 83.60 | 2 | 74.66 | 17 | 68.80 | 45 | 52.08 | 64 |
| **Luxembourg** | **69.61** | **30** | **69.19** | **68** | **66.98** | **57** | **71.34** | **39** | **70.94** | **9** |

Source: WEF

Luxembourg scored as follows in the four sub-categories:

- Capacity: 68th (69.19);
- Deployment: 57th (66.98);
- Development: 39th (71.34);
- Know-how: 9th (70.94).

## g. Miscellaneous indicators

A multitude of other factors play an important role in the debate regarding territorial attractiveness and competitiveness: functioning and governance of public authorities, business environment, human resources, etc. There are regular publications on benchmarks and country rankings focusing on a multitude of these topics, some of which are reviewed below.

### g.1 Corruption perceptions index[31]

The institutional and regulatory framework within which economic activities take place, impacts on the way resources are distributed, investment decisions are orientated and creativity and innovation are stimulated. Corruption weakens a country and harms the stability and security of the decisions economic agents make.

In January 2017, the non-governmental organisation Transparency International published an updated version of its index on the perception of corruption in the public sector, first produced in 1995: the 'Corruption Perceptions Index' (CPI). The latest version of this survey covers 176 countries. The composite CPI, based on data from several sources which report on corruption perception (corruption perception polls and ratings compiled by various renowned institutions), ranges from 100 (lowest level of perceived corruption) to 0 (highest level of perceived corruption). Although no country is free of corruption, the countries at the top of the range share the following features: a transparent government, freedom of the press, protection of civil liberties and independent legal systems.

In the latest edition, Denmark and New Zealand achieve the best scores overall (90), closely followed by Finland (89) and Sweden (88). Luxembourg comes in 10th place overall (81), ranking equally along with Germany and the United Kingdom (5th in the EU). The Netherlands are ranked 8th (83), Belgium 15th (77) and France 23rd (69).

[31] For more information: https://www.transparency.org/news/feature/corruption_perceptions_index_2016

Table 20
**CPI ranking**

| Rank | Country | Score | Rank | Country | Score | Rank | Country/Territory | Score |
|---|---|---|---|---|---|---|---|---|
| 1 | Denmark | 90 | 21 | Uruguay | 71 | 41 | Brunei | 58 |
| 1 | New Zealand | 90 | 22 | Estonia | 70 | 41 | Costa Rica | 58 |
| 3 | Finland | 89 | 23 | France | 69 | 41 | Spain | 58 |
| 4 | Sweden | 88 | 24 | Bahamas | 66 | 44 | Georgia | 57 |
| 5 | Switzerland | 86 | 24 | Chile | 66 | 44 | Latvia | 57 |
| 6 | Norway | 85 | 24 | United Arab Emirates | 66 | 46 | Grenada | 56 |
| 7 | Singapore | 84 | 27 | Bhutan | 65 | 47 | Cyprus | 55 |
| 8 | Netherlands | 83 | 28 | Israel | 64 | 47 | Czech Republic | 55 |
| 9 | Canada | 82 | 29 | Poland | 62 | 47 | Malta | 55 |
| 10 | Germany | 81 | 29 | Portugal | 62 | 50 | Mauritius | 54 |
| **10** | **Luxembourg** | **81** | 31 | Barbados | 61 | 50 | Rwanda | 54 |
| 10 | United Kingdom | 81 | 31 | Qatar | 61 | 52 | Korea (South) | 53 |
| 13 | Australia | 79 | 31 | Slovenia | 61 | 53 | Namibia | 52 |
| 14 | Iceland | 78 | 31 | Taiwan | 61 | 54 | Slovakia | 51 |
| 15 | Belgium | 77 | 35 | Botswana | 60 | 55 | Croatia | 49 |
| 15 | Hong Kong | 77 | 35 | Saint Lucia | 60 | 55 | Malaysia | 49 |
| 17 | Austria | 75 | 35 | Saint Vincent and The Grenadines | 60 | 57 | Hungary | 48 |
| 18 | United States | 74 | 38 | Cape Verde | 59 | 57 | Jordan | 48 |
| 19 | Ireland | 73 | 38 | Dominica | 59 | 57 | Romania | 48 |
| 20 | Japan | 72 | 38 | Lithuania | 59 | 60 | Cuba | 47 |

Source: Transparency International

## 2.3 Conclusions

Many reports are published each year on the several aspects of competitiveness and territorial attractiveness. Country rankings are undoubtedly the most mediatised sections of reports by far. However, those reports tell a more complex tale which belies the apparent simplicity of overall rankings. When analysing benchmarks and rankings, one should not lose sight of the intrinsic limitations of such an exercise:

1. A rise or fall in the rankings does not mean that the performance of Luxembourg has improved or deteriorated. Such a development may also stem from the fact that other territories have experienced the effects of a shock more or less severely than Luxembourg. It is essential to take this relativity into account in international comparisons.

2. It is worth noting that there is a time lag between the time of publication of the rankings and many statistics used therein. The composite indices analysed in this 2017 edition of the Report still often use statistics dating back to 2013, 2014, 2015 and 2016. Therefore, these rankings should not be considered as short-term predicting tools.

3. Many rankings assume methodological differences. While the WEF attempts for example to measure the ability of countries to achieve sustainable economic growth, the IMD analyses the ability of countries to create and maintain a supporting environment for company competitiveness, as wealth creation is supposed to happen at the level of companies that operate within a national environment which either facilitates or hampers their competitiveness. Luxembourg's positions therefore vary from one ranking to another, even if they try to measure 'territorial competitiveness'.

4. The different rankings are criticized over suffering from methodological weaknesses, especially in three areas: the quality of sources (primary and secondary data), the core indicators used and the method for calculating the composite index (formulas, weights, etc.). For example, the 'one size fits all' indicators used in the same way for all countries analysed, often prove to be inadequate to the specificities of Luxembourg, which is a very small economy that is widely open. The best-known example is the 'GDP per capita' which, by its statistical construction, does not take into account the large flow of incoming cross-border workers in Luxembourg.[32] Thus, it strongly overestimates Luxembourg's performance. Another example is the indicator concerning the number of Luxembourg students in higher education or associated, such as the science and technology graduates 'STEM' indicator[33], for which the data used often ignores the fact that a majority of Luxembourg students are studying abroad. Hence these indicators often considerably underestimate Luxembourg's performance.

5. The detail of which countries are analysed has an impact on comparability. For example, the WEF compares 137 countries, the IMD only 63 and the Heritage Foundation 180. This affects the relative position of countries in the rankings. For example, a decision could be made to only compare the EU. Luxembourg would then climb from the 19th world position to the 8th position (WEF), from the 8th to the 4th position (IMD) and from the 14th to the 4th position (Heritage Foundation).

6. There are countries or groups of countries in these rankings for which the performance is close, i.e. whose numerical values of the calculated composite indices are very close to each other. The mere country rankings can usually not show this. All things being equal, a slight increase (or decrease) in the value of the composite index could therefore lead to a significant rise (or fall) in the rankings. The rankings should therefore not be looked at separately from the value of the composite index. Significant differences in the rankings of countries may sometimes be related to small differences in the index.

[32] Nearly 45% of the labour force in Luxembourg is currently border-workers.

[33] "In 2014, the number of science and technology graduates ranged from about 24.7 per 1,000 inhabitants in Ireland to 9.2 per 1,000 inhabitants in Cyprus and 3.5 per 1,000 inhabitants in Luxembourg. The very low ratio of science graduates in Luxembourg and Cyprus might be explained to a large extent by the number of students who pursue their studies abroad. Since some of the graduates reported by a country may be foreigners who return home following their studies, this pushes up the ratio in the country where they studied and pulls down the ratio for their country of origin."

For more information: http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_R%26D_and_innovation

Considering the above remarks, what should one think of these rankings? Even if they trigger numerous concerns, these reports provide a useful performance calibration tool worthy to monitor. On one hand, these benchmarks summarize complex issues down to one single value, being thus extremely efficient communication tools that favour political debate and allow authorities to evaluate their policies by comparing them to best practice. On the other hand, due to press coverage, these benchmarks also have a significant impact on the brand image of a territory and can influence the investors' perception (nation branding perspective).

Consequently, it is important to avoid caving into the syndrome of ranking for the sake of ranking. The indications provided in the final rankings are often of a character too general to be used and should help to focalise attention and lead to a more rigorous analysis. There is, indeed, no unique recipe. Different policies may be compared, but each country needs to adapt them to its own socio-economic environment. The strategies implemented succeed when economic imperatives and national social cohesion are in perfect balance.

To this end, in 2003 the Tripartite Coordination Committee in Luxembourg had identified the need for an enlarged indicator scoreboard in order to gain a better insight into the competitiveness of the country, through indicators that better reflect the specificities of the country. The Committee entrusted Professor Fontagné (University Paris I - Sorbonne) the task of elaborating proposals (November 2004)[34]. The Observatoire de la compétitivité has since updated this national scoreboard till 2016. The Economic and Social Council[35] have been preparing the revision of the scoreboard for several years and were able to unanimously adopt an opinion on a national indicators list for the new, updated and reorganised scoreboard in July 2016. The results of this new list of indicators are presented for the first time in this Competitiveness Report[36].

[34] FONTAGNÉ L., Compétitivité du Luxembourg : une paille dans l'acier, Rapport pour le ministère de l'Économie et du Commerce extérieur, Luxembourg, November 2004, pp.102-120

For more information: http://www.odc.public.lu/publications/perspectives/PPE_003.pdf

[35] CCES, Le système d'indicateurs national, Avis, 8 July 2016

For more information: http://www.ces.public.lu/content/dam/ces/fr/actualites/2016/07/2016-indicateurs.pdf

[36] See Chapter 3 in this Competitiveness Report.

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# 3 National competitiveness scoreboard


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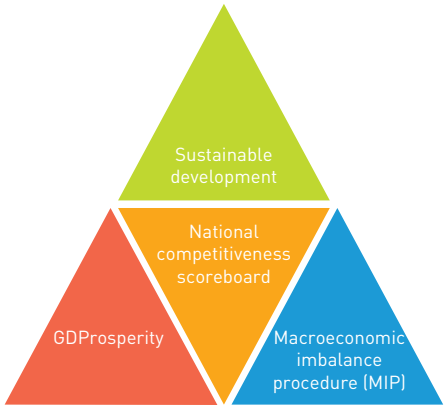
# 3.1 Introduction

Due to the co-existence of a multitude of old and new scoreboards (Europe 2020 indicators, EU-wide Macroeconomic Imbalance Procedure (MIP) indicators, GDProsperity indicators, national sustainable development scoreboard, etc.), some of which overlap at different points, it is difficult to draw comparisons and obtain an overview of the economic, social and environmental situation in Luxembourg.




The role of the Observatoire de la compétitivité (ODC), which was established by the Ministry of the Economy in 2003 following discussions in the Tripartite Coordination Committee, is to assist the government and social partners in setting out guidelines and policy content which are favourable to and compatible with long-term competitiveness and serve as a source of growth and well-being. The ODC acts as a tool for documenting, observing and assessing the development of competitiveness in Luxembourg and serves as a monitoring body tasked with investigating and monitoring matters as well as encouraging designated partners to support the process.

To ensure that the public authorities can rely on an efficient instrument to measure and evaluate progress in the field of competitiveness whilst also considering the country's specific characteristics, the ODC worked with Professor Lionel Fontagné and the social partners in 2004 to draw up a national competitiveness scoreboard (TBCO). This scoreboard has been updated on an annual basis since 2006 as part of the Competitiveness Report. The competitiveness scoreboard featured 77 indicators sub-divided into 10 categories: Macroeconomic Performance, Employment, Productivity and Labour Costs, Market Operations, Institutional and Regulatory Framework, Entrepreneurship, Education and Training, Knowledge Economy, Social Cohesion, and Environment.

On the tenth anniversary of the scoreboard's creation, Mr. Étienne Schneider, Minister for the Economy and Foreign Trade, expressed the following wish in the preface to the 2013 Competitiveness Report: *"...In order to ensure better operational and integrated monitoring of this competitiveness, I suggest to introduce a new system of indicators at the national level, based on the European Union's macroeconomic imbalances' procedure scoreboard, called 'MIP'. This new system should allow us to better detect any significant internal and external deterioration in our competitiveness. But I also want this new system of indicators to be further enriched by the ongoing discussions in the Economic and Social Council and in the Higher Council for Sustainable Development within a long-term perspective of the PIBien-être project and, after consulting the Tripartite Coordination Committee, I hope this new system will be enshrined in a new 'Law on competitiveness'. This law would replace the set of obsolete indicators mentioned in the Grand-Ducal Regulation of 4 April 1985 adopted in application of the amended law of 24 December 1977, that is to say, the law establishing the Tripartite Coordination Committee."*

As the years passed, it became necessary to revise the 2004 national scoreboard as some of the indicators were no longer providing relevant information or had been replaced by new indicators of better statistical quality. In conjunction with the Economic and Social Council (ESC), the review of the TBCO began in early 2014 and the opinion of the ESC on 'the national system of indicators' was adopted on 8 July 2016[1]. However, this review of the national scoreboard indicators did not equate to a full revision of the definition of competitiveness. The ODC continues to use the broad definition of the concept of competitiveness, a definition which was upheld by the Tripartite Coordination Committee and used by the ESC. Furthermore, the ESC sets the following objectives for the government: *"(...) the main role of the State is to contribute to achieving and upholding of a high, sustainable quality of life for the country's population"*[2]. According to ESC competitiveness is a means to achieve these objectives. According to a current definition, a country is internationally competitive if concurrently *"its productivity increases at a rate which is similar to or higher than that of its major trading partners with a comparable level of development; it maintains external equilibrium in the context of an open free-market economy; and it realises a high level of employment"*[3]. Broadly speaking, the ESC defines competitiveness as *"a nation's ability to sustainably improve the quality of life of its inhabitants and ensure a high level of employment and social cohesion whilst also preserving the environment"*.

1 http://www.ces.public.lu/content/dam/ces/fr/actualites/2016/07/2016-indicateurs.pdf

2 http://www.ces.public.lu/content/dam/ces/fr/avis/politique-generale/2001-role-etat.pdf

3 http://ec.europa.eu/economy_finance/publications/pages/publication8051_en.pdf

In order to ensure a clearly structured new set of indicators and an appropriate balance between the different aspects of sustainable development in the new system, the ESC decided to produce a single scoreboard covering economic, social and environmental dimensions. The ESC suggested that a balance be maintained between these three dimensions and that they be regarded as a group of indicators covering aspects of competitiveness, well-being and sustainability whilst making sure there are no non-relevant indicators in any particular category.

The ESC has also decided to highlight a limited number of 'meta' indicators for each dimension. These are considered the most significant indicators in each of the respective dimensions and should ensure that Luxembourg can be compared with the rest of Europe. The other indicators focus on the specific features of Luxembourg and, although considered secondary, are nevertheless useful in terms of providing more detailed information should the need arise. An indicative, non-exhaustive list of relevant secondary indicators has been drawn up, which however should not be considered as an integral part of the new system of indicators.

The indicators which were retained for the new system of national indicators had to fulfil several criteria, notably:

- Ensure spatial and temporal comparability with EU-level indicators;
- Ensure that the relevance, statistical quality and frequency of indicator publication is sufficient to enrich future political and societal debates;
- Take into account the Europe 2020 and MIP indicators;
- Eliminate obsolete and inactive indicators as well as duplication.

The new system of indicators is not set in stone and may be adapted over time if necessary. It is designed to be used as the main reference tool for social dialogue and to enrich public debate. Furthermore, it should assist in shedding light on areas where Luxembourg's performance is unsatisfactory. The general diagnostics established by the new system of indicators may be followed up by a road map of activities with precise, quantifiable and measurable objectives drawn up in cooperation with all social partners.

## 3.2 Methodology

The method of comparison does not vary from the method used in the previous iteration of the scoreboard. First, Luxembourg's position compared to the European average is highlighted.

- If Luxembourg's performance is at least 20% better than the EU average, then the indicator is classified as 'green' (favourable position).
- If Luxembourg's performance is between +20% and -20% in relation to the EU average, then the indicator is classified as 'orange' (neutral position).
- If Luxembourg's performance is more than 20% lower than the EU average, then the indicator is classified as 'red' (unfavourable position).

This ranking is a purely visual tool to quickly see where Luxembourg is in comparison with the EU average.

Secondly, Luxembourg's absolute performance is analysed over time by comparing the most recent data values with those from previous years. The arrows will indicate in which direction each indicator has recently changed (improvement or deterioration).

- ↑ If Luxembourg's performance has improved since the last edition of the Scoreboard, an arrow pointing upward will signal the indicator in question.
- → If Luxembourg's performance has remained stable since the last edition of the Scoreboard, a horizontal arrow will signal the indicator in question.
- ↓ If Luxembourg's performance has deteriorated since the last edition of the Scoreboard, an arrow pointing downward will signal the indicator in question.

Apart from the comparison with the European average, Luxembourg is also compared to the best and worst countries from the EU.

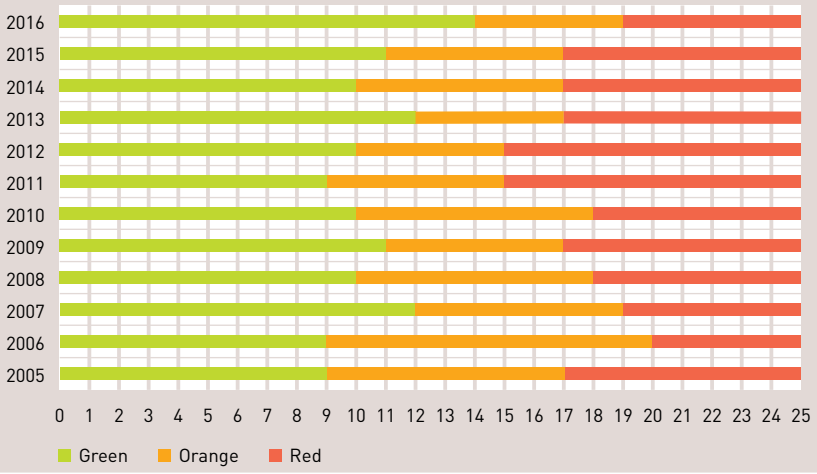
# 3.3 Economic dimension

| | | Trend | LU | Position | EU Average | DE | BE | FR | First | Last |
|---|---|---|---|---|---|---|---|---|---|---|
| A1 | Public debt (% of GDP) | ↑ | 20.0 | 2 / 28 | 83.5 | 68.3 | 105.9 | 96.0 | Estonia: 9.5 | Greece: 179 |
| A2 | Government balance (% of GDP) | ↑ | 1.6 | 1 / 28 | -1.7 | 0.8 | -2.6 | -3.4 | Luxembourg: 1.6 | Spain: -4.5 |
| A3 | Current account balance, % of GDP (average over 3 years)[1] | ↑ | 5.0 | 20 / 28 | 2.0 | 8.1 | -0.2 | -0.7 | Bulgaria: 1.4 | Denmark: 8.7 |
| A4 | Market share of world exports (% change over 5 years) | ↑ | 24.8 | 2 / 28 | 4.5 | 3.3 | -1.8 | -2.1 | Ireland: 55.1 | Greece: -18.7 |
| A5 | Net international investment position (% of GDP) | ↓ | 23.2 | 7 / 28 | -30.7 | 54.4 | 49.5 | -15.8 | Netherlands: 75.9 | Ireland: -185.3 |
| A6 | Real effective exchange rate (42 trade partners, % change over 3 years) | ↑ | -1.4 | 16 / 28 | -1.7 | -2.0 | 0.0 | -3.0 | Sweden: -8.8 | Latvia: 5.3 |
| A7 | Real GDP growth (%; average over 3 years) | ↑ | 4.6 | 3 / 28 | 1.9 | 1.7 | 1.4 | 1.1 | Ireland: 13.3 | Greece: 0.1 |
| A8 | Inflation rate (%)[2] | ↑ | 0.3 | 2 / 28 | 0.3 | 0.4 | 1.8 | 0.3 | France: 0.3 | Bulgaria: -1.3 |
| A9 | Time required to set up a company (days) | → | 16.5 | 24 / 28 | 10.4 | 10.5 | 4.0 | 3.5 | Denmark: 3 | Poland: 37 |
| A10 | Long-term government bond yields | ↑ | 0.3 | 2 / 27 | 1.1 | 0.1 | 0.5 | 0.5 | Germany: 0.1 | Greece: 8.4 |
| A11 | Regulatory capital for risk-weighted assets | ↓ | 21.7 | 7 / 28 | 18.3 | 18.3 | 18.7 | 17.1 | Estonia: 28 | Ireland: 0.2 |
| A12 | Availability of financial resources for entrepreneurs | ↓ | 2.3 | 23 / 27 | 2.7 | 2.9 | 3.2 | 2.7 | Netherlands: 3.3 | Romania: 2 |
| A13 | Employment rate of population aged 20-64 (%) | ↓ | 70.7 | 13 / 28 | 71.1 | 78.7 | 67.7 | 70.0 | Sweden: 81.2 | Greece: 56.2 |
| A14 | Unemployment rate (%) | ↑ | 6.3 | 11 / 28 | 8.5 | 4.1 | 7.8 | 10.1 | Czech Republic: 4 | Greece: 23.6 |
| A15 | Average annual level of variation in total factor productivity in the economy overall (%) | ↑ | 122.7 % | 9 / 28 | 71.7 % | 77.5 % | -9.4 % | 35.5 % | Latvia: 465% | Denmark: -26% |
| A16 | Real labour productivity per hour worked (%; average growth rate over 3 years) | ↓ | 1.6 | 10 / 28 | 0.9 | 0.7 | 1.1 | 1.8 | Ireland: 10.3 | Hungary: -0.3 |
| A17 | Nominal unit salary costs (% change over 3 years) | ↑ | -1.2 | 5 / 28 | 1.9 | 5.4 | -0.7 | 1.4 | Ireland: -19.9 | Latvia: 15.9 |
| A18 | Corporate tax rates (%) | → | 29% | 23 / 28 | 22 % | 30 % | 34 % | 33 % | Bulgaria: 10% | Malta: 35% |
| A19 | Profitability of non-financial companies (%) | ↑ | 5.9 | 28 / 28 | 10.1 | 9.5 | 8.5 | 6.3 | Ireland: 15.2 | Luxembourg: 5.9 |
| A20 | GDP/hour worked (US=100%) | ↑ | 139 % | 1 / 28 | 71 % | 97 % | 102 % | 98 % | Luxembourg: 139% | Bulgaria: 37% |
| A21 | Gross domestic R&D expenditure (% of GDP) | ↑ | 1.3 | 16 / 28 | 2.0 | 2.9 | 2.5 | 2.2 | Sweden: 3.3 | Cyprus: 0.5 |
| A22 | Share of jobs in medium-high and high-tech manufacturing sectors (% of total jobs) | → | 0.8 | 27 / 28 | 5.8 | 9.8 | 4.5 | 4.4 | Czech Republic: 11.5 | Cyprus: 0.8 |
| A23 | Entrepreneurial intent (%) | ↓ | 11.9 | 13 / 27 | 12.7 | 6.2 | 10.9 | 15.7 | Romania: 29 | Spain: 5.1 |
| A24 | Quality of the education system (average score; 1 to 7) | ↓ | 4.5 | 11 / 28 | 4.2 | 5.3 | 5.6 | 4.5 | Finland: 5.7 | Romania: 2.8 |
| A25 | Life-long learning as a % of the population aged 25-64 | ↓ | 16.8 | 6 / 28 | 10.8 | 8.5 | 7.0 | 18.8 | Sweden: 29.6 | Romania: 1.2 |

[1] Countries are ranked based on the extent to which their current account balance deviates from the average of the two thresholds set by the MIP (the aim is for the balance to be close to +1% of the GDP).
[2] Countries are ranked against the benchmark of the EU average inflation rate.
Note: the indicators in dark purple are new, the indicators in light purple have been carried over and adapted from the former scoreboard.

The economic dimension covers areas such as the stability and attractiveness of a country as well as cost-competitiveness and certain aspects of non-cost competitiveness. Luxembourg is in the leading group for most of the indicators. Five of the 25 indicators are orange, indicating that Luxembourg scores close to the EU average for these particular indicators. The number of green indicators has increased over the last few years, going up from 9 in 2011 to 14 in 2016. Conversely, the number of red indicators has decreased over the last few years, totalling 9 in 2011 and 2012 and only 5 in 2016. Luxembourg's 2016 performance is an improvement on the 2015 scores for 14 of the 25 indicators.

Chart 1
**Colour changes in the economic dimension**




## Detailed description of the economic dimension indicators

Alongside the government balance indicator (**A2** indicator), public debt (**A1**) determines the health of a Member State's public finances. Luxembourg had a gross public debt of 20% in 2016, which was one of the lowest rates in the European Union with only Estonia scoring better. Only 12 EU Member States posted figures lower than the reference value set by EU rules (60% of GDP). The Luxembourg Stability Programme predicts a slight increase in public debt from 22.2% of GDP at the end of 2017 to 22.6% of GDP in 2021. The euro area government balance was -1.5% in 2016 (-1.7% in the EU as a whole) and thus was on the right side of the -3% threshold limit. Ten Member States registered a government balance surplus in 2016: Luxembourg, Malta, Sweden, Germany, Greece, the Czech Republic, Cyprus, the Netherlands, Estonia and Lithuania. The main challenge facing European governments is ensuring the repayment of public debt while managing public spending in a manner which favours economic growth.

The economic and financial crisis has seen many European governments face major challenges. Ten-year government bond yields (**A10**) are a marker of the confidence that the financial markets have in these countries' ability to implement healthy financial policies and thus to repay invested capital. Germany is currently the country which provides the greatest reassurance for investors and is thus able to sell its bonds at the best market price, i.e. 0.1% in 2016. Luxembourg's rate was slightly higher than the German figure in 2016 at 0.3%.

The current account balance (**A3**) provides an indication of the competitiveness and trade situation in a country compared with its main trade partners. In 2016, Luxembourg's current account balance was +5% of GDP (average over 3 years). Consequently, Luxembourg's score was between the two thresholds (+6% and -4%) set by the European Commission as part of the macroeconomic imbalance procedure. The United Kingdom and Cyprus were below the lower limit of -4% in 2016 whilst Malta, Germany, Denmark and the Netherlands reported higher results than the upper limit of +6%.

The percentage change over 5 years in Luxembourg's market share of world exports (**A4**) stood at +24.8% in 2016. Only Ireland had a higher market share (+55.1%) in 2016. This indicator, which is also part of the MIP and its system of indicators, factors in structural competitiveness losses which may accumulate. A country may lose export market share not only if its exports are reduced but also if its exports do not grow at the same rate as world exports, which could see the country's global position regress.

An indicator that features in the MIP, the net international investment position as a % of GDP (**A5**), denotes whether a country's stock of foreign assets is worth more or less than the stock of domestic assets owned by foreign investors. This determines whether a country is in credit or in debt vis-à-vis the rest of the world. Luxembourg's score in 2016 was +23.2%, with the country ranking 7th out of the 28 EU Member States.

The percentage change in the real effective exchange rate over 3 years (**A6**) serves to measure price competitiveness and cost competitiveness by providing a macroeconomic comparison of domestic and foreign prices in a common currency using a price or cost indicator to account for inflation. The MIP states that a country is potentially at risk if this indicator is over +5% or under -5%. For most of the years under analysis, Luxembourg was within this range and not considered to be at risk of imbalance.

In 2016, the real GDP growth rate (average over 3 years) (**A7**) in Luxembourg was +4.6%. Only two countries outperformed Luxembourg: Malta (+6.9%) and Ireland (+13.3%). It should be borne in mind that this rate is an average rate over 3 years and thus covers the spectacular 26.3% increase in Ireland's GDP in 2015 owing to decisions taken by several major foreign economic operators to relocate to Ireland.

Since 2011, the inflation rate (**A8**) has progressed at a slower pace in Luxembourg, with the 2016 figure equating to +0.3%. Several countries posted a negative inflation rate in 2016: Bulgaria, Ireland, Spain, France, Croatia, Cyprus, Poland, Romania, Slovenia and Slovakia. This trend certainly has short-term benefits for consumers, but a prolonged period of negative inflation rates leads to deflation, a phenomenon which often results in reduced wages and deferred consumer spending. This would also mean reduced tax receipts for the public purse and a reduction in private investment in companies.

The number of days required to set up a company (**A9**) is one of the indicators used by the World Bank in its *'Doing Business'* report, which measures corporate legislation and its effective application. Luxembourg's performance is rather mediocre in comparison to the other Member States of the European Union as an average of 16.5 days are required to obtain all the paperwork necessary to set up a company. Since 2010, Luxembourg's score for this indicator has remained unchanged. In Denmark, the process of setting up a company requires an average of just 3 days. The recent creation (in 2017) in Luxembourg of the 'simplified limited liability company' status (*'SARL simplifiée'*) should contribute over time to an improvement in Luxembourg's score for this indicator. However, due to the methodology used by the World Bank[4], such an improvement might not be borne out in forthcoming editions of the *'Doing Business'* report.

With a view to ensuring the stability and robustness of the banking system, the banking regulator introduced bank solvency requirements. The regulatory capital for risk-weighted assets indicator (**A11**) pertains to capital requirements for banks in relation to their credit risk. Each asset is assigned a weighted risk to ensure the bank is not exposed to a higher level of risk than it can bear. The ratio in Luxembourg was 21.7% in 2016. The highest score was posted by Estonia (28%) with Ireland chalking up the lowest score (0.2%). Whilst on the one hand, a stable banking system has a significant impact on a country's competitiveness, it also means that banks which adhere to this ratio only offer safe loans, which does not make it easy for start-ups and SMEs to access credit. Indicator **A12**, which pertains to the availability of financial resources for small and medium-sized enterprises, was taken from the Global Entrepreneurship Monitor (GEM). Luxembourg scored below the EU average and placed 23 out of 27 countries. Entrepreneurial intent (**A23**) is also covered by the GEM study. This indicator sees Luxembourg score close to the European average with 11.92% in 2016. Romania led the standings with 29.01%.

[4] Information on the World Bank's methodology: http://www.doingbusiness.org/Methodology/Starting-a-Business

Luxembourg posted a score close to the EU average for the indicator referring to the employment rate among 20 to 64-year-olds (**A13**). In 2016, Sweden posted a score of 81.2% whilst Luxembourg's figure was 70.7%. The unemployment rate (**A14**) in Luxembourg in 2016 was 6.3%. France's unemployment rate was 10.1% in 2016, an increase on the 2006 figure of 8.8% whilst Germany posted a rate of 4.1% in 2016, a reduction on the 2006 unemployment rate of 10.1%.

Over the last few years, Luxembourg has performed very well in indicator categories relating to price and cost competitiveness. Luxembourg came in the top 10 in the European Union for average annual level of variation in total factor productivity in the economy overall (**A15**), real labour productivity per hour worked (**A16**), nominal unit salary costs (**A17**) and GDP per hour worked (**A20**). However, Luxembourg brings up the rear of the EU standings for nominal corporate tax rates (**A18**) and profitability of non-financial companies (**A19**).

Luxembourg has a very low level of gross internal R&D expenditure (**A21**), which accounted for just 1.3% of GDP in 2016, and the proportion of medium and high-tech jobs (**A22**), which was a mere 0.8% in 2016. According to the WEF, Luxembourg, which has a service-based economic structure, can harness innovation from sources other than R&D[5].

In the World Economic Forum report, one of the indicators used to measure the quality of the national education system (**A24**) derives from the response given to the following question which was asked as part of the annual survey of economic decision-makers: "How well does the education system in your country meet the needs of a competitive economy?" Luxembourg placed 11 amongst the 28 EU Member States with a score of 4.5 out of 7 (maximum score = 7). Finland led the way in 2016 with a score of 5.7.

Life-long learning among the population aged 25-64 (**A25**) is of great importance for both the employability of employees and the competitiveness of companies. The Nordic countries, i.e. Sweden, Denmark, Finland, had the highest scores for life-long learning (29.6%, 27.7% and 26.4% respectively in 2016) whilst Luxembourg posted a score of 16.8% in 2016.

[4] World Economic Forum - 'Global Competitiveness Report (GCR)' 2014-2015

## Analysis of the quality of indicators in the economic dimension

The correlations in the different dimensions can be used to determine how homogeneous the information provided by the indicators has been. A particularly close correlation between several indicators could indicate that a particular issue is over-represented.

The correlations between the indicators in the economic dimension are, for the most part, not particularly significant. The highest correlation is between real GDP growth (A7) and real labour productivity (A16).

Table 1

| | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | A9 | A10 | A11 | A12 | A13 | A14 | A15 | A16 | A17 | A18 | A19 | A20 | A21 | A22 | A23 | A24 | A25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A1** | 1.00 | | | | | | | | | | | | | | | | | | | | | | | | |
| **A2** | -0.29 | 1.00 | | | | | | | | | | | | | | | | | | | | | | | |
| **A3** | -0.15 | 0.31 | 1.00 | | | | | | | | | | | | | | | | | | | | | | |
| **A4** | -0.36 | 0.00 | 0.04 | 1.00 | | | | | | | | | | | | | | | | | | | | | |
| **A5** | -0.36 | 0.05 | 0.38 | -0.38 | 1.00 | | | | | | | | | | | | | | | | | | | | |
| **A6** | -0.14 | -0.06 | -0.14 | -0.11 | 0.28 | 1.00 | | | | | | | | | | | | | | | | | | | |
| **A7** | -0.32 | 0.11 | 0.13 | 0.89 | -0.40 | -0.29 | 1.00 | | | | | | | | | | | | | | | | | | |
| **A8** | -0.02 | -0.10 | -0.20 | 0.07 | -0.19 | -0.22 | 0.02 | 1.00 | | | | | | | | | | | | | | | | | |
| **A9** | -0.21 | -0.04 | -0.30 | 0.12 | -0.09 | -0.15 | 0.00 | 0.14 | 1.00 | | | | | | | | | | | | | | | | |
| **A10** | 0.58 | 0.03 | -0.20 | -0.16 | -0.60 | -0.27 | -0.20 | 0.21 | 0.19 | 1.00 | | | | | | | | | | | | | | | |
| **A11** | -0.40 | 0.24 | 0.00 | -0.54 | 0.58 | 0.40 | -0.61 | 0.05 | 0.05 | -0.13 | 1.00 | | | | | | | | | | | | | | |
| **A12** | -0.17 | -0.01 | 0.05 | -0.06 | 0.41 | 0.34 | 0.02 | -0.28 | -0.08 | -0.54 | 0.07 | 1.00 | | | | | | | | | | | | | |
| **A13** | -0.58 | 0.28 | 0.46 | -0.04 | 0.57 | 0.12 | 0.11 | -0.28 | -0.17 | -0.69 | 0.26 | 0.51 | 1.00 | | | | | | | | | | | | |
| **A14** | 0.69 | -0.13 | -0.33 | -0.28 | -0.56 | -0.11 | -0.25 | 0.07 | -0.04 | 0.64 | -0.17 | -0.40 | 0.76 | 1.00 | | | | | | | | | | | |
| **A15** | -0.40 | 0.03 | -0.13 | 0.50 | -0.32 | 0.06 | 0.40 | 0.25 | 0.05 | 0.00 | -0.03 | -0.3 | -0.11 | -0.05 | 1.00 | | | | | | | | | | |
| **A16** | -0.28 | 0.04 | 0.06 | 0.84 | -0.41 | -0.22 | 0.90 | 0.17 | 0.01 | -0.15 | -0.59 | -0.05 | -0.01 | -0.18 | 0.57 | 1.00 | | | | | | | | | |
| **A17** | -0.37 | 0.01 | -0.23 | -0.41 | 0.41 | 0.52 | -0.50 | -0.12 | 0.07 | -0.18 | 0.70 | 0.18 | .032 | -0.27 | 0.10 | -0.50 | 1.00 | | | | | | | | |
| **A18** | 0.41 | -0.17 | 0.01 | -0.35 | 0.48 | 0.02 | -0.39 | -0.32 | -0.11 | -0.11 | 0.03 | 0.14 | -0.14 | 0.17 | -0.49 | -0.38 | -0.05 | 1.00 | | | | | | | |
| **A19** | 0.10 | -0.15 | 0.27 | 0.38 | -0.36 | -0.10 | 0.44 | 0.20 | -0.11 | 0.21 | -0.46 | -0.13 | -0.01 | -0.05 | 0.18 | 0.44 | -0.39 | -0.48 | 1.00 | | | | | | |
| **A20** | -0.08 | 0.13 | 0.47 | 0.13 | 0.47 | -0.11 | 0.25 | -0.29 | -0.20 | -0.55 | -0.15 | 0.24 | 0.32 | -0.22 | -0.32 | 0.17 | -0.39 | 0.55 | -0.22 | 1.00 | | | | | |
| **A21** | -0.10 | 0.03 | 0.34 | -0.35 | 0.66 | -0.02 | -0.13 | -0.28 | -0.14 | -0.56 | 0.13 | 0.46 | 0.60 | -0.39 | -0.46 | -0.15 | 0.03 | 0.41 | -0.23 | 0.57 | 1.00 | | | | |
| **A22** | -0.19 | -0.18 | -0.03 | 0.08 | 0.15 | -0.13 | 0.11 | -0.10 | 0.06 | -0.28 | -0.17 | 0.11 | 0.23 | -0.42 | 0.04 | 0.06 | 0.11 | 0.02 | 0.04 | -0.13 | 0.32 | 1.00 | | | |
| **A23** | -0.20 | -0.12 | -024 | 0.38 | -0.31 | 0.17 | 0.13 | 0.18 | 0.09 | 0.23 | 0.03 | -0.28 | -0.16 | -0.15 | 0.44 | 0.25 | 0.14 | -0.37 | 0.19 | -0.44 | -0.53 | -0.12 | 1.00 | | |
| **A24** | -0.05 | 0.10 | 0.51 | -0.05 | 0.49 | 0.08 | 0.12 | -0.24 | -0.29 | -0.59 | -0.09 | 0.56 | 0.55 | -0.34 | -0.38 | 0.11 | -0.26 | 0.26 | -0.01 | 0.74 | 0.70 | -0.13 | -0.40 | 1.00 | |
| **A25** | -0.19 | 0.09 | 0.43 | -0.38 | 0.58 | -0.05 | -0.16 | -0.40 | -0.24 | -0.48 | 0.29 | 0.28 | 0.58 | -0.24 | -0.35 | -0.21 | 0.03 | 0.26 | -0.26 | 0.59 | 0.77 | -0.12 | -0.41 | 0.65 | 1.00 |

17 of the 25 indicators displayed were provided by Eurostat, which drew up a code of practice setting a standard for the development, production and dissemination of European statistics. The sources of the other 8 indicators are the World Bank, the *Global Entrepreneurship Monitoring* (GEM) study, AMECO, the European Commission, the World Economic Forum (WEF) and the International Monetary Fund (IMF). Of the 25 indicators which make up the economic dimension, 8 indicators (**A1, A3, A4, A5, A6, A14, A17** and **A21**) are used by the European Commission in the macroeconomic imbalance procedure.

14 of the indicators already featured in the former version of the scoreboard, although 4 of these have been slightly adapted to better suit the new system of indicators: the real effective exchange rate (**A6**) now takes account of 42 trade partners as supposed to 37 (alignment with the MIP scoreboard) whilst real GDP growth rate (**A7**) and real unit salary costs (**A17**) are highly volatile indicators which the social partners decided to measure over a 3-year period. Furthermore, the employment rate (**A13**) covers the population aged 20-64 (Europe 2020 strategy) as opposed to using a 15-64 age range (former Lisbon strategy indicator).

Most of the economic dimension data is readily available and is based on well-established indicators, such as unemployment rate. However, some indicators have only been developed recently, such as regulatory capital for risk-weighted assets (**A11**), for which data has only existed since 2009. Indicators pertaining to the availability of financial resources for entrepreneurs (**A12**) and entrepreneurial intent (**A23**) can be traced back to the *Global Entrepreneurship Monitor* (GEM) study, in which only some of the EU Member States participate (22 countries in 2016). Luxembourg has only participated in the study since 2013 while countries such as the United Kingdom, the Netherlands and Spain have participated in the study every year since 2005.

Table 2
**Incomplete data in the economic dimension**

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Economic dimension | 20.4% | 14.7% | 12.7% | 9.3% | 5.0% | 3.9% | 3.0% | 1.7% | 2.1% | 1.9% | 7.0% | 10.1% |

The current account balance indicator (**A3**) is part of the MIP, which states that a country is potentially at risk if it has a current account balance with a deficit greater than -4% of GDP (lower threshold) or a surplus greater than +6% of GDP (upper threshold). It is therefore difficult to draw up country rankings. The ESC decided to rank countries based on the extent to which a country's current account balance differs from the average of the two thresholds, hence the objective is to be as close to +1% of GDP as possible.

Furthermore, the inflation rate indicator (**A8**) posed a similar problem and does not feature in the MIP scoreboard. Neither negative inflation nor an excessively high rate of inflation is desirable. The ESC opted to take the EU average figure as a reference and rank countries based on the difference between the national rate and the EU average rate.

# 3.4 Social dimension

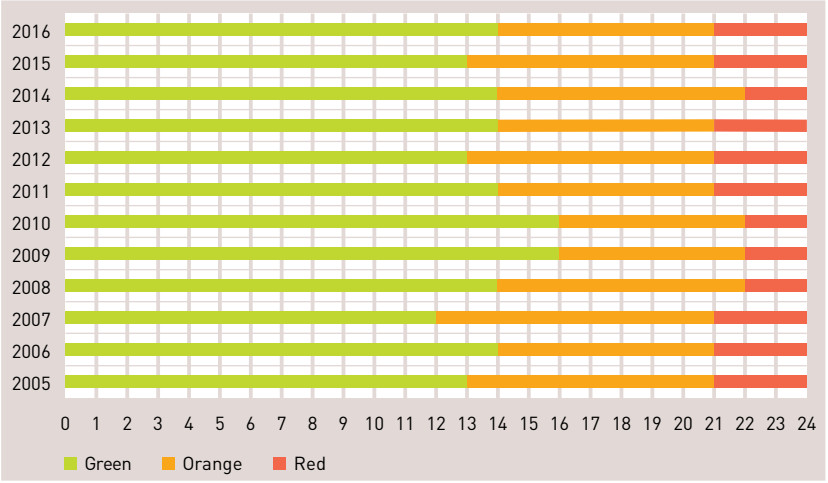
| | | Trend | LU | Position | EU Average | DE | BE | FR | First | Last |
|---|---|---|---|---|---|---|---|---|---|---|
| B1 | Long-term unemployment rate (%) | ↓ | 2.2 | 9 / 28 | 4.0 | 1.7 | 4.0 | 4.3 | Sweden: 1.3 | Greece: 17 |
| B2 | Risk of in-work poverty (%) | ↓ | 11.9 | 25 / 28 | 9.5 | 9.6 | 4.7 | 7.5 | Finland: 3.1 | Romania: 18.6 |
| B3 | Proportion of employees with fixed-term contracts (%) | ↑ | 7.4 | 10 / 28 | 11.2 | 10.1 | 7.4 | 13.3 | Romania: 1 | Poland: 21.6 |
| B4 | Young people not in employment, education or training (NEET) (%) | ↑ | 5.4 | 2 / 28 | 11.5 | 6.6 | 9.9 | 11.9 | Netherlands: 4.6 | Italy: 19.9 |
| B5 | Involuntary part-time work (%) | ↑ | 11.7 | 5 / 28 | 28.5 | 12.1 | 8.8 | 44.4 | Belgium: 8.8 | Greece: 72.3 |
| B6 | Employees with involuntary long hours | → | 35.0 | 24 / 28 | 30.0 | 30.0 | 28.0 | 32.0 | Lithuania: 16 | Sweden: 52 |
| B7 | Change in employment rate compared to the previous year (%) | ↑ | 3.0 | 2 / 28 | 1.2 | 1.2 | 1.3 | 0.6 | Malta: 3.5 | Romania: -0.9 |
| B8 | Individuals having prematurely left education and training | ↑ | 5.5 | 5 / 28 | 10.7 | 10.2 | 8.8 | 8.8 | Croatia: 2.8 | Malta: 19.6 |
| B9 | Level of higher education amongst 30 to 34-year-olds | ↑ | 54.6 | 2 / 28 | 39.1 | 33.2 | 45.6 | 43.6 | Lithuania: 58.7 | Romania: 25.6 |
| B10 | School year repetition rate (%) | ↑ | 30.9 | 25 / 28 | 12.0 | 18.1 | 34.0 | 22.1 | Croatia: 1.6 | Belgium: 34 |
| B11 | Median income (% change from previous year) | ↓ | 2.8 | 13 / 28 | 2.0 | 4.7 | 3.0 | 1.0 | Estonia: 9.3 | Sweden: -5.5 |
| B12 | Median income expressed in purchasing power standard | ↓ | 29,285 | 1 / 28 | 15,016 | 20,365 | 20,820 | 19,885 | Luxembourg: 29,285 | Romania: 4,720 |
| B13 | Gender wage gap | ↓ | 5.5 | 1 / 28 | 16.3 | 22.0 | 6.5 | 15.8 | Italy and Luxembourg: 5.5 | Estonia: 26.9 |
| B14 | Wage changes (%) in the economy (real ULC), over 3 years | ↑ | -1.0 | 23 / 28 | -0.5 | 0.0 | -1.2 | -0.1 | Latvia: 4.1 | Ireland: -7.3 |
| B15 | Household debt (consolidated) | ↓ | 58.1 | 18 / 27 | 53.9 | 53.0 | 58.7 | 55.7 | Romania: 16.8 | Cyprus: 127.7 |
| B16 | Net wealth per household (in EUR k) | ↑ | 768 | 1 / 20 | 218 | 214 | 330 | 243 | Luxembourg: 768.4 | Latvia: 40 |
| B17 | At-risk-of-poverty rate after social transfers (%) | ↓ | 16.5 | 15 / 28 | 17.3 | 16.7 | 15.5 | 13.6 | Czech Republic: 9.7 | Romania: 25.3 |
| B18 | Serious material deprivation rate (%) | → | 2.0 | 2 / 28 | 7.8 | 3.9 | 5.5 | 4.4 | Sweden: 0.7 | Bulgaria: 31.9 |
| B19 | Gini index (income inequality) | ↓ | 31 | 17 / 28 | 31.0 | 30.1 | 26.3 | 29.2 | Slovakia: 23.7 | Bulgaria: 38.3 |
| B20 | Effectiveness of social transfers (difference between the at-risk-of-poverty rate before and after social transfers) | ↑ | 29.4 | 8 / 28 | 27.4 | 27.2 | 28.7 | 30.7 | Hungary: 33.1 | Estonia: 18.1 |
| B21 | Individuals living in over-crowded accommodation (% of the total population) | ↓ | 6.8 | 8 / 28 | 16.7 | 7.0 | 3.7 | 7.4 | Cyprus: 1.4 | Romania: 48.4 |
| B22 | Incidence of housing cost being over 25% of household revenue (owners and tenants) | ↓ | 21.3 | 4 / 28 | 34.0 | 43.8 | 30.2 | 24.5 | Malta: 12.5 | Greece: 74.4 |
| B23 | Delinquency, violence or vandalism in the surrounding area | ↑ | 14.9 | 24 / 28 | 13.6 | 13.8 | 13.4 | 14.2 | Croatia: 2.8 | Bulgaria: 25 |
| B24 | Healthy life expectancy | ↑ | 62.2 | 14 / 28 | 63.0 | 66.4 | 64.2 | 63.6 | Sweden: 73.9 | Latvia: 53 |

The social dimension seeks notably to ascertain developments in the standard of living, quality of life, well-being and social cohesion in Luxembourg. The indicators in this dimension primarily cover the labour market, education, income, assets and private indebtedness, social inequality and living conditions.

In 2016, 14 of the 24 available indicators are green, which means that Luxembourg's performance in these areas was at least 20% above the EU average. Seven indicators are displayed in orange whilst three are red. There were fewer colour changes in the social dimension than in the economic dimension given that the social dimension is more structural than cyclical in nature.

As far as upward and downward trends are concerned, it is interesting to note that Luxembourg's score improved on the previous year's performance for 12 of the 24 indicators.

Chart 2
**Colour changes in the social dimension**



## Detailed description of the social dimension indicators

In Luxembourg, the rate of long-term unemployment (**B1**), which notably affects jobseekers with low levels of qualifications, was 2.2% in 2016. This rate is relatively low when compared to other countries but has nevertheless risen over the last few years. In 2014, ADEM and the University of Luxembourg (Life-long Learning and Guidance institute) signed an agreement seeking to combat long-term unemployment. An initial assessment of the effectiveness of the agreement was presented in March 2017[6] as part of a research project on the profiles of Luxembourg jobseekers. The project sought to ensure the early detection of individuals with a greater risk of becoming long-term unemployed so that they can be offered more appropriate and better-tailored labour market reinsertion assistance.

Involuntary part-time work (**B5**) tends to oscillate depending on the unemployment rate, which indicates that individuals are obliged to work part-time rather than being allowed to work full-time during economic slumps. In Luxembourg, the involuntary part-time rate was 11.7% in 2016. Greece posted a score of 72.3% in 2016 whilst Belgium recorded the lowest rate, i.e. 8.8%.

Luxembourg performed very strongly compared to the other EU Member States for the change in employment rate (**B7**) indicator. In 2016, the employment rate increased by 3% compared to the previous year. Only Malta was able to outdo Luxembourg, posting a 3.5% growth in its employment rate.

In 2016, the share of workers with fixed-term contracts (**B3**) was 11.2% in the EU 28. In France, 13.3% of workers had fixed-term contracts whilst 10% of their German counterparts found themselves in the same position. In Luxembourg and in Belgium, the rate was 7.4% in 2016. In the other EU Member States, the proportion of employees with a fixed-term contract ranged from 21.6% in Poland to a mere 1% in Romania. The considerable variations between Member States are due to labour supply and demand, company growth forecasts and procedures set out in labour law pertaining to recruitment and dismissal of staff.

Luxembourg's performance in the indicators assessing household income was mixed. The median income after social transfers (**B12**) was the highest in the EU (EUR 29,258 in purchasing power standard) and rose by 2.1% over a 12-month period (**B11**), but Luxembourg ranked 25th for the risk of in-work poverty (**B2**) indicator with a score of 11.9%. The risk of in-work poverty indicator measures the proportion of people who are working but have an available income that is lower than the at-risk-of-poverty threshold, which is fixed at 60% of the median national available income (after social transfers).

The Gini index (**B19**) measures income inequality. A score of 0 would mean that all the population has the same revenue (perfect equality) whereas a score of 1 refers to a situation where a single individual earns the entirety of the income whilst everyone else has an income of 0 (total inequality). In 2016, Luxembourg's Gini coefficient was 31, close to the European average. Slovakia posted the lowest Gini coefficient (23.7) whilst the largest income disparity in the European Union is to be found in Bulgaria.

[6] https://wwwfr.uni.lu/flshase/actualites/bilan_positif_pour_la_collaboration_entre_l_uni_et_l_adem

The percentage change in real ULC over 3 years (**B14**) improved slightly compared to the previous year and Luxembourg's score was close to the EU average. This indicator compares real labour costs and productivity expressed in volume. It presupposes 'price setter' behaviour and is identical to the wage share of GDP.

The at-risk-of-poverty after social transfers (**B17**) score was worse than that of the previous year with Luxembourg's figure for 2016 being 16.5%. Between 2013 and 2014, Luxembourg's at-risk-of-poverty rate rose by 0.5 percentage points (pp) before falling 0.9 pp in 2015 to 15.3%. Between 2005 and 2015, the at-risk-of-poverty rate remained relatively stable in the EU 28, increasing slightly from 16% to 17.3%.

In the EU-SILC survey, the rate of material deprivation (**B18**) indicator refers to the inability to procure certain goods and services which most individuals deem to be necessary for an acceptable standard of living. A distinction is therefore made between individuals who are unable to procure certain goods and services and those who don't have them for other reasons such as not wanting them or not deeming them necessary. Luxembourg ranked 2nd behind Sweden for this indicator.

In 2015, 16.7% of the EU population lived in overcrowded accommodation (**B21**). The highest rates of overcrowding amongst the EU Member States were in Romania (48.4%) and Poland (43.4%), whilst Cyprus (1.4%) and Belgium (1.6%), the Netherlands (3.3%), Ireland (3.4%) and Malta (3.5%) had the lowest rates of overcrowding. The rate of overcrowding in Luxembourg in 2015 was 6.8%

In 2015, 21.3% of the Luxembourg population faced housing costs that were more than 25% of the available household income (owners and tenants) (**B22**). In the 2005-2015 period, the rate remained relatively stable in Luxembourg. Some countries, such as Bulgaria, Croatia and Hungary, were able to reduce their scores by 55.7 pp, 40.6 pp and 29.5 pp respectively. However, the figure in Greece rose by 35 pp between 2005 and 2015.

Household debt (**B15**) refers to liabilities incurred by households. Private sector debt is calculated based on credit. These data are presented in consolidated terms; hence they exclude transactions between units in the same sector. The indicator for Luxembourg is orange and is therefore close to the EU average.

Net household wealth (**B16**) measures the difference between real and financial assets on the one hand and liabilities such as loans and mortgages on the other. Luxembourg topped the EU rankings with a net wealth of EUR 768,400.

Whilst the proportion of young people not in employment, education or training (NEETs) (**B4**) remained reasonably stable in the EU between 2005 and 2015, there have been significant changes in some Member States over the last decade. The greatest reductions in the NEET percentage were recorded in Bulgaria (-6.9 pp), the Czech Republic (-6.3 pp), Germany (-4.3 pp), Sweden (-4 pp), Cyprus (-3.6 pp), Slovakia (-3.5 pp), Poland (-3.4 pp) and Malta (-3.3 pp). However, the NEET rate increased significantly in Italy (+2.8 pp), the United Kingdom (+2.5 pp) and Ireland (+2.1 pp) over the same period.

Individuals having prematurely left education or training (**B8**) is an education indicator which provides key information for the Europe 2020 strategy objectives. Luxembourg's figure for 2016 was 5.5%. It should be noted that these data are taken from the Community Labour Force Survey (LFS) and that this indicator is not a full reflection of the situation in Luxembourg due to the limited sampling carried out in Luxembourg for the LFS. Luxembourg's National Education Ministry uses an additional method to calculate early school-leaving rates. On average, 140 students drop out every month in Luxembourg. 48.7% of early school leavers say that their reason for dropping out is that they were unable to find an apprenticeship or access the training course they wanted to pursue.

In 2016, the percentage of the population aged 30-34 with a higher education qualification (**B9**) was 54.6% in Luxembourg, with the country ranking 2nd amongst the 28 EU Member States. Lithuania was the only country to perform better than Luxembourg, posting a score of 58.7%. The lowest rate in the EU in 2016 was in Romania (25.6%).

The school year repetition rate (**B10**) is one of the three indicators classified in red for Luxembourg, which posted a score of 34.5% in 2016. The lowest rate was in Lithuania (2.5% in 2016).

The indicator labelled 'delinquency, violence or vandalism in the surrounding area' (**B23**) measures a population's sense of insecurity and is taken from the EU-SILC study on well-being, which measures levels of satisfaction in a range of specific areas. Luxembourg posted a score of 14.6% for this indicator in 2015 whilst Bulgaria registered the highest score.

Healthy life expectancy (**B24**) stood at 62.2 years in 2016, earning Luxembourg 14th place in the EU rankings. This indicator measures the number of years that a person of a specific age should be able to live without moderate or severe health problems. This indicator is also known as 'disability-free life expectancy'. Therefore, this is a composite indicator which combines mortality and health data. In 2016 Sweden and Malta posted healthy life expectancy rates of 73.9 years and 73.6 years respectively and thus scored better than the other EU countries by almost 10 years.

Luxembourg shared top spot with Italy for the gender pay gap (**B13**) indicator. The gap was 5.5% in Luxembourg whilst the EU average was 16.3%. It should be noted that the data only span industry, construction and services and do not cover public administration, defence or mandatory social security.

## Analysis of the quality of indicators in the social dimension

There are no strong correlations in the social dimension. Only a few indicators overlap, such as the NEETs indicator (B4), which has a correlation of over 0.7 with involuntary part-time work (B5) and the severe material deprivation rate (B18).

Table 3

| | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 | B9 | B10 | B11 | B12 | B13 | B14 | B15 | B17 | B18 | B19 | B20 | B21 | B22 | B23 | B24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **B1** | 1.00 | | | | | | | | | | | | | | | | | | | | | | |
| **B2** | 0.37 | 1.00 | | | | | | | | | | | | | | | | | | | | | |
| **B3** | 0.19 | -0.13 | 1.00 | | | | | | | | | | | | | | | | | | | | |
| **B4** | 0.59 | 0.48 | 0.00 | 1.00 | | | | | | | | | | | | | | | | | | | |
| **B5** | 0.69 | 0.57 | 0.12 | 0.83 | 1.00 | | | | | | | | | | | | | | | | | | |
| **B6** | -0.06 | -0.29 | 0.23 | -0.37 | -0.17 | 1.00 | | | | | | | | | | | | | | | | | |
| **B7** | 0.04 | -0.27 | 0.13 | -0.27 | -0.14 | 0.29 | 1.00 | | | | | | | | | | | | | | | | |
| **B8** | 0.04 | 0.43 | -0.12 | 0.32 | 0.31 | -0.17 | 0.00 | 1.00 | | | | | | | | | | | | | | | |
| **B9** | -0.11 | -0.21 | 0.00 | -0.42 | -0.17 | 0.39 | 0.27 | -0.54 | 1.00 | | | | | | | | | | | | | | |
| **B10** | 0.09 | 0.13 | 0.26 | -0.14 | -0.05 | 0.02 | 0.20 | 0.28 | 0.01 | 1.00 | | | | | | | | | | | | | |
| **B11** | -0.25 | 0.00 | -0.32 | -0.26 | -0.42 | -0.28 | -0.12 | 0.09 | -0.02 | 0.06 | 1.00 | | | | | | | | | | | | |
| **B12** | -0.34 | -0.42 | 0.15 | -0.61 | -0.49 | 0.55 | 0.39 | -0.24 | 0.45 | 0.46 | -0.13 | 1.00 | | | | | | | | | | | |
| **B13** | -0.10 | -0.23 | -0.14 | -0.29 | -0.17 | 0.09 | -0.08 | -0.06 | 0.01 | -0.14 | 0.16 | -0.05 | 1.00 | | | | | | | | | | |
| **B14** | -0.04 | 0.25 | -0.26 | -0.06 | 0.02 | -0.39 | -0.38 | 0.00 | 0.00 | -0.20 | 0.10 | -0.33 | 0.31 | 1.00 | | | | | | | | | |
| **B15** | 0.01 | -0.30 | 0.40 | -0.28 | 0.00 | 0.64 | 0.30 | -0.12 | 0.43 | 0.19 | -0.33 | 0.55 | 0.07 | -0.25 | 1.00 | | | | | | | | |
| **B17** | 0.41 | 0.77 | -0.22 | 0.63 | 0.53 | -0.38 | -0.37 | 0.42 | -0.18 | -0.03 | 0.16 | -0.60 | -0.19 | 0.26 | -0.40 | 1.00 | | | | | | | |
| **B18** | 0.44 | 0.58 | -0.36 | 0.74 | 0.66 | -0.48 | -0.33 | 0.25 | -0.33 | -0.30 | -0.17 | -0.76 | -0.18 | 0.21 | -0.40 | 0.65 | 1.00 | | | | | | |
| **B19** | 0.36 | 0.70 | -0.22 | 0.56 | 0.59 | -0.40 | -0.29 | 0.35 | -0.01 | -0.03 | 0.13 | -0.55 | 0.00 | 0.32 | -0.21 | 0.89 | 0.66 | 1.00 | | | | | |
| **B20** | 0.09 | -0.19 | 0.27 | -0.18 | -0.03 | 0.45 | 0.16 | -0.25 | 0.05 | 0.28 | -0.35 | 0.43 | -0.09 | -0.48 | 0.22 | -0.54 | -0.24 | -0.55 | 1.00 | | | | |
| **B21** | 0.15 | 0.44 | -0.21 | 0.50 | 0.31 | -0.54 | -0.52 | 0.02 | -0.46 | -0.44 | 0.07 | -0.77 | -0.17 | 0.41 | -0.67 | 0.47 | 0.69 | 0.33 | -0.24 | 1.00 | | | |
| **B22** | 0.46 | 0.19 | 0.01 | 0.04 | 0.22 | -0.13 | -0.05 | -0.10 | -0.12 | -0.05 | -0.07 | -0.26 | 0.17 | 0.25 | 0.08 | -0.08 | 0.30 | -0.04 | 0.15 | 0.26 | 1.00 | | |
| **B23** | 0.06 | 0.30 | -0.30 | 0.23 | 0.22 | -0.18 | -0.11 | 0.41 | -0.23 | 0.32 | -0.22 | 0.12 | -0.05 | -0.05 | 0.01 | 0.15 | 0.34 | 0.24 | 0.01 | -0.08 | 0.13 | 1.00 | |
| **B24** | -0.02 | -0.07 | 0.07 | -0.06 | 0.00 | 0.49 | 0.43 | 0.24 | 0.04 | 0.12 | -0.31 | 0.36 | -0.22 | -0.54 | 0.26 | -0.14 | -0.16 | -0.16 | 0.25 | -0.41 | -0.18 | 0.29 | 1.00 |

Of the 24 indicators in this dimension, 20 are calculated by Eurostat. The data for indicator B6 (employees with involuntary long hours) were gathered by Eurofound (European Foundation for the Improvement of Living and Working Conditions) as part of a study. The school year repetition rate (**B10**) data came from the OECD database and the real unit labour cost (**B14**) information was provided by AMECO. The household wealth (**B16**) information was provided by the ECB. Of the 24 indicators in the social dimension, 5 (**B1, B4, B7, B17** and **B18**) are used by the European Commission as part of the MIP.

Eight of the 24 indicators featured in the former version of the scoreboard. However, two indicators, namely NEETs (**B4**) and involuntary part-time (**B5**), have been adapted slightly. Indicator B5 only covers involuntary part-time whilst indicator B4 only takes account of young people not in employment, education or training (the former indicator grouped together all unemployed young people).

Table 4
**Incomplete data in the social dimension**

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Social dimension | 26.8% | 21.9% | 15.3% | 15.2% | 11.5% | 13.7% | 13.4% | 8.8% | 10.6% | 12.8% | 4.9% | 45.4% |

The average figure for incomplete data in the social dimension is 16.7%. Data are generally made available only with a certain time lag, which explains why there is a data incompleteness figure of 45% for 2016.

Data for indicator **B6** (employees with involuntary long hours) were only available for 2015 and thus do not adhere to the ESC criteria, especially those aiming to ensure temporal comparability.

Data on the school year repetition rate (**B10**) are published as part of the OECD's PISA study and were only available for three calendar years (2009, 2012, 2015).

The data for indicator **B22** (housing costs more than 25% of available household income) factors in the percentage of homeowners/tenants in each Member State and the housing costs for each household. The calculation was performed by the ODC using data published by Eurostat.

# 3.5 Environment dimension

| | | Trend | LU | Position | EU Average | DE | BE | FR | First | Last |
|---|---|---|---|---|---|---|---|---|---|---|
| C1 | Energy intensity (energy consumption per GDP unit) | ↑ | 89.1 | 3 / 28 | 120.4 | 112.6 | 141.3 | 120.5 | Ireland: 62 | Bulgaria: 448.5 |
| C2 | Share of crude oil and petroleum products in total household energy consumption | ↓ | 34.1 | 26 / 28 | 12.6 | 22.0 | 33.1 | 17.0 | Slovakia: 0.2 | Ireland: 38.2 |
| C3 | Energy productivity | ↑ | 11.2 | 3 / 28 | 8.3 | 8.9 | 7.1 | 8.3 | Ireland: 16.1 | Bulgaria: 2.2 |
| C4 | Resource productivity | ↑ | 3.6 | 2 / 28 | 2.2 | 2.2 | 2.6 | 2.7 | Italy: 4 | Bulgaria: 0.6 |
| C5 | Domestic raw material consumption (RMC) (in tonnes per head) | ↓ | 21.9 | 23 / 28 | 13.2 | 16.1 | 12.9 | 11.3 | Italy: 6.9 | Finland: 30.5 |
| C6 | Renewable energy share (% of national 2020 target) | ↑ | 45.5 | 27 / 28 | 83.5 | 81.1 | 60.8 | 66.1 | Croatia: 145 | Netherlands: 41.4 |
| C7 | Greenhouse gas emission intensity | ↑ | 96.6 | 24 / 28 | 89.1 | 95.5 | 89.2 | 82.2 | Finland: 74.2 | Bulgaria: 112 |
| C8 | Waste production per head | ↑ | 12713 | 24 / 28 | 4931 | 4785 | 5838 | 4913 | Croatia: 879 | Bulgaria: 24872 |
| C9 | Municipal waste recycling rate (%) | ↑ | 48.0 | 6 / 28 | 45.0 | 66.1 | 53.4 | 39.5 | Germany: 66.1 | Malta: 6.7 |
| C10 | E-waste recycling rate (%) | ↑ | 35.4 | 14 / 28 | 34.9 | 36.0 | 28.4 | 26.3 | Bulgaria: 68.3 | Malta: 11.5 |
| C11 | Urban population exposure to air pollution (NOx concentration) | ↓ | 1545 | 5 / 25 | 3243 | 3074 | 2125 | 3573 | Romania: 495 | Greece: 7201 |
| C12 | Air: quality and satisfaction rate | ↑ | 20.7 | 10 / 26 | 22.5 | 20.3 | 21.7 | 18.2 | Finland: 13.7 | Bulgaria: 41.2 |
| C13 | Water: quality and satisfaction rate | ↓ | 1.9 | 10 / 18 | 2.2 | 0.0 | 2.2 | 1.3 | Slovenia: 1 | Romania: 4 |
| C14 | Total expenditure on environmental protection (% of GDP) | ↑ | 1.3 | 4 / 28 | 0.8 | 0.6 | 0.7 | 1.1 | Netherlands: 1.7 | Cyprus: 0.3 |
| C15 | Land protected (%) | → | 27.0 | 6 / 28 | 18.0 | 15.0 | 13.0 | 13.0 | Slovenia: 38 | Denmark: 8 |
| C16 | Eco-innovation Index | ↑ | 139.0 | 2 / 28 | 100.0 | 140.0 | 81.0 | 99.0 | Germany: 140 | Bulgaria: 41 |
| C17 | Greening (% of GDP) | ↓ | 3.5 | 17 / 19 | 5.2 | 5.5 | 8.0 | 4.0 | Estonia: 11.9 | Ireland: 1.2 |
| C18 | Number of green jobs (% of total jobs) | ↓ | 2.5 | 7 / 18 | 1.9 | 1.2 | 2.1 | 1.7 | Estonia: 3.9 | Ireland: 0.8 |
| C19 | Non-energetic material productivity | | | | | | | | | |
| C20 | Circular economy | | | | | | | | | |

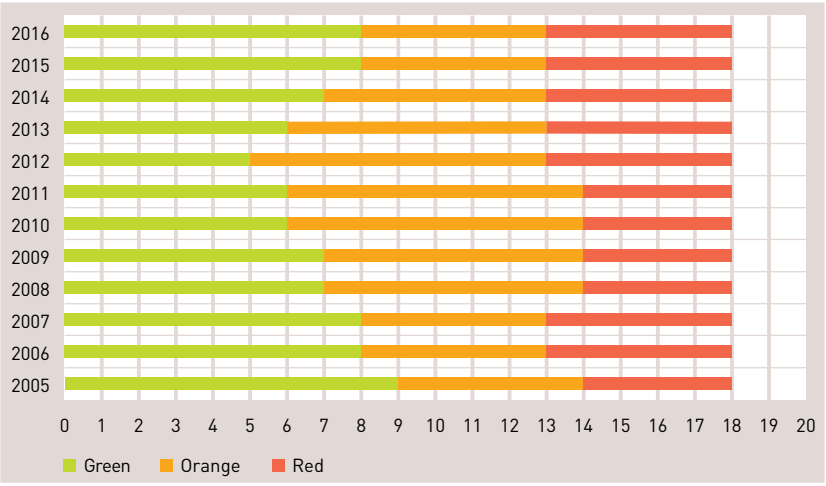
Note: the indicators shown in dark purple are new whilst those shown in light purple have been adapted from the old scoreboard.

A country's development cannot be fostered at the expense of the environment. Non-sustainable development is not only untenable in the long term but also deprives citizens of another form of wealth, namely natural heritage. Sustainable preservation of the natural environment appears to be a crucial matter and thus the environmental dimension is an integral part of the system of indicators. A range of indicators cover issues such as raw materials, energy efficiency, renewable energies, harmful emissions, waste processing, nature and the eco-system, biodiversity and the transition towards a green economy.

Luxembourg's performance is more mixed for this dimension than it was for the other two dimensions, with 5 of the 18 indicators being red in colour. This number has remained unchanged for 5 years whilst the number of green indicators increased from 5 in 2012 to 8 in 2015 and 2016. Luxembourg was able to improve its performance in 11 indicators pertaining to the environment over the last year.

It should be noted that for the bigger part of the indicators, the most recent data were from 2014 or 2015.

Chart 3
**Colour change in the environment dimension**



### Detailed description of the environment dimension indicators

As part of the Europe 2020 strategy, the European Council set the following European objective: *"reducing greenhouse gas emissions by 20% compared to 1990 levels; increasing the share of renewables in final energy consumption to 20%; and moving towards a 20% increase in energy efficiency"*.

The intensity of greenhouse gas emissions (**C7**) is the ratio between greenhouse gas emissions linked to energy production (carbon dioxide, methane, nitrogen oxide) and gross domestic energy consumption. This index (year 2000=100) shows that several Member States have been able to reduce their GHG emissions since 2000: Finland did so by more than 25% and hence placed 1st in the rankings. However, this index does not provide any information on the initial level of consumption. Luxembourg ranked close to the EU average with a score of 96.6 in 2015.

When it comes to the share of renewable energy in gross domestic energy consumption (% of the national 2020 objective) (**C6**), many countries had already reached their 2020 targets by 2015: Bulgaria, the Czech Republic, Denmark, Estonia, Croatia, Italy, Lithuania, Hungary, Romania, Finland and Sweden. Luxembourg achieved 45.5% of its the national 2020 target (11%) but remains on-track to meet its target.

Energy intensity refers to energy consumption per unit of GDP (**C1**). For this indicator, Luxembourg (89.1) stood alongside Denmark (65.1), Ireland (62), Italy (100.4) and Malta (90.7) as the countries with the lowest energy intensity in 2015. The highest energy intensity score was recorded in Bulgaria (448.5). Energy productivity (**C3**) is calculated by dividing the gross domestic product (GDP) by the gross domestic energy consumption over the course of a given calendar year. Therefore, it is the opposite of indicator C1.

Indicator **C2** refers to the share of crude oil and petroleum products in the total energy consumption of the residential sector. In Luxembourg, the figure was 34.1% in 2015, thus placing the country 26th among the 28 EU Member States.

To calculate the productivity of resources (**C4**) indicator, GDP is divided by the domestic consumption of raw materials. Luxembourg scored 3.55 in 2015 and topped the rankings together with Italy (4.00).

Domestic consumption of raw materials (**C5**) in Luxembourg equated to 21.9 tons per head of the population. The top-performing EU Member State was Italy with 6.9 tons per head. This indicator takes account of raw materials imported into national economies. It also covers all imported solids, liquids and gases, except for water and air. Over the last few years, the indicator levels have remained stable for most countries.

Luxembourg performed relatively poorly in terms of waste produced per head (**C8**). In 2014, Luxembourg produced around 12.7 tons of waste per head of the population. Other countries, such as Sweden, Estonia and Bulgaria, produce even more waste. Croatia (879 kg per head) produces the least waste in the EU. As regards the recycling of municipal waste (**C9**), Luxembourg managed a rate of 48% in 2015 but still trailed Germany, which achieved a recycling rate of 66.1% in 2015.

Luxembourg (35.4%) performed slightly better than the EU average (34.9% in 2014) in terms of e-waste recycling (**C10**). Posting a score of 68.1%, Bulgaria earned the top spot in the EU rankings in 2014.

The urban population exposure to air pollution (concentration of NOx emissions) (**C11**) calculates the weighted ozone concentration to which the urban population is potentially exposed. In 2014, Luxembourg registered a score of 1,545 micrograms per cubic metre per day. The indicator score is five times higher in Greece than in Luxembourg. Luxembourg's performances for air quality and satisfaction with air quality (**C12**) and water quality (**C13**) were average. Slovenia recorded the best water quality and satisfaction with water quality score in 2012 (latest available figures). The air quality indicator saw Finland and Sweden perform the best in 2014, scoring 13.7% and 14.3% respectively. Luxembourg's total expenditure on environmental protection (**C14**) is amongst the highest in the European Union with a score of 1.3% of GDP in 2012. Only the Czech Republic, Malta and the Netherlands posted a higher score.

27% of the surface area of Luxembourg is protected land (**C15**). This figure placed Luxembourg in 6th position in the EU rankings behind Slovenia, Croatia, Bulgaria, Slovakia and Cyprus.

The Eco-Innovation Observatory (EIO) defines eco-innovation as an innovation that reduces both the use of natural resources and the emission of harmful substances throughout the whole life cycle. The eco-innovation index (**C16**) and the corresponding scoreboard seek to cover the different aspects of eco-innovation through 16 indicators which span five thematic areas[7]: (1) measuring the financial and human resources earmarked for starting eco-innovation activities, (2) illustrate the extent to which companies in a given country are active in the field of eco-innovation, (3) quantify the efficiency of eco-innovation activities in patents, academic publications and the media, (4) measure efficiency whilst framing eco-innovation in the context of the efficient use of a country's resources (i.e. energy, water) and the efficiency and intensity of GHG emissions, (5) quantify the socioeconomic benefits illustrating the level at which eco-innovation can generate positive social (employment) and economic (turnover, exports) outcomes. Luxembourg placed 2nd in the rankings, just behind Germany.

Combating climate change and using natural resources in an efficient way are not only necessary for ensuring sustainable development but also provide new opportunities for the economy. Green activities (**C17**) accounted for 3.8% of Luxembourg's GDP in 2014. Estonia and Austria posted scores of 12.3% and 11.1% respectively. This not only enables new sectors of the environmental economy to emerge but also green jobs to be created. The number of green jobs as a percentage of total jobs (**C18**) refers to jobs created by commitments to protect the environment and natural resources. The figure for Luxembourg was 2.5% in 2016. Austria and Estonia once again led the way, both posting scores in excess of 3% in 2015. It should be borne in mind that several countries do not have any available data on green jobs.

[7] Source: https://ec.europa.eu/environment/ecoap/scoreboard_en

### Analysis of the quality of indicators in the environment dimension

The environment dimension is characterised by a greater level of homogeneity than the first two dimensions. Energy intensity (energy consumption per GDP unit) (**C1**) has a strong correlation with energy productivity (**C3**), which is calculated by taking GDP and dividing it by gross domestic energy consumption. This should come as no surprise as C3 and C1 can be seen as two sides of the same coin. The eco-innovation index indicator (**C16**) has a strong correlation with indicators C1, C3 and C4.

Table 5

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 | C18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **C1** | 1.00 | | | | | | | | | | | | | | | | | |
| **C2** | -0.58 | 1.00 | | | | | | | | | | | | | | | | |
| **C3** | -0.84 | 0.59 | 1.00 | | | | | | | | | | | | | | | |
| **C4** | -0.74 | 0.67 | 0.66 | 1.00 | | | | | | | | | | | | | | |
| **C5** | 0.41 | -0.12 | -0.14 | -0.57 | 1.00 | | | | | | | | | | | | | |
| **C6** | 0.65 | -0.76 | -0.55 | -0.88 | 0.46 | 1.00 | | | | | | | | | | | | |
| **C7** | 0.57 | -0.13 | -0.48 | -0.21 | 0.06 | 0.19 | 1.00 | | | | | | | | | | | |
| **C8** | 0.73 | -0.16 | -0.40 | -0.29 | 0.50 | 0.30 | 0.54 | 1.00 | | | | | | | | | | |
| **C9** | -0.55 | 0.48 | 0.43 | 0.59 | -0.46 | -0.45 | -0.32 | -0.30 | 1.00 | | | | | | | | | |
| **C10** | 0.32 | -0.12 | -0.02 | -0.18 | 0.11 | 0.40 | 0.66 | 0.38 | -0.07 | 1.00 | | | | | | | | |
| **C11** | -0.11 | -0.06 | -0.05 | -0.03 | -0.33 | 0.16 | -0.23 | -0.23 | 0.61 | 0.09 | 1.00 | | | | | | | |
| **C12** | 0.63 | -0.42 | -0.58 | -0.51 | 0.07 | 0.35 | 0.67 | 0.45 | -0.19 | 0.36 | 0.10 | 1.00 | | | | | | |
| **C13** | 0.43 | -0.35 | -0.48 | -0.44 | 0.18 | 0.24 | 0.49 | 0.31 | -0.47 | -0.01 | -0.31 | 0.68 | 1.00 | | | | | |
| **C14** | -0.06 | 0.32 | -0.03 | 0.49 | -0.11 | -0.47 | 0.27 | 0.19 | -0.16 | -0.08 | -0.30 | -0.27 | -0.11 | 1.00 | | | | |
| **C15** | 0.49 | -0.03 | -0.45 | -0.25 | 0.17 | 0.15 | 0.46 | 0.51 | -0.01 | 0.10 | 0.12 | 0.52 | 0.24 | 0.13 | 1.00 | | | |
| **C16** | -0.83 | 0.45 | 0.75 | 0.73 | -0.20 | -0.52 | -0.52 | -0.46 | 0.57 | -0.23 | 0.14 | -0.65 | -0.58 | 0.24 | -0.26 | 1.00 | | |
| **C17** | 0.16 | -0.38 | -0.25 | -0.43 | 0.39 | 0.52 | -0.42 | -0.03 | 0.07 | -0.18 | 0.24 | -0.14 | -0.06 | -0.46 | -0.31 | -0.03 | 1.00 | |
| **C18** | 0.08 | -0.23 | -0.27 | -0.29 | 0.33 | 0.36 | -0.29 | -0.12 | 0.25 | -0.15 | 0.44 | -0.13 | -0.20 | -0.19 | -0.05 | 0.16 | 0.81 | 1.00 |

Most of the indicators are new, with only indicators C1, C6 and C7 having featured on the old scoreboard. Indicators C6 and C7 have undergone slight alterations: renewable energy (**C6**) is now assessed in relation to the national Europe 2020 target and no longer expressed as a percentage of total energy. Indicator **C7** does not only cover greenhouse gas emissions but also indicates the intensity, i.e. the ratio of emissions to gross domestic energy consumption.

Table 6
**Incomplete data in the environment dimension**

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aspect Environnement | 25.4% | 20.2% | 25.0% | 16.8% | 19.8% | 8.9% | 13.6% | 7.7% | 21.3% | 15.9% | 40.5% | 75.0% |

In the environment dimension, data for 2016 were only available for three indicators: the share of renewable energy (**C6**), the indicator on protected land (**C15**) and the eco-innovation index (**C16**). Other indicators have only existed for a few years or are in the process of being adapted. Worthy of mention is the fact that the UN adopted 17 sustainable development goals in September 2015 with new indicators to measure progress. These indicators could also serve as a source of inspiration for indicators to be adapted in the future.

Data on waste production per head (**C8**) were only available for one year in every two, i.e. 2006, 2008, 2010, 2012, 2014.

Indicators **C13** (water: quality and satisfaction with water quality) and **C14** (total expenditure on environmental protection) have not been updated since 2012.

For indicator **C19** (non-energetic material productivity), the ODC did not find any data compliant with the criteria set by ESC, especially in terms of ensuring temporal and spatial comparability at EU level.

The circular economy (indicator **C20**) is a very complex issue. There is a European definition of the term but standards and indicators to measure it are yet to be established.

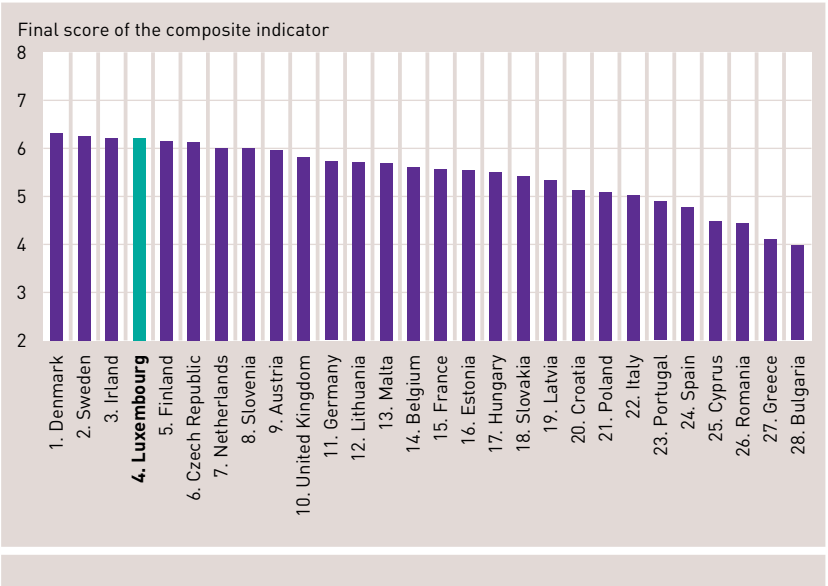
# 3.6 Competitiveness composite indicator

## 3.6.1 Overall result

A composite indicator can be used to summarise the performances of a country for the various indicators under the three different dimensions of Economy, Social and Environment, with all the pros and the cons that this entails. Often appreciated by the media, appreciating instantaneous compact information, such a composite indicator - and the country rankings which are drawn up as a result - cannot replace a serious and detailed analysis, looking more specifically at the individual indicators, sectors and areas of activity. On the contrary the composite indicator should in fact prompt readers to consult the base data used in greater detail.

In the ODC's composite indicator calculated based on the new national system of indicators for the year 2016, Luxembourg ranked 4th among the EU-28, behind Denmark, Sweden and Ireland. Germany was 11th, Belgium 14th and France 15th in the overall rankings. Bulgaria found itself in last place.

Chart 4
**Overall result**




The country rankings varied only slightly from 2015 to 2016, with Luxembourg maintaining the same position. The countries which recorded the biggest changes were Italy, falling 2 places to 22nd position, and Malta, which moved forward three places from 16th to 13th place.

The ODC not only analysed the data for 2016, but also recalculated the overall rankings under the new system of national indicators for the years 2005 to 2015. Denmark stayed at the top of table throughout this entire period. Overall, Luxembourg made positive progress throughout these ten years, improving its position almost continually (apart from in 2012) from its ranking at 10th place in 2006, climbing to 4th place in 2015 and 2016, and even reaching 3rd place in 2014.

Different degrees of variations in the country rankings can be observed over the years. If we compare the situation in 2016 to that of 2005, Austria and Italy fell the furthest down the scoreboard. While Austria suddenly fell by several places from 4th to 9th in 2015 alone, Italy's decline from 17th to 22nd place was a slower process. Croatia (-4 places) and Cyprus (-4 places) also fell a considerable number of places during this period. Conversely, other countries considerably improved their position in the overall rankings, including Hungary (from 23rd to 17th place), Lithuania (18th to 12th) and the Czech Republic (11th to 6th).

Table 7
**Overall rankings from 2005 to 2016**

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Germany | 14 | 11 | 12 | 11 | 11 | 10 | 9 | 6 | 10 | 14 | 11 | 11 |
| Austria | 4 | 4 | 4 | 3 | 2 | 3 | 3 | 2 | 2 | 4 | 9 | 9 |
| Belgium | 10 | 12 | 10 | 8 | 8 | 7 | 7 | 9 | 8 | 10 | 13 | 14 |
| Bulgaria | 27 | 28 | 27 | 28 | 27 | 25 | 27 | 27 | 27 | 27 | 27 | 28 |
| Cyprus | 21 | 21 | 19 | 20 | 20 | 21 | 22 | 25 | 26 | 26 | 26 | 25 |
| Croatia | 16 | 17 | 17 | 17 | 16 | 19 | 19 | 21 | 21 | 21 | 21 | 20 |
| Denmark | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Spain | 22 | 23 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 24 | 24 |
| Estonia | 15 | 14 | 16 | 16 | 17 | 18 | 14 | 13 | 16 | 16 | 15 | 16 |
| Finland | 2 | 3 | 3 | 2 | 4 | 6 | 6 | 3 | 4 | 5 | 6 | 5 |
| France | 12 | 13 | 13 | 13 | 13 | 13 | 12 | 14 | 13 | 13 | 14 | 15 |
| Greece | 26 | 26 | 26 | 27 | 25 | 28 | 28 | 28 | 28 | 28 | 28 | 27 |
| Hungary | 23 | 22 | 24 | 22 | 21 | 17 | 16 | 19 | 17 | 17 | 17 | 17 |
| Ireland | 6 | 6 | 8 | 12 | 14 | 14 | 13 | 15 | 11 | 11 | 2 | 3 |
| Italy | 17 | 18 | 20 | 19 | 18 | 15 | 20 | 20 | 20 | 20 | 20 | 22 |
| Latvia | 19 | 19 | 21 | 25 | 28 | 27 | 23 | 17 | 18 | 19 | 19 | 19 |
| Lithuania | 18 | 16 | 14 | 18 | 22 | 24 | 18 | 12 | 12 | 9 | 12 | 12 |
| **Luxembourg** | **8** | **10** | **6** | **6** | **5** | **4** | **4** | **7** | **5** | **3** | **4** | **4** |
| Malta | 13 | 15 | 15 | 14 | 12 | 12 | 15 | 16 | 15 | 15 | 16 | 13 |
| Netherlands | 5 | 5 | 5 | 5 | 6 | 5 | 5 | 5 | 6 | 8 | 7 | 7 |
| Poland | 24 | 24 | 22 | 21 | 15 | 20 | 17 | 22 | 22 | 22 | 22 | 21 |
| Portugal | 25 | 25 | 25 | 24 | 24 | 22 | 25 | 23 | 23 | 23 | 23 | 23 |
| Romania | 28 | 27 | 28 | 26 | 26 | 26 | 26 | 26 | 25 | 25 | 25 | 26 |
| United Kingdom | 7 | 7 | 11 | 10 | 9 | 9 | 11 | 11 | 9 | 12 | 10 | 10 |
| Czech Republic | 11 | 9 | 9 | 9 | 10 | 11 | 10 | 10 | 7 | 6 | 5 | 6 |
| Slovakia | 20 | 20 | 18 | 15 | 19 | 16 | 21 | 18 | 19 | 18 | 18 | 18 |
| Slovenia | 9 | 8 | 7 | 7 | 7 | 8 | 8 | 8 | 14 | 7 | 8 | 8 |
| Sweden | 3 | 2 | 2 | 4 | 3 | 2 | 2 | 4 | 3 | 2 | 3 | 2 |

The methodology for calculating the composite indicator based on this new national system of indicators remains unchanged. The previous TBCO composite indicator was calculated in the same way. Please see below for a reminder of the calculation methodology.

Frame
**Methodology**

The methodology for calculating the composite indicator is not different from the one used in the former scoreboard and we take the recommendations made by the audit into account (2010 Competitiveness Report, Perspectives économiques No. 15).

In order to address the problem of missing values, the 'hot-deck imputation' method is used. The idea is to estimate a country's missing values based on the values of a country that shows a similar performance for the other indicators in the same dimension.

For some indicators, there are outliers[8]. The real GDP growth rate (A7), real labour productivity per hour rate (A16) and long-term unemployment rate (B1) are three such indicators for the year 2016. For each of these indicators, there is a country that has a value significantly higher than all other countries: Ireland (A7 and A16) and Greece (B1). As these indicators are likely to influence the result too much, extreme values were replaced by the value of the country in second position.

Net wealth per household (B16) is not factored into the calculation of the composite indicator as these data were only available for 2013 and 2016, and even for those years not all countries reported their data (13 countries failed to report data in 2013 and 9 countries in 2016).

For the composite indicator calculation, basic indicators are standardized first. Each indicator is processed by the following formula by country j at time t.

$$y_{ij}^{t} = \frac{x_{ij}^{t} - \min_{j} x_{ij}^{t}}{\max_{j} x_{ij}^{t} - \min_{j} x_{ij}^{t}}$$

The composite indicator C for an aspect k (k = 1, 2, 3) at time t is calculated by averaging the sub-indicators of this aspect in the new scale:

$$C_{k,j}^{t} = \frac{1}{m_k} \sum_{i=1}^{m_k} y_{ij}^{t}$$

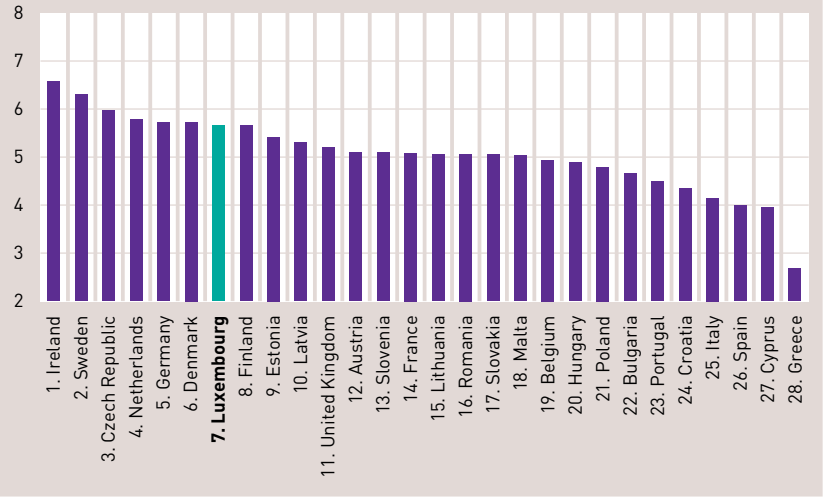
The final composite indicator CI is achieved by a simple arithmetic mean of these composite indicators.

[8] Technically, these indicators have been identified by the fact they have a very high skewness and kurtosis (skewness > 2 and kurtosis >7).

## 3.6.2 Results for the three dimensions

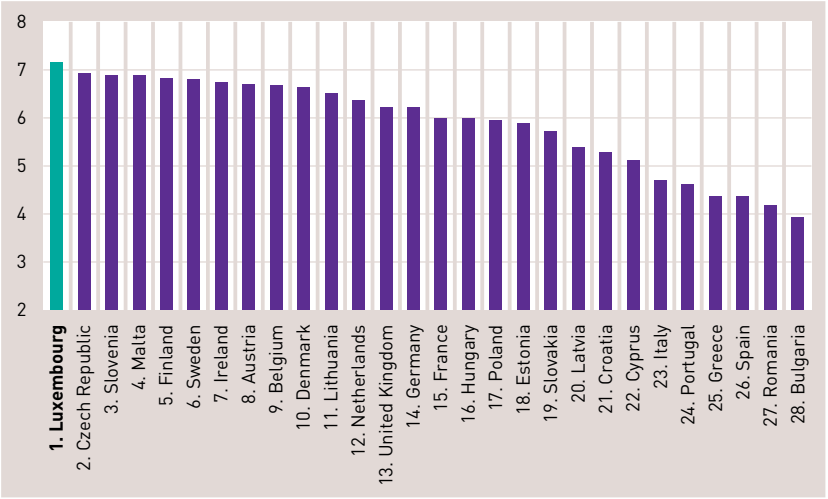
Ireland came 1st for the economic dimension, followed by Sweden, the Czech Republic, the Netherlands and Germany completing the top 5. Luxembourg came 7th, France 14th and Belgium 19th. Greece was ranked last place for this dimension.

Chart 5
**Economic dimension**



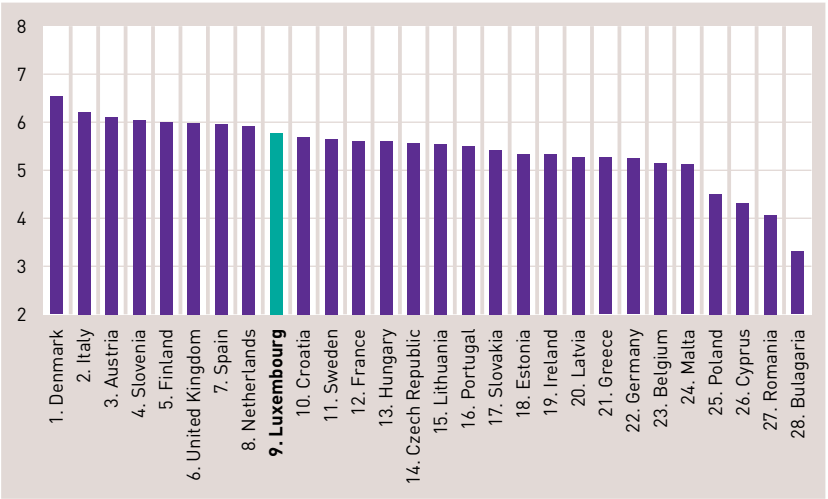

Luxembourg came in 1st place for the social dimension with a considerable lead over the Czech Republic, Slovenia, Malta, Finland and Sweden, which all finished very close together. Luxembourg's neighbouring countries found themselves around the middle of the table, with Belgium in 9th place, Germany 14th and France 15th for this dimension. The bottom rungs of the rankings are mainly populated by southern European countries (Italy, Portugal, Greece, Spain, Romania and Bulgaria).

Chart 6
**Social dimension**




Denmark performed best in the environment category, with Italy and Austria completing the top 3. Luxembourg came in 9th place, which is the country's lowest ranking among the three different dimensions. Nonetheless, it still outperformed its neighbouring countries, with France ending 12th, Germany 22nd and Belgium only 23rd out of the EU-28. Bulgaria was at the bottom of the table once again.

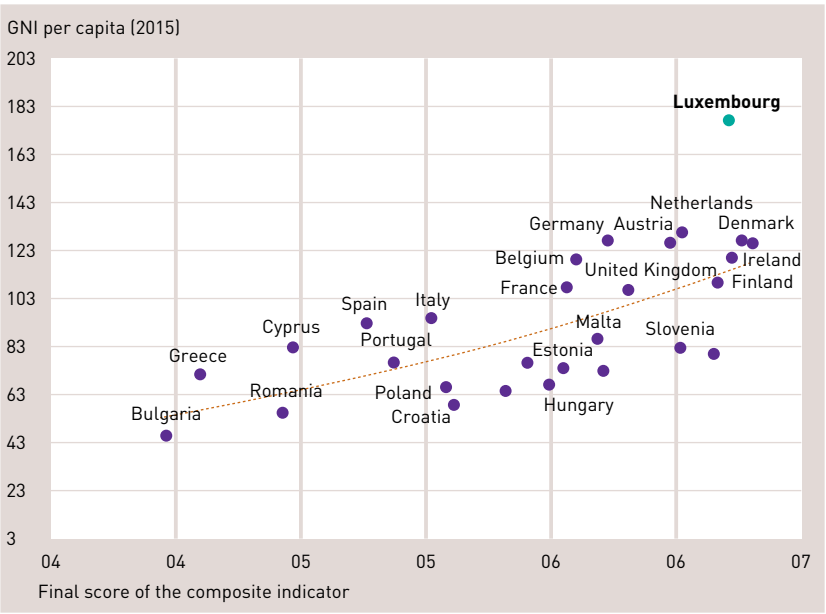
Chart 7
**Environment dimension**



## Competitiveness and wealth

When national competitiveness level (axis x – final composite indicator result according to the new system of indicators) is cross-referenced with the standard of living of the country's inhabitants (axis y – gross national income per inhabitant), a positive correlation between these two variables can be observed. Luxembourg seems to be an outlier in this respect as its wealth per inhabitant is well above the curve. The net wealth per inhabitant for Luxembourgers therefore appears to be much higher than the country's level of competitiveness would initially suggest (according to the curve).

Chart 8

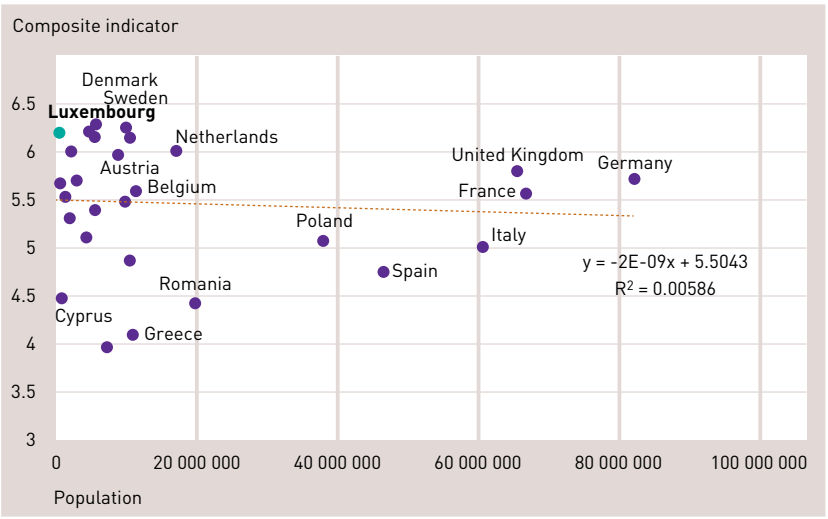



Note: Gross national income at market prices, per inhabitant in PPS (2015 data)

## Competitiveness and population size

Questions are often asked about the link between competitiveness and population size: does the population of a country affect its competitiveness level? The composite indicator results for 2016 indicate that there is no clear model for determining whether population size has a positive or negative impact on competitiveness. The correlation between the final result for the composite indicator and population size is not statistically relevant ($r^2$= 0.006), which demonstrates that the indicator has no linear link with population size. This is also true when we look at the three dimensions individually.

Chart 9




## The composite indicator stress test

The ODC carried out a stress test on its composite indicator based on the new system of indicators. The test consists in recalculating the overall rankings with one of the 66 indicators excluded from the calculation each time.

The table below reveals that Luxembourg varied between 1st and 6th place depending on the different scenarios. It came 4th in 41% of cases, 3rd in 29% of cases, 5th in 12% of cases, 2nd in 9% of cases, 6th in 8% of cases and 1st in 2% of cases. These calculations therefore demonstrate that Luxembourg's position is not static, and that the top 6 countries are all relatively close to one another. The stress test also put Denmark 1st in 82% of cases, whereas Bulgaria remained in last position in 97% of cases. Portugal stayed in 23rd place in all cases, and Spain also remained in 24th place in all scenarios.

There was significant volatility for the countries in the middle of the scoreboard, particularly those falling in at 11th-13th place (Germany, Lithuania and Malta) and 14th-17th place (Belgium, France, Estonia and Hungary).

Table 8
**The 2016 stress test, as a %**

| | Average of alternative scenarios | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Denmark | 1.21 | 82 | 15 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sweden | 2.26 | 6 | 70 | 18 | 5 | 2 | | | | | | | | | | | | | | | | | | | | | | | |
| Ireland | 3.48 | 11 | 6 | 33 | 32 | 11 | 8 | | | | | | | | | | | | | | | | | | | | | | |
| **Luxembourg** | **3.76** | **2** | **9** | **29** | **41** | **12** | **8** | | | | | | | | | | | | | | | | | | | | | | |
| Finland | 4.91 | | | 14 | 14 | 42 | 29 | 2 | | | | | | | | | | | | | | | | | | | | | |
| Czech Republic | 5.42 | | | 3 | 9 | 33 | 52 | 3 | | | | | | | | | | | | | | | | | | | | | |
| Netherlands | 7.52 | | | | | | 5 | 48 | 38 | 9 | | | | | | | | | | | | | | | | | | | |
| Slovenia | 7.67 | | | | | | | 44 | 45 | 11 | | | | | | | | | | | | | | | | | | | |
| Austria | 8.79 | | | | | | | 3 | 17 | 79 | 2 | | | | | | | | | | | | | | | | | | |
| United Kingdom | 10.03 | | | | | | | | | 2 | 94 | 5 | | | | | | | | | | | | | | | | | |
| Germany | 11.53 | | | | | | | | | | 3 | 48 | 41 | 8 | | | | | | | | | | | | | | | |
| Lithuania | 11.92 | | | | | | | | | | 2 | 38 | 32 | 24 | 5 | | | | | | | | | | | | | | |
| Malta | 12.61 | | | | | | | | | | | 9 | 26 | 61 | 5 | | | | | | | | | | | | | | |
| Belgium | 14.32 | | | | | | | | | | | | 2 | 6 | 59 | 27 | 5 | 2 | | | | | | | | | | | |
| France | 15.27 | | | | | | | | | | | | | | 9 | 58 | 30 | 3 | | | | | | | | | | | |
| Estonia | 15.45 | | | | | | | | | | | | | 2 | 21 | 14 | 58 | 6 | | | | | | | | | | | |
| Hungary | 16.85 | | | | | | | | | | | | | | 2 | 2 | 8 | 89 | | | | | | | | | | | |
| Slovakia | 18.06 | | | | | | | | | | | | | | | | | | 94 | 6 | | | | | | | | | |
| Latvia | 18.94 | | | | | | | | | | | | | | | | | | 6 | 94 | | | | | | | | | |
| Croatia | 20.24 | | | | | | | | | | | | | | | | | | | | 77 | 21 | 2 | | | | | | |
| Poland | 20.92 | | | | | | | | | | | | | | | | | | | | 20 | 68 | 12 | | | | | | |
| Italy | 21.83 | | | | | | | | | | | | | | | | | | | | 3 | 11 | 86 | | | | | | |
| Portugal | 23.00 | | | | | | | | | | | | | | | | | | | | | | | 100 | | | | | |
| Spain | 24.00 | | | | | | | | | | | | | | | | | | | | | | | | 100 | | | | |
| Cyprus | 25.32 | | | | | | | | | | | | | | | | | | | | | | | | | 68 | 32 | | |
| Romania | 25.68 | | | | | | | | | | | | | | | | | | | | | | | | | 32 | 68 | | |
| Greece | 27.03 | | | | | | | | | | | | | | | | | | | | | | | | | | | 97 | 3 |
| Bulgaria | 27.97 | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 97 |

Source: Observatoire de la compétitivité

### Comparison with the results of the former version of the competitiveness scoreboard

The new national system of indicators replaces the former version of the scoreboard (known as the TBCO) developed in 2004 by Professor Lionel Fontagné and the social partners and updated annually since then by the Observatoire de la compétitivité. The TBCO contained 77 indicators split into 10 categories, namely Macroeconomic Performance, Employment, Productivity and Labour Cost, Market Operations, Institutional and Regulatory Framework, Entrepreneurship, Education and Training, Knowledge Economy, Social Cohesion, and Environment. Some of the TBCO indicators became less relevant over time, such as rate of Internet penetration in households which in the meantime had risen to almost 100% for all Member States or the Lisbon strategy indicators which were replaced by the Europe 2020 strategy indicators. The European MIP scoreboard indicators were also missing.

However, several of the 'meta' indicators employed in the new national system of indicators were carried over from the TBCO, which goes some way towards explaining why the results for the old and new versions are similar. For most countries the differences for the past 3 years are negligible (the detailed results for 2005-2015 are displayed in the annexe to this chapter). In both versions Luxembourg came 5th in 2013, however in the new national system of indicators it came 3rd for 2014 (TBCO: 7th) and 4th for 2015 (TBCO: 8th). Some countries fare better under the new system of indicators for all years, including Austria, Belgium, Hungary, Malta and Slovenia, whereas others lost several places. This is notably the case for Bulgaria, Estonia, Latvia, Romania and the United Kingdom.

Non-OECD countries recorded the biggest variations (Bulgaria, Cyprus, Croatia, Latvia, Lithuania, Malta and Romania), which could be explained by the fact that several indicators in the previous version of the TBCO were calculated based on data drawn from the OECD database, which therefore did not contain data for these countries. With the new system of indicators, this shortfall could be remedied.

Table 9
**Comparison between the overall rankings under new national system of indicators and the former version of the scoreboard (2013-2015)**

| | 2013 | | 2014 | | 2015 | |
|---|---|---|---|---|---|---|
| | **New** | **Former** | **New** | **Former** | **New** | **Former** |
| Germany | 10 | 11 | 14 | 11 | 11 | 11 |
| Austria | 2 | 8 | 4 | 10 | 9 | 10 |
| Belgium | 8 | 18 | 10 | 17 | 13 | 19 |
| Bulgaria | 27 | 25 | 27 | 23 | 27 | 22 |
| Cyprus | 26 | 27 | 26 | 27 | 26 | 21 |
| Croatia | 21 | 24 | 21 | 24 | 21 | 26 |
| Denmark | 1 | 2 | 1 | 2 | 1 | 2 |
| Spain | 24 | 26 | 24 | 26 | 24 | 27 |
| Estonia | 16 | 7 | 16 | 9 | 15 | 9 |
| Finland | 4 | 6 | 5 | 6 | 6 | 5 |
| France | 13 | 10 | 13 | 12 | 14 | 12 |
| Greece | 28 | 28 | 28 | 28 | 28 | 28 |
| Hungary | 17 | 22 | 17 | 21 | 17 | 23 |
| Ireland | 11 | 16 | 11 | 8 | 2 | 6 |
| Italy | 20 | 20 | 20 | 19 | 20 | 20 |
| Latvia | 18 | 13 | 19 | 14 | 19 | 14 |
| Lithuania | 12 | 15 | 9 | 15 | 12 | 15 |
| **Luxembourg** | **5** | **5** | **3** | **7** | **4** | **8** |
| Malta | 15 | 23 | 15 | 25 | 16 | 25 |
| Netherlands | 6 | 3 | 8 | 3 | 7 | 3 |
| Poland | 22 | 19 | 22 | 16 | 22 | 18 |
| Portugal | 23 | 21 | 23 | 22 | 23 | 24 |
| Romania | 25 | 12 | 25 | 20 | 25 | 16 |
| United Kingdom | 9 | 4 | 12 | 4 | 10 | 4 |
| Czech Republic | 7 | 9 | 6 | 5 | 5 | 7 |
| Slovakia | 19 | 17 | 18 | 18 | 18 | 17 |
| Slovenia | 14 | 14 | 7 | 13 | 8 | 13 |
| Sweden | 3 | 1 | 2 | 1 | 3 | 1 |

# 3.7 Robustness analysis

In their opinion paper on the national system of indicators, the ESC announced that a statistical robustness test should be carried out to assess data availability and reliability. Such a test is vital to ensure the quality of the indicators system and better understand Luxembourg's competitiveness and how this interacts with specific national characteristics. The analyses below were mainly inspired by the European Commission Joint Research Centre (JRC)[9] audit commissioned by the ODC in 2010 pertaining to the former version of the scoreboard[10].

## 3.7.1 Dealing with outliers

The min-max method (see frame on p. 94) is usually sensitive to outliers. If these are not processed correctly, they can become unintentional reference points. Moreover, outliers can have a significant impact on the correlation structure and thereby introduce bias into the interpretation of results. While there are numerous suitable methods for detecting outliers, in the context of strengthening composite indicators it seems particularly appropriate to use a combination of skewness and kurtosis. A skewness value of more than 2 with a kurtosis value of more than 7 (in absolute terms) was used to detect problematic indicators which need to be processed before generating the composite indicator. In the 2010 JRC audit, the recommended values for detecting outliers were 1 for skewness and 3.5 for kurtosis; however, a broader range was applied here to keep data processing to a minimum.

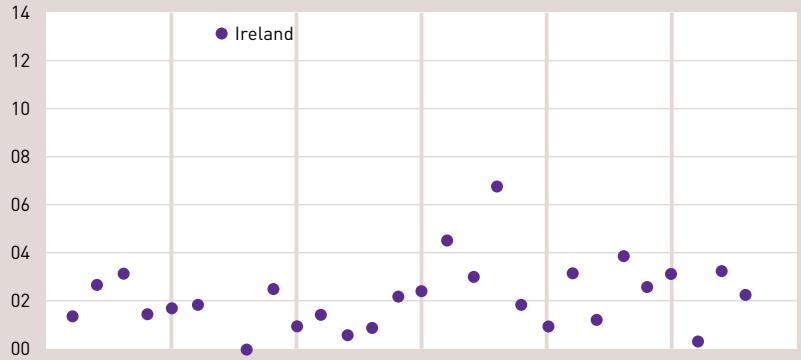
There were three indicators for 2016 which could be considered problematic from this point of view: real GDP growth rate (A7), real labour productivity per hour worked (A16) and long-term unemployment rate (B1). Ireland was an outlier for the first two indicators due to its exceptional GDP growth in 2015 (+26.3% compared to an EU average of +2.2%) and Greece for indicator B1 (long-term unemployment rate of 17.1% compared to an EU average of 4%).

[9] For more information: http://composite-indicators.jrc.ec.europa.eu/

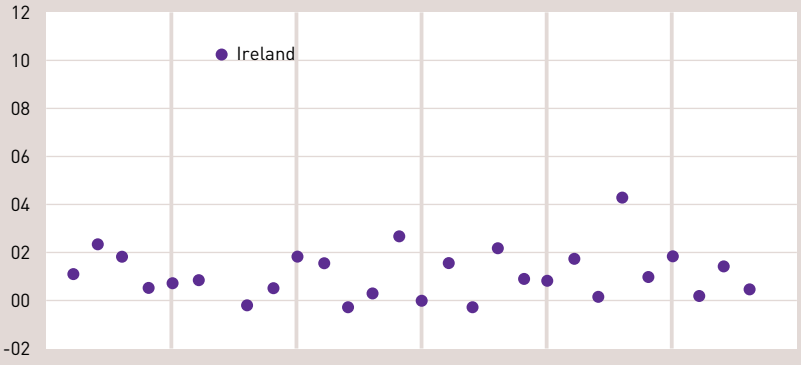
[10] Perspectives de politique économique N° 15: The Luxembourg Competitiveness Index: Analysis & Recommendations: https://odc.gouvernement.lu/dam-assets/publications/rapport-etude-analyse/perspectives-politique-economique/perspectives-politique-economique-15/ppe-015-en.pdf

Chart 10

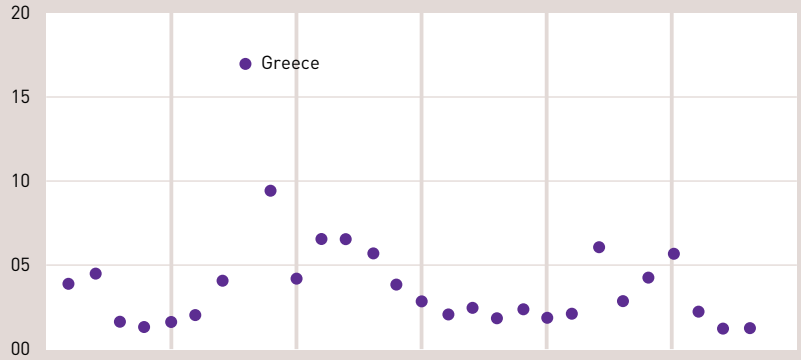
**A7: Real GDP growth rate (average over 3 years)**




**A16: Real labour productivity per hour worked (average growth rate over 3 years)**



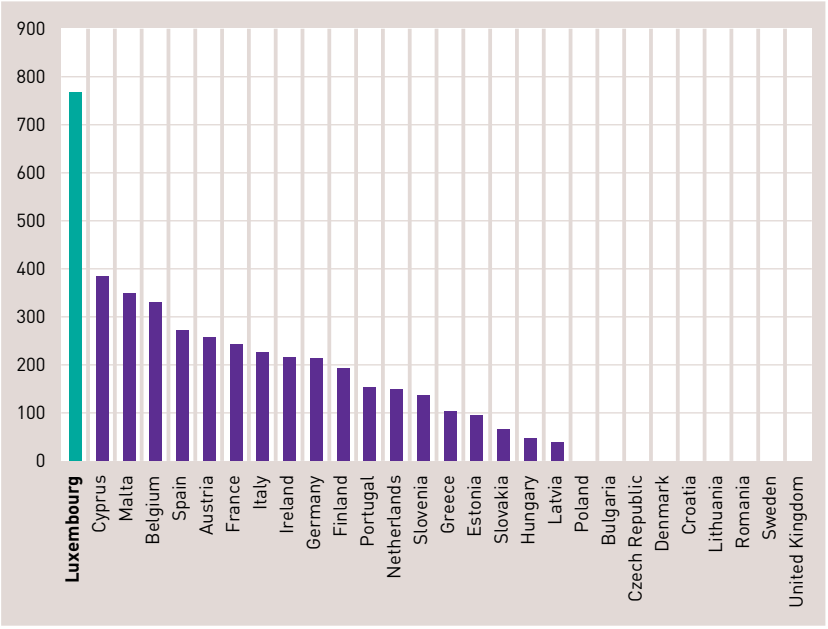

**B1: Long-term unemployment rate**



The outliers are therefore replaced by the next highest value. For indicator A7, the value for Ireland (13.3%) is replaced by that of Malta (6.9%). For indicator A16, the value for Ireland (10.3%) is replaced by that of Romania (4.3%). For indicator B1, the value for Greece (17.0%) is replaced by that of Spain (9.5%).

The problem for the indicator on net wealth per household (B16) is of a different nature. Luxembourg appears to be an outlier: its wealth is double that of the next highest country (Cyprus) and data was only available for the years 2013 and 2016. Moreover, many countries did not have data even for these years. Data was only available for 15 countries for 2013 and 19 countries for 2016. Due to this lack of data, it was deemed more appropriate not to factor this indicator into the calculation of the composite indicator.

Chart 11
**Net wealth per household (B16) - 2016**



## 3.7.2 Correlation between the three dimensions and the composite indicator

Table 10

| | Economic dimension | Social dimension | Environment dimension | Composite indicator |
|---|---|---|---|---|
| Economic dimension | 1.00 | | | |
| Social dimension | 0.61 | 1.00 | | |
| Environment dimension | 0.56 | 0.60 | 1.00 | |
| Composite indicator | 0.85 | 0.86 | 0.85 | 1.00 |

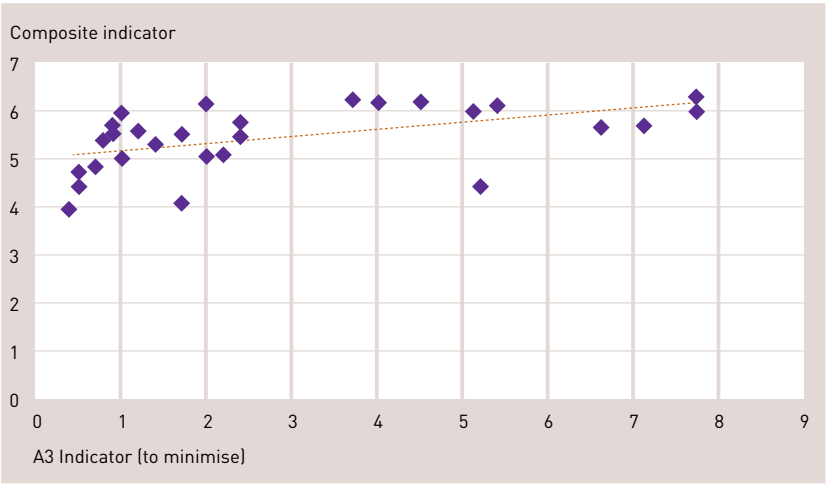
A Pearson correlation from 0.4 to 0.8 between the main dimensions is considered a positive result as it suggests that the areas are positively and significantly linked to one another and the overall index. The respective correlations fall within this bracket, and furthermore the three dimensions are positively and significantly linked to the final result.

## 3.7.3 Correlation between dimension result and underlying indicators

The aim of each indicator under a given dimension is to correlate positively with the overall dimension result. For each dimension, however, there is at least one indicator which is pointing in the wrong direction.

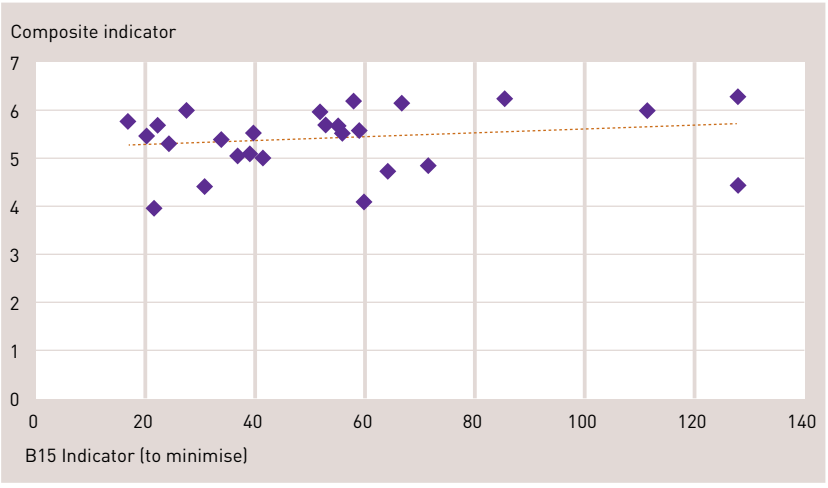
For the economic dimension, indicator A3 (current account balance in % of GDP) is negatively correlated with the overall result and the result for this dimension, which means a low score signals an improvement in competitiveness. However, the source of this wrong direction could be the calculation method used for integration into the composite indicator: current account balance is one of the European Union MIP indicators, which stated that a country may be at risk if its current account balance either falls below -4% of GDP (lower threshold) or exceeds +6% of GDP (upper threshold). For the purposes of the composite indicator in the new National competitiveness scoreboard, the countries are nonetheless ranked based on how much their current account balance diverges from the simple average between the two limits (therefore the aim is for the balance to be around 1% of GDP).

Chart 12



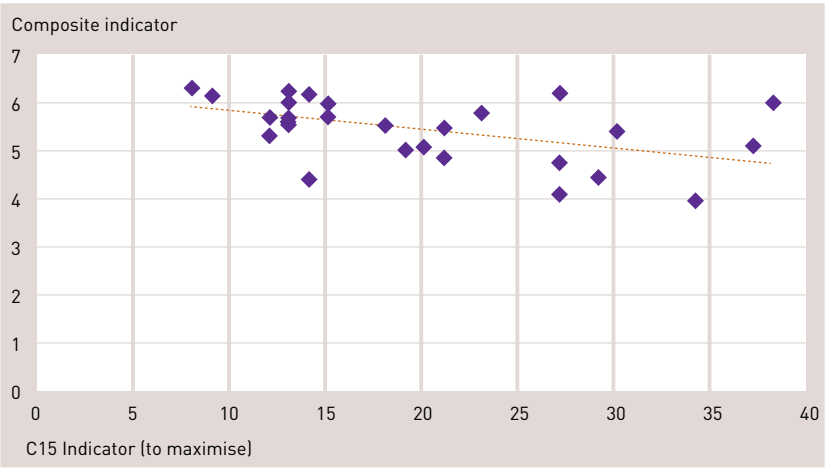

Household debt (indicator B15) has a negative correlation with the overall result and the result for the social dimension. An increase in household debt would therefore amount to an increase in competitiveness if calculated according to the new system of indicators. One could argue that an increase in debt (e.g. for construction or purchase of housing) would act as a source of investment with an ensuing positive effect on national employment and economic growth.

Chart 13



Indicator C15 (protected land surface area) has a negative correlation with the overall result and the result for the environment dimension.

Chart 14




# 3.8 Annex

## 3.8.1 Secondary indicators

The ESC drew up an indicative, non-exhaustive list of relevant secondary indicators in its opinion paper on the national system of indicators. These indicators are not integrated into the composite indicator calculations, to avoid overloading the key element of the system of indicators. Nonetheless, the secondary indicators are pertinent and are therefore presented here for indicative purposes. They provide more information on specific areas and can help provide a more targeted analysis where needed. As such, they provide a fuller overview of the three economic, social and environment dimensions.

It must be noted however that there are several problems related to the availability of data for these indicators. For some, no data was available at all, while for others the information is only available for Luxembourg. The corresponding fields in the tables are left blank where this is the case but will be filled in as soon as the relevant data becomes available.

Table 11
**Economic dimension**

| | | Trend | LU | Position | EU Average | DE | BE | FR | First | Last |
|---|---|---|---|---|---|---|---|---|---|---|
| D1 | Net external debt (as a % of GDP) | ↑ | 4.7 | 20 / 28 | 2.2 | 8.3 | -0.4 | -0.9 | Cyprus: -5.3 | Netherlands: 8.4 |
| D2 | Terms of trade per item (% variation over 5 years) | ↓ | -1.0 | 27 / 28 | 3.1 | 6.5 | 2.2 | 6.0 | Portugal: 8.2 | Slovakia: -2.3 |
| D3 | Real effective exchange rate for the euro area (% variation over 3 years) | ↓ | -0.2 | 11 / 28 | -1.1 | 0.4 | 2.1 | 0.1 | United Kingdom: 5.1 | Sweden: -7.7 |
| D4 | Direct Investment in the reporting economy (stocks, in % of GDP) | ↓ | 8412.4 | 1 / 28 | | 42.1 | 212.2 | 44.8 | Luxembourg: 8412.4 | Greece: 16.7 |
| D5 | Direct investment in reporting economy (flows, in % of GDP) | ↓ | -25.3 | 28 / 28 | 3.2 | 1.5 | 4.2 | 1.7 | Ireland: 27.4 | Luxembourg: -25.3 |
| D6 | Net trade balance for energy products as a % of GDP | ↑ | -2.4 | 21 / 28 | -2.0 | -1.5 | -2.2 | -1.4 | Denmark: 0 | Malta: -9.8 |
| D7 | Share of OECD exports market | ↓ | 21.3 | 2 / 28 | 1.6 | 0.4 | -4.5 | -4.8 | Ireland: 50.7 | Greece: -20.9 |
| D8 | Rate of growth in liabilities for the entire financial sector (% variation over 3 years) | ↑ | 20.3 | 1 / 28 | 4.8 | 3.3 | 1.9 | 2.6 | Luxembourg: 20.3 | Greece: -3.2 |
| D9 | 10-year bond returns | ↑ | 0.3 | 2 / 27 | 1.1 | 0.1 | 0.5 | 0.5 | Germany: 0.1 | Greece: 8.4 |
| D10 | Number of days needed to acquire a building permit | → | 157.0 | 15 / 28 | 172.7 | 96.0 | 212.0 | 183.0 | Denmark: 64 | Cyprus: 617 |
| D11 | Regulation quality index | ↑ | 1.7 | 7 / 28 | 1.2 | 1.7 | 1.3 | 1.2 | United Kingdom: 1.9 | Croatia: 0.4 |
| D12 | Administration efficiency index | ↑ | 1.7 | 7 / 28 | 1.1 | 1.7 | 1.4 | 1.4 | Denmark: 1.8 | Romania: 0 |
| D13 | Flexibility of wage determination | ↑ | 4.9 | 15 / 28 | 4.7 | 3.9 | 3.9 | 5.1 | Estonia: 6.2 | Austria / Finland: 2.2 |
| D14 | Hiring and firing practice | ↓ | 3.7 | 19 / 28 | 3.5 | 3.4 | 2.6 | 2.7 | Italy: 2.4 | Denmark: 5.3 |
| D15 | Price of electricity - Industrial users (euro/kWh) | ↑ | 0.087 | 9 / 28 | 0.117 | 0.151 | 0.112 | 0.099 | Sweden: 0.062 | Italy: 0.153 |
| D16 | Price of gas - industrial users | ↑ | 9.8 | 15 / 26 | 8.8 | 9.4 | 7.2 | 9.3 | Bulgaria: 6.4 | Finland: 11.5 |
| D17 | Broadband Internet access rates (USD/MB) | ↑ | 6.6 | 15 / 20 | | 25.6 | 1.7 | 6.3 | Belgium: 1.7 | Poland: 188.8 |
| D18 | Venture capital investment (% PIB) | → | 4.7 | 18 / 28 | 6.3 | 4.9 | 7.2 | 8.3 | Estonia: 13.6 | Malta: 0.0 |
| D19 | R&D expenditure in the business sector (% PIB) | ↓ | 0.7 | 17 / 28 | 1.3 | 2.0 | 1.8 | 1.5 | Sweden: 2.3 | Cyprus: 0.1 |
| D20 | Non-R&D innovation expenditure as % of turnover | ↓ | 0.1 | 28 / 28 | 0.8 | 1.3 | 0.6 | 0.5 | Lithuania: 2 | Luxembourg: 0.1 |
| D21 | SMEs innovating inhouse as % SMEs | ↓ | 30.6 | 12 / 28 | 28.8 | 37.7 | 40.5 | 32.5 | Belgium: 40.5 | Romania: 2.5 |
| D22 | Innovative SMEs collaborating with others as % SMEs | ↑ | 9.2 | 17 / 28 | 11.2 | 10.1 | 28.6 | 13.2 | Belgium: 28.6 | Romania: 1.8 |
| D23 | Public-private co-publications per million population | ↓ | 8.9 | 17 / 28 | 28.7 | 45.3 | 61.0 | 32.2 | Denmark: 132 | Latvia: 0.5 |
| D24 | Patents applications per billion GDP | ↑ | 1.9 | 13 / 28 | 3.7 | 6.3 | 3.3 | 4.2 | Sweden: 9.6 | Romania: 0.3 |
| D25 | Patents applications in health and environment per billion GDP | → | 0.68 | 10 / 28 | 1.01 | 1.47 | 0.77 | 0.92 | Denmark: 2.05 | Romania: 0.04 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| D26 | USPTO issued patents per million inhabitants | ↑ | 90.6 | 11 / 28 | 86.8 | 203.8 | 100.6 | 98.8 | Sweden: 270.1 | Latvia: 2 |
| D27 | Patents applications per million inhabitants | ↓ | 111.2 | 9 / 28 | 112.0 | 257.0 | 137.7 | 138.7 | Sweden: 350.4 | Croatia: 3.4 |
| D28 | SMEs introducing product or process innovation as % of SMEs | ↓ | 37.0 | 9 / 28 | 30.9 | 41.6 | 48.3 | 35.5 | Belgium: 48.3 | Romania: 4.9 |
| D29 | SMEs introducing marketing or organizational innovation as % of SMEs | ↑ | 54.3 | 1 / 28 | 34.9 | 49.1 | 45.1 | 41.6 | Luxembourg: 54.3 | Romania: 8.8 |
| D30 | Employment in fast-growing firms of innovative sectors | ↑ | 4.2 | 15 / 27 | 4.8 | 4.5 | 2.5 | 4.3 | Ireland: 8.8 | Cyprus: 0.8 |
| D31 | Taxes and bureaucracy - The extent to which public policies support entrepreneurship | ↓ | 2.9 | 7 / 27 | 2.4 | 2.5 | 2.0 | 3.3 | Estonia: 3.8 | Croatia: 1.5 |
| D32 | Basic-school Entrepreneurial education and training | ↓ | 2.0 | 12 / 27 | 2.0 | 1.7 | 2.0 | 1.7 | Netherlands: 3.3 | Austria: 1.4 |
| D33 | Post-school entrepreneurial education and training | ↓ | 3.1 | 6 / 26 | 2.8 | 2.6 | 3.2 | 3.2 | Netherlands: 3.6 | Poland: 2.1 |
| D34 | Perceived capabilities for entrepreneurship | ↓ | 40.8 | 17 / 27 | 42.6 | 37.4 | 31.9 | 36.3 | Poland: 60.2 | Italy: 31.2 |
| D35 | Entrepreneurship as a career choice | ↓ | 42.1 | 26 / 27 | 57.8 | 51.8 | 54.2 | 57.1 | Netherlands: 77.9 | Finland: 40.3 |
| D36 | Cultural and social norms | ↓ | 2.4 | 14 / 27 | 2.6 | 2.6 | 2.5 | 2.3 | Estonia: 3.8 | Croatia: 1.8 |
| D37 | PISA math and sciences scores | ↓ | 486.0 | 17 / 22 | 495.2 | 506.0 | 507.0 | 493.0 | Estonia: 520 | Greece: 454 |
| D38 | New doctorate graduates per 1000 population aged 25-34 | → | 1.0 | 23 / 28 | 1.8 | 2.9 | 1.8 | 1.7 | Slovenia: 3.5 | Malta: 0.5 |
| D39 | International scientific co-publications per million population | ↑ | 1714.5 | 3 / 28 | 493.6 | 778.2 | 1408.1 | 700.2 | Denmark: 2228.9 | Romania: 182.5 |
| D40 | Scientific publications among the top 10% most cited worldwide | ↑ | 13.1 | 4 / 28 | 10.6 | 11.5 | 12.7 | 11.3 | United Kingdom: 14.6 | Bulgaria: 4.1 |
| D41 | Non-EU doctorate students as a % of all doctorate students | ↑ | 87.0 | 1 / 27 | 26.1 | 9.1 | 42.3 | 40.1 | Luxembourg: 87 | Poland: 1.9 |

Table 12
**Social dimension**

| | | Trend | LU | Position | EU Average | DE | BE | FR | First | Last |
|---|---|---|---|---|---|---|---|---|---|---|
| E1 | Share of low-wage workers as a % of the overall workforce | ↑ | 11.9 | 7 / 28 | 17.2 | 22.5 | 3.8 | 8.8 | Sweden: 2.6 | Latvia: 25.5 |
| E2 | Participation rate | ↓ | 70.0 | 20 / 28 | 72.9 | 77.9 | 67.6 | 71.7 | Sweden: 82.1 | Italy: 64.9 |
| E3 | Quality of Work-Index | | | | | | | | | |
| E4 | People living in households with very low labour intensity | ↑ | 5.7 | 1 / 28 | 10.7 | 9.8 | 14.6 | 8.6 | Luxembourg: 5.7 | Ireland: 19.2 |
| E5 | Fatal accidents in the workplace | ↓ | 3.3 | 23 / 28 | 1.8 | 1.0 | 1.3 | 2.6 | Netherlands: 0.5 | Romania: 5.6 |
| E6 | Feeling of job insecurity | ↑ | 2.1 | 1 / 22 | 6.3 | 2.7 | 3.6 | 4.6 | Luxembourg: 2.1 | Greece: 32 |
| E7 | Workers who report they are satisfied with their work-life balance | | 7.2 | | | | | | | |
| E8 | Level of studies achieved | | 39.8 | | | | | | | |
| E9 | Reading skills in 15-year old students (PISA) | ↓ | 481.4 | 19 / 22 | 495.2 | 509.1 | 498.5 | 499.3 | Finland: 526.4 | Slovakia: 452.5 |
| E10 | Knowledge and use of Luxembourgish, French, German and/or English | | | | | | | | | |
| E11 | Civic skills of students | → | 473.0 | | | | | | | |
| E12 | Support from social network | → | 90.3 | 21 / 25 | 85.1 | 94.7 | 93.4 | 0.0 | Denmark: 97.1 | United Kingdom: 43.9 |
| E13 | Participation in social, cultural and sports associations | → | 35.4 | 4 / 26 | 19.6 | 21.6 | 33.0 | 23.2 | Netherlands: 45.9 | Bulgaria: 1.6 |
| E14 | Time spent volunteering | → | 36.9 | 8 / 25 | 35.0 | 37.4 | 13.4 | 17.4 | Slovenia: 69.2 | Denmark: 3 |
| E15 | Frequency of social contacts | → | 59.6 | 13 / 26 | 57.3 | 60.4 | 60.7 | 45.4 | Cyprus: 80.2 | Poland: 41.3 |
| E16 | Number of voters as a % of the voting age population | → | 91.0 | 1 / 22 | 68.0 | 72.0 | 89.0 | 80.0 | Luxembourg: 91 | Slovenia: 52 |
| E17 | Existence of formal consultation procedures during law-making and production of regulations | | 6.0 | | | | | | | |
| E18 | Participation in political and civic associations | → | 4.7 | 11 / 25 | 4.2 | 6.4 | 0.0 | 2.7 | Denmark: 12.2 | Lithuania: 1.9 |
| E19 | Trust in institutions | → | 5.47 | 9 / 28 | 4.67 | 5.53 | 5.23 | 4.37 | Finland: 7.1 | Croatia: 3.1 |
| E20 | Tax rate for physical persons (%) | → | 43.6 | 12 / 28 | 39.3 | 47.5 | 53.8 | 50.3 | Bulgaria: 10 | Sweden: 57 |
| E21 | Real annual growth rate of different income statistics per household | | 103.0 | | | | | | | |
| E22 | Overall household consumption including non-market services | | | | | | | | | |
| E23 | Population unable to make ends meet | ↓ | 12.4 | 5 / 28 | 25.7 | 7.2 | 21.5 | 19.2 | Finland: 6.9 | Greece: 76.8 |
| E24 | Rooms per person | → | 2.0 | 2 / 22 | 1.8 | 1.8 | 2.2 | 1.8 | Belgium: 2.2 | Hungary: 1.1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| E25 | Number of houses built per year | | 2642.0 | | | | | | | |
| E26 | Social housing | | | | | | | | | |
| E27 | Time spent on pastimes and personal hobbies | ↑ | 15.2 | 9 / 22 | 14.9 | 15.6 | 15.8 | 16.4 | France: 16.4 | Latvia: 13.8 |
| E28 | Relative incidence of parental leave | | 0.3 | | | | | | | |
| E29 | Feeling of discrimination (nationality) | | 24.0 | | | | | | | |
| E30 | Feeling of security | → | 72.2 | 19 / 27 | 74.7 | 73.1 | 79.5 | 74.5 | Finland: 90.9 | Bulgaria: 49.5 |
| E31 | Satisfaction with life | ↓ | 6.7 | 9 / 22 | 6.5 | 7.0 | 6.9 | 6.4 | Denmark: 7.5 | Portugal: 5.1 |
| E32 | Incidence and seriousness of mental health problems | | | | | | | | | |
| E33 | Suicide rate | ↓ | 13.4 | 16 / 28 | 11.3 | 11.9 | 17.3 | 14.1 | Cyprus: 4.5 | Lithuania: 31.5 |
| E34 | Death rate according to cause | → | 463.6 | 2 / 28 | 559.9 | 537.5 | 555.7 | 476.0 | Spain: 447.8 | Bulgaria: 883.9 |
| E35 | Consumption of psychotropic drugs | ↑ | 5.6 | | | | | | | |
| E36 | Adults who report they are in good or very good health | ↓ | 70.6 | 10 / 28 | 66.9 | 64.6 | 74.6 | 68.0 | Ireland: 82.6 | Lithuania: 42.8 |
| E37 | Adults who report they have a long-term illness or health problem | | 23.2 | | | | | | | |
| E38 | Adults who report they are unable to perform their usual activities due to a health problem | | 25.7 | | | | | | | |

Table 13
**Environment dimension**

| | | Trend | LU | Position | EU Average | DE | BE | FR | First | Last |
|---|---|---|---|---|---|---|---|---|---|---|
| F1 | Primary energy consumption | ↑ | 86.9 | 10 / 28 | 89.3 | 92.3 | 89.6 | 92.0 | Lithuania: 72.7 | Estonia: 114.3 |
| F2 | Final energy consumption - accountability mechanism | ↑ | 3988 | 5 / 28 | 1,083,957 | 21,2124 | 35,780 | 14,4123 | Malta: 572 | Germany: 212,123 |
| F3a | Share of renewable energy - solar panels | ↑ | 7.9 % | 7 / 28 | 4.3 % | 8.6 % | 8.9 % | 2.9 % | Malta: 54.1 % | Estonia: 0.0 % |
| F3b | Share of renewable energy - hydroelectric | ↓ | 7.5 % | 22 / 28 | 14.3 % | 4.2 % | 0.9 % | 21.9 % | Sweden: 35.2 % | Cyprus: 0.0 % |
| F3c | Share of renewable energy - wind | ↑ | 7.8 % | 14 / 28 | 12.7 % | 17.5 % | 16.2 % | 8.5 % | Ireland: 57.6 % | Malta: 0.0 % |
| F3d | Share of renewable energy - cogeneration | | | | | | | | | |
| F3e | Share of renewable energy - thermal | ↑ | 1.7 % | 7 / 28 | 2.1 % | 1.7 % | 0.7 % | 0.5 % | Cyprus: 57.5 % | Estonia: 0.0 % |
| F4 | Number of subsidies granted | | | | | | | | | |
| F5a | Total greenhouse gas emissions per capita - ETS | ↑ | 5.1 | 21 / 28 | 3.8 | 5.9 | 4.3 | 1.6 | Latvia: 1.2 | Estonia: 9.5 |
| F5b | Total greenhouse gas emissions per million inhabitants - non-ETS | ↑ | 15.6 | 28 / 28 | 5.0 | 5.5 | 6.5 | 5.5 | Malta: 3.2 | Luxembourg: 15.6 |
| F5c | Total greenhouse gas emissions per million inhabitants - of which transport | ↑ | 10.1 | 28 / 28 | 1.8 | 2.0 | 2.4 | 2.0 | Romania: 0.8 | Luxembourg: 10.1 |
| F5d | Total greenhouse gas emissions per capita -buildings | | | | | | | | | |
| F6 | Urban population exposure to air pollution (NOx emissions and concentration) | ↑ | 11.4 | 7 / 25 | 15.2 | 15.1 | 14.2 | 12.6 | Sweden: 7.2 | Bulgaria: 26.1 |
| F7a | NH3/thousand people | ↑ | 10.2 | 25 / 28 | 7.9 | 9.4 | 5.8 | 10.2 | Malta: 3.4 | Ireland: 23.4 |
| F7b | NH3/GDP | ↑ | 0.1 | 1 / 28 | 0.3 | 0.3 | 0.2 | 0.3 | Luxembourg: 0.1 | Romania: 1.1 |
| F8a | NMVOC emissions/ thousand people | ↓ | 17.3 | 22 / 28 | 12.9 | 12.6 | 10.6 | 9.4 | Malta: 4.8 | Ireland: 21.9 |
| F8b | NMVOC emissions/GDP | ↓ | 0.2 | 1 / 28 | 0.5 | 0.4 | 0.3 | 0.3 | Luxembourg: 0.2 | Bulgaria: 2.3 |
| F9 | Environmental morbidity rate | → | 0.13 | 5 / 28 | 0.14 | 0.13 | 0.13 | 0.13 | Denmark: 0.12 | Romania: 0.18 |
| F10 | Noise | ↓ | 20.1 | 23 / 28 | 18.0 | 25.8 | 15.6 | 16.4 | Ireland: 8 | Germany: 25.8 |
| F11 | Dangerous waste generated (kg/person) | ↑ | 426.0 | 26 / 28 | 187.0 | 269.0 | 262.0 | 163.0 | Greece: 20 | Estonia: 7,919 |
| F12 | Packaging waste per type of waste and waste flow | ↓ | 46.3 | 14 / 28 | 44.1 | 51.8 | 47.4 | 24.4 | Croatia: 22.5 | Bulgaria: 109.7 |
| F13 | Organic crop area by agricultural production methods and crops | ↓ | 3.2 | 21 / 28 | 6.4 | 6.4 | 5.3 | 4.8 | Austria: 20.3 | Malta: 0.3 |
| F14 | Number of ISO 14001 and EMAS certifications per 100,000 inhabitants | ↑ | 19.0 | 16 / 28 | 21.4 | 10.1 | 10.2 | 10.3 | Romania: 53.2 | Poland: 7.4 |
| F15 | Number of ISO 9001 certifications per 100,000 inhabitants | ↑ | 44.8 | 22 / 28 | 78.2 | 65.3 | 31.7 | 41.9 | Italy: 218.6 | Poland: 28.1 |
| F16 | Gross fresh water abstractions per capita (m3 per inhabitant) | ↓ | 83.7 | 1 / 25 | 426.6 | 403.9 | 477.9 | 459.7 | Luxembourg: 83.7 | Estonia: 1,323.9 |
| F17 | Built-up areas | → | 3.0 | 24 / 27 | 1.3 | 2.4 | 6.0 | 1.5 | Finland: 0.3 | Malta: 18.7 |
| F18 | Houses in "Wohnvorranggemeinden" | | | | | | | | | |

## 3.8.2 Results of the former version of 2005-2015 competitiveness scoreboard (TBCO)

Table 14

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Germany | 15 | 9 | 10 | 8 | 9 | 7 | 6 | 8 | 11 | 11 | 11 |
| Austria | 9 | 11 | 9 | 7 | 8 | 10 | 10 | 7 | 8 | 10 | 10 |
| Belgium | 16 | 16 | 15 | 15 | 15 | 17 | 16 | 18 | 18 | 17 | 19 |
| Bulgaria | 18 | 25 | 24 | 14 | 21 | 24 | 24 | 24 | 25 | 23 | 22 |
| Cyprus | 21 | 22 | 18 | 17 | 20 | 22 | 22 | 25 | 27 | 27 | 21 |
| Croatia | 20 | 26 | 21 | 21 | 23 | 21 | 21 | 26 | 24 | 24 | 26 |
| Denmark | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 |
| Spain | 17 | 17 | 16 | 18 | 17 | 25 | 23 | 23 | 26 | 26 | 27 |
| Estonia | 6 | 6 | 6 | 10 | 13 | 9 | 8 | 5 | 7 | 9 | 9 |
| Finland | 3 | 4 | 4 | 4 | 5 | 4 | 4 | 6 | 6 | 6 | 5 |
| France | 13 | 15 | 13 | 12 | 12 | 12 | 14 | 9 | 10 | 12 | 12 |
| Greece | 28 | 20 | 23 | 25 | 25 | 28 | 28 | 28 | 28 | 28 | 28 |
| Hungary | 23 | 24 | 28 | 26 | 28 | 27 | 25 | 27 | 22 | 21 | 23 |
| Ireland | 11 | 10 | 12 | 13 | 11 | 14 | 15 | 15 | 16 | 8 | 6 |
| Italy | 22 | 21 | 20 | 19 | 16 | 18 | 20 | 20 | 20 | 19 | 20 |
| Latvia | 12 | 13 | 17 | 28 | 24 | 15 | 7 | 12 | 13 | 14 | 14 |
| Lithuania | 10 | 14 | 11 | 20 | 26 | 16 | 13 | 10 | 15 | 15 | 15 |
| **Luxembourg** | **7** | **7** | **7** | **9** | **7** | **6** | **9** | **13** | **5** | **7** | **8** |
| Malta | 24 | 27 | 27 | 27 | 27 | 26 | 27 | 21 | 23 | 25 | 25 |
| Netherlands | 5 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| Poland | 27 | 23 | 22 | 23 | 14 | 19 | 17 | 19 | 19 | 16 | 18 |
| Portugal | 25 | 28 | 25 | 24 | 19 | 23 | 26 | 22 | 21 | 22 | 24 |
| Romania | 26 | 18 | 26 | 22 | 18 | 20 | 18 | 17 | 12 | 20 | 16 |
| United Kingdom | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 4 | 4 | 4 | 4 |
| Czech Republic | 8 | 8 | 14 | 11 | 6 | 8 | 11 | 11 | 9 | 5 | 7 |
| Slovakia | 19 | 19 | 19 | 16 | 22 | 13 | 19 | 16 | 17 | 18 | 17 |
| Slovenia | 14 | 12 | 8 | 6 | 10 | 11 | 12 | 14 | 14 | 13 | 13 |
| Sweden | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |

## 3.8.3 Changes between TBCO and new system of indicators

Table 15

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Germany | 1 | -2 | -2 | -3 | -2 | -3 | -3 | 2 | 1 | -3 | 0 |
| Austria | 5 | 7 | 5 | 4 | 6 | 7 | 7 | 5 | 6 | 6 | 1 |
| Belgium | 6 | 4 | 5 | 7 | 7 | 10 | 9 | 9 | 10 | 7 | 6 |
| Bulgaria | -9 | -3 | -3 | -14 | -6 | -1 | -3 | -3 | -2 | -4 | -5 |
| Cyprus | 0 | 1 | -1 | -3 | 0 | 1 | 0 | 0 | 1 | 1 | -5 |
| Croatia | 4 | 9 | 4 | 4 | 7 | 2 | 2 | 5 | 3 | 3 | 5 |
| Denmark | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 0 | 1 | 1 | 1 |
| Spain | -5 | -6 | -7 | -5 | -6 | 2 | -1 | -1 | 2 | 2 | 3 |
| Estonia | -9 | -8 | -10 | -6 | -4 | -9 | -6 | -8 | -9 | -7 | -6 |
| Finland | 1 | 1 | 1 | 2 | 1 | -2 | -2 | 3 | 2 | 1 | -1 |
| France | 1 | 2 | 0 | -1 | -1 | -1 | 2 | -5 | -3 | -1 | -2 |
| Greece | 2 | -6 | -3 | -2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hungary | 0 | 2 | 4 | 4 | 7 | 10 | 9 | 8 | 5 | 4 | 6 |
| Ireland | 5 | 4 | 4 | 1 | -3 | 0 | 2 | 0 | 5 | -3 | 4 |
| Italy | 5 | 3 | 0 | 0 | -2 | 3 | 0 | 0 | 0 | -1 | 0 |
| Latvia | -7 | -6 | -4 | 3 | -4 | -12 | -16 | -5 | -5 | -5 | -5 |
| Lithuania | -8 | -2 | -3 | 2 | 4 | -8 | -5 | -2 | 3 | 6 | 3 |
| **Luxembourg** | **-1** | **-3** | **1** | **3** | **2** | **2** | **5** | **6** | **0** | **4** | **4** |
| Malta | 11 | 12 | 12 | 13 | 15 | 14 | 12 | 5 | 8 | 10 | 9 |
| Netherlands | 0 | -2 | -3 | -3 | -4 | -2 | -2 | -2 | -3 | -5 | -4 |
| Poland | 3 | -1 | 0 | 2 | -1 | -1 | 0 | -3 | -3 | -6 | -4 |
| Portugal | 0 | 3 | 0 | 0 | -5 | 1 | 1 | -1 | -2 | -1 | 1 |
| Romania | -2 | -9 | -2 | -4 | -8 | -6 | -8 | -9 | -13 | -5 | -9 |
| United Kingdom | -3 | -2 | -6 | -5 | -5 | -4 | -6 | -7 | -5 | -8 | -6 |
| Czech Republic | -3 | -1 | 5 | 2 | -4 | -3 | 1 | 1 | 2 | -1 | 2 |
| Slovakia | -1 | -1 | 1 | 1 | 3 | -3 | -2 | -2 | -2 | 0 | -1 |
| Slovenia | 5 | 4 | 1 | -1 | 3 | 3 | 4 | 6 | 0 | 6 | 5 |
| Sweden | -2 | -1 | -1 | -3 | -2 | -1 | -1 | -2 | -2 | -1 | -2 |

Note: figure > 0 → positions climbed in the new system of indicators compared to the TBCO

# 4 Luxembourg in the European semester


| | | |
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This chapter is monitoring Luxembourg's indicators and targets within the framework of the European Union strategy for growth and jobs (Europe 2020 strategy) and the macroeconomic imbalance procedure (MIP)[1]. These two pillars of the new European economic governance were implemented by the REGULATION (EU) No. 1175/2011 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 November 2011 amending Council Regulation (EC) No. 1466/97 on the strengthening of the surveillance of budgetary positions and the surveillance and coordination of economic policies[2]. This chapter focuses mainly on Luxembourg performances and national targets. Consequently, it doesn't aim to assess European indicators and objectives at EU level.

# 4.1 Thematic coordination of structural policies

## 4.1.1 Implementation of thematic coordination under the Europe 2020 strategy

The Europe 2020 strategy[3], which is a central element of the EU's response to the global economic crisis, has been designed to update and replace the Lisbon strategy[4] that was launched in March 2000 and renewed in 2005 as a European strategy for growth and jobs. This new strategy involves closer coordination of economic policies and focuses on the key areas where action must be taken to boost the potential of sustainable and inclusive growth and competitiveness in Europe. It was considered that the end of the crisis should be the entry point into a social market economy, a greener and smarter economy, in which prosperity will be the result of the capacity to innovate and of a better use of resources, and where knowledge will be a key element. In early 2010, the Commission made proposals to implement this new Europe 2020 strategy[5]. In March 2010, on the basis of a communication from the Commission, the European Council discussed and approved the strategy's main elements, including key objectives which will guide its implementation, as well as provisions to improve monitoring. The European Council agreed on a series of elements[6]. The June European Council[7] finally completed the development of the new Europe 2020 strategy.

1 However, the analysis of the situation of Luxembourg in the coordination of budgetary policies (SGP) is not the subject of this section. With regards to the economic policy measures implemented by Luxembourg to achieve the objectives of the Europe 2020 strategy, reference is made to the NRP submitted in April 2017 by the government to the European Commission within the framework of the European Semester.

2 For additional details: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:306:0012:0024:FR:PDF

3 For additional details: https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/european-semester_en

4 For additional details: http://ec.europa.eu/archives/growthandjobs_2009/

5 EUROPEAN COMMISSION, EUROPE 2020 - A strategy for smart, sustainable and inclusive growth, COM (2010) 2020, Brussels, le 3.3.2010

6 EUROPEAN COUNCIL, Conclusions, Brussels, March 2010

For additional information: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/fr/ec/113602.pdf

7 EUROPEAN COUNCIL, Conclusions, Brussels, June 2010

For additional information: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/fr/ec/115348.pdf

The European Council confirmed in particular five major EU objectives, which are shared objectives guiding the action of Member States and of the EU in terms of promoting employment, improving the conditions for innovation and R&D, achieving the objectives in the field of climate change and energy, improving education levels and promoting social inclusion, in particular by reducing poverty:

- *Aiming to raise to 75% the employment rate for women and men aged 20-64, including through the greater participation of young people, older workers and low-skilled workers and the better integration of legal migrants;*

- *Improving the conditions for research and development, in particular with the aim of raising combined public and private investment levels in this sector to 3% of GDP; the Commission will elaborate an indicator reflecting R&D and innovation intensity;*

- *Reducing greenhouse gas emissions by 20% compared to 1990 levels; increasing the share of renewables in final energy consumption to 20%; and moving towards a 20% increase in energy efficiency; the EU is committed to taking a decision to move to a 30% reduction by 2020 compared to 1990 levels as its conditional offer with a view to a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities;*

- *Improving education levels, in particular by aiming to reduce school dropout rates to less than 10% and by increasing the share of 30-34 years old having completed tertiary or equivalent education to at least 40%;*

- *Promoting social inclusion, in particular through the reduction of poverty, by aiming to lift at least 20 million people out of the risk of poverty and exclusion. The population is defined as the number of persons who are at risk-of-poverty and exclusion according to three indicators (at-risk-of poverty; material deprivation; jobless household), leaving Member States free to set their national targets on the basis of the most appropriate indicators.*

## 4.1.2 Priorities, objectives and indicators

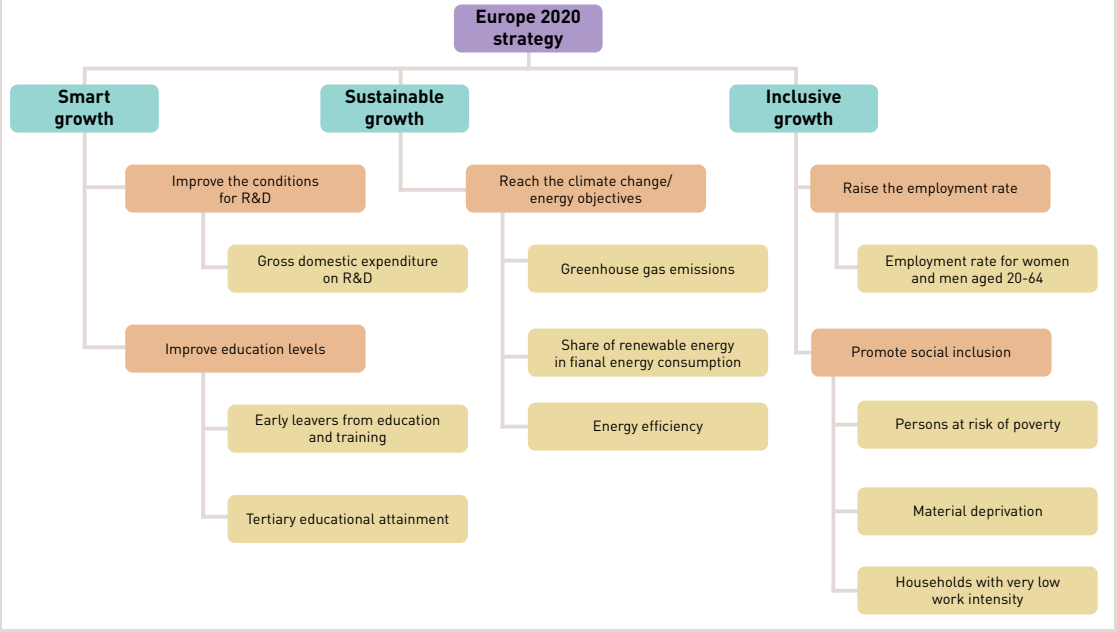
Obviously the new governance of the Europe 2020 strategy, including main European objectives and monitoring indicators, will not alone create growth, jobs and prosperity. It should nevertheless ensure that major emphasis on quantitative targets and indicators. Implementing policies without measurable goals and without monitoring indicators is not the way forward because the assessment would then be totally subjective. Despite the many limitations of the indicators (data availability, comparability, etc.) such a tool for decision support is the best way to measure the performance of policies. Past experience has shown that for a successful monitoring the system must meet certain initial conditions. It is not enough to base the monitoring mechanism only on territory rankings resulting from a list of indicators selected during painstaking negotiations and based on compromise (and which is therefore likely to please everyone); to discuss objectives and indicators only amongst experts, without ensuring an adequate involvement of the general public; to be restricted to ex-ante indicators (input) measuring the resources invested, without resorting to indicators measuring ex-post performance and the efficiency of the resources involved (output).

The 'thematic coordination of structural policies' component of the Europe 2020 strategy is based on three priorities, five goals and ten indicators:

- Three mutually reinforcing priorities - smart growth, sustainable growth and inclusive growth;
- Five major European goals to reach by 2020 - to improve the conditions for R&D, to improve education levels, to reach the climate change and energy objectives, to promote employment and to reduce poverty;
- Ten indicators to measure the progress in achieving the objectives[8] - gross domestic expenditure on R&D, early school leaving rate, proportion of higher education graduates or with an equivalent level of education, greenhouse gas emissions, share of renewable energy sources in final energy consumption, energy efficiency, employment rate for women and men aged 20-64, risk of poverty, material deprivation and jobless household.

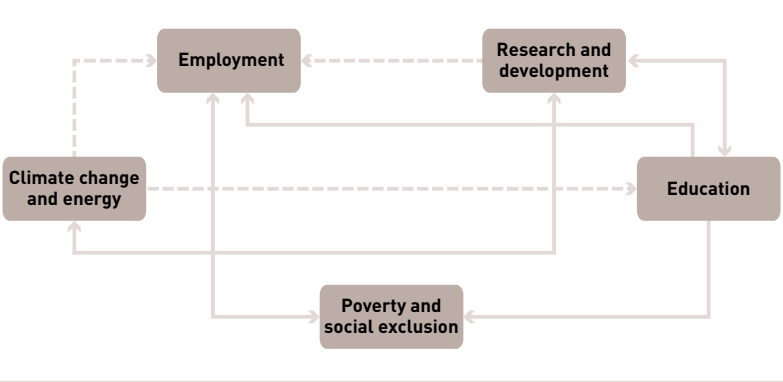
[8] For additional details: http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_background

Chart 1
**Priorities, objectives and indicators of the 'thematic coordination' in Europe 2020**




These priorities and objectives are closely linked. For example, higher education levels improve employability and help increase the employment rate, which helps reduce poverty, and a greater R&D and innovation capacity combined with increased resource efficiency improves competitiveness and promotes job creation; investing in cleaner and low carbon technologies improves the environment, contributes to fight against climate change and creates new business and job opportunities.

Chart 2
**Links between the 5 objectives of the Europe 2020 strategy**




Source: Eurostat

Given the diversity of EU Member States and their varying levels of development, applying the same objectives and criteria to all Member States as it had been originally done in the context of the Lisbon Agenda, has not proven to be the right approach. The major European objectives therefore no longer apply uniformly to all Member States in the context of Europe 2020. They are European objectives to be broken down into national targets, according to the initial conditions and specificities of each Member State, in dialogue with the European Commission.

Table 1
**National targets set by Luxembourg (April 2017)**

| | | **European objective 2020** | **Luxembourg target 2020** |
|---|---|---|---|
| **Priority 1** *'smart growth'* | *Objective 1* | *'(...) raising combined public and private investment levels to **3%** of GDP'* | **2.3 to 2.6% interval** |
| | *Objective 2* | *'(...) reduce the early school leaving rate to **less than 10%**'* | sustainably less than **10%**[a] |
| | | *'(...) increasing the share of people aged 30-34 who graduated from higher education or reached an equivalent level to **at least 40%**'* | **66%**[b] |
| **Priority 2** *'sustainable growth'* | *Objective 3* | *'(...) **reducing** greenhouse gas emissions **by 20%** (...)'* | reducing non-ETS greenhouse gas emissions by **-20%** compared to 2005 (emissions of approximately 8.145 Mt $CO_2$ in 2020)[c] |
| | | *'(...) increasing the share of renewable energy sources in final energy consumption to **20%**'* | **11%**[c] (2015/2016 average 5.45%) |
| | | *'(...) moving towards a **20%** increase in energy efficiency'* | Final energy consumption: **49,292 GWh**, being **4,239.2 ktoe** |
| **Priority 3** *'inclusive growth'* | *Objective 4* | *'(...) raise to **75%** the employment rate for women and men aged 20-64'* | **73%** |
| | *Objective 5* | *'(...) lift at least **20 million people** out of the risk of poverty and exclusion.'* | reduce the number of people at risk of poverty or social exclusion **by 6,000 people** by 2020[d] |

Sources: European Council, Eurostat

[a] National data will also be used as a measuring instrument, since the indicator calculated by Eurostat, from the Labour force survey, is not fully representative for Luxembourg. Attention should be paid to producing statistics that better distinguish people who attended schools in Luxembourg, in order to measure the quality of the national education system (national resident population) and assess the ability of the Luxembourg school system to train young people.

[b] Luxembourg would like this indicator to provide information on the ability of the national education system to make young people able to successfully complete tertiary education, rather than it being a reflection of the skills needed within the higher education labour market. In Luxembourg there is a strong disparity by country of birth (according to Eurostat, the foreigner resident rate is close to 60% and the national resident rate is somewhat above 40%), while in neighbouring countries, the differences between these two populations are much less pronounced and the proportion of graduates in these countries is higher among indigenous people than among non-indigenous people.

[c] For greenhouse gas emissions and renewable energy binding national targets already existed before the launch of the Europe 2020 strategy. For the 2013-2020 post-Kyoto period only non-ETS sectors are subject to targets set at Member State level. The 2020 non-ETS emissions reduction objective is compared to the level of 2005.

[d] As regards the methodology, the indicator used in the Europe 2020 strategy does not sufficiently take into account national demographics. Luxembourg has very dynamic demographics, even in times of crisis, and thus the relative nature of the indicator used, i.e. a % of the population, inevitably leads to an increase in the absolute number of people concerned.

European objectives can only be achieved if, on the one hand the sum of national targets leads to the fulfilment of European objectives and on the other hand, the first condition being fulfilled, if each Member State meets its national commitments for 2020. This type of governance therefore includes a *de facto* system of 'peer pressure', which should ensure that countries that do not adequately implement their national commitments are called to order by their peers as they may cause the failure of major European objectives, and therefore also the efforts of those countries that have fulfilled their commitments.

Eurostat publishes periodically monitoring indicators for each Member State in order to be able to annually take stock of the state and determine if performances are going in the right direction.

The following pages will analyse the updated indicators for Luxembourg in more detail and a descriptive overview[9] will be presented[10]. Reference is made to the 2017 NRP for Luxembourg for more details on the measures implemented, in order to explain the evolution of the indicators[11].

## A. Smart growth

### a.1 Improving conditions for innovation and R&D

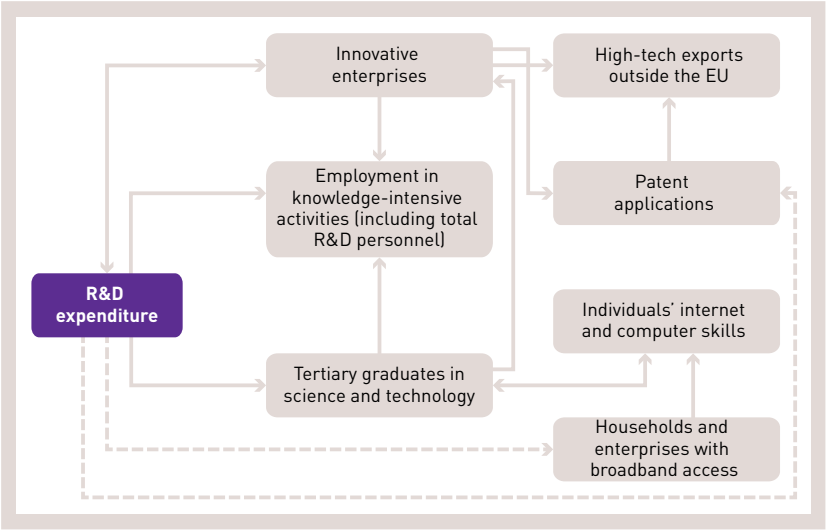
Investment in R&D, along with human capital, is essential for the development of knowledge and new technologies. The Barcelona European Council set the spending target of 3% of GDP on R&D in March 2002. This was one of the two key objectives of the former Lisbon strategy. The logic underlying the setting of this objective was that knowledge-based economies allocated a significant portion of their resources to R&D when the Lisbon strategy was launched (e.g. in 2000 2.7% in the United States and 3% in Japan). For the Europe 2020 strategy, it was proposed that this 3% European objective be maintained as a symbol, to focus political attention on the importance of R&D. The evolution of this indicator will largely depend on structural factors and public policies promoting R&D.

[9] On its website Eurostat provides comments regarding the quality of the statistics for the different Member States (series breaks, projections, uncertain data, etc.), which will not be repeated here.

[10] For more details about other EU Member States: EUROSTAT, Smarter, greener, more inclusive? Indicators to support the Europe 2020 strategy - 2017 edition, Eurostat statistical books, Luxembourg, 2017. Source: http://ec.europa.eu/eurostat/documents/3217494/8113874/KS-EZ-17-001-EN-N.pdf/c810af1c-0980-4a3b-bfdd-f6aa4d8a004e

[11] For additional details: https://odc.gouvernement.lu/fr/publications/rapport-etude-analyse/programme-national-de-reforme/2017-pnr-luxembourg-2020.html

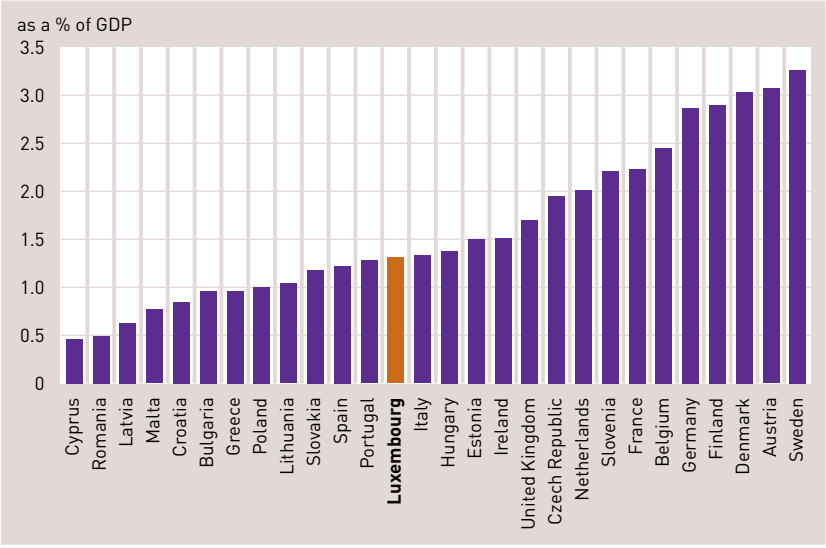
Chart 3
**R&D objectives**




Source: Eurostat

The average R&D expenditure rate for EU countries in 2015 was 2%. With a rate of 1.3% in 2015, Luxembourg therefore falls short of the EU average for R&D expenditure[12].

Chart 4
**Gross domestic expenditure on R&D, as a % of GDP (2015)**



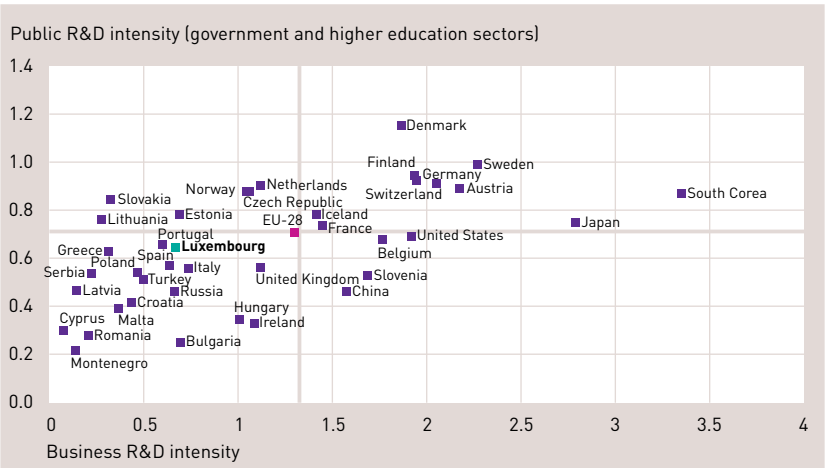

Source: Eurostat

[12] For additional details:
http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_R%26D_and_innovation

https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/european-semester_en

Luxembourg is one of a group of Member States whose private company-level expenditure on R&D is much lower than the EU-28 average, although its public R&D expenditure is close to the EU-28 average.

Chart 5
**R&D expenditure by sector and by country**

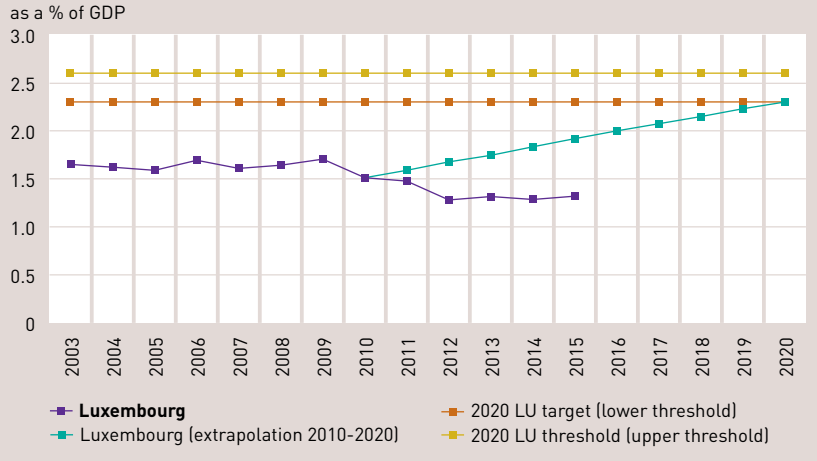



Source: Eurostat
Note: Provisional data for business enterprise and private non-profit sector, SI, BG, BE, AT, UK, FR, DK, IT, CZ, LU, MT, PT, EE, EL and CY: Data are estimates and/or provisional; DE, NL, LV and NO: Data for business enterprise, government and higher education sector are provisional and/or estimates; DE, NL, HR and US: Definition differs for private non-profit sector; IE, TU, ME, RS, KR, JO, CN: 2014 data for business enterprise sector; IE: Data for higher education sector are estimates; HU and US: Definition differs for business enterprise sector; HU, DE, NL, HR, SK, CH and ME: Definition differs for government sector; LT: Data for business enterprise sector are provisional; CH, TU, ME, RS, KR, JO and CN: 2014 data for higher education sector; CH: 2012 data for private non-profit sector; ME, RS, KR, JO: 2014 data for private non-profit sector; TU, ME, RS, KR, JO and CN: 2014 data for government sector; HU, ME and US: Definition differs for higher education sector; US: 2013 data for all sectors.

As part of its NRP, Luxembourg set a national target to be achieved in 2020 of spending 2.3-2.6% of GDP by 2020, with 1.5-1.9% being contributed by the private sector and 0.7-0.8% by the public sector. In 2015 Luxembourg is still far from achieving its national target for 2020, as well as being significantly below the upward trend which needs to materialise if it is to achieve this national 2020 target.

Public spending on R&D and innovation in Luxembourg has risen year on year since 2000, whereas private R&D expenditure[13] in EUR millions fell between 2007 and 2012, only to begin slowly climbing again from 2013 onwards. The share of overall R&D expenditure spent on public research in Luxembourg has therefore increased from 7.5% in 2000 to almost 50% at present. R&D activities carried out by companies in the private sector therefore currently account for over 50% of total expenditure[14]. However, as the European Commission recorded in its 2017 country report for Luxembourg as part of the European Semester, the relatively low level of R&D expenditure on the part of companies could be partially due to the weight of the financial sector (25% of GDP) and the low level of investment required for this sector's activities. It is therefore worthwhile analysing the main R&D indicators in greater detail, including the data breakdown for each economic sector[15]. According to the STATEC data, R&D intensity accounted for 7.3% of added value in 2013 in the Luxembourg industrial sector, the same figure as for Belgium. This placed the country in a respectable position compared to the Scandinavian countries and Germany (between 8.2% and 11.6%). Luxembourg's low level of R&D intensity (0.6%) in non-financial services is similar to that of Germany (0.9%) and Malta (0.6%). Luxembourg fares worse than most of the selected comparison countries for financial services (0.1%) despite these countries also having low levels of R&D in the financial sector (apart from the Scandinavian countries which have rates of between 1.6% and 4%).

Chart 6
**Gross domestic expenditure on R&D (GERD), as a % of GDP[16]**




Source: Eurostat, 2017 NRP
Note: The green line connecting the years 2010-2020 is an example to illustrate the linear trend Luxembourg's performance should display after 2010 in order to achieve national target set for 2020, i.e. 2.3%.

[13] The R&D expenditure (in millions of euros) of companies with commercial economic activity employing at least 10 people.

[14] For additional details: http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_R%26D_and_innovation

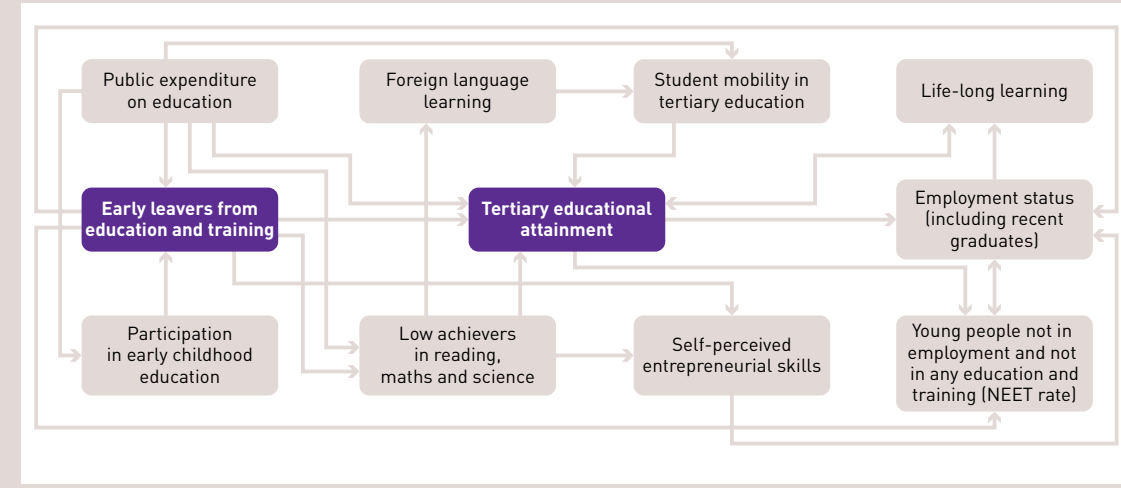
[15] Source: STATEC, Eurostat (2013, NACE Rev. 2) - Industries: Sections C-E – Non-financial sector and services: Sections G-J, L-N – Financial services: section K. Comparison countries were selected based on the following criteria: neighbouring countries and other Benelux countries, countries with a similar size or which are similar in terms of financial position (CY, EE, IE, MT), Scandinavian countries (DK, FI, SE).

[16] Definition: R&D comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications (Frascati Manual, 2002 edition, § 63). R&D is an activity where there are significant transfers of resources between units, organizations and sectors and it is important to trace the flow of R&D funds.

## a.2 Improving education levels

Investments in human resources alongside those in R&D are essential to ensure the development of knowledge and new technologies. The objective of the Europe 2020 strategy is smart and inclusive growth, two objectives are fixed for education and training. The trajectory of these two indicators is determined by demographic and social changes as well as political and institutional reforms, and should not therefore be influenced by cyclic fluctuations.

Chart 7
**Objectives regarding levels of education**




Source: Eurostat

### a.2.1 Early school leavers

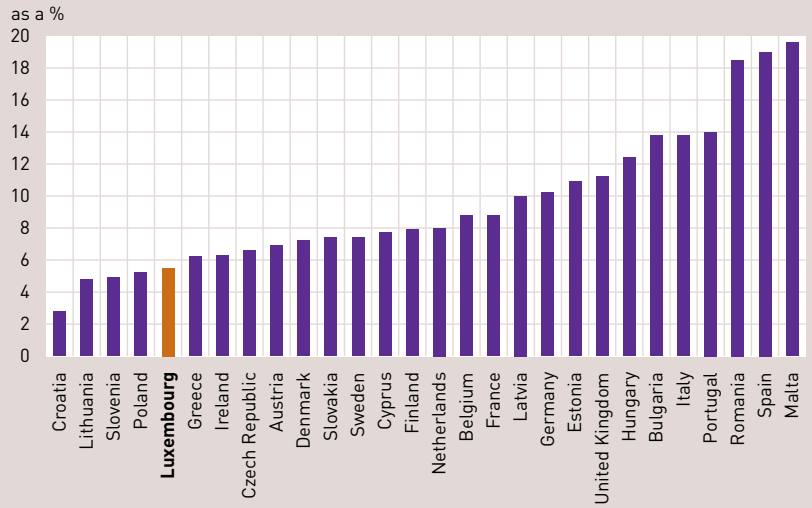
The EU-28 average for early school leavers[17] is 10.7 % in 2016. Luxembourg's score is 5.5 %, below the EU average[18].

The EU has set an objective for an early school leaving rate of under 10% by 2020. Luxembourg has rallied behind this European objective and has set a national target to keep the early school leaving rate under the 10% mark in the long-term.

[17] Definition: From 20 November 2009, this indicator is based on annual averages of quarterly data instead of one unique reference quarter in spring. Early school leavers refers to persons aged 18 to 24 fulfilling the following two conditions: first, the highest level of education or training attained is ISCED 0, 1, 2 or 3c short, second, respondents declared not having received any education or training in the four weeks preceding the survey (numerator). The denominator consists of the total population of the same age group, excluding no answers to the questions "highest level of education or training attained" and "participation to education and training". Both the numerators and the denominators come from the EU Labour Force Survey.

[18] For additional details: http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_education

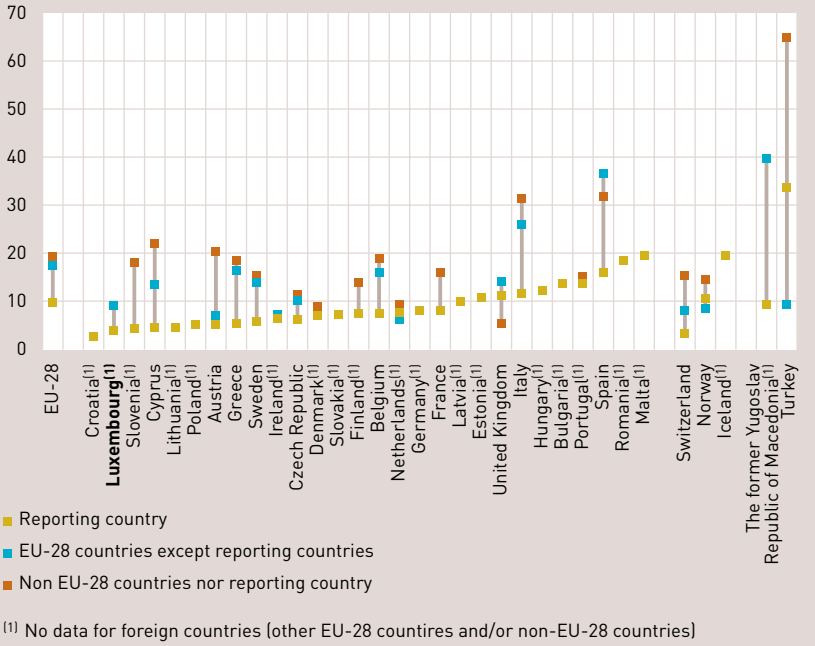
Chart 8
**Young people having left education and training prematurely, % of 18-24 year olds not in education or training with up to lower secondary education (2016)**




Source: Eurostat

The country of origin or birth has a significant influence on whether young people drop out of school. Young people studying in a country which is not their country of birth are more likely to leave school early. This is also true in Luxembourg.

Chart 9
**People having left education and training prematurely, by country of birth**




[1] No data for foreign countries (other EU-28 countires and/or non-EU-28 countries)

Source: Eurostat

The underlying statistics of this indicator calculated by Eurostat result from the Labour Force Survey (LFS)[19] and are prone to yearly variations for Luxembourg, due to the limited size of the survey sample. The Ministry of National Education in Luxembourg has therefore set up its own national survey on early school leaving, and levels of early school leaving calculated are different from LFS ones.

Table 2
**Statistics on early school-leaving rate according to the national study on early school leaving (national figures)**

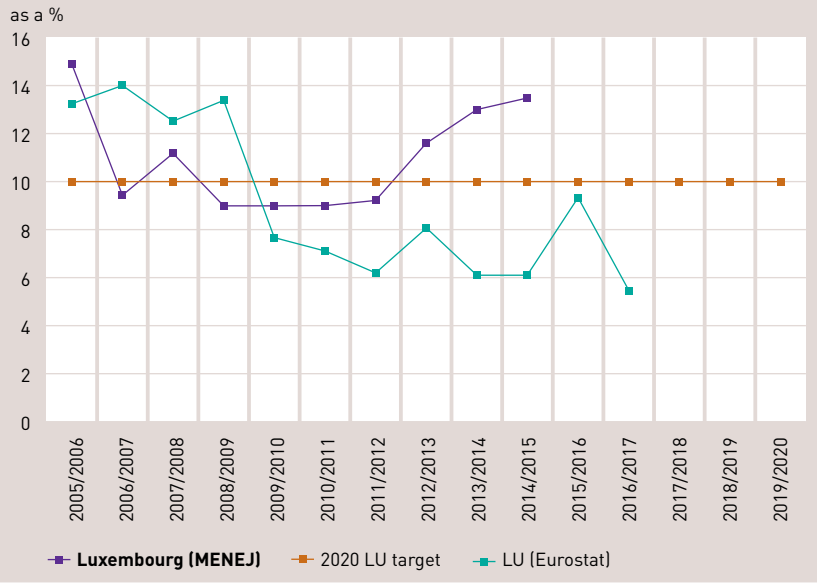
| Study | | Early school-leaving rate |
|---|---|---|
| 1 | 2003-2004 | 17.20% |
| 2 | 2005-2006 | 14.90% |
| 3 | 2006-2007 | 9.40% |
| 4 | 2007-2008 | 11.20% |
| 5 | 2008-2009 | 9.00% |
| 6 | 2009-2010 | 9.00% |
| 7 | 2010-2011 | 9.00% |
| 8 | 2011-2012 | 9.20% |
| 9 | 2012-2013 | 11.60% |
| 10 | 2013-2014 | 13.00% |
| 11 | 2014-2015 | 13.50% |

Source: Ministry of National Education, Childhood and Youth (MENEJ)
Definition: The notion of 'early school leavers' refers to young people who permanently left school without a diploma and who joined the labour market, benefiting from a professional integration measure or not having a specific occupation. It also includes young people who, after an initial leaving, have re-registered in a school, and then left again during the same period of observation, and for whose any additional information on their current situation is not available.
Note: National early school-leaving rate not available for 2004/2005.

According to Eurostat, Luxembourg is therefore well within its national target of 10%. However, according to national statistics, Luxembourg exceeded this symbolic threshold in 2012/2013, 2013/2014 and 2014/2015 schoolyears.

[19] For additional details: http://ec.europa.eu/eurostat/statistics-explained/index.php/Early_leavers_from_education_and_training

Chart 10
**People having left education and training prematurely**

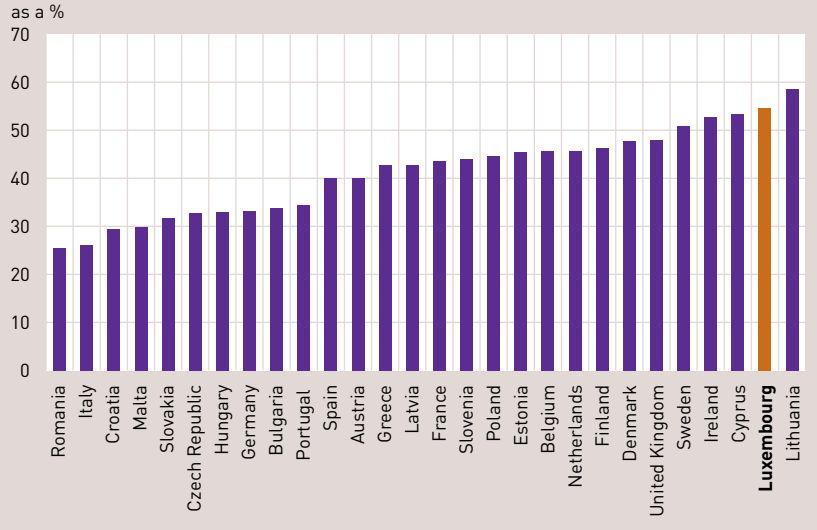



Source: Eurostat, NRP 2017
Note: There is a time gap between MENEJ and Eurostat data.

## a.2.2 Share of higher education graduates

In 2016, the percentage of the population aged 30-34 with a higher education qualification was 39.1% for the EU-28. With a rate of over 54% in 2016, Luxembourg is one of the best-performing Member States in this regard[20].

Chart 11
**Level of higher education graduates in the age group 30-34 (%), 2016**



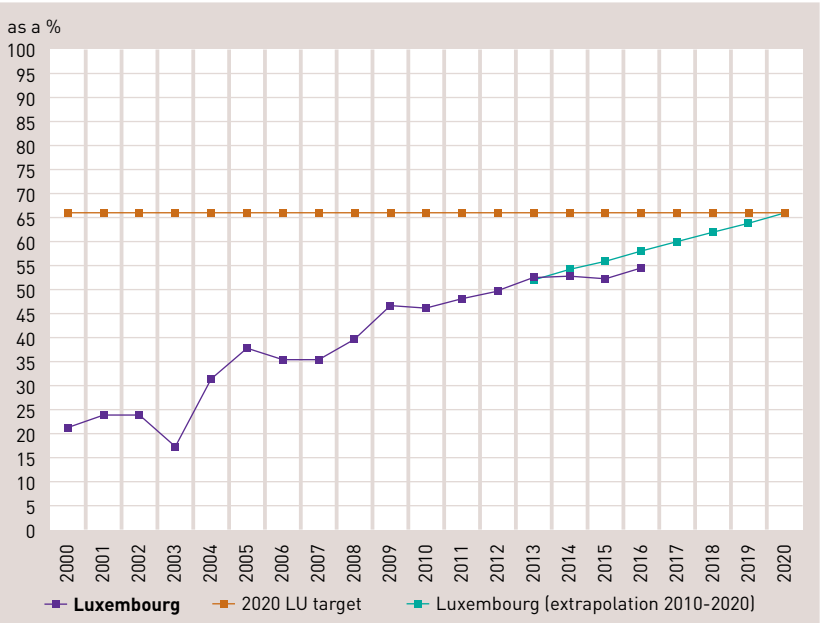

Source: Eurostat

[20] For additional details: http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_education

The overall EU objective is to achieve a rate of 40% of people aged 30-34 graduated in higher education by 2020. Luxembourg set a much higher objective in its NRP (66%). Luxembourg has experienced a significant increase in this indicator, which rose from 21.2% in 2000 to more than 54% in 2016. Luxembourg thus already exceeds by now the European objective and shows a positive mid- and long-term trend.

As the indicator for early school leaving, this indicator results from the Labour Force Survey (LFS). It is not fully representative for Luxembourg. On the one hand it includes foreign graduates living and working in Luxembourg (around 45% of residents in Luxembourg do not have Luxembourg nationality). On the other hand this indicator can neither capture national from Luxembourg who graduated and work abroad, nor the numerous cross-border workers coming to Luxembourg (around 45% of the total workforce in Luxembourg).

Chart 12
**Level of higher education graduates in the age group 30-34**[21]




Source: Eurostat, 2017 NRP
Note: The green line connecting the years 2010-2020 is an example to illustrate the linear trend Luxembourg's performance should display after 2010 in order to achieve national target set for 2020.

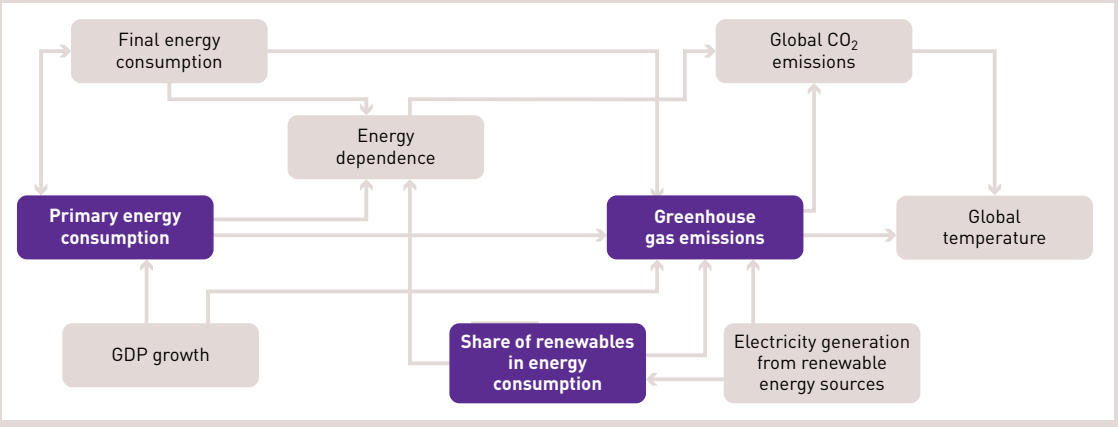
[21] Definition: The share of the population aged 30-34 years who have successfully completed university or university-like (tertiary-level) education with an education level ISCED 1997 (International Standard Classification of Education) of 5-6.

## B. Sustainable growth

### b.1 Reaching the climate change and energy objectives

In order to reach the climate change and energy objectives, the objectives set at the European Council in March 2007 were kept within the framework of the Europe 2020 strategy. The greenhouse gas emissions reduction targets and the share of renewable energy in the total energy consumption are legally binding[22.23].

Chart 13
**Objectives regarding climate change and energy**




Source: Eurostat

### b.1.1 Greenhouse gas emissions

In the 2013-2020 post-Kyoto period, only the non-ETS sectors have objectives which are set at Member State level. In Luxembourg, the 2020 target for non-ETS emissions is a 20% reduction on the 2005 reference level. This target is to be acieved following a linear path with the 2013 starting point consisting of the average rate of emissions between 2008 and 2010. The effects of the economic crisis have certainly not been favourable to Luxembourg as there has been a reduction in the emissions budget post-2013. The annual budget is based on annual emission allocations. In 2020, non-ETS emissions[24] will be limited to 8.145 Mt $CO_2$.

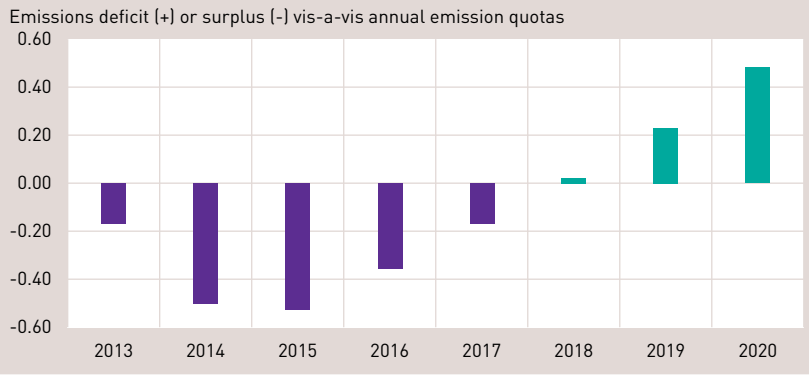
According to the forecast sent by Luxembourg to the European Commission (March 2016), featured in the 2017 NRP, the government predicts in its primary scenario that, for the 2013-2020 period, Luxembourg could generate an emissions surplus of around 1 Mt $CO_2$e by using existing measures (total over the period). Over this eight-year period, stock-taking (2013-2014) and forecasts (2015-2020) show that Luxembourg will begin to have an emissions deficit vis-à-vis its annual emissions quota in 2018. However, these calculations are heavily dependent on the expected developments in one particular sector, namely road transport, which alone represents almost two thirds of total non-ETS emissions.

22 See EU Directive 2006/32/CE. The reduction in energy consumption is a policy objective endorsed by the Member States in their Energy efficiency action plan.

23 For additional details: http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_climate_change_and_energy

24 Accounting for the adjustment stipulated in Article 10 of Decision (EC) 406/2009, as published in Commission Implementing Act 2013/634/EU of 31/10/2013. Amounts expressed on the basis of the existing GWPs featured in the 4th IPCC report, based on 2015 inventory submissions.

Chart 14
**Projected GHG emissions, non-LULUCF & ETS (2013-2020)**

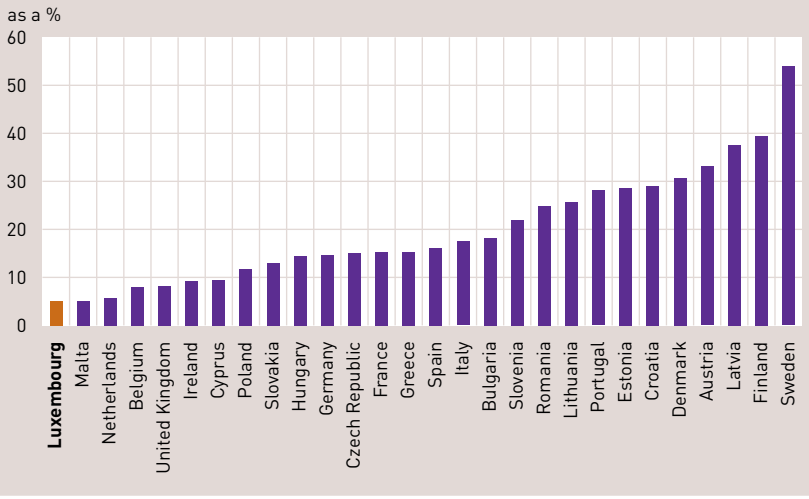



Source: 2017 NRP

### b.1.2 Share of renewable energy in energy consumption

In 2015, the share of renewable energies in gross final energy consumption accounted for an average of 16.7% among the EU-28. Luxembourg's rate was 5%, placing it at the bottom of the EU rankings.

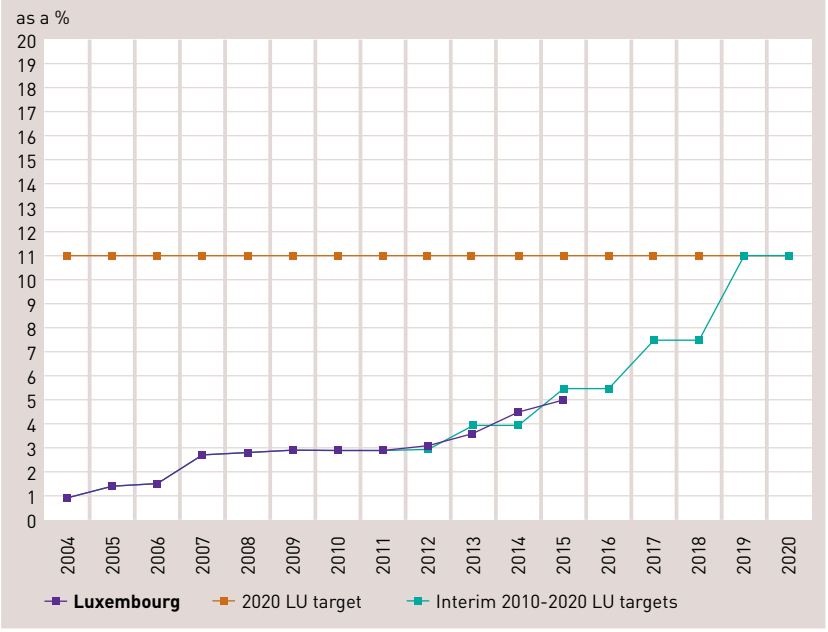
Chart 15
**Renewable energy in gross final energy consumption (2015)**




Source: Eurostat

As an objective, the EU has set the share of renewable energy to 20% by 2020. In this context, Luxembourg has set an overall target of 11% share of renewable energy in final energy consumption, with a series of interim targets. Luxembourg is in this interim development but will have to make significant efforts in the coming years to achieve its 2020 national target.

Chart 16
**Share of renewable energy in gross final energy consumption[25]**




Source: Eurostat, 2017 NRP
Note: The green line is the interim development set by the government after 2010 in order to achieve the national target set for 2020.

## b.1.3 Energy efficiency

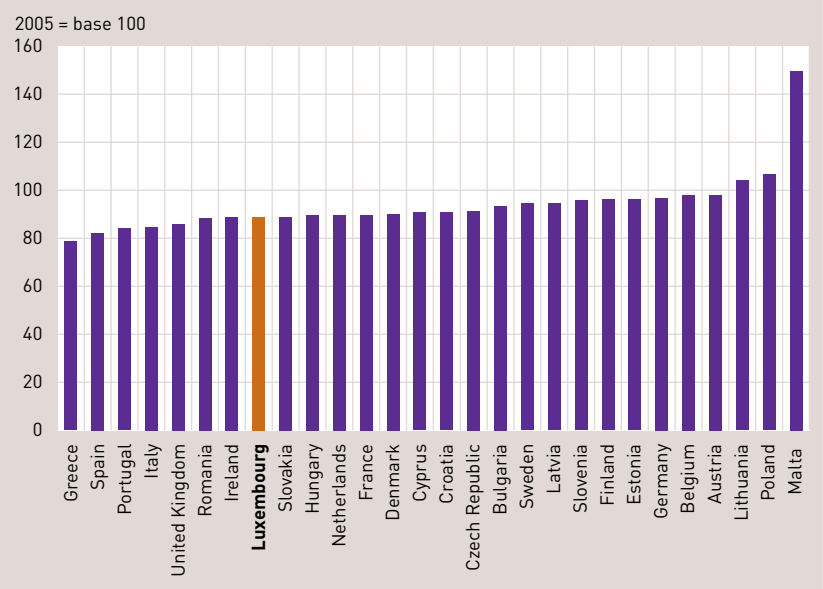
The Energy Efficiency Directive has set an energy efficiency objective for the whole of Europe by 2020. The EU has set an objective of a 20% increase in energy efficiency by that date. Although it applies to the EU as a whole, the Europe 2020 indicator does not provide practical information about national energy efficiency rates in the Member States. In fact, the Europe 2020 indicator only takes into account the energy savings of the EU in comparison to a scenario whereby policies remained unchanged, and based on economic predictions dating from 2007. Member States were obliged to set indicative national targets for primary and/or final energy consumption levels. In order to draw comparisons on the basis of this information regarding energy consumption, Eurostat subsequently calculates the primary and final energy consumption in million tonnes oil equivalent[26] in order to assess the progress made in energy efficiency at national level. It is worth noting that the economic and financial crisis which began in 2008, and the resulting downturn in economic activity, had a significant impact on energy consumption during the period of time taken into consideration. Therefore, the reduction in the volume of energy recorded in recent years, both in the EU as a whole and in the Member States, may not necessarily only signal an increase in energy efficiency, but may also be the result of declining activity.

All things considered, final energy consumption fell more between 2005 and 2015 in Luxembourg (indicator of 89.1, 2005 = base 100) than in the EU as a whole (90.8). As a result, final energy consumption was about 10.9% lower in 2015 in Luxembourg than in 2005.

[25] Definition: This indicator is calculated on the basis of energy statistics covered by the Energy Statistics Regulation. It may be considered an estimate of the indicator described in Directive 2009/28/EC, as the statistical system for some renewable energy technologies is not yet fully developed to meet the requirements of this Directive. However, the contribution of these technologies is rather marginal for the time being. More information about the renewable energy shares calculation methodology and Eurostat's annual energy statistics can be found in the Renewable Energy Directive 2009/28/EC, the Energy Statistics Regulation 1099/2008 and in DG ENERGY transparency platform.

[26] Definition: The term 'primary energy consumption' means gross inland consumption with the exception of any non-energy use of energy products (e.g. natural gas used not for combustion but for the production of chemicals). This quantity is relevant to measure the actual energy consumption. 'Percentage of savings' is calculated using 2005 values and their forecasts for 2020. The Europe 2020 target will be achieved when this value reaches the level of 20%.

Chart 17
**Final energy consumption in Luxembourg (2005 = base 100)**




Source: Eurostat

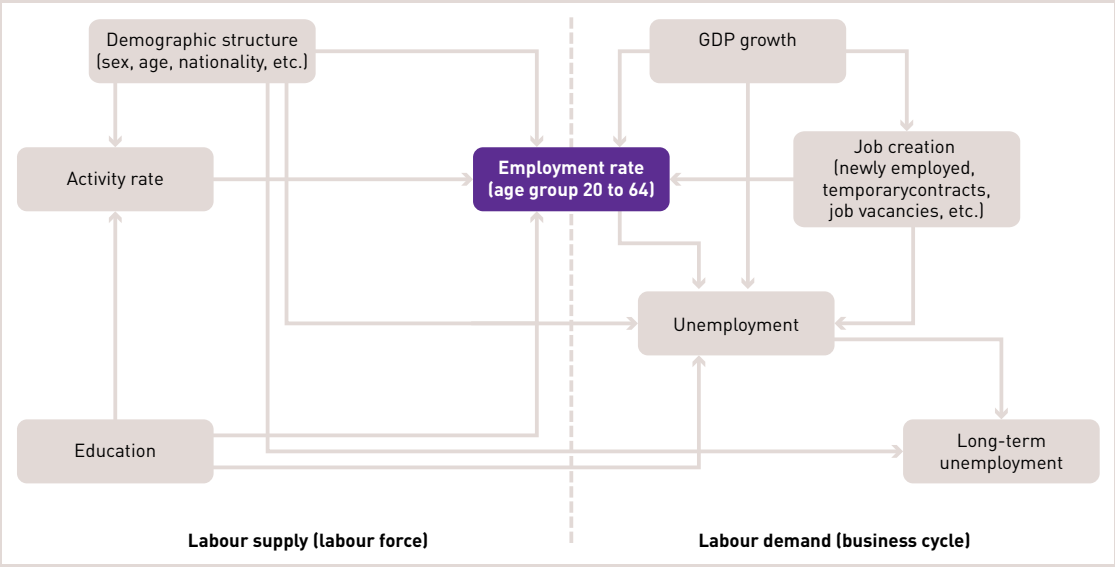
Luxembourg set a national target for 2020 with the aim being for annual consumption to be less than 49,292 GWh (4,239.2 ktoe). In addition to the energy efficiency target, Luxembourg also set itself the goal of saving 5,993 GWh by the end of 2020. Luxembourg intends to achieve all of its energy saving targets via a system of energy efficiency obligations, which were established in 2015. Even though the energy saving target is not linked to the energy efficiency target given that the latter is completely independent of the variation in final annual energy consumption, the energy efficiency obligations are one of the primary instruments in the bid to meet the energy efficiency target.

## C. Inclusive growth

### c.1 Promoting employment

The Lisbon strategy (2000-2010) included a target related to employment policies, namely the employment rate. The new Europe 2020 target shows two major changes compared to the former Lisbon objective: firstly, the age range considered (20-64 for 2020 instead of 15-64 for 2010) in order to reduce potential conflicts between employment policies and education policies, and secondly the reference value to be achieved (75% by 2020 instead of 70% by 2010). Developments in the employment rate depend on many uncertainties, which must be considered when setting quantified targets for the Europe 2020 strategy. Indeed, the employment rate indicator is a very cyclical indicator. For example, the actual exit date of the 2008/2009 crisis plays a key role in the development of this indicator.

Chart 18
**Employment objective**

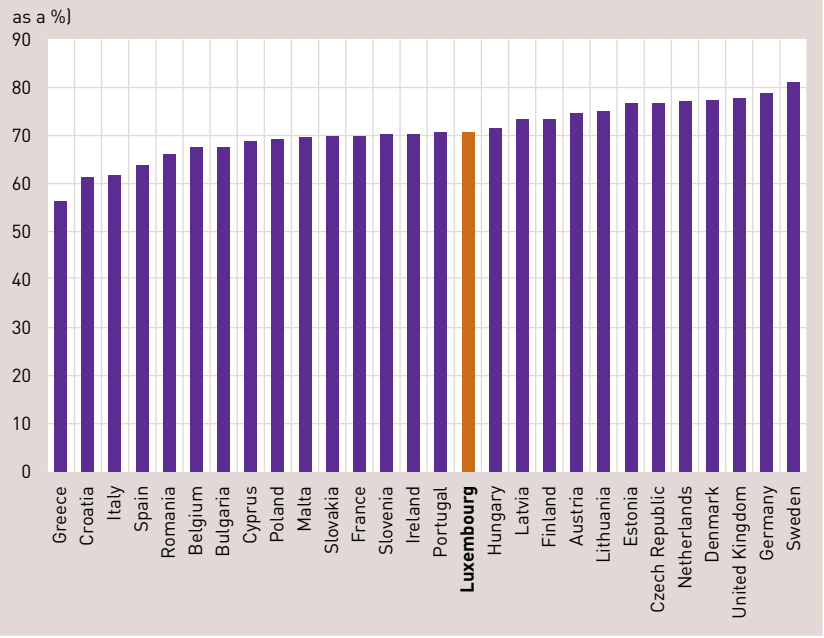



Source: Eurostat

The EU-28 employment rate is 71.1% in 2016. With an employment rate of 70.7%, Luxembourg ranks below the EU average[27]. The employment rate, which is an average of the resident workforce, does however hide considerable differences in the employment rate per socio-economic category observed. Proceeding to a narrower segmentation of the employment rate, for example according to gender or age of the worker, reveals important fluctuations in the employment rate. For example, in 2016, the male employment rate is around 76.1% in Luxembourg whilst the female employment rate is close to 65%. The employment rate for 55-59 year olds is around 57% whilst the employment rate for 60-64 year olds stands only at 17.7%.

[27] For additional details: http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_employment

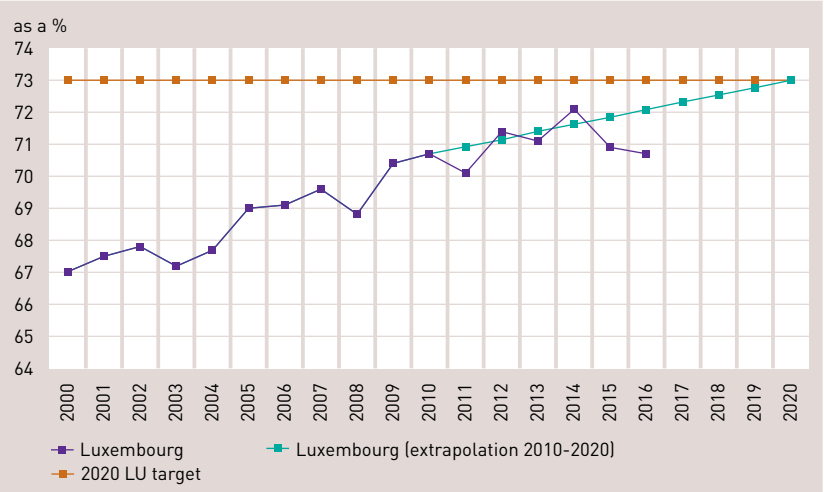
Chart 19
**Employment rate of people aged 20-64 (2016)**




Source: Eurostat

Luxembourg set as a national target a 73% employment rate by 2020. The employment rate in the country has increased from 67.4% (2000) to 70.7% (2016). The trend since 2000 has therefore been a positive one, with particularly notable increases in the female and senior employment rates, but the indicator has stalled during the past two years and in fact seems likely to dip[28].

Chart 20
**Employment rate of people aged 20-64[29]**




Source: Eurostat
Note: The green line connecting the years 2010-2015 and 2015-2020 is an example to illustrate the linear trend Luxembourg's performance should display after 2010 in order to achieve the national target set by Luxembourg.

[28] Changes were made to the methodology of the Luxembourg workforce survey (LFS – labour force survey) in 2015. It is currently unclear as to whether the recent lack of progress in the employment rate is a true trend or simply a break in the data series.

[29] Definition: The employment rate is calculated by dividing the number of persons aged 20 to 64 in employment by the total population of the same age group. The indicator is based on the EU Labour Force Survey. The survey covers the entire population living in private households and excludes those in collective households such as boarding houses, halls of residence and hospitals. Employed population consists of those persons who during the reference week did any work for pay or profit for at least one hour, or were not working but had jobs from which they were temporarily absent.

Finally, although a higher employment rate generally allows increasing the supply of domestic labour, boosting growth and relieving social spending and public spending, these statements must be put in perspective in the case of Luxembourg. Labour supply in Luxembourg consists of three components: the indigenous, cross-border and the immigrant offers. However cross-border workers are not considered in the definition of the employment rate. This is a purely national concept, related to the place of residence of the worker. Yet cross-border workers in Luxembourg make up more than 45% of domestic employment. As noted by the Economic and Social Council (ESC)[30], this indicator *'is not representative of macroeconomic reality in Luxembourg and is even less suitable for a macroeconomic employment target, on which employment policy should be defined'*. In contrast, the employment rate for young people, women and older workers is useful for understanding the use of human resources in the economy.

### c.2 Reducing poverty

The European objective that was initially proposed by the European Commission for social inclusion focused on reducing poverty by 20 million people at risk of poverty. However, in order to meet the Europe 2020 strategy objective of promoting inclusive growth, the European Council in March 2010 had asked the Commission to work further on social inclusion indicators, including also non-monetary indicators. In June 2010 the European Council decided to ensure that 20 million people at least no longer be faced with the risk of poverty and exclusion, and defined this population as the number of people at risk of poverty and exclusion according to three indicators, Member States being free to set their national targets on the basis of indicators they consider most appropriate among these:

- At-risk-of-poverty rate: people living on less than 60% of the national median income. The at-risk-of-poverty rate is the key indicator to measure and monitor poverty in the EU. This is a relative measure of poverty, linked to the income distribution, which takes into account all sources of monetary income, including market revenues and social transfers. It reflects the role of employment and social protection in the prevention and reduction of poverty;

- Material deprivation rate: people whose lives are severely limited by a lack of resources[31]. The material deprivation rate is a non-monetary measure of poverty, which also reflects the different levels of prosperity and quality of life in the EU, as it is based on a single European level;

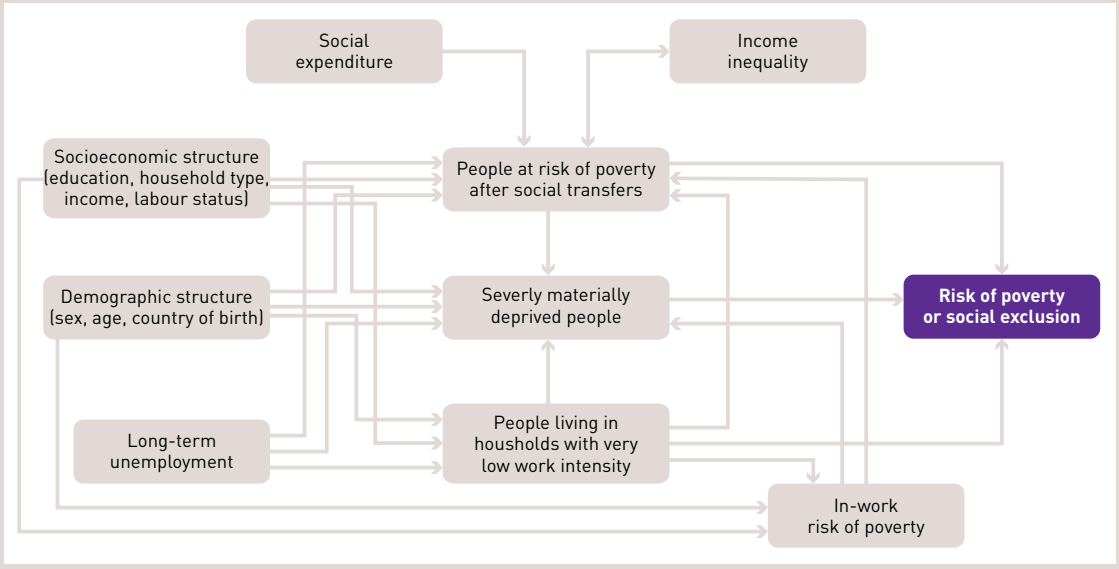
- People living in households with very low work intensity: this population is defined relative to zero or very low work intensity over an entire year, in order to properly reflect the situations of prolonged exclusion from the labour market. These are people living in families in a situation of long-term exclusion from the labour market. The long-term exclusion from the labour market is one of the main factors of poverty and increases the risk of transmission of disadvantage from one generation to another.

[30] CES, Deuxième avis sur les Grandes Orientations des Politiques Économiques des États membres et de la Communauté (GOPE), Luxembourg, 2003. For more information: http://www.ces.public.lu/fr/avis/index.html

[31] Definition: Currently the agreed EU material deprivation indicator is defined as the share of people are concerned with at least 3 out of the 9 following situations: people cannot afford i) to pay their rent or utility bills, ii) keep their home adequately warm, iii) face unexpected expenses, iv) eat meat, fish, or a protein equivalent every second day, v) a week of holiday away from home once a year, vi) a car, vii) a washing machine, viii) a colour tv, or ix) a telephone.

The risks that have an impact on the evolution of poverty indicators are related to macroeconomic developments, but also to the ability of employment policies to promote an inclusive labour market and employment opportunities for all and to the welfare system's capacity to improve efficiency and effectiveness because of the constraints on public finances. Note that monetary indicators of poverty, such as the poverty rate, are significantly limited. They do not take into account the many non-monetary public services that are available to citizens. In Luxembourg, among other things, we can mention in this context the service vouchers that are not taken into account.

Chart 21
**Risk of poverty and social exclusion objective**



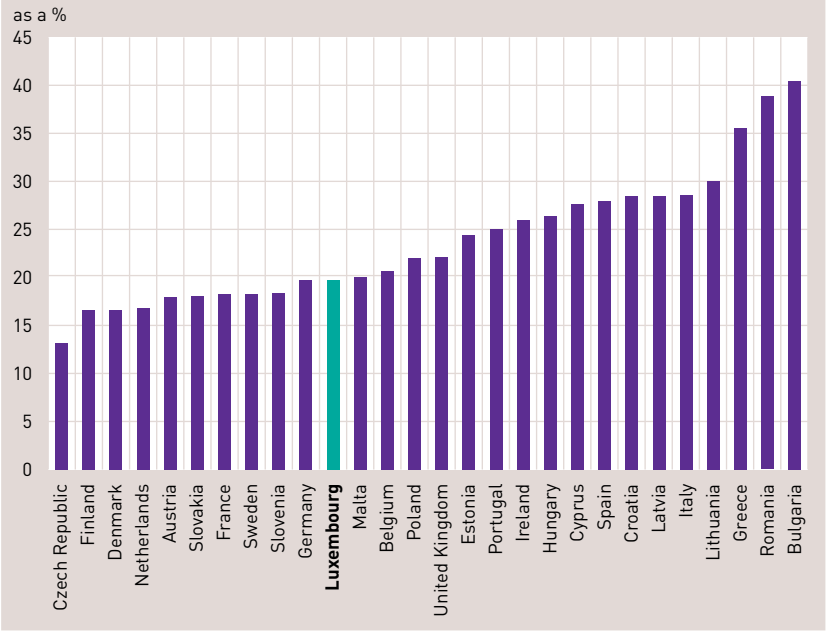

Source: Eurostat

For a more comprehensive view of people experiencing poverty or exclusion, Eurostat has developed an indicator to better quantify the percentage of the population facing the risk of poverty or exclusion, by combining the three individual indicators mentioned above.

In 2016, an average of 23.4% of the overall population in the EU-28 was considered at risk of poverty or social exclusion. According to the most recent data published by STATEC[32], the share of people at risk of poverty or social exclusion was 19.7% in Luxembourg in 2016 and has therefore increased in comparison with 2015 (+1.2 p.p.).

[32] For additional details: http://www.statistiques.public.lu/fr/publications/series/cahiers-economiques/2017/123-cohesion-sociale/index.html

Chart 22
**Share of people at risk of poverty or social exclusion (2016)**




Note: Italy, Ireland (2015)
Source: Eurostat, Statec

In 2016, the people considered to be at risk of poverty or social exclusion in Luxembourg are[33, 34]:

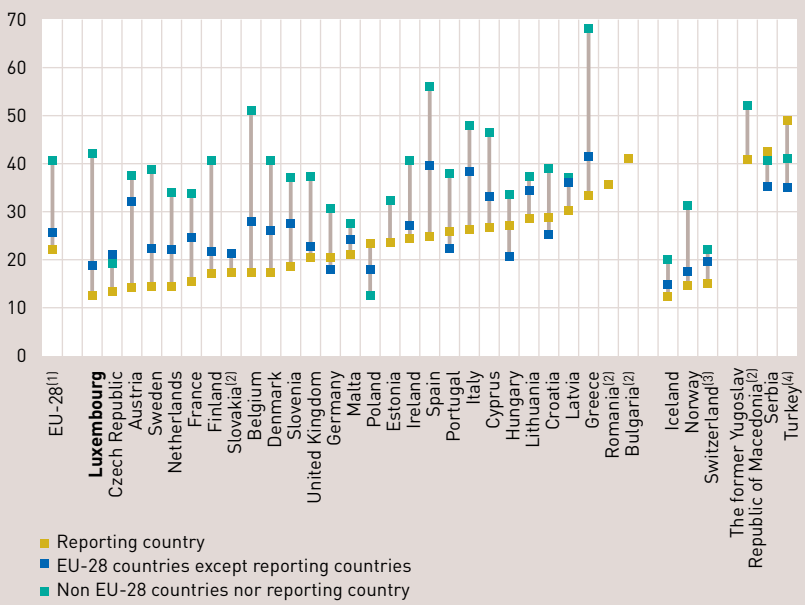
- Primarily people at risk of poverty following social transfers (16,5%);
- To a much lesser extent, people living in a family with a very low work intensity (5,4%);
- To a much lesser extent also, people living in severe material deprivation (1,6%).

In 2015, the share of people at risk of poverty or social exclusion in the EU was higher for third country nationals than for residents from other EU countries or nationals residing in their Member State of origin. This situation is also true in Luxembourg.

[33] For additional details: http://www.statistiques.public.lu/fr/publications/series/cahiers-economiques/2017/123-cohesion-sociale/index.html

[34] For additional details, see also: https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/european-semester_en

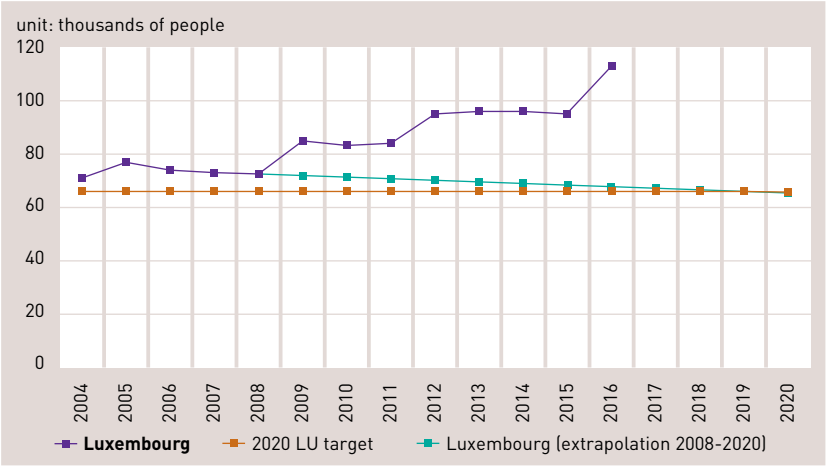
Chart 23
**Rate of people at risk of poverty or social exclusion by country of birth**




Source: Eurostat
(1) Estimated data for foreign countries
(2) Missing data due to low reliability
(3) 2014 data
(4) 2013 data

In its NRP Luxembourg has adopted a national target for 2020, which is 'to reduce by 6,000 the number of people at risk of poverty or social exclusion'. As is the case for the vast majority of Member States, Luxembourg is far from reaching its national 2020 target. In fact, since the recent economic and financial crisis, the number of people at risk of poverty or social exclusion has been steadily rising in Luxembourg. With about 113,800 people in 2016, Luxembourg is way above the downward trend necessary to reach its national target by 2020, according to the methodology used by the European Commission in its assessment (taking 2008 as the reference year). The national target would need Luxembourg to display 6,000 people less in 2020 as compared to 2008 (72,000 people). This would imply that in 2020 only 66,000 people should be at risk of poverty or social exclusion in Luxembourg.

Chart 24
**Trend in rate of people at risk of poverty or social exclusion**




Source: Eurostat, Statec, 2017 NRP
Note: The green line connecting the years 2008-2020 is an example to illustrate the linear trend Luxembourg's performance should display after 2008 in order to achieve national target set for 2020. 2020 target corresponds thus to 2008 figure minus the 6,000 people Luxembourg intends to lift out of poverty or social exclusion.

## 4.1.3 Conclusions – Taking stock of the situation in Luxembourg

In the Luxembourg country report published in February 2017 as part of the European Semester[35], the European Commission made the following comments on Luxembourg's range of national targets under the Europe 2020 strategy. *'Regarding progress in reaching the national targets under the Europe 2020 Strategy, Luxembourg is performing well in the areas of employment, renewable energy, energy efficiency, reducing early school leaving and improving tertiary education attainment. By contrast, Luxembourg is still far from reaching its targets for investment in research and developments (R&D), reducing greenhouse gas emission, and reducing poverty.'*

More specifically, the European Commission set the following national targets:

- R&D: Luxembourg is highly unlikely to achieve its R&D intensity target for 2020 due to the clear reduction in this intensity in companies. On the other hand, R&D intensity in the public sector has increased continually. This five-fold multiplication shows that there is a willingness to develop public research capabilities;
- Early school leaving: the early school leaving rate remains below both the EU average (11%) and the national target (10%). National data seem to show that this rate is increasing;
- Higher education: the rate of 30-34-year olds with higher education qualifications is well above the EU target of 40%;

[35] For additional details: https://ec.europa.eu/info/sites/info/files/2017-european-semester-country-report-luxembourg-fr.pdf

- Greenhouse gas emissions: according to the latest national forecasts and considering existing measures, the European Commission expects non-ETS emissions to fall by 15% from 2005-2020 and that the target for 2020 will not be achieved;

- Renewable energy: in 2015 the share of renewable energy in final energy consumption was higher than the indicative pathway for 2015-2016. Given that this pathway will accelerate as 2020 approaches, Luxembourg will need to continue promoting the deployment of renewable energies across all sectors to achieve its aims in the domain of renewables;

- Energy efficiency: Luxembourg has made good progress in this domain. Although Luxembourg has already reduced its energy consumption levels to fall below the indicative national thresholds for 2020 (4.5 Mtoe for primary energy consumption and 4.2 Mtoe for final energy consumption), further effort will be required to maintain these levels until 2020;

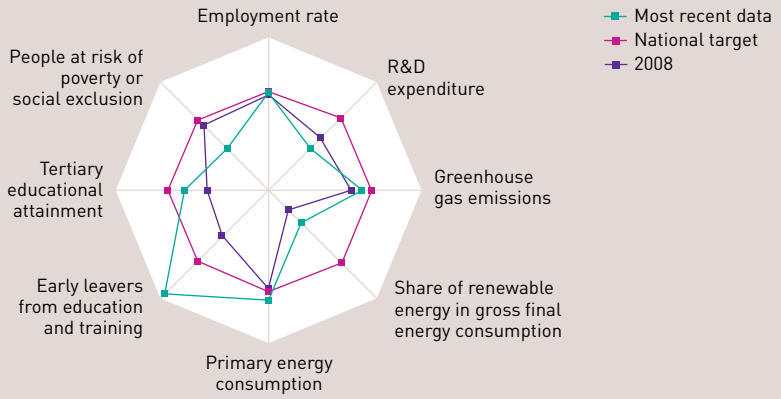
- Employment: the overall employment rate for the local population has fallen slightly, leaving the country slightly less likely to achieve its target;

- Risk of poverty or social exclusion: the share of people at risk of poverty or social exclusion in 2016 remains much higher than the national target.

In a statistical report published in July 2017 on achievements in implementing the Europe 2020 strategy, Eurostat also made the following observation concerning Luxembourg[36]: *'Luxembourg has continuously exceeded its target on early leavers from education and training since 2009. It has also continued to meet its target on primary energy consumption since 2011. Luxembourg has the most ambitious target on tertiary education across the EU, aiming for 66% of the population aged 30 to 34 having attained tertiary education by 2020. Despite a 14.8 percentage point rise between 2008 and 2016, it still has further to go to meet its national target than other Member States. Although in 2016 the country was closer to its employment target than the EU as a whole, a gap of 2.3 percentage points persists. In 2015, Luxembourg spent relatively less on R&D as a percentage of GDP than the EU overall and it has moved further away from its national target since 2008. The number of people at risk of poverty or social exclusion increased by 32% between 2008 and 2015, pushing Luxembourg further from its national target. In terms of climate change mitigation, it did not reach its national target on the expansion of renewable energy and had one of the lowest shares of renewables in gross final energy consumption in the EU in 2015. And its 13.6% reduction in non-ETS GHG emissions in 2015 (compared to 1990) was not enough for the country to reach its national target to reduce emissions by 20%.'*

[36] For additional details: http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_Luxembourg

Chart 25
**Luxembourg profile: 2008, most recent data and national targets 2020**




| | Data | Year | Target |
|---|---|---|---|
| Employment rate age group 20-64 (%) | 70.7 | 2016 | 73 |
| Gross domestic expenditure on R&D (% of GDP) | 1.31[1] | 2015 | 2.3[2] |
| Greenhouse gas emissions in non-ETS sectors (% change since ESD base year) | -13.6 | 2015 | -20 |
| Share of renewable energy in gross final energy consumption (%) | 5.0 | 2015 | 11 |
| Primary energy consumption(million tonnes of oil equivalent) | 4.1 | 2015 | 4.5 |
| Early leavers from education and training (% of population aged 18-24) | 5.5 | 2016 | 10[3] |
| Tertiary educational attainment (% of population aged 30-34) | 54.6[4] | 2016 | 66 |
| People at risk of poverty or social exclusion (thousands) | 95 | 2015 | 66 |

[1] Estimated/provisional data
[2] National target: 2.3-2.6%
[3] National target: less than 10%
[4] Data has low reliability
Source: Eurostat

Table 3
**Summary table of the Europe 2020 strategy objectives**

| **Priorities** | **Smart growth** | | | **Sustainable growth** | | | **Inclusive growth** | |
|---|---|---|---|---|---|---|---|---|
| Objectives | Improving conditions for innovation and R&D | Improving education levels | | Reaching the climate change/energy objectives | | | Promoting employment | Reducing poverty |
| Indicators | R&D | Early school leaving rate | Higher education | GHG emissions | Renewable energy | Energy efficiency | Employment rate | Poverty |
| Unit | % of GDP | % | % of 30-34 year olds | Mtoe | % | Mtoe | % of 20-64 year olds | People |
| LU* | 1.31 | 5.5** | 54.6 | 8.8 | 5 | 4.0 | 70.7% | 113,800 |
| National target 2020 | 2.3-2.6% | <10% | 66% | 8.14*** | 11% | 4.2**** | 73.0% | 66,000 |

Source: Eurostat, Statec, 2017 NRP
Notes: * Update according to the most recent data available
** National data (MENEJ) : 13.5% (2014/2015)
*** -20% in relation to 2005
**** Final energy consumption

# 4.2 Macroeconomic surveillance

## 4.2.1 Implementation of the monitoring of macroeconomic imbalances

The years before the 2008/2009 financial and economic crisis were characterized in the euro area by divergent macroeconomic developments that have created imbalances among Member States. However, before the onset of the global economic and financial crisis, little attention was paid to these imbalances within the EU, in particular within the euro area. For example, public and private debt rose sharply in Greece, real estate bubbles were created in Spain and Ireland, and Italy, Spain, Portugal and Greece experienced significant losses in cost competitiveness[37]. Public attention only started to focus on this unhealthy situation after the crisis began. As a result, new challenges have arisen in monetary policy and coordination of economic and fiscal policies because of the interdependence of the European economies and because the existing mechanisms were insufficient. It was therefore important to reinforce and further coordinate economic policy.

So, the Commission proposed to further strengthen the coordination of economic policy. In its May 2010 communication 'Reinforcing Economic Policy Coordination', the Commission highlighted a persistent accumulation of macroeconomic imbalances, which is able to destabilize the euro area and the functioning of the European Monetary Union. Based on this communication, in June 2010 the European Council decided to establish a European stabilization mechanism. The Commission subsequently developed its ideas in its 'Enhancing economic policy coordination for stability, growth and jobs – Tools for stronger EU economic governance' communication on the governance of economic policy and proposed to develop a new structured mechanism to detect and to correct macroeconomic imbalances. In order to better detect these imbalances, the Commission along with the Member States established a first scoreboard with economic and financial indicators. On 29 September 2010, the Commission finally proposed a legislative package ('Six Pack'), which includes the monitoring of internal and external macroeconomic imbalances in the Member States, such as housing and increasing differences in cost competitiveness between Member States[38]. The European Parliament finally voted this legislative package on economic governance on 28 September 2011 and the European regulation entered into force in late 2011.

[37] MONETARY POLICY AND THE ECONOMY, Prevention and Correction of Macroeconomic Imbalances: the Excessive Imbalances Procedure, Q4/2011

[38] Based on both European regulations1176/2011 and 1174/2011. For additional details:

http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32011R1176

http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32011R1174

## 4.2.2 Macroeconomic imbalance procedure

The monitoring procedure includes a preventive and a corrective arm.

### a. The preventive arm

In the preventive component of the procedure, a scoreboard was established and is published annually by the Commission. The first edition of this scoreboard was published in the Alert Mechanism Report (AMR)[39] en février 2012. in February 2012. For each Member State this mechanism analyses several indicators compared with 'alert thresholds' and is accompanied by an economic reading of the indicators, so as to not limit the interpretation to a 'mechanical' reading. This procedure allows the Commission to identify a potential risk. If this initial scoreboard reveals the existence of a potential macroeconomic imbalance within a Member State, in a second step the Commission calls for an in-depth analysis. This further analysis examines the origin, nature and severity of a potential imbalance.

In the analytical work carried out within the context of the implementation of this scoreboard, it proved to be very difficult to agree on 'one size fits all' indicators for all Member States, which can take into account both the specificities of each Member State and the potential methodological problems. It was thus agreed that the results should not be limited to a 'mechanical' interpretation but to accompany the reading by an economic analysis. The selection of indicators is mainly based on four guidelines: indicators should detect the major macroeconomic imbalances and signs of loss of competitiveness; indicators should enable the analysis of both the level and flows; indicators should serve as an important communication tool; the statistical quality of data should be high and suitable to make international comparisons.

The initially adopted main scoreboard included eleven indicators divided into two categories: external and internal imbalances. The analysis of external imbalances includes indicators such as the current account balance (foreign exchange of a country), or factors having a direct impact on this aggregate such as cost competitiveness. In terms of internal imbalances, the experience gained through the crises in the past has allowed identifying various key indicators such as unusual developments in the financial sector; extreme changes in credit with a high increase in house prices. Statistics that are used annually in the scoreboard are updated periodically by Eurostat[40]. For each of these indicators, the Commission - in collaboration with Member States - had also defined the thresholds at which performances can be regarded as potentially 'at risk' based on the historical statistical distribution of each indicator[41]. This means that if a Member State exceeds a threshold, it could display a macroeconomic imbalance. It is important to stress that the defined thresholds are usually the same for all Member States, making a difference only in some cases between Member States being in or out the euro area. However, the thresholds should not be considered as political objectives to be reached, but should only be used to identify developments that may lead to imbalances[42].

[39] EUROPEAN COMMISSION, Alert Mechanism Report, Report prepared in accordance with Articles 3 and 4 of the Regulation on the prevention and correction of macro-economic imbalances, Brussels, 14.2.2012 COM(2012)68 final

[40] For additional details: http://ec.europa.eu/eurostat/web/macroeconomic-imbalances-procedure/indicators

[41] For more details about the implementation methodology of the AMR scoreboard: EUROPEAN COMMISSION, Scoreboard for the surveillance of macroeconomic imbalances, European Economy. Occasional Papers 92, Brussels, February 2012.

Source: http://ec.europa.eu/economy_finance/publications/occasional_paper/2012/op92_en.htm

[42] CENTRE FOR EUROPEAN POLICY STUDIES, Macroeconomic Imbalances in the Euro Area: symptom or cause of the crisis?, Policy Brief No. 266, April 2012

Since late 2015, the European Commission has added three new employment indicators to the initial scoreboard: the activity rate in the total population (aged 15-64), long-term unemployment rate (active population aged 15-74), youth unemployment rate (active population aged 15-24). It brings now to 14 the total number of major indicators in the main scoreboard[43].

**b. The corrective arm**

If in-depth examination, which is performed after the scoreboard-based analysis, finds that an excessive macroeconomic imbalance exists in a Member State, the corrective arm of the procedure is triggered. The Member State concerned is then placed in an excessive imbalances situation. In this case the Member State must submit a corrective action plan to the Council specifying concrete measures and a detailed implementation schedule. The Commission and the Council assess the corrective action plan that is either found to be satisfactory, which leads to the issuing of regular progress reports to the Council, or insufficient, and the Member State is then requested to amend its action plan. If, after the amendments, the action plan remains insufficient, the Council adopts sanctions on the basis of recommendations of the Commission, unless the Council supports the arguments of exceptional economic circumstances by a reverse qualified majority.

## 4.2.3 The 2017 edition of the macroeconomic imbalance procedure

The sixth edition of the scoreboard was published in the Alert Mechanism Report released in November 2016 as part of the European Semester. In the November 2016 edition, the European Commission concluded Luxembourg analysis as follows: *'In the previous round of the MIP, no macroeconomic imbalances were identified in Luxembourg. In the updated scoreboard, a number of indicators are beyond the indicative threshold, namely real house prices, private sector credit flow and indebtedness. The structurally high current account surplus was stable in 2015 and is narrowly within the threshold. The positive net international investment position increased, mostly reflecting the dominance of the financial sector, while only a limited share of the flows is related to domestic economic activity. Wages growth is low contributing to the recent labour costs moderation. Combined with the improvement in productivity recorded over the recent years, it helps to explain the recovery of export market shares. The low government debt further declined. Credit growth remained dynamic and buoyant growth of loans for housing acquisition has pushed up the level of household debt close to the euro area average, while deleveraging pressures on households' and corporations' balance sheets appear contained. Housing prices are accelerating from already high levels, which warrants close monitoring. Several factors, such as sizeable net migration flows, a dynamic labour market and low financing costs concur to sustain housing demand, while supply remains relatively constraint as also reflected in a low growth of building permits. Loan to value ratios have decreased as has housing affordability. Unemployment increased but from a low level. Overall, the economic reading points mainly to issues related to the increasing housing prices although overall risks still appear relatively contained. Therefore, the Commission will at this stage not carry out further in-depth analysis in the context of the MIP.'*

[43] In addition to the main scoreboard, there is an auxiliary scoreboard which enables performing more detailed analyses. This will not be reviewed in this chapter. For more details, see http://ec.europa.eu/eurostat/cache/Imbalance_Scoreboard/MIPs_AUX_EN_banner.html

Table 4
**AMR scoreboard indicator results (November 2016 edition)**

| | External imbalances and competitiveness | | | | | Internal imbalances | | | | | | Employment indicators[1] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 2015 | Current account balance - % of GDP (3 year average) | Net international investment position (% of GDP) | Real effective exchange rate - 42 trading partners, HICP deflator (3 year % change) | Export market share - % of world exports (5 year % change) | Nominal unit labour cost index (2010=100) (3 year % change) | House price index (2010=100), deflated (1 year % change) | Private sector credit flow, consolidated (% of GDP) | Private sector debt, consolidated (% of GDP) | General government gross debt (% of GDP) | Unemployment rate (3 year average) | Total financial sector liabilities, non-consolidated (1 year % change) | Activity rate - % of total population aged 15-64 (3 year change in p.p.) | Long-term unemployment rate - % of active population aged 15-74 (3 year change in p.p.) | Youth unemployment rate - % of active population aged 15-24 (3 year change in p.p) |
| Thresh-olds | -4/+6% | -35% | ±5% (EA) ±11% (Non-EA) | -6% | 9% (EA) 12% (Non-EA) | 6% | 14% | 133% | 60% | 10% | 16.5% | -0.2 p.p. | 0.5 p.p. | 2 p.p. |
| BE | -0.2 | 61.3 | -1.2 | -11.3 | 1.5 | 1.3p | 4.5 | 166.3 | 105.8 | 8.5 | -1.0 | 0.7 | 1.0 | 2.3 |
| BG | 0.6 | -60.0 | -4.1 | 12.8 | 14.9p | 1.6bp | -0.3 | 110.5 | 26.0 | 11.2 | 7.0 | 2.2 | -1.2 | -6.5 |
| CZ | 0.2 | -30.7 | -8.0 | 0.1 | 0.5 | 3.9p | 0.9 | 68.6 | 40.3 | 6.1 | 7.7 | 2.4 | -0.6 | -6.9 |
| DK | 8.8 | 39.0 | -1.5 | -8.8 | 4.9 | 6.3 | -3.3 | 212.8 | 40.4 | 6.6 | -2.0 | -0.1 | -0.4 | -3.3 |
| DE | 7.5 | 48.7 | -1.4 | -2.8 | 5.7 | 4.1 | 3.0 | 98.9 | 71.2 | 4.9 | 2.8 | 0.4 | -0.4 | -0.8 |
| EE | 0.9 | -40.9 | 6.4 | 8.5 | 14.4 | 6.8 | 3.3 | 116.6 | 10.1 | 7.4 | 8.1 | 1.9 | -3.1 | -7.8 |
| IE | 4.7* | -208.0* | -5.9 | 38.3* | -18.1 | 8.3 | -6.7 | 303.4 | 78.6 | 11.3 | 9.5 | 0.8 | -3.7 | -9.5 |
| EL | -1.2 | -134.6 | -5.5 | -20.6 | -11.1p | -3.5e | -3.1 | 126.4 | 177.4 | 26.3 | 15.7 | 0.3 | 3.7 | -5.5 |
| ES | 1.3 | -89.9 | -2.9 | -3.5 | -0.7p | 3.8 | -2.7 | 154.0 | 99.8 | 24.2 | -2.1 | 0.0 | 0.4 | -4.6 |
| FR | -0.7 | -16.4 | -2.7 | -5.4 | 2.5p | -1.3 | 4.4 | 144.3 | 96.2 | 10.3 | 1.8 | 0.8 | 0.6 | 0.3 |
| HR | 2.7 | -77.7 | 0.1 | -3.5 | -5.0 | -2.4 | -1.3 | 115.0 | 86.7 | 17.0 | 2.1 | 2.9 | 0.1 | 0.9 |
| IT | 1.5 | -23.6 | -2.2 | -8.9 | 1.5 | -2.6p | -1.7 | 117.0 | 132.3 | 12.2 | 1.7 | 0.5 | 1.3 | 5.0 |
| CY | -4.1 | -130.3 | -6.2 | -16.8 | -10.5p | 2.9bp | 4.4 | 353.7 | 107.5 | 15.7 | 2.8 | 0.4 | 3.2 | 5.1 |
| LV | -1.8 | -62.5 | 3.1 | 10.5 | 16.0 | -2.7 | 0.7 | 88.8 | 36.3 | 10.9 | 12.2 | 1.3 | -3.3 | -12.2 |
| LT | 0.9 | -44.7 | 4.0 | 15.5 | 11.6 | 4.6 | 2.2 | 55.0 | 42.7 | 10.5 | 6.7 | 2.3 | -2.7 | -10.4 |
| **LU** | **5.3** | **35.8** | **-0.5** | **22.9** | **0.6** | **6.1** | **24.2** | **343.1** | **22.1** | **6.1** | **15.5** | **1.5b** | **0.3** | **-1.4** |
| HU | 3.0 | -60.8 | -6.9 | -8.0 | 3.9 | 11.6 | -3.1 | 83.9 | 74.7 | 8.2 | 0.4 | 4.9 | -1.9 | -10.9 |
| MT | 4.3 | 48.5 | -0.2 | -8.8 | 3.9 | 2.8p | 5.4 | 139.1 | 64.0 | 5.9 | 1.3 | 4.5 | -0.7 | -2.3 |
| NL | 9.1 | 63.9 | -0.6 | -8.3 | 0.2p | 3.6 | -1.6p | 228.8p | 65.1 | 7.2 | 3.2p | 0.6 | 1.1 | -0.4 |
| AT | 2.1 | 2.9 | 1.8 | -9.6 | 6.1 | 3.5 | 2.1 | 126.4 | 85.5 | 5.6 | 0.6 | 0.4 | 0.5 | 1.2 |
| PL | -1.3 | -62.8 | -1.0 | 9.7 | -0.4p | 2.8 | 3.2 | 79.0 | 51.1 | 8.9 | 2.4 | 1.6 | -1.1 | -5.7 |
| PT | 0.7 | -109.3 | -2.8 | 2.8 | 0.0e | 2.3 | -2.3 | 181.5 | 129.0 | 14.4 | -1.6 | 0.0 | -0.5 | -6.0 |
| RO | -1.0 | -51.9 | 2.7 | 21.1 | 0.5p | 1.7 | 0.2 | 59.1 | 37.9 | 6.9 | 4.1 | 1.3 | 0.0 | -0.9 |
| SI | 5.4 | -38.7 | 0.6 | -3.6 | -0.6 | 1.5 | -5.1 | 87.3 | 83.1 | 9.6 | -3.4 | 1.4 | 0.4 | -4.3 |
| SK | 1.1 | -61.0 | -0.7 | 6.7 | 2.2 | 5.5 | 8.2 | 81.4 | 52.5 | 13.0 | 4.5 | 1.5 | -1.8 | -7.5 |
| FI | -1.0 | 0.6 | 2.3 | -20.5 | 3.6 | -0.4 | 9.5 | 155.7 | 63.6 | 8.8 | 1.5 | 0.6 | 0.7 | 3.4 |
| SE | 5.0 | 4.1 | -7.9 | -9.3 | 3.6 | 12.0 | 6.5 | 188.6 | 43.9 | 7.8 | 2.3 | 1.4 | 0.0 | -3.3 |
| UK | -4.8 | -14.4 | 11.3 | 1.0 | 1.7 | 5.7 | 2.5 | 157.8 | 89.1 | 6.3 | -7.8 | 0.8 | -1.1 | -6.6 |

Flags: b: break in time series. e: estimated. p: provisional.
Note: * The level shift is due to relocation to Ireland of balance sheets of large multi-national enterprises and inclusion of corresponding transactions in the Irish BoP and IIP statistics. 1) See page 2 of the AMR 2016. 2) House price index e = source NCB of EL. 3) The level of TFSL in Greece is higher than would otherwise have been recorded, due to the improved treatment of banks' holdings of short-term debt securities issued by banks.
Source: European Commission

## 4.2.4 Updating alert mechanism scoreboard data

The data used in this chapter to illustrate the position of Luxembourg under the alert mechanism come from Eurostat database. This is an update of the data published in the last AMR scoreboard (November 2016). Therefore, differences can occur between the present results in the 2017 Competitiveness Report and those of the last alert mechanism scoreboard. The present data were downloaded end July 2017, and are thus an update halfway between the last alert mechanism report and the one that the Commission will publish in November 2017 in the context of its annual Growth Survey, which will launch the 2018 European semester.

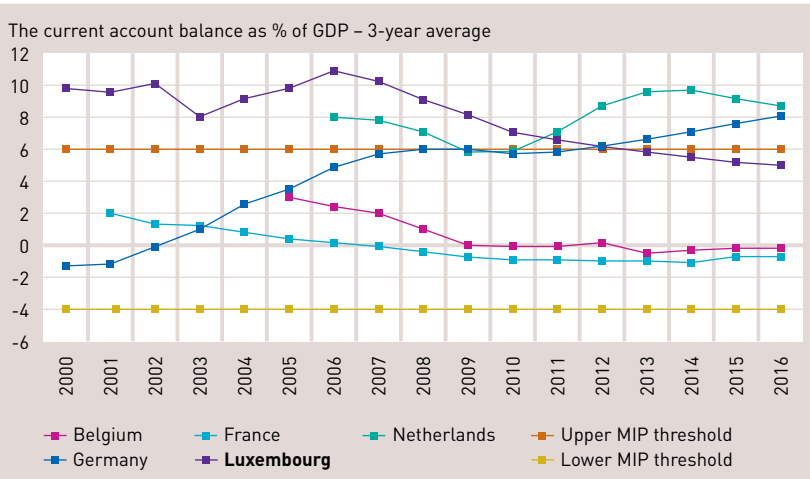
### 4.2.4.1 External and competitiveness imbalances

#### a. Current account balance[44]

Regarding the current account balance, unlike a country financing need (negative balance), a financing capacity (positive balance) does not seem an evidence of imbalance since it doesn't threaten the sustainability of its external debt. For this indicator, it has been agreed under the MIP that a country is potentially at risk if it has a current account balance with either a deficit higher than -4% of GDP or a surplus of over +6% of GDP.

Luxembourg exceeded the upper threshold limit between 2002 and 2012 but, over the last decade, its current account surplus has fallen and, since 2013, has been below the upper threshold limit and is thus included in the interval defined as not posing a macroeconomic imbalance risk.

Chart 26
**The current account balance, as % of GDP (3-year average)**




Source: Eurostat, yellow and orange lines = thresholds of -4%/+6% set by MIP
Note: A Member State is considered to be at risk of imbalance if its balance surplus exceeds the +6% of GDP threshold or if the deficit of its balance is below -4% of GDP.
If the trade balance is between those two thresholds (in the 'tunnel'), a Member State is not considered to be potentially at risk.

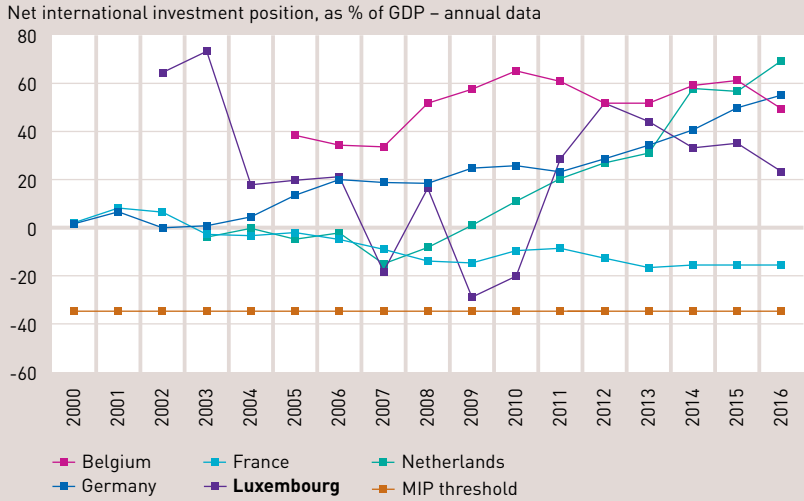
[44] The balance of payments is a statistical statement that systematically summarizes, for a specific period, the economic transactions of an economy with the rest of the world. It is divided into three main sub-balances: the current account, the capital account and the financial account. The current account is the main determinant of the financing capacity or need of an economy; it provides important information on the economic relations of a country with the rest of the world. It reports all transactions (other than those recorded under financial headings) in economic values that occur between resident and non-resident units.

## b. Net international investment position[45]

The indicator of the net external position provides information on the relationship between foreign assets and the external debt of a country[46]. For this indicator, it has been agreed under the MIP that a country is potentially at risk if it has a negative balance over -35% of GDP.

Luxembourg's performance varies wildly. However, over the entire period for which data on Luxembourg are available, i.e. from 2002 to 2016, Luxembourg is above the threshold limit. In line with a large current account surplus, Luxembourg adheres to the criteria with regard to its net international position. Luxembourg's foreign assets far outweigh its foreign liabilities.

Chart 27
**Net international investment position, as % of GDP**




Source: Eurostat, orange line = threshold of -35% set by MIP
Note: A Member State is considered to be at risk of imbalance if its net international position is below -35% of GDP. If the indicator is above this threshold, a Member State is not considered to be at risk.

[45] The statistics of the international investment position (IIP) records the status of financial assets and liabilities of a country relative to the rest of the world. They are an important measure of the net position of the domestic economic sectors relative to the rest of the world. The net international investment position (NIIP) is calculated by the difference between assets and liabilities in the IIP. It allows a stock flow analysis of external positions.

[46] For additional details: http://ec.europa.eu/eurostat/statistics-explained/index.php/International_investment_position_statistics

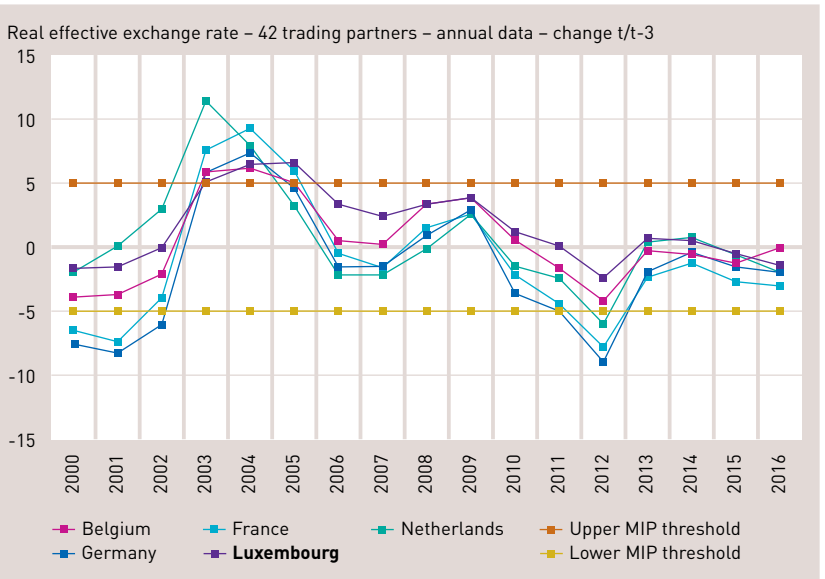
### c. Real effective exchange rate (REER)[47]

The REER indicator tracks the evolution of price competitiveness and cost competitiveness by analysing the relationship between domestic prices or costs and foreign prices or costs in euro. Thus an increase in the REER is usually equivalent to a decline of competitiveness, due to the fact that domestic prices/costs increase faster than those in foreign countries. The REER is constructed from currencies of major trading partners.

For this indicator, it has been agreed for the euro area Member States that a country is potentially at risk if the REER indicator is above + 5% or under -5%.

Just like its neighbouring countries, Luxembourg often ranks in the interval considered as not posing a risk of imbalances.

Chart 28
**The real effective exchange rate (% change over 3 years)**




Source: Eurostat, orange and yellow lines = thresholds of +/- 5% for euro area Member States
Note: A euro area Member State is considered to be at risk of imbalance if its REER is above +5% or below –5%. If REER changes are within these two thresholds (in the 'tunnel'), a Member State is not considered to be at risk.

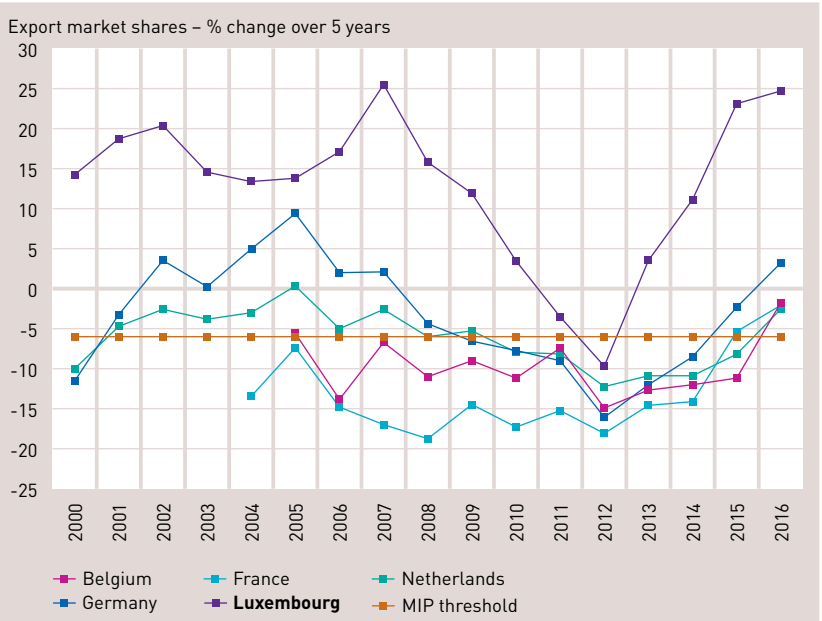
[47] The REER (or 'real effective exchange rate') aims to assess the price competitiveness or the cost competitiveness of a country compared to its main competitors in international markets. Changes in cost competitiveness and price competitiveness depend not only on changes in the exchange rate, but also on the cost and price evolution. The specific REER for excessive imbalance procedure is deflated with the price index compared to a group of 42 countries (double weighting of exports is used to calculate the REER in order to take into account not only the competition on the domestic markets of the various competitors, but also on other export markets). A positive value implies a real appreciation. Data are given in 3-year percentage change and in 1-year percentage change. The scoreboard indicator corresponds to the 3-year percentage change of the real effective exchange rate based on the consumer price index of the 42 trading partners.

### d. Export market shares[48]

The scoreboard includes an indicator on changes in the market share of a country in global exports of goods and services, in order to measure in volume the slow and persistent losses in competitiveness. It is an outcome indicator, which also captures the components of non-cost competitiveness, or the ability of a country to exploit new business opportunities due to the increased demand. For this indicator, it has been agreed under the MIP that a country is potentially at risk if this indicator is less than -6%.

For the majority of the years under observation, Luxembourg has observed the established threshold limits, with the exception of 2012. Between 2007 and 2012, Luxembourg's shares fell significantly but, since 2013, they have been on the rise again.

Chart 29
**Export market shares (% change over 5 years)**




Source: Eurostat, orange line = threshold of -6% set by the MIP
Note: A Member State is considered to be at risk of imbalance if the change in its export market shares is below -6%. If the indicator is above this threshold, a Member State is not considered to be at risk.

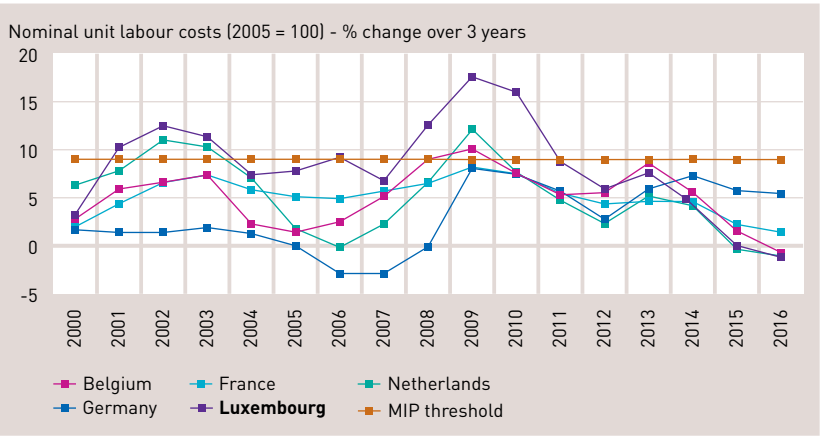
[48] This indicator shows the evolution of the export shares of goods and services of the EU Member States in total world exports. Data on the values of exports of goods and services are developed in the context of the balance of payments of each country. To take into account the structural losses of competitiveness that can accumulate over long periods, the indicator is calculated by comparing year Y to year Y-5. The indicator is based on the data from the balance of payments provided to Eurostat by the 28 EU Member States.

### e. Nominal unit labour costs[49]

The nominal unit labour costs (nominal ULC) are the indicator traditionally used to measure the cost-competitiveness of an economy. The change in domestic nominal unit labour costs of a country, or the cost of labour per unit of value added produced, is compared to those of the main trading partner countries. Thus this indicator includes two factors: firstly, the average labour cost in an economy and secondly, the level of productivity. For this indicator, it has been agreed that a country is at risk if this indicator is higher than +9%.

Luxembourg's performance for this indicator has varied somewhat. The 2008 increase is largely due to a drop in productivity, which can be observed in almost all sectors. An explanation for Luxembourg's sub-par performance is the stronger weighting of the financial sector in Luxembourg's economy, a sector whose significant loss of productivity over the last few years has heavily contributed to the increase in Luxembourg's ULC. The same explanation can be given for industry, which, over the course of the most recent years of the crisis, has implemented major job-saving plans. Luxembourg has scored under the threshold limit every year since 2011 and therefore does not constitute a macroeconomic imbalances risk under this indicator.

Chart 30
**Nominal ULC - % change over 3 years**




Source: Eurostat, orange line = threshold of +9% for euro area Member States
Note: A euro area Member State is considered to be at risk of imbalance if the change in its nominal ULC is above +9%. If the indicator is below this threshold, a Member State is not considered to be at risk.

[49] The nominal unit labour costs (NULC) are defined as the ratio of total employee compensation (D1), in millions of national currency, relative to the total number of employees, divided by the ratio of GDP at market prices in millions, expressed in chain-linked volume for the reference year 2010 with the 2005 exchange rate into national currency relative to the total number of people employed. The change in nominal unit labour costs is the change in the total compensation of employees by number of employees not covered by the change in labour productivity as well as the change in the proportion of employees in total employment. The input data are obtained through official data transmissions from countries' national accounts in the SEC2010 transmission programme. Data are expressed as a percentage change in indices between the year Y and the year Y-3.

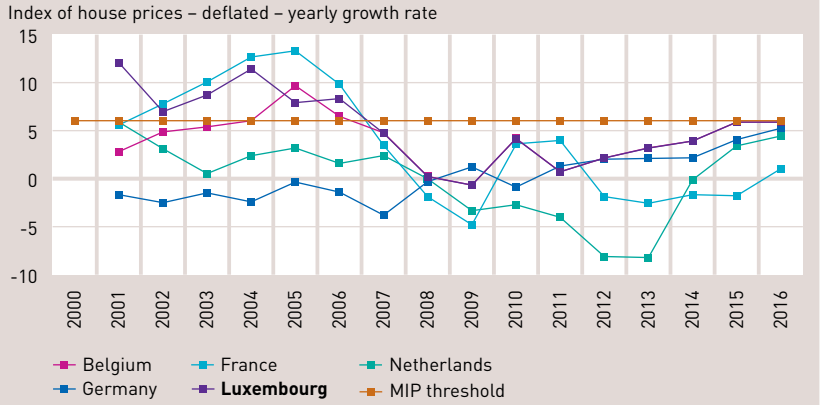
## 4.2.4.2 Internal imbalances

### a. House prices[50]

This indicator measures changes in the acquisition prices of real estate within the EU Member States to detect internal imbalances linked to a potential 'housing bubble'. It has been agreed under the MIP that a country is at risk if this indicator is higher than +6%.

Real estate prices (housing) have risen, in real terms, almost continuously since 2001, with the exception being in 2009. Between 2001 and 2006, Luxembourg was above the threshold limit, with prices rising too quickly. Since 2007, annual price rises have been below the threshold limit although Luxembourg's score was very close to the threshold limit in 2015 and 2016.

Chart 31
**Deflated index of house prices (% change over 1 year)**




Source: Eurostat, orange line = threshold of +6% set by MIP
Note: A Member State is considered to be at risk of imbalance if the change in housing prices is above +6%. If the indicator is below this threshold, a Member State is not considered to be at risk.

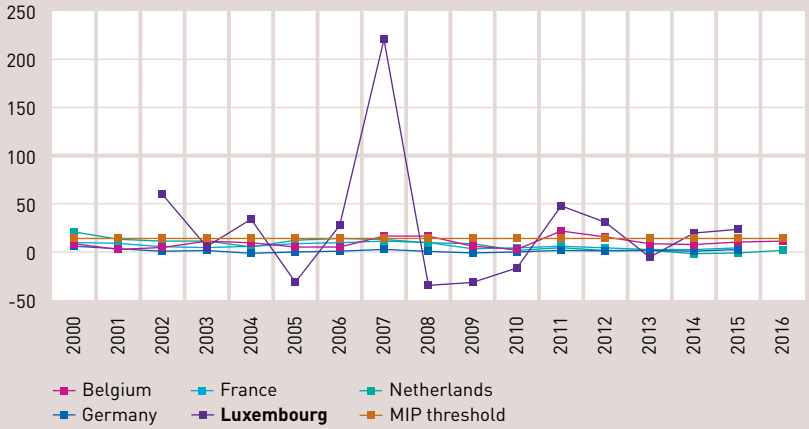
[50] The deflated index of house prices is the ratio between the housing price index and the deflator of private final consumption expenditure (households and non-profit institutions). Therefore, this indicator measures inflation in the housing market compared to that of final consumption of households and NPI. Eurostat index of housing prices reflects the price changes of all types of housing purchased by households (apartments, detached and non-detached houses, etc.), both new and existing, regardless of their final use and previous owner. Only market prices are considered, so built housing on own account is excluded. The land is included. Data show changes in percentage from year Y compared to the year Y-1.

### b. Private sector credit flow[51]

This indicator measures the credit flow of the private sector that corresponds to the net changes in liabilities of the non-financial corporate sectors, households and non-profit institutions serving households. A country is at risk if this indicator is above +14%.

Luxembourg's performance for this indicator varies greatly, much more than the performance of neighbouring countries. The structure of the Luxembourg economy, a very small but open economy, home to several large, non-financial companies, whose financial decisions can have a major impact on the national economy, could be the explanation for this situation.

Chart 32
**Private sector credit flow (as % of GDP)**




Source: Eurostat, orange line = threshold of +14% set by MIP
Note: A Member State is considered to be at risk of imbalance if the change of private sector credit flows is above +14%. If the indicator is below this threshold, a member State is not considered to be at risk.

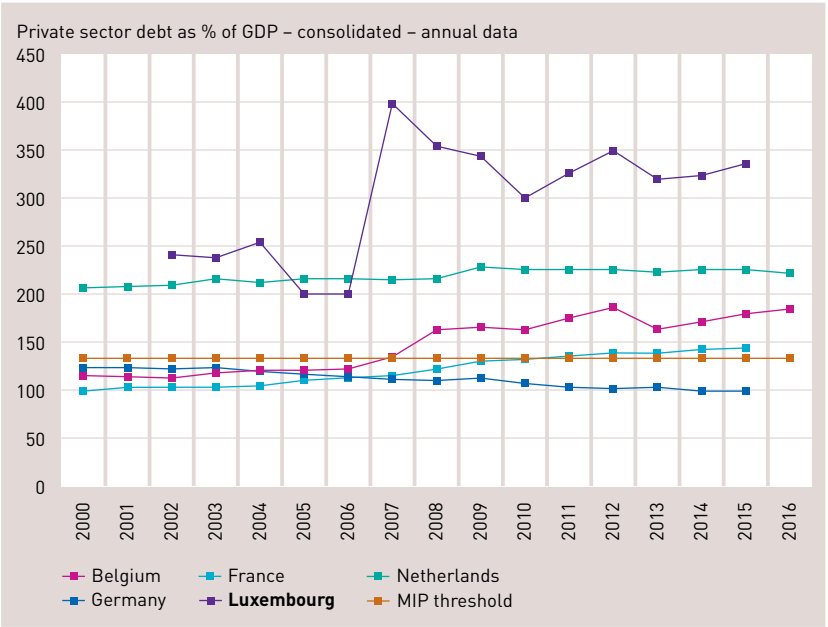
[51] The private sector credit flow corresponds to the net changes in liabilities of the non-financial corporate sectors (S.11), households and non-profit institutions serving households (S.14_S.15) incurred during the year. The instruments included in the calculation of private sector credit flow are the 'Securities other than shares' (F.3) and 'Credits' (F.4), to the exclusion of any other instrument. The concepts used in the definition of sectors and instruments are consistent with SEC2010. Data are expressed in EUR million and calculated on a non-consolidated basis, i.e. by including transactions among units of the same sector.

## c. Private sector debt[52]

The private sector debt indicator is important because if it is excessively high, private sector debt involves significant risks to growth and financial stability of a country. The indicator measures the level of private debt of the economy: non-financial corporations, private households and non-profit institutions serving households (as a % of GDP). The indicator is based on non-consolidated data, meaning it includes for example intra-sector debt at national level. It has been agreed that a country is potentially at risk if this indicator is above +133% of GDP.

Since this indicator is available for Luxembourg, it significantly overruns the threshold set by the MIP. For Luxembourg this indicator should be interpreted with caution because non-financial companies incur most of this private sector debt. Given the liquidity of financial markets and the experience in international transactions, a company may choose to incur debt through funding in Luxembourg, not for its own need but for another related entity that may be located abroad (e.g. intra-group loans). This debt then contributes to the numerator of the 'private sector debt relative to GDP' indicator used here, without taking into account the added value produced by this funding if it is out of Luxembourg because the GDP (denominator) is a national concept. For a small and very open economy such as Luxembourg, this indicator therefore tends to be overestimated because the numerator (debt) is overvalued and the denominator (GDP) is undervalued because the added value created abroad from these sources of financing (debt) raised inside the country is not taken into account. With particular regard to household debt, this debt results mainly from loans taken for housing acquisition.

Chart 33
**Consolidated private sector debt (as a % of GDP)**




Source: Eurostat, orange line = threshold of 133% set by MIP
Note: A Member State is considered to be at risk of imbalance if the private sector debt exceeds 133% of GDP. If the indicator is below this threshold, a Member State is not considered to be at risk.

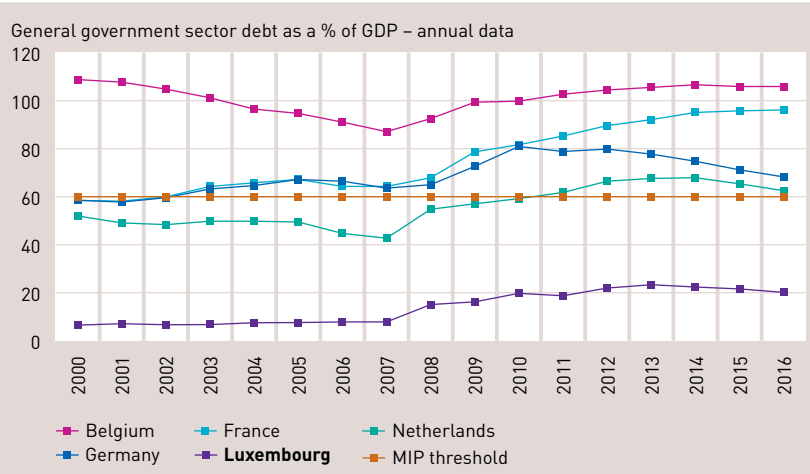
[52] The private sector debt corresponds to the outstanding amount of liabilities of non-financial corporate sectors (S.11), households and non-profit institutions serving households (S.14_S.15). Instruments included in the calculation of the private sector debt are 'Securities other than shares', to the exclusion of financial derivatives (F.33) and 'Credits' (F.4) to the exclusion of any other instrument. The concepts used in the definition of sectors and instruments are consistent with SEC2010. Data is calculated on a non-consolidated basis, i.e. excluding transactions among units of the same sector. The PDM indicator is calculated as a percentage of GDP.

### d. General government sector debt[53]

This indicator takes into account the potential contribution of general government sector debt to macroeconomic imbalances. The definition used is that set by the Stability and Growth Pact (SGP). This indicator is not included to monitor the risk of unsustainable public finances, but should be considered as a complement to the indicator on private debt. A high level of government debt is more alarming when accompanied by a high level of private debt. For this indicator, it has been agreed under the MIP that a country is potentially at risk if this indicator is above +60% of GDP.

The rate of gross government sector debt is well below the "Maastricht" threshold (60% of GDP). However, government sector debt had started to rise considerably in Luxembourg since 2007 before stabilising in the past few years.

Chart 34
**General government sector debt (as a % of GDP)**




Source: Eurostat, orange line = threshold of 60% set by the Maastricht treaty
Note: A Member State is considered to be at risk of imbalance if its general government sector debt exceeds 60% of GDP. If the indicator is below this threshold, a Member State is not considered to be at risk.

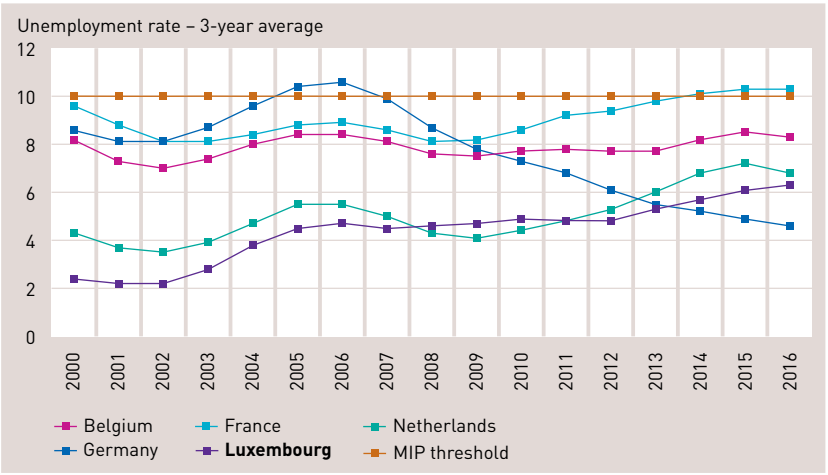
[53] General government gross debt is defined in the Maastricht Treaty as the consolidated gross debt of the whole general government sector in nominal value at the end of the year. The government sector includes the following subsectors: central government, State government, local government and social security funds. Definitions are available in the 479/2009 Regulation, as amended by the 679/2010 Council Regulation. National data for the general government sector are consolidated over sub-sectors. The series are available as a percentage of GDP. GDP denominator comes from the SEC2010 transmission programme, and not from the EDP notifications. The revised GDP data being transmitted in a delayed schedule, it may result in potential differences in debt as a % of GDP, according to the source, EDP or AMR score-board.

## e. Unemployment rate[54]

This indicator is intended to monitor high and persistent unemployment rates and it points a possible misallocation of resources (incompatibility) and the general lack of responsiveness in the economy. It should therefore be read in conjunction with other more future-oriented indicators and should be used to better understand the potential severity of macroeconomic imbalances. It has been agreed that a country is at risk if this indicator is above 10%.

Luxembourg has an unemployment rate well below the threshold. However, since 2000 the unemployment rate has risen sharply in Luxembourg.

Chart 35
**Unemployment rate (3-year average)**




Source: Eurostat, orange line = threshold of 10% set by MIP
Note: A Member State is considered to be at risk of imbalance if its unemployment rate exceeds 10%. If the indicator is below this threshold, a Member State is not considered to be at risk.

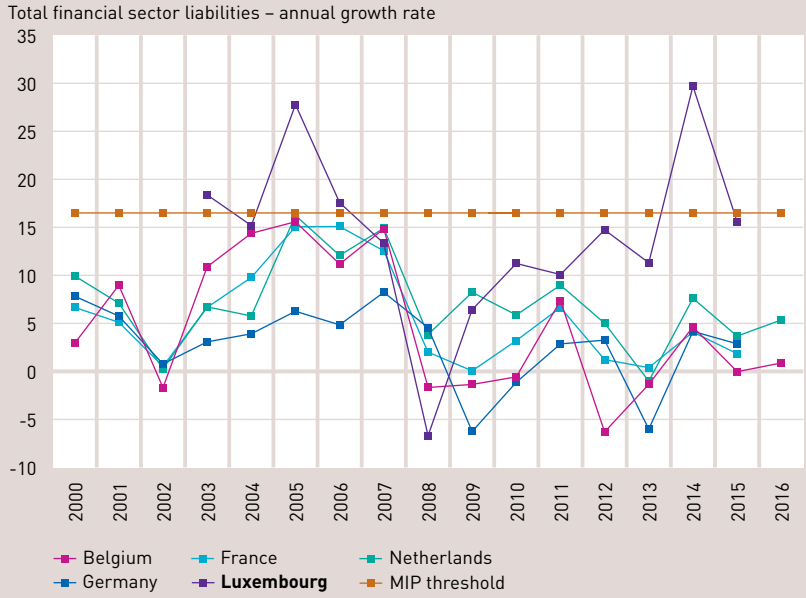
[54] The unemployment rate represents the number of unemployed persons as a percentage of the labour force as defined by the International Labour Organization (ILO). The labour force consists of employed and unemployed persons. Unemployed persons are those aged 15 to 74 who: - were jobless during the reference week - were available for work during the next two weeks - and were either looking actively for a job during the previous four weeks or had already found a job that began in the following three months. Data are 3-year moving averages, i.e. year Y data are the arithmetic mean of the years Y, Y -1, Y -2. In this context, it is not the national definition of unemployment used in Luxembourg, which is the one used by the Agency for Employment Development (Adem): *'The unemployment rate is the ratio between the number of resident jobseekers available and the labour force. The latter consists of all persons living in the country who are working (employee or self-employed) or looking for a job (jobseeker).'* For additional details: http://www.adem.public.lu

## f. Total financial sector liabilities[55]

This indicator measures the evolution of the sum of the liabilities of the entire financial sector of a country. The indicator is expressed as an annual growth rate. For this indicator, it has been agreed under the MIP that a country is potentially at risk if this indicator is higher than +16.5%.

In most of the years under analysis, Luxembourg was below the threshold limit. In 2003, 2005 2006 and 2014, Luxembourg exceeded the threshold. In 2015, the year of the latest available data, Luxembourg was again slightly below the threshold limit.

Chart 36
**Growth rate of the total financial sector liabilities**




Source: Eurostat, orange line = threshold of 16.5% set by MIP
Note: A Member State is considered to be at risk of imbalance if the growth rate of the total financial sector liabilities exceeds +16.5%. If the indicator is below this threshold, a Member State is not considered to be at risk.

[55] Total financial sector liabilities measure the evolution of the sum of all liabilities (including currency and deposits, securities other than shares, loans, shares and other equity, insurance technical reserves and other accounts payable) of the entire financial sector. The indicator is expressed as an annual growth rate.

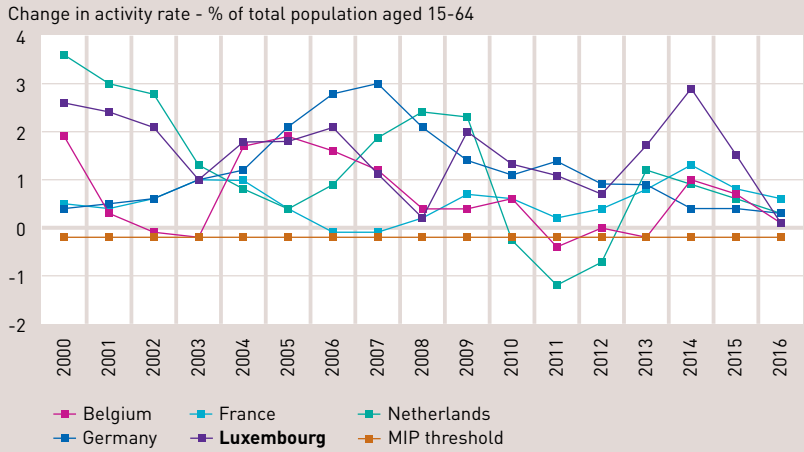
## 4.2.4.3 Employment indicators

### a. Activity rate[56]

This indicator measures variations in the activity rate amongst Member State residents. The indicator is expressed in percentage points over a three-year period. For this indicator, a country is deemed to be potentially at risk if the activity rate falls by more than -0.2 p.p. over the period in question.

Over the entire period under analysis, Luxembourg posted positive growth figures for its activity rate and thus exceeds the threshold limit.

Chart 37
**Activity rate - % of total population aged 15-64 - 3 years change in p.p. (t, t-3)**




Source: Eurostat, orange line = threshold of -0,2 p.p. set by MIP
Note: A Member State is considered to be at risk of imbalance if the growth rate is below -0.2 p.p. If the indicator exceeds this threshold, a Member State is not considered to be at risk.

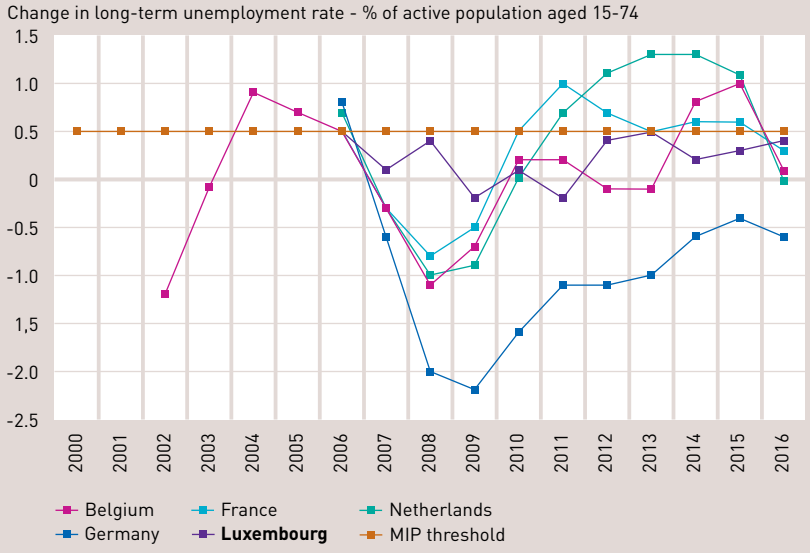
[56] The activity rate is the ratio between the number of economically active individuals aged 15-64 years and the total population in the same age bracket. In line with the International Labour Organisation (ILO) definitions and for the purpose of compiling labour market statistics, individuals are categorised as follows: employed, unemployed and economically inactive. The economically active population (also referred to as 'the labour force') corresponds to the sum of employed and unemployed individuals. Inactive individuals are individuals who, during the reference period, were neither employed or unemployed. The scoreboard indicator reveals the change over three years expressed in percentage points. The indicative threshold is -0.2 p.p. This indicator is based on the results of the EU's quarterly Labour Force Survey (LFS), which covers the resident population living in private households.

## b. Long-term unemployment rate[57]

This indicator measures the variation in long-term unemployment rates in the Member States. The indicator is expressed in percentage points and measured over a three-year period. For this indicator, a country is deemed potentially at risk if the rate increases by more than +0.5 p.p. over the period in question.

Over the entire period under analysis, Luxembourg's long-term unemployment rate variation has been below or equal to the threshold limit.

Chart 38
**Long-term unemployment rate - % of active population aged 15-74 - 3 years change in p.p. (t, t-3)**




Source: Eurostat, orange line = threshold of +0,5 p.p. set by MIP
Note: A Member State is considered to be at risk of imbalance if the growth rate exceeds +0,5 p.p. If the indicator is below this threshold, a Member State is not considered to be at risk.

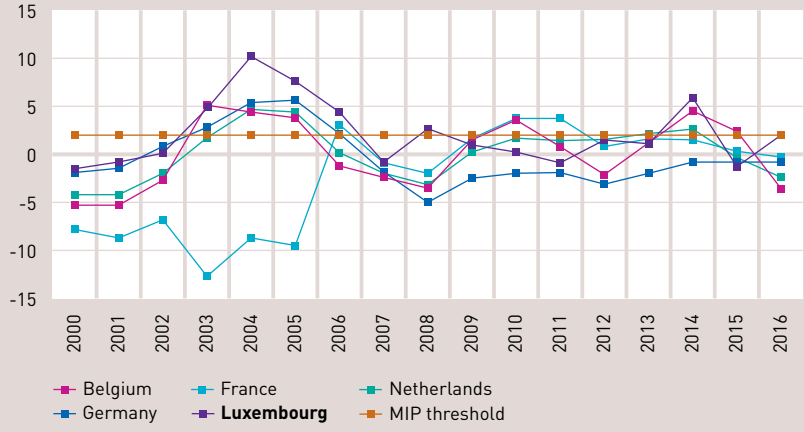
[57] The long-term unemployment rate is the number of individuals who have been unemployed for at least 12 months expressed as a percentage of the active population (the economically active population). The unemployment rate is the percentage of unemployed individuals in the active population (the total number of persons employed and unemployed), as per the International Labour Organisation (ILO) definition. The term 'unemployed' covers individuals aged 15 -74 who meet the following criteria:
- unemployed during the reference week;
- available to begin work within the following two weeks;
- actively looking for a job during the four previous weeks or have found a job which they will start within the following three months.
The scoreboard indicator corresponds to the change in percentage points over a three-year period. The indicative threshold is 0.5 p.p. This indicator is based on the results of the EU's quarterly Labour Force Survey (LFS), which covers the resident population living in private households.

## c. Youth unemployment rate[58]

This indicator measures the variation in the youth unemployment rate in the Member States. The indicator is expressed in percentage points over a three-year period. For this indicator, a country is deemed to be at risk if the rate increases by more than +2 p.p. over the period in question.

The youth unemployment rate in Luxembourg has been oscillating around the threshold. In some years the indicator has risen above the threshold, whereas in other years it has remained below. According to the latest available data, Luxembourg was slightly above the threshold in 2016 (+2.1 p.p.).

Chart 39
**Youth unemployment rate - % of active population aged 15-24 - 3 years change in p.p (t, t-3)**




Source: Eurostat, orange line = threshold of +2 p.p. set by MIP
Note: A Member State is considered to be at risk of imbalance if the growth rate exceeds +2 p.p. If the indicator is below this threshold, a Member State is not considered to be at risk.

[58] The youth unemployment rate is the percentage of unemployed individuals aged 15-24 in the active population of the same age bracket. The unemployment rate is the percentage of unemployed individuals in the active population (the total number of persons employed and unemployed), as per the International Labour Organisation (ILO) definition. The term 'unemployed' covers individuals aged 15-74 who meet the following criteria:
- unemployed during the reference week;
- available to begin work within the following two weeks;
- actively looking for a job during the four previous weeks or have found a job which they will start within the following three months.
The scoreboard indicator corresponds to the change in percentage points over a three-year period. The indicative threshold is +2 p.p. This indicator is based on the results of the EU's quarterly Labour Force Survey (LFS), which covers the resident population living in private households.

### 4.2.4.4 Interim conclusions

Based on the updated data used in this chapter, and pending the 2018 Alert Mechanism Report, issued in November 2017 by the European Commission, we note that Luxembourg has exceeded 3 thresholds: the private sector credit flow (consolidated), the private sector debt (consolidated) and the change in youth unemployment rate (aged 15-24).

Table 5
**Summary table of the alert mechanism update (July 2017)**

| | External imbalances | | | | | Internal imbalances | | | | | | Employment indicators | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Current account balance | Net international investment position | Real effective exchange rate | Export market share | Nominal ULC | Deflated house prices | Private sector credit flow | Private sector debt | General government sector debt | Unemployment rate | Total financial sector liabilities | Activity rate | Long-term unemployment rate | Youth unemployment rate |
| **LUX*** | +5.0 | 23.2 | -1.4 | +24.7 | -1.2 | +5.8 | +23.7 | 335.8 | 20.0 | 6.3 | 15.5 | +0.1 | +0.4 | +2.1 |
| Thresholds** | > -4%<br>< +6% | > -35% | > -5%<br>< +5% | > -6% | < +9% | < +6% | < +14% | < 133% | < 60% | < 10% | < +16.5% | > -0.2 p.p. | < +0.5 p.p. | < +2 p.p. |

Source: European Commission, Eurostat
Notes: * Data 2016, except for the private sector debt and the private sector credit flow (2015).
** Conditions for not being considered imbalanced (for some indicators these thresholds are different for the euro area Member States and for other Member States).

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# 5 The economic impact of the 5 new priority sectors


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# 5.1 Introduction

The Observatoire de la compétitivité (ODC) has carried out this study to produce a pool of statistics so as to better assess developments in the government's 5 new priority sectors, namely information and communication technologies (ICT), space technologies, logistics, health sciences and technologies and eco-technologies. The aim is to measure and analyse the economic impact of these new sectors on productivity, economic growth and employment.

Following an analysis of the available studies and the proposal of a single definition for each of the 5 sectors in question (see 2014 Competitiveness Report[1]), it was possible to identify several indicators for monitoring de developments in the government's 5 new priority sectors.

# 5.2 Methodology

The results set out in this study were calculated based on the available data provided by STATEC and the RCS (Trade and Companies Register). While respecting the confidentiality rules applicable to STATEC data, the ODC calculated the value added at factor cost for each company according to the International Accounting Standards (IAS), namely the Commission Regulation (EC) 250/2009 of 11 March 2009[2].

The difference between the Charts published in the current chapter and those of previous years can be explained primarily by the regular updating of annual business accounts and/or national accounts published by STATEC.

Due to a lack of availability of more recent data, the data published in this 2017 Competitiveness Report date from the years prior to and including 2014. As such, they do not reflect the impact of more recent changes or projects in these priority sectors.

Finally, this study only analyses businesses in the private sector with headquarters in Luxembourg and whose activities can be considered as directly linked to the 5 new priority sectors.

1 https://odc.gouvernement.lu/fr/publications.html

2 Value added at factor cost refers to 'turnover, plus capitalised production, plus other operating income (including operating subsidies), plus or minus the changes in stocks, minus the purchases of goods and services, minus other taxes on products which are linked to turnover but not deductible, minus the duties and taxes linked to production'.

# 5.3 Macroeconomic indicators of the 5 new priority sectors

## 5.3.1 Information and communication technologies (ICT)

ICT is a cross-cutting tool for the economy. The sector, as initially defined in the 2014 Competitiveness Report, is composed of three categories of stakeholders[3]:

- ICT producers, according to the strict OECD or Eurostat definitions (electronic hardware and components, telecommunications, ICT services or software, etc.);
- Activities involving digital content, the existence of which is linked to the emergence of ICT (online services, video games, e-commerce, etc.);
- ICT users who use ICT to make productivity gains but whose activities pre-date the emergence of ICT (banks, insurance, automotive and aeronautics, distribution, administration and tourism, etc.).

This analysis draws upon two previously employed definitions:

- Strict definition: this definition includes the production of ICT hardware and software (manufacturing), the distribution of ICT products and services (commerce) and the provision of services to facilitate the use of ICT (service activities), on the basis of the OECD and Eurostat definitions of the ICT sector[4];
- Broad definition: this definition is more difficult to pinpoint as it comprises other activities indirectly linked to ICT use, such as activities which are dependent upon the emergence of ICT, e.g. e-commerce, media and digital content).

Statistical analysis of ICT in the private sector is based upon activities which fall under the strict and broad definitions of the sector.

[3] Sociétal No. 73, L'impact de l'économie numérique, 2011

[4] OECD, Guide to measuring the information society, 2011

## a) ICT (strict definition)

The strict definition of the ICT sector is underpinned by the analysis of activities listed in the European nomenclature of economic activities, NACE Rev. 2, based on the Eurostat definition (Table 1).

Table 1
**List of ICT activities under the strict definition of the sector**

| Activities | NACE Rev. 2 Code | Description |
|---|---|---|
| Manufacturing industries | 26.110 | Manufacture of electronic components |
| | 26.120 | Manufacture of loaded electronic boards |
| | 26.200 | Manufacture of computers and peripheral equipment |
| | 26.300 | Manufacture of communication equipment |
| | 26.400 | Manufacture of consumer electronics |
| | 26.800 | Manufacture of magnetic and optical media |
| Services industries | 46.510 | Wholesale of computers, computer peripheral equipment and software |
| | 46.520 | Wholesale of electronic and telecommunications equipment and parts |
| | 58.210 | Publishing of computer games |
| | 58.290 | Other software publishing |
| | 61.100 | Wired telecommunications activities |
| | 61.200 | Wireless telecommunications activities |
| | 61.300 | Satellite telecommunications activities |
| | 61.900 | Other telecommunications activities |
| | 62.010 | Computer programming activities |
| | 62.020 | Computer consultancy activities |
| | 62.030 | Computer facilities management activities |
| | 62.090 | Other information technology and computer service activities |
| | 63.110 | Data processing, hosting and related activities |
| | 63.120 | Web portals |
| | 95.110 | Wholesale of computers, computer peripheral equipment and software |
| | 95.120 | Wholesale of electronic and telecommunications equipment and parts |

Table 2 lists several macroeconomic indicators showing how the ICT sector has developed since 2005.

Table 2
**Indicators relating to the ICT services sector**

| ICT (strict definition) | 2005 | 2007 | 2009 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| **Number of companies** | 1,357 | 1,497 | 1,618 | 1,755 | 1,838 | 1,960 | 2,054 |
| | *5.1%* | *5.3%* | *5.3%* | *5.4%* | *5.5%* | *5.6%* | *5.7%* |
| **Number of people employed** | 10,467 | 12,458 | 13,888 | 15,022 | 15,353 | 15,833 | 16,493 |
| | *3.4%* | *3.7%* | *3.9%* | *4.1%* | *4.0%* | *4.1%* | *4.2%* |
| **Number of salaried workers** | 10,303 | 12,309 | 13,722 | 14,816 | 15,169 | 15,613 | 16,252 |
| | *3.6%* | *3.9%* | *4.1%* | *4.3%* | *4.3%* | *4.3%* | *4.4 %* |
| **Value added at factor cost** (in EUR million) | 1,593.4 | 1,887.3 | 2,186.1 | 2,766.1 | 2,853.3 | 2,989.7 | 3,520.8 |
| | *6.0%* | *5.8%* | *6.7%* | *7.2%* | *7.3%* | *7.3%* | *8.0%* |
| **Turnover** (in EUR million) | 5,398.0 | 6,064.7 | 6,635.9 | 9,694.2 | 11,487.2* | 14,652.6 | 17,226.8 |
| **Staff costs** (in EUR million) | 629.6 | 802.3 | 920.1 | 1,074.1 | 1,079.1 | 1,139.2 | 1,210.1 |
| **Gross investment in tangible goods** (in EUR million) | 125.7 | 340.8 | 454.6 | 649.3 | 628.7 | 336.1 | 928.5 |
| **Turnover per employee** (in EUR million) | 515.7 | 486.8 | 477.8 | 645.3 | 745.7 | 925.4 | 1,044.4 |
| **Apparent labour productivity** (gross value added per employee) | 152.2 | 151.5 | 157.4 | 184.1 | 185.8 | 188.9 | 213.5 |
| **Investment rate** (investment/value added at factor cost) | 7.9 | 18.1 | 20.8 | 23.5 | 22.0 | 11.2 | 26.4 |

Note : Aside from the 'number of companies' variable, which refers to the whole of the ICT industry (manufacturing and service providers), all other above indicators refer only to ICT services due to the confidential nature of data relating to ICT manufacturing activities (3 companies).
The percentages shown in italics represent the sector's share of the total indicator for Luxembourg.
* Break in the series due to the reclassification of certain companies.
Source: Structural Business Statistics (STATEC)

During the past few years, the number of businesses active in the ICT sector has increased considerably, particularly in 2012-2013. In 2005 there were 1,357 listed ICT companies, a figure which had risen to 2,054 by 2014 (+51.4% or an average annual growth rate of +4.7%). In 2014 these companies, which represented 5.7% of the total number of companies in the Luxembourg, employed around 16,500 staff (4.2% of workers employed in the country).

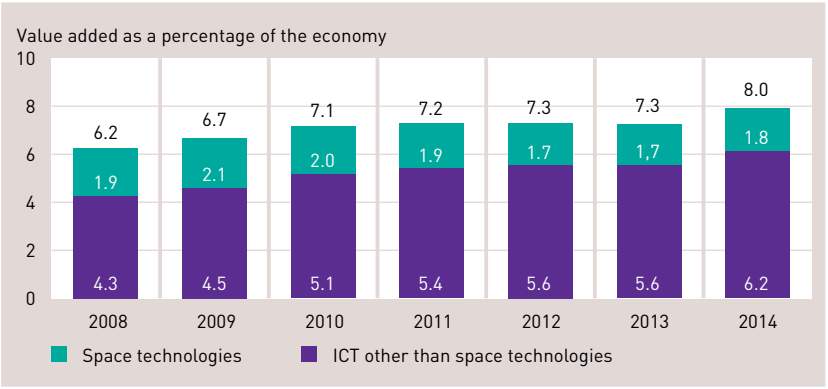
Following a sharp rise in the number of jobs in ICT before the crisis (2005-2008), recruitment in the sector has continued to increase but at a slower pace. The number of jobs has increased by 57.6% (6.4% average annual growth rate) with an 92.2% increase in spending on staff during the same period (i.e. an average annual growth rate of 10.2%). The ICT sector in Luxembourg therefore seems to have largely escaped the effects of the economic and financial crisis, as the numbers of companies and employees (Chart 1) as well as turnover have all grown considerably, in particular since 2012.

Chart 1
**Evolution of the number of employees and companies in the ICT sector (strict definition)**


Source: Structural Business Statistics (STATEC)

By the end of 2014 ICT companies were creating 8% of the value added of the Luxembourg economy, i.e. over EUR 3.5 billion (an increase of 121% compared to 2005 or +67.6% between 2008 and 2014). 1.8% of this value added was generated by companies in the space technology sector, which fell under the Eurostat definition of ICT companies (see paragraph 5.3.2) (Chart 2).

Chart 2
**Breakdown of value added at factor cost in the ICT sector (strict definition)**



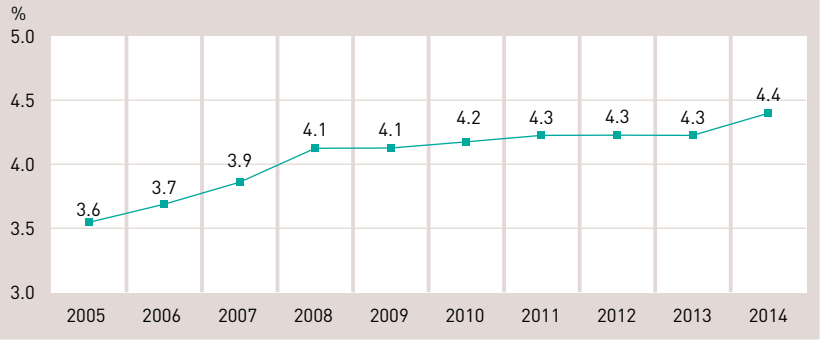

Source: Structural Business Statistics (STATEC), Balance sheets available at the RCS, Calculation: ODC

Telecommunications activities (most of which occur within the space technology sector) created most of the value added for the whole ICT sector in 2014 (46.8%), despite a 10 points of percentage drop compared to 2012 (but remaining almost equivalent in absolute terms). Programming, consultancy and other ICT activities are gaining ground and increased to 22.9% (i.e. an increase of 32.2% in absolute terms compared to 2011).

Electronic games and other software production accounted for 3.8% of the value added created and were the activities which grew the most in recent years (+170.7% compared with 2011). The ICT sector (strict definition) thus generated a gross value added of over EUR 3.5 billion and a turnover of over EUR 17 billion in 2014.

While this sector accounted for 3.6% of salaried jobs in 2005, this figure had reached 4.4% of the country's salaried workers by 2014, i.e. over 16,200 on average in 2014 (Chart 3).

Chart 3
**Evolution of the number of jobs in the ICT sector (strict definition) as a % of total jobs**




Note: IGSS data annual average
Source: Structural Business Statistics (STATEC)

Jobs in this sector are mainly concentrated in the ICT services sector (89.7%) and ICT trade (10.1%). ICT manufacturing in Luxembourg only provides 0.2% of the total number of jobs in the sector. The specific area of telecommunications activities provided over 5,000 paid jobs in 2014, with Post Luxembourg alone employing over 4,000 employees[5]. However, while over half of the jobs in the sector are to be found in the domains of programming, consultancy and other ICT activities, with over 8,600 workers, these activities represent just 22.6% of the overall value added of the sector, i.e. EUR 800 million and a turnover of around EUR 2 billion[6]. The 78 companies active in the production of electronic games and other software produced 3.8% of the value added of the sector, i.e. EUR 134 million. This growth was mainly driven by the creation of 27 new companies in the software production sector since 2012. The number of people employed in software production therefore increased from 389 to 468 in 2 years, i.e. a 20.3% increase between 2012 and 2014[7].

[5] It should be noted that this figure accounts for the whole of the Post Luxembourg group as the NACE for a company's, or group's, primary activity code is allocated by STATEC on the basis of the activities which generate over 50% of the company's value added (STATEC, NACELUX Rev. 2, Luxembourg version of NACE Rev. 2, statistical nomenclature of economic activities in the European Community. Introduction, structure and explanatory notes, 2008).

[6] Source: Structural Business Statistics (STATEC).

[7] Source: Structural Business Statistics (STATEC).

Table 3 lists 5 of the main employers in the ICT sector, based on the group's primary activity.

Table 3
**Main employers in the ICT sector**

| Name | Approx. number of employees |
|---|---|
| Group Post Luxembourg | 4,350 |
| Sogeti Luxembourg SA | 650 |
| Groupe Editpress Luxembourg | 480 |
| Telindus SA | 480 |
| Saint-Paul Luxembourg et Participations | 390 |

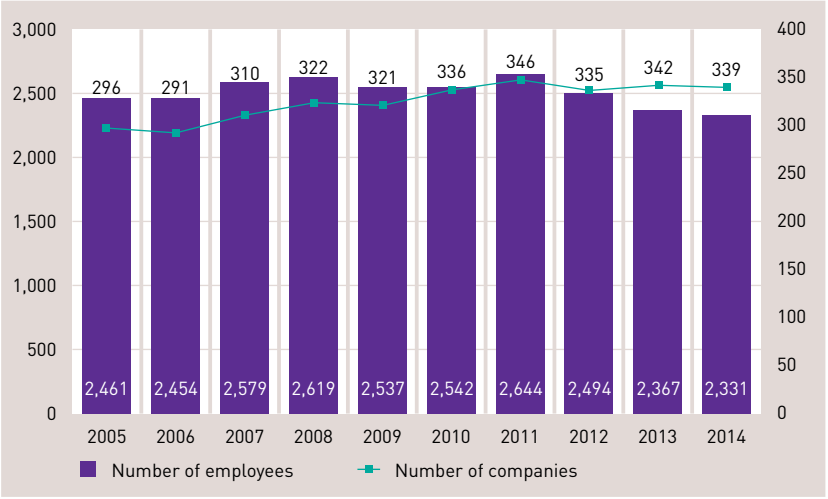
Note: The willingness of each participant to contribute to the survey and authorise STATEC to share the data collected has an impact on the thoroughness of the list.
Source: List of Luxembourg's main employers, situation on 1st January 2017 (STATEC).

## b) ICT (broad definition)

### Content and media

In addition to Eurostat's definition of the ICT sector, the ODC carried out analysis of ICT-related activities in a bid to gain a more comprehensive understanding of the sector and include activities whose existence is dependent upon ICT. Therefore, the sector which the OECD refers to as 'content and media' and Eurostat calls 'information services'[8] was analysed. At the end of 2014 this sector featured 339 companies employing 2 331 staff (steady decrease since 2011) and representing a gross value added of the country's economy of 0,5% (Chart 4). RTL Group is Luxembourg's major stakeholder in this sector.

Chart 4
**Evolution of the content and media sector**




Source: Structural Business Statistics (STATEC)

[8] Definition of the 'information services' sector: NACE code 58.1 – Publishing of books, periodicals and other publishing activities, 59.1 – Motion picture, video and television programme activities, 59.2 – Sound recording and music publishing activities, 60.1 – Radio broadcasting, 60.2 – Television programming and broadcasting activities, 63.9 – Other information service activities.

## E-commerce

In addition to the 'content and media' activities, distance selling (e-commerce) should also be included as it is an activity which needs 'traditional' ICT infrastructure to exist. Such activities, very significant in Luxembourg's ICT landscape, deserve special attention in order to present the as complete snapshot as possible of the ICT sector. The e-commerce sector has grown exponentially since its arrival in Luxembourg, a country which, for several years, has been very attractive for e-commerce companies in spite of the departure of some large companies in the sector, e.g. Netflix, Kabam and Zynga.

In order to measure the economic characteristics of this sector, the Ministry of the Economy worked with the Ministry of State's Media and Communications Service to develop a list of key players in the sector. The list is based on a definition of e-commerce featuring several activities such as distance selling, online gaming and financing (predominantly mobile payment) which are dependent upon e-commerce and could not exist without it. The indicators shown in the table below only apply to the shortlist of companies which represent almost all of the added value and jobs created in this sector.

By 2014 there were 52 legal entities on the list of the main e-commerce groups headquartered in Luxembourg, compared to only 7 in 2005. Whereas at the time these 7 companies employed just 58 people in total, by 2014 the number of employees had risen to 1,427 (Table 4). The most significant growth took place between 2012-2013, with the number of employees increasing by 58% in just one year to reach 0.4% of the overall employee population (Chart 5). The growth in the number of companies in the sector which are based in Luxembourg flattened out after the announcement of planned changes to distance-selling regulations (e-VAT) coming into effect from 1st January 2015.

[9] The concept of a legal unit is different from that of a company (INSEE definitions):

1. A legal unit is a legal entity governed by public or private law. A legal entity may be a legal person, whose existence is recognised by law regardless of the persons or institutions who own it or who are members thereof, or a natural person who, as a self-employed individual, can exercise an economic activity;

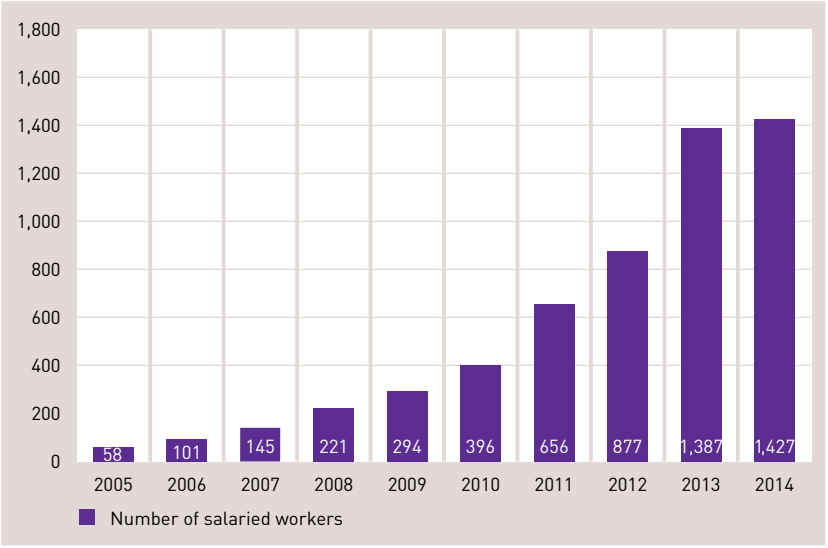
2. A company is the smallest combination of legal entities forming an organisational unit producing goods and services which can enjoy a certain independence in decision-making, especially in terms of allocating current resources.

Table 4
**E-commerce indicators**

| **E-commerce** | **2005** | **2007** | **2009** | **2011** | **2012** | **2013** | **2014** |
|---|---|---|---|---|---|---|---|
| **Number of legal entities**[9] | 7 | 12 | 15 | 27 | 39 | 50 | 52 |
| **Number of salaried workers** | 58 | 145 | 294 | 656 | 877 | 1,387 | 1,427 |
| | *0.0%* | *0.0%* | *0.1%* | *0.2%* | *0.2%* | *0.4%* | *0.4%* |
| **Value added at factor cost** | -153.4 | 203.8 | 539.9 | 568.8 | 689.5 | 1,215.7 | 1,538.3 |
| (in EUR million) | *-0.6%* | *0.6%* | *1.6%* | *1.5%* | *1.8%* | *2.9%* | *3.5%* |
| Sample size: | 7 | 11 | 15 | 27 | 38 | 45 | 45 |
| **Turnover** (in EUR million) | 116.7 | 7,291.5 | 9,855.1 | 13,058.7 | 17,309.8 | 20,811.5 | 24,964.2 |

Note: Information on the sector's added value is only available for companies included in the 'sample size' figure.
Source: Balance sheets available at the RCS, Central Balance Sheet Data (STATEC), IGSS, Calculation: ODC

Chart 5
**Evolution of the employment in the e-commerce sector (key players)**




Source: Balance sheets available at the RCS, Central Balance Sheet Data (STATEC), IGSS
Calculation: ODC

Based on the information for these companies, an estimate was made of the impact of e-commerce on the national economy. In 2014 the sector represented 3.5% of the overall value added of the national economy (Chart 6). According to the public data and the ODC's calculations, it appears the Amazon group remains the key player in the sector in Luxembourg, as it alone provided 1.8% of the total value added of the national economy in 2014. However, this data for the e-commerce sector dates from 2014, prior to the implementation of changes to distance-selling regulations (e-VAT) from 1st January 2015. It would therefore be useful to assess the potential effect of these changes on the e-commerce sector during the ensuing years.

Chart 6
**Evolution of the added value generated by e-commerce as a share of the national economy**


Note: Data available at the Trade and Companies Register and Balance Sheet Centre at the time of drafting this document. The calculation basis may be lower than the number of companies recorded for the same year.
Source: Balance sheets available at the RCS, Central Balance Sheet Data (STATEC), IGSS
Calculation: ODC

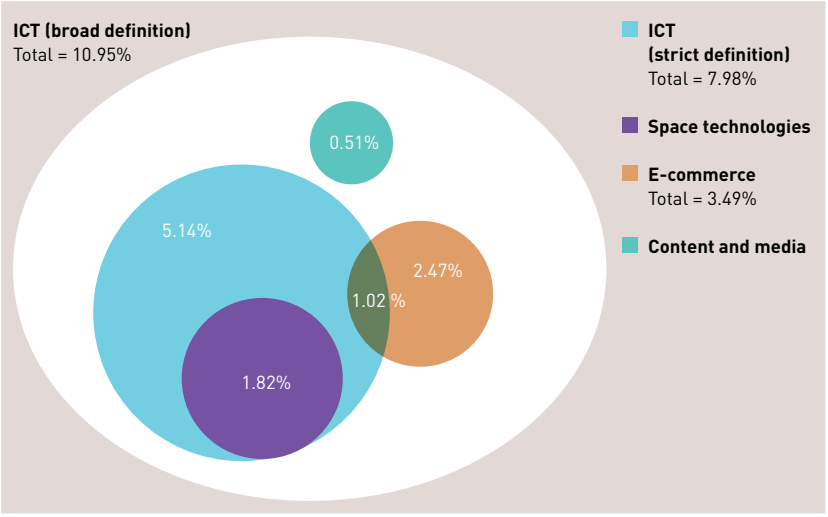
Note that this analysis considers only companies whose main activity is e-commerce. Unfortunately, it is not currently possible to measure this kind of activity within Luxembourg companies listed under NACE codes other than those linked to the previous definition of ICT. As such, the impact of this kind of activity is therefore larger than that which can be reported in this report.

### ICT (broad definition)

In order to appraise the ICT sector in its broader definition, it seems useful to add up the results of the different aspects to obtain a comprehensive overview of the sector. As a whole, the ICT sector employs almost 20,000 people (5.4% of the total salaried workforce) and accounts for over 2,445 companies in Luxembourg (6.8% of companies). Since 2005, the number of companies and the size of the salaried workforce increased by 56.2% and 47.3% respectively, with an annual growth rate of 5.1% and 4.4% respectively.

The value added generated by the ICT sector in its broad definition can be sub-divided into different sub-sectors on the basis of the different NACE codes assigned to each company under analysis. This reflects how complex it is to define the sector in question (Chart 7). In 2014, the gross added value of ICT according to the Eurostat definition (including space technologies) was 8% (see section 5.3.2). However, by also including related activities such as e-commerce and the content and media sector, which are dependent on ICT, the figure equates to 10.9% of Luxembourg's economy.

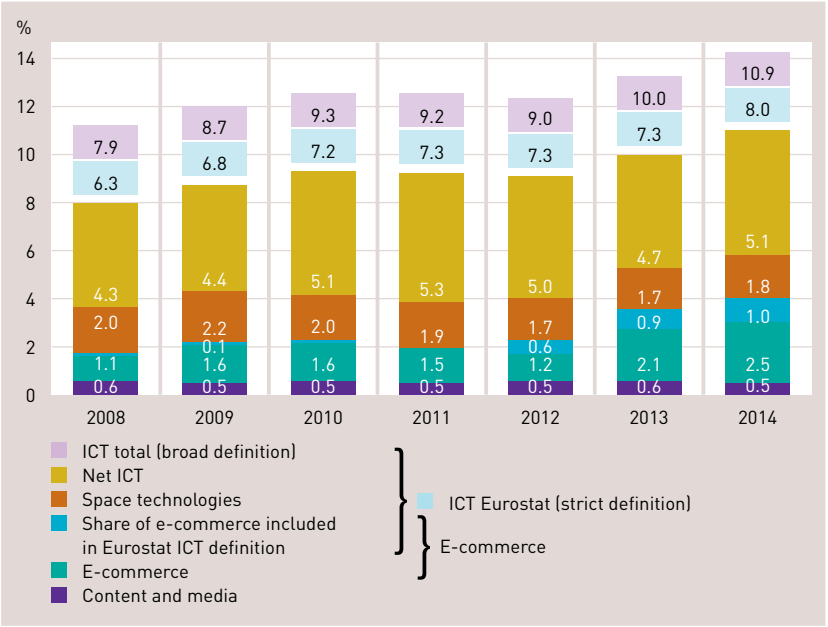
Chart 7
**Simplified diagram of ICT (broad definition) added value per NACE code - 2014**




Calculation: ODC

2014 was a very positive year for the ICT sector, especially for the e-commerce sector which generated 3.5% of the country's value added. Under the broad definition, the sector created 10.9% of Luxembourg's value added, the highest level recorded since 2008 (Chart 8).

Chart 8
**Evolution of the share of ICT (broad definition) added value as a % of the economy as a whole**




Calculation: ODC

## 5.3.2 Space technologies

The definition of the space sector which has been used in this study is an adaptation of the OECD definition: 'all activities and resources used which create and offer value and advantages to human beings in space exploration, management and use. Consequently, the space economy includes all public and private sector players involved in the development, supply and use of space-related products and services, ranging from research and development and the manufacturing and use of space infrastructure (ground stations, launchers and satellites) to applications for space components (navigation equipment, satellite telephones, weather service) and to scientific knowledge generated by these activities. The areas of application for space technologies are satellite communication, satellite navigation, satellite earth observation, space exploration and space science.

In 2014, the sector comprised 18 companies employing 598 individuals (Table 5), with 441 people employed by SES group, by far Luxembourg's largest employer in the sector (73.7% of total jobs in the sector).

Table 5
**Space technologies sector indicators – Private sector**

| **Space technologies** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** |
|---|---|---|---|---|---|---|---|
| **Number of companies** | 14 | 14 | 16 | 16 | 16 | 18 | 18 |
| | *0.1%* | *0.1%* | *0.1%* | *0.1%* | *0.1%* | *0.1%* | *0.1%* |
| **Number of employees** | - | - | 596 | 597 | 639 | 634 | 598 |
| | - | - | *0.2%* | *0.2%* | *0.2%* | *0.2%* | *0.2%* |
| **Value added at factor cost** | 657.8 | 694.9 | 705.3 | 710.1 | 670.8 | 694.8 | 803.3 |
| (in EUR million) | *1.00%* | *2.10%* | *2.00%* | *1.90%* | *1.70%* | *1.70%* | *1.80%* |
| Sample size: | 8 | 10 | 10 | 14 | 16 | 16 | 17 |

Note: The percentages in italics show the share of the sector in the overall value of the indicator for Luxembourg. Employment data was not available for the years 2008 and 2009. Information on the value added of the sector is available only for the number of companies mentioned under "sample size". Estimates of the share of jobs and value added generated by space technologies were made based on estimates provided by companies during personal interviews and/or via targeted questionnaires.
Source: Balance sheets available at the RCS, STATEC. Calculation: ODC

In 2014, these 18 companies generated 1.8% of the economy's value added, which amounts to over EUR 800 million (+22.1% compared to 2008, or an annual growth rate of +3.4%). Although new operators have recently established premises in Luxembourg, so far almost all the value added has been generated by the SES group (Chart 9).

Chart 9
**Evolution of the added value generated by space technologies**


Source: Balance sheets available at the RCS
Calculation: ODC

Since the creation of SES in 1985 telecommunications and media capabilities via satellite and corresponding land infrastructure have generated most of the growth in the space sector in Luxembourg. While this area remains dominant for the moment, it is now offset by the recent arrival of new operators in the domain of earth observation, and more specifically geo-information services. Luxembourg's activities in the domains of space exploration and the use of spatial resources are also gaining ground.

## 5.3.3 Logistics

As part of the analysis of the economic impact of the logistics sector, a decision was taken to only focus on aspects linked to freight transport, thus excluding passenger transport and removal activities. Therefore, the indicators shown below are based on logistics activities as defined in the NACE, which refer to a company's main activity (Table 6).

Table 6
**Overview of logistics sector activities**

| NACE Rev. 2 Code | Description |
|---|---|
| 49.200 | Freight rail transport |
| 49.410 | Freight transport by road |
| 50.200 | Sea and coastal freight water transport |
| 50.400 | Inland freight water transport |
| 51.210 | Freight air transport |
| 52.100 | Warehousing and storage |
| 52.210 | Service activities incidental to land transportation |
| 52.220 | Service activities incidental to water transportation |
| 52.230 | Service activities incidental to air transportation |
| 52.240 | Cargo handling |
| 52.290 | Other transportation support activities |
| 53.200 | Other postal and courier activities |

However, in the future, it would be propitious to include companies with important activities linked to the logistics sector even if they fall under a different NACE code. For example, Champ Cargosystems and CTI Systems are major players offering a range of solutions to logistics companies based in Luxembourg and abroad. FANUC and RAK Porcelain also perform significant logistics and supply chain activities in Luxembourg. Furthermore, Amazon manages its 'European Fulfilment Network' from Luxembourg and POST Luxembourg delivers packages which have been purchased from cyber-traders (for whom logistics lies at the heart of the business model). These examples, among others, illustrate the fact that the logistics sector is indeed much larger than a definition of the sector based on the concept of principal activity. Finally, it should be stressed that the below analysis does not include the activities of the NATO Support and Purchase Agency (NSPA) which employs over 1,000 individuals in Luxembourg and provides logistics support services to NATO member countries and other NATO agencies.

Table 7 displays a selection of the macroeconomic indicators analysed. Since 2011, the number of companies active in the goods transport sector has fallen (715 companies in 2014 compared to 746 in 2011). However, apparent labour productivity has increased continually since 2009, thanks to the increase in value added which reached almost EUR 1 billion in 2014. This is the highest level ever achieved by the logistics sector.

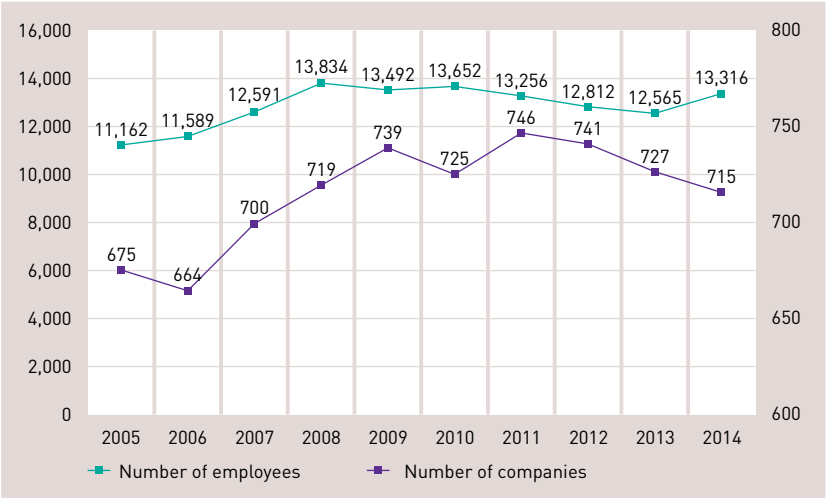
Table 7
**Logistics sector indicators – Private sector**

| Logistics | 2005 | 2007 | 2009 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| **Number of companies** | 675 | 700 | 739 | 746 | 741 | 727 | 715 |
| | *2.5%* | *2.5%* | *2.4%* | *2.3%* | *2.2%* | *2.1%* | *2.0%* |
| **Number of employees** | 11,162 | 12,591 | 13,492 | 13,256 | 12,812 | 12,565 | 13,316 |
| | *3.6%* | *3.8%* | *3.8%* | *3.6%* | *3.4%* | *3.3%* | *3.4%* |
| **Number of salaried workers** | 10,995 | 12,454 | 13,285 | 12,975 | 12,635 | 12,458 | 12,275 |
| | *3.8%* | *4.0%* | *4.0%* | *3.7%* | *3.5%* | *3.4%* | *3.3%* |
| **Value added at factor cost** (in EUR million) | 765.8 | 817.3 | 673.1 | 800.0 | 824.3 | 859.8 | 998.9 |
| | *2.9%* | *2.5%* | *2.0%* | *2.1%* | *2.1%* | *2.1%* | *2.3%* |
| **Turnover** (in EUR million) | 2,696.8 | 3,434.3 | 3,048.8 | 3,850.8 | 3,742.9 | 3,843.6 | 4,396.5 |
| **Staff costs** (in EUR million) | 485.1 | 564.0 | 623.3 | 653.3 | 653.8 | 657.1 | 673.9 |
| **Gross investment in tangible goods** (in EUR million) | 80.7 | 185.2 | 85.9 | 67.0 | 567.3 | 371.9 | 442.5 |
| **Turnover per employee** (in EUR million) | 241.6 | 272.8 | 226.0 | 290.5 | 292.1 | 305.9 | 330.2 |
| **Apparent labour productivity** (gross added value per employee) | 68.6 | 64.9 | 49.9 | 60.4 | 64.3 | 68.4 | 75.0 |
| **Investment rate** (investment/added value at factor cost) | 10.5% | 22.7% | 12.8% | 8.4% | 68.8% | 43.3% | 44.3% |

Note: Percentages in italics refer to the sector's share of the total indicator figure for Luxembourg.
Source: Structural Business Statistics (STATEC)

Although the number of jobs in the logistics sector fell between 2008 and 2013 mainly due to a decline in the number of road freight transport-related jobs, over 750 new jobs were created in 2014 in non-road transport companies (13,316 employees in 2014 compared to 12,565 in 2013). There were 183 fewer salaried jobs compared to 2013, but meanwhile 934 non-salaried positions (for self-employed workers) were created. The number of employees increased by 19.3% since 2005, with an annual growth rate of 2% (Chart 10). Labour costs reached EUR 673.9 million; an increase of 38.9% compared to 2005.

Chart 10
**Evolution of the number of employees and companies in the logistics sector**




Source: Structural Business Statistics (STATEC)

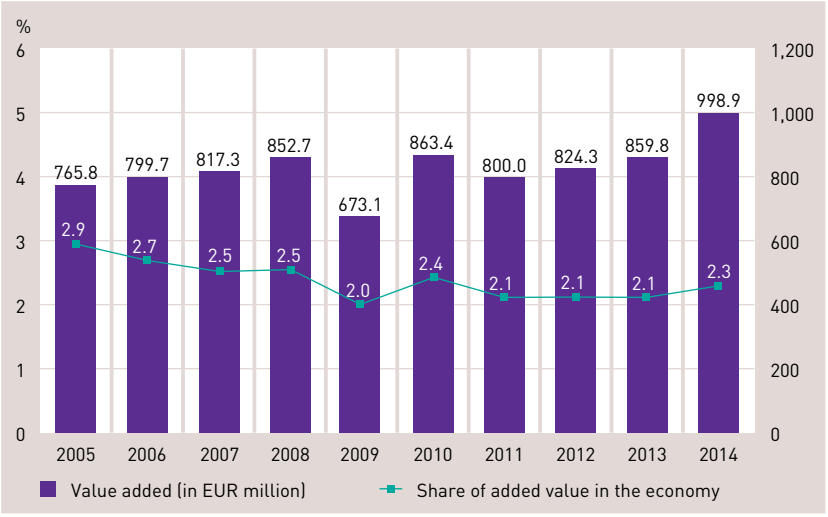
Road freight accounted for 64% of jobs in the sector in 2005 (employees). Today the figure is a mere 53.6%, with other freight transport activities consistently on the rise since 2005 (Chart 11). The number of companies providing auxiliary transport services has been constantly rising: from 153 companies active in 2006 to 200 in 2014. Thus, in spite of a reduction in the number of road transport jobs, there has been an increase in the number of jobs linked to services providing high value-added services and other ancillary services (from 36% to 46.4% between 2005 and 2014) which align with the sector's strategic objectives.

Chart 11
**Evolution of the share of salaried workers in the logistics sector**


Source: Structural Business Statistics (STATEC), Calculation: ODC

The turnover generated by the logistics sector reaches almost EUR 4.4 billion in 2014. The value added created by the sector declined from 2.9% in 2005 to 2.3% of the national economy in 2014 and was worth in absolute terms almost EUR 1 billion.

Chart 12
**Evolution of the added value at factor cost of the logistics sector**




Source: Structural Business Statistics (STATEC)

In 2014, the logistics sector consisted of 429 road freight transport companies (60% of the sector's companies producing 36.7% of the sector's added value), 200 others providing auxiliary transport services and a further 51 companies engaged in postal and courier activities. In addition, there were 7 air transport companies and one firm providing rail freight services (CFL Cargo) and 7 warehousing and storage companies. Cargolux Airlines International SA, the leader in air freight, accounted for nearly 40% of 2014 sector's turnover and employed almost 1,400 salaried workers on 1 January 2017.

Since 2011, the turnover of road freight transport companies has remained fairly consistent at around EUR 1.2 billion (Table 8). The same is true of the value added generated which remained around the EUR 366 million mark since 2011, apart from a slight dip in 2013. In 2014 these companies represented 1.8% of overall employment with 7,131 salaried workers, despite the loss of almost 1,600 jobs since 2008, when 8,567 workers were recorded. Conversely, the number of supporting and auxiliary transport companies grew continually since 2006 to reach 200 companies in 2014.

Table 8
**Road freight transport indicators**

| **Road freight transport** | **2005** | **2007** | **2009** | **2011** | **2012** | **2013** | **2014** |
|---|---|---|---|---|---|---|---|
| **Number of companies** | 433 | 453 | 483 | 482 | 468 | 445 | 429 |
| **Number of employees** | 7,141 | 8,066 | 8,416 | 7,991 | 7,647 | 7,361 | 7,131 |
| **Number of salaried workers** | 7,030 | 7,976 | 8,260 | 7,761 | 7,520 | 7,298 | 7,072 |
| **Value added at factor cost** (in EUR million) | 338.8 | 379.8 | 358.9 | 366.7 | 367.5 | 351.1 | 366.5 |
| **Turnover** (in EUR million) | 898.1 | 1,077.8 | 1,037.2 | 1,209.5 | 1,187.3 | 1,177.9 | 1,186.5 |

Source: Structural Business Statistics (STATEC)

Finally, Table 9 shows 5 of the main employers in the logistics sector, based on their main activity, on 1 January 2017.

Table 9
**Main employers in the logistics sector**

| Name | Staff numbers (approx.) |
|---|---|
| Cargolux Airlines International SA | 1,400 |
| Luxair Cargo | N.C. |
| CFL Multimodal SA | N.C. |
| Kuehne + Nagel SARL | 600 |
| Groupe Arthur Welter Transports | 470 |

Note: The willingness of each participant to contribute to the survey and authorise STATEC to share the data collected has an impact on the thoroughness of the list.
Source: List of Luxembourg's main employers, situation on 1st January 2017 (STATEC)

## 5.3.4 Health sciences and technologies

This sector was initially restricted to 'health technologies'. It has since been enlarged to include, in addition to the biomedical domain, synergies and relationships between sectors as well as technologies.

In 2014 there were around 30 companies and almost 600 workers in this sector; almost triple the numbers recorded in 2008 (Table 10). At the same time, the generated value added more than doubled in absolute terms since 2008 to reach 0.18% of the overall value added of the national economy in 2014.

Table 10
**Indicators for the health sciences and technologies sector - private sector**

| Health sciences and technologies | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| **Number of companies** | 17 | 19 | 22 | 29 | 31 | 30 | 28 |
| | *0.06%* | *0.06%* | *0.07%* | *0.09%* | *0.09%* | *0.09%* | *0.08%* |
| **Number of salaried workers** | 168 | 202 | 233 | 473 | 552 | 572 | 599 |
| | | *0.06%* | *0.07%* | *0.14%* | *0.16%* | *0.16%* | *0.16%* |
| **Value added at factor cost** | 37.7 | 38.4 | 39.5 | 49.0 | 65.7 | 100.4 | 76.6 |
| (in EUR million) | *0.11%* | *0.12%* | *0.11%* | *0.13%* | *0.17%* | *0.24%* | *0.17%* |
| Sample size: | 9 | 10 | 11 | 24 | 27 | 26 | 26 |

Note: The percentages in italics denote the share of the sector in the total value of the indicator for Luxembourg. Information on numbers of employees and the added value of the sector is only available for the number of companies listed in the 'sample size' row. Numbers of employees were not available.
Source: Balance sheets available at the RCS, STATEC and IGSS, Calculation: ODC

## 5.3.5 Eco-technologies

### a) Eco-technology producers

In 2012 a first list of companies active in the eco-technologies sector was drawn up by sector's national experts. It included 134 companies 'producing' eco-technologies that were involved in the sector in varying degrees:

a) The eco-technologies sector, under the strict definition of the term, consisted of 30 companies. The main activity of these companies was oriented towards developing and selling products and services aimed at measuring, preventing, limiting or redressing environmental impacts and reducing the consumption of natural resources whilst still meeting the same needs as traditional techniques;

b) 104 companies were developing eco-technologies focussed on clean production, without necessarily being part of the eco-technologies sector (e.g. Bétons Feidt, Goodyear, Paul Wurth, etc.). These eco-activities covered all goods and services production tasks which support environmental protection and rational management of natural resources.

In addition to these two categories, many companies in Luxembourg may be considered 'environmentally responsible' as considerable efforts have been made to protect the environment through strict regulations. Furthermore, SuperDrecksKëscht, an initiative with almost 3,600 affiliate companies directly involved in the optimal management of waste (and which can thus be considered 'environmentally responsible'), was recognised as an example of 'best practice' in Europe[10].

Since then, an updated list has enabled the monitoring of indicators linked to companies in the sector. The eco-technologies sector in the strict definition remains limited in size. In 2014, the development of eco-technologies was the primary activity of 37 companies and 640 employees who were producing almost 0.1% of the gross value added of the Luxembourg economy (Table 11).

Table 11
**Indicators relating to the eco-technologies sector (strict definition) – Private sector**

| Eco-technologies | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| **Number of companies** | 22 | 22 | 24 | 29 | 32 | 35 | 37 |
| | *0.07%* | *0.07%* | *0.08%* | *0.09%* | *0.10%* | *0.10%* | *0.10%* |
| **Number of salaried workers** | 497 | 543 | 535 | 569 | 579 | 637 | 640 |
| | *0.15%* | *0.16%* | *0.16%* | *0.16%* | *0.16%* | *0.18%* | *0.17%* |
| **Value added at factor cost** (in EUR million) | 27.7 | 23.9 | 19.2 | 39.9 | 36.1 | 40.1 | 37.6 |
| | *0.08%* | *0.07%* | *0.05%* | *0.10%* | *0.09%* | *0.10%* | *0.09%* |
| Sample size: | 10 | 10 | 13 | 26 | 30 | 22 | 33 |

Note: Percentages shown in italics represent the sector's share of the total indicator figure for Luxembourg. Information pertaining to the number of salaried workers and the sector's added value was only available for the companies included in the 'sample size'.
Data on employee numbers were not available
Source: Balance sheets available at the RCS, STATEC and IGSS, Calculation: ODC

[10] https://www.sdk.lu/index.php/en/about-us

The number of companies producing eco-technologies (strict definition) and the share of the national value added still remain low in spite of the fact that these companies have created several hundred jobs. However, the figures do not include companies that are developing eco-innovative products, such as Goodyear and Arcelor, but cannot be included in the sector as this is not their primary activity.

## b) Eco-technology users

Whilst the previous section of the analysis only covers companies whose principal activity is the development of new technologies with a view to fulfilling sustainable development goals, several other companies make use of these technologies. Given the growing importance of the development of environmentally friendly processes and products, several companies in a wide range of different sectors are developing innovative products or processes which have a positive impact on the environment whilst also improving the efficiency and productivity of the company's internal processes. Such activities are analysed by STATEC in the context of the environmental goods and services sector (EGSS), collected by Eurostat. Production activities of goods and services seeking to prevent, measure, control, limit, minimise or redress environmental damage and the depletion of natural resources are thus measured. Such activities represent in 2014 almost 2.4% of the Luxembourg's gross added value across all sectors of the nation's economy and account for more than 9,400 jobs. The industrial sector, as a whole, produces the lion's share (54.2%) of the gross added value of the EGSS (Table 12).

Table 12
**EGSS data**

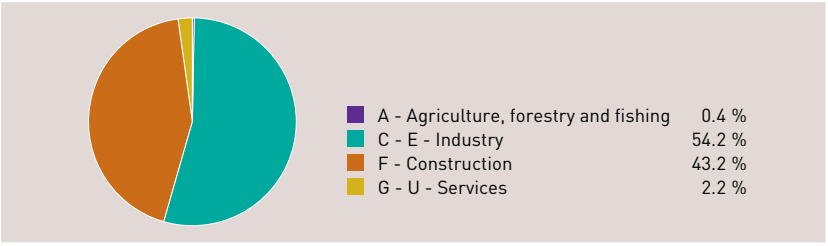
| EGSS | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|
| **Production** (in EUR million) | 1,698.8 | 1,340.7 | 1,524.3 | 1,664.5 | 1,587.6 | 1,610.5 | 1,723.7 |
| | *1.5%* | *1.4%* | *1.3%* | *1.3%* | *1.2%* | *1.1%* | *1.0%* |
| **Gross added value** (in EUR million) | 625.9 | 565.4 | 668.7 | 723.6 | 722.3 | 729.2 | 770.5 |
| | *1.9%* | *1.7%* | *1.9%* | *1.9%* | *1.9%* | *1.8%* | *1.8%* |
| **Employees** (FTE) | 10,215 | 8,721 | 9,529 | 9,276 | 9,518 | 9,239 | 9,428 |
| | *2.9%* | *2.5%* | *2.7%* | *2.5%* | *2.5%* | *2.4%* | *2.4%* |

Note: Percentages shown in italics represent the sector's share of the total indicator value for Luxembourg.
FTE = full-time equivalents
Source: STATEC

In 2014 the construction sector is the main contributor, accounting for 43,2% of gross added value in terms of environmental goods and services[11] (Chart 13).

[11] The definition of this industry covers all activities to do with the manufacturing, production and distribution of electricity, gas, steam and conditioned air as well as water production and distribution activities, sanitation, waste management and pollution control.

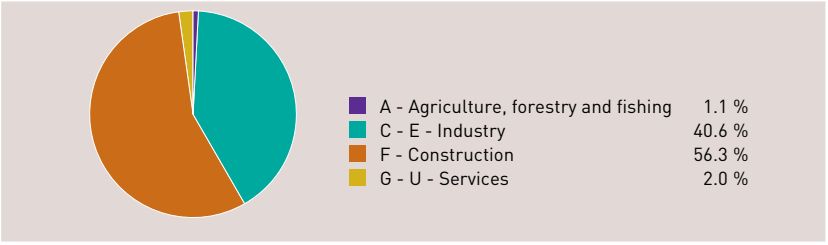
Chart 13
**Breakdown of gross added value linked to environmental goods and services by branch - 2014**




Source: STATEC

As regards employment, these proportions are similar between industry and construction accounting for 40.6% and 56.3% of EGSS jobs respectively in 2014. This demonstrates the intensity of EGSS jobs in the construction sector (Chart 14).

Chart 14
**Share of jobs linked to EGSS per branch – 2014**




Source: STATEC

It is possible to conclude that, in addition to the development of the sector, eco-innovation enables greater competitiveness in all sectors, especially via a circular economy approach aiming to decouple growth from the use of raw materials and thereby reduce companies' exposure to price volatility. In a 2014 study, the Ministry of the Economy concluded that at least 7,000 jobs in Luxembourg are dependent upon the circular economy[12]. By further developing the circular economy, Luxembourg could create numerous jobs in the years to come and make substantial savings on the cost of raw materials.

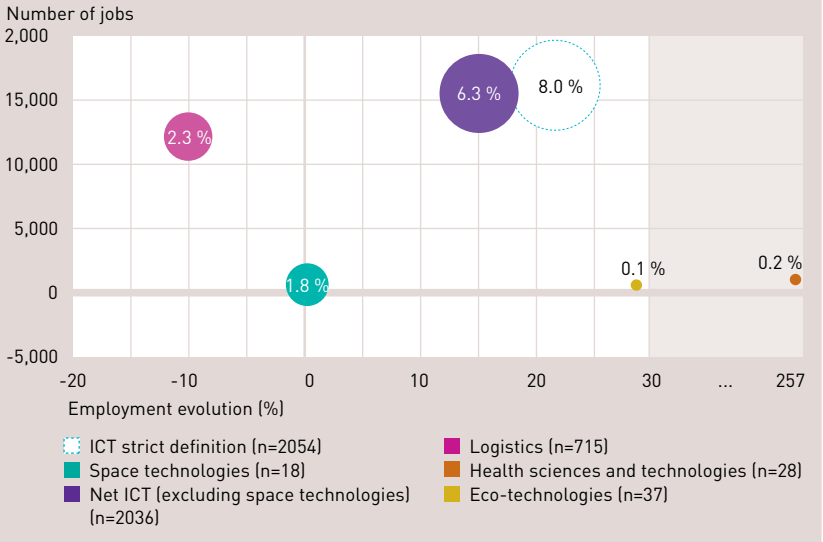
[12] https://gouvernement.lu/dam-assets/fr/actualites/communiques/2015/02-fevrier/09-closener-economie/Presentations-a-la-Chambre-de-Commerce_9-fevrier-2015.pdf

# 5.4 Conclusions

In 2014, the 5 new priority sectors for the private sector (not the public sector), according to their strict definitions, accounted for 10.5% of the value added of the national economy and almost 33,000 jobs in over 2,830 companies. The data displayed in this chapter date from the years prior to and including 2014 and therefore do not take into account any more recent changes or projects, such as the recently launched 'Space Resources' initiative[13].

ICT is by far the 'new sector' which has generated the most value added and created the most new jobs in the economy, followed by logistics and space technologies. Although the number of jobs has increased consistently since 2008 in 4 of the 5 new sectors, the logistics sector has recorded a slight drop in the number of jobs, mainly due to the decline of road freight transport following stiff international competition in the sector. Notwithstanding this effect, the sector nonetheless listed nearly 12,300 salaried workers (i.e. 3.3% of overall employment) in 2014 and had almost recovered pre-crisis employment levels (Chart 15). In fact, over 800 new jobs were created in this sector since 2013.

Chart 15
**Economic impact of the five new priority sectors (private sector) – 2008-2014 development**

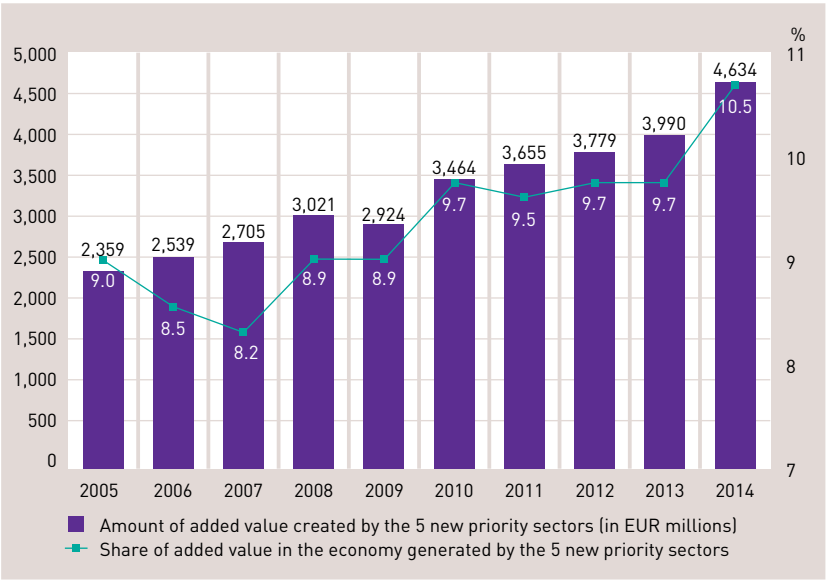



Note: The size of the bubble and the percentage display the share of the sector in the economy in terms of value added. The ICT sector includes space technologies and "net ICT (excluding space)". As the numbers of salaried workers in the space technologies sector were not available for 2008 and 2009, development was measured based on the values for 2010.
n = number of companies
Calculation: ODC

[13] http://www.spaceresources.public.lu/en.html

In absolute terms, the value added generated by the five new priority sectors (strict definition) has grown consistently since 2005, with the exception of 2009 (following the economic and financial crisis), and reaches more than EUR 4.6 billion in 2014, accounting for 10.5% of the total value added of the economy (Chart 16).

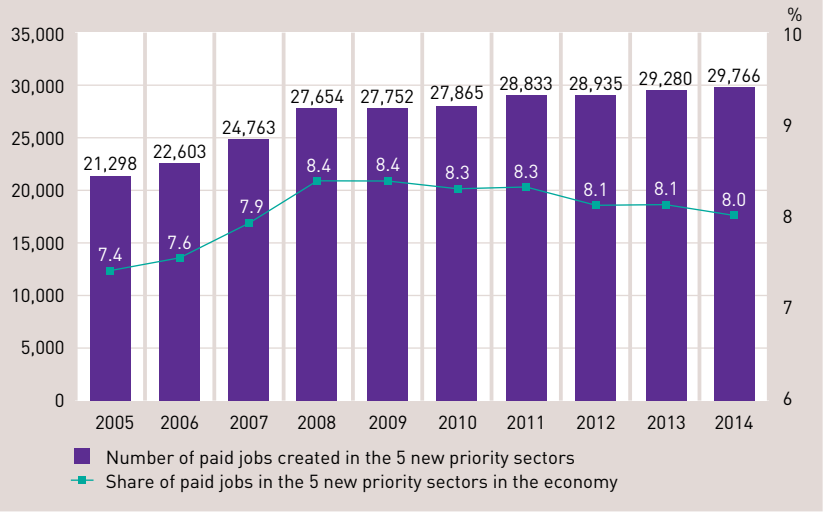
Chart 16
**Evolution of the added value created by the 5 new priority sectors (private sector)**




Calculation: ODC

A similar trend can be observed in the number of jobs, which has been steadily rising since 2005 to reach almost 29,800 salaried jobs in 2014 across the 5 priority sectors under analysis, an increase of almost 8,500 jobs over a 9-year period. After three years of rapid growth between 2005 and 2008, the share of new jobs accounting for these new sectors fell slightly to 8% of total jobs in Luxembourg in 2014 (Chart 17).

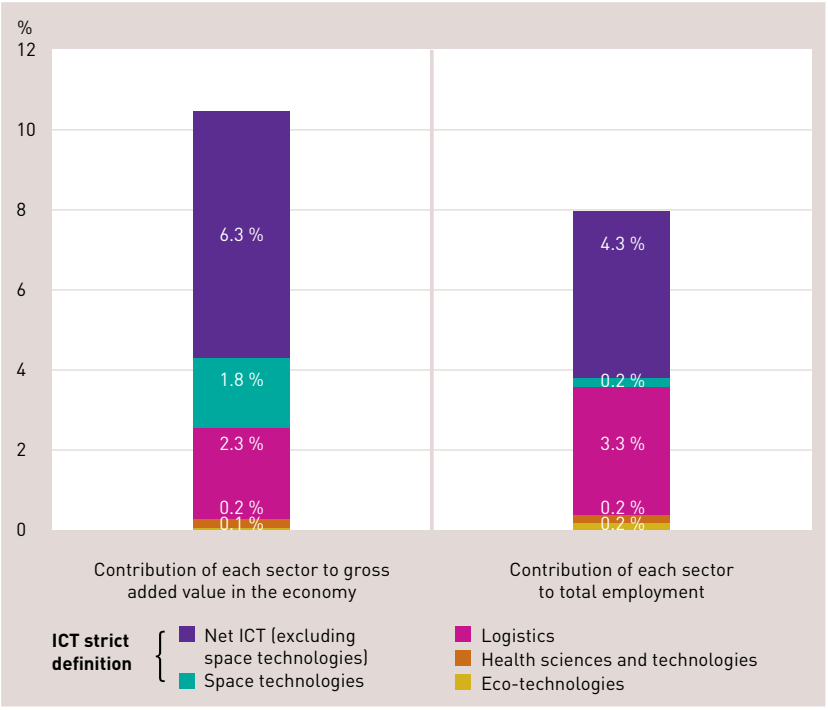
Chart 17
**Evolution of the jobs created in the 5 new priority sectors (private sector)**




Calculation: ODC

The ICT sector, defined in the strict sense and including space technologies, remains the main contributor to value added and jobs created in the 5 new priority sectors in 2014. ICT (strict definition) represents 8% of the gross value added to the economy and 4.4% of Luxembourg's total salaried employment. The logistics sector is in second place, accounting for 2.3% of gross value added and 3.3% of total jobs in Luxembourg. Currently the contribution made to these two macroeconomic indicators by health sciences and technologies and eco-technologies remains low (Chart 18). Figures relating to e-commerce and media and content could be added and would register a value added of 3 percentage points to the Luxembourg economy and account for almost 1 percentage point of the number of jobs created. Therefore, the value added and jobs generated by the 5 new priority sectors represent almost 13.5% and 9% of the national total respectively.

Chart 18
**Contribution of each priority sector to gross added value and employment (private sector) – 2014**




Calculation: ODC

The main conclusions for each sector under analysis are outlined below. However, it should be borne in mind, as a reminder, that the data used in this chapter refers to 2014. This means that the figures do not take into account more recent information and projects.

- The **ICT** sector is currently the best-established of the 5 new priority sectors identified by the government and represents 8% of gross added value in the economy and 4.4% of Luxembourg's salaried employment. From the perspective of both producers and users of ICT, the sector has been experiencing clear growth in Luxembourg for several years now. The number of jobs and ICT production companies based in Luxembourg and active in this sector, according to the strict definition, has grown continuously since 2005, mainly due to public and private significant investment in creating high-quality infrastructure (data centres, broadband networks, etc.), a favourable business environment and a modern and attractive regulation. This is especially true for certain "e-commerce" companies, which create numerous jobs in Luxembourg and generate a great deal of added value. Electronic trade activities based in Luxembourg have been growing considerably for several years now, and represent 3.5% of the gross added value in the economy in 2014. These activities have grown considerably since 2009, and Luxembourg now lists several major names in the sector which run their activities from the country.

However, the impact of the changes to distance-selling regulations (e-VAT) in the next few years remains to be seen. The consistently rising number of ICT users in all sectors of the economy also reflects the positive developments in the sector.

- The **space technologies** sector, which is an integral part of the definition of the ICT sector, is dominated by a major international operator: the SES group makes up almost the entirety of the sector. The government would like to strengthen its position in the sector by investing in flagship projects and supporting space research, particularly via the smaller companies which are also present in the Luxembourg space sector. Moreover, as part of the "Space Resources" project, the government of Luxembourg has recently approved a law aiming to establish the country as a pioneer in space exploration and the use of space resources. One of the main aims of this law is to ensure legal security for economic operators and investors with regard to ownership of minerals and other valuable space resources. In so doing, Luxembourg is the first European country to establish a legal framework giving private operators guarantees regarding their rights over resources extracted in space.

- The **logistics** sector has reported a slight fall in the number of jobs since 2008 as a result of heightened international competition in the road freight transport domain. Nevertheless, the number of staff employed in high-value added activities in this sector has increased since 2013. The sector has almost 12,300 salaried workers and also offers employment opportunities for low-skilled or unskilled workers.

- Activities in the domain of **health sciences and technologies** are still very limited in the private sector. The number of active companies is small and the value added created remains small too. Therefore, a great deal of progress still needs to be made in adapting the regulatory framework to promote dynamism in the sector and attract more private companies to the sector.

- The impact of the **eco-technologies** sector remains difficult to assess, as innovations in this sector are often subject to increasingly strict regulations. Although the number of companies producing eco-technologies remains very small in Luxembourg, the environment is becoming an increasingly important issue for both companies and households. As such, the number of companies using eco-technologies has been increasing consistently for several years.

It is quite difficult to compare (benchmark) these sectors because of their numerous different characteristics. For example, levels of maturity vary widely depending on the sector. While the ICT and logistics sectors are well-established priority sectors for over a decade, other sectors which depend heavily on R&D such as space technologies, health sciences and technologies and eco-technologies became priorities at a much later stage. Therefore, while the health sciences and technologies sector has mainly developed in the public domain, the eco-technologies sector has developed along rather different lines. Although the number of companies producing eco-technologies based in Luxembourg remains very small, Luxembourgish companies are experiencing a change in mind-set in terms of the attention they pay to the environment and to the use of resources. For example, they are trying to reduce the energy and environmental impact caused by their operations by developing production methods for goods and services which use of eco-technologies to prevent, measure, check, restrict, minimize or counteract environmental damage and the using up of natural resources. The macroeconomic impact is therefore indirect rather than direct, as more efficient production is ensured. Moreover, other factors such as R&D activities or the current regulatory framework have bolstered or hampered the development of certain sectors in comparison to others in relation to the macroeconomic indicators taken into consideration in this analysis.

# 6 Analysis of the impact of sectoral interaction on wage variation in Luxembourg and neighbouring countries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# 6.1 Introduction

For decades, wage formation in general and automatic indexation in particular stimulate the economic, social and political debate in Luxembourg. The fact that the automatic indexation mechanism has been the subject of a series of studies over the last few years, featuring a range of methodologies, data and levels of analysis, therefore comes as no surprise.

One such example is a legal study commissioned by the Observatoire de la formation des prix in 2012 to focus in particular on conventional and automatic mechanisms for price adaptation in contractual relations[1]. Interviews conducted among a sample set of commercial and artisanal companies located in Luxembourg also formed the basis of a microeconomic study published in 2013, which analysed price adaptation mechanisms in companies in Luxembourg[2]. In 2014, the Observatoire de la compétitivité (ODC) published a study carried out by the University of Luxembourg analysing wage formation and automatic indexation mechanisms[3]. This comparative econometric study compared four countries, i.e. Luxembourg and its neighbouring countries (Germany, France and Belgium), and concluded that institutionalized indexation does not significantly modify the hourly wage formation process. This conclusion was drawn by observing long-term relations and dynamic reactions to exogenous shocks. In other words, although discrepancies in wage rigidity may exist, they are not caused by automatic indexation mechanisms.

Wage formation is also an integral part of multilateral monitoring and economic policy coordination in the European Union, referred to as the 'European Semester'. In 2015 the EU Council of Ministers described the Luxembourg economy as being characterised by significant labour productivity variations across economic sectors, with the financial sector being twice as productive as non-financial sectors. Consequently, a greater variation in real salaries across different sectors, in line with the sectoral workforce productivity, could lend itself to a redistribution of labour towards new competitive sectors or sectors suffering from a lack of cost competitiveness. The barriers which are thwarting the necessary long-term wage adjustments in each sector still remain. The EU Council of Ministers has therefore recommended that Luxembourg *"reform the wage-setting system, in consultation with the social partners and in accordance with national practices, with a view to ensuring that wages evolve in line with productivity, in particular at sectoral level[4]"*.

1 "Modalités de la réglementation des clauses d'indexation de prix en France, Allemagne, Belgique et Luxembourg", Perspectives de politique économique n° 19, May 2012.

2 "Étude des adaptations de prix des entreprises au Luxembourg", Perspectives de politique économique n° 26, July 2013.

3 "Formation des salaires et indexation automatique. Analyse comparative de quatre pays européens", Perspectives de politique économique n° 28, July 2014.

4 COUNCIL RECOMMENDATIONS of 14 July 2015 on the 2015 National Reform Programme of Luxembourg and delivering a Council opinion on the 2015 Stability Programme of Luxembourg.

More recently, in July 2017, the ODC published an econometric study entitled *'Analysis of the Impact of Sectoral Interaction on Wage Variation: a 4-country comparison'*[5], carried out by the University of Luxembourg. The study sought to analyse sectoral wage interaction in Luxembourg and its three neighbouring countries (Germany, Belgium and France), with a special focus on the interaction in wage dynamics in the public and private sectors. In Luxembourg, the financial sector, which accounts for around 25% of GDP under the strict definition, has a significant bearing on wage formation, a role which was specifically taken into account in the study.

The issue which triggered this study was the concern that one sector could play a dominant role in wage formation. What are the spill-over effects in other sectors vis-à-vis wage development? The predominance of one sector could have a negative effect on the competitiveness of other sectors such as industry, a sector which is very exposed to international competition and could face something akin to Dutch disease[6]. Previous international studies had given credence to the idea that public sector wages served as an incentive or that this role was played by the financial sector due to its relatively high wages and the sector's own dynamics.

[5] "Analyse de l'impact des interactions sectorielles sur l'évolution des salaires. Comparaison de quatre pays", Perspectives de politique économique n° 32, July 2017.

[6] The 'Dutch disease' is an economic phenomenon whereby a sector that is internationally competitive (e.g. the financial sector in Luxembourg) penalises other less competitive sectors which are exposed to international competition due to the flow of labour towards a very competitive sector and an overall rise in prices and incomes in the economy as a whole.

## 6.2 Overview of the University of Luxembourg study (2017)

The wage determination method plays a significant role in developing the competitiveness and economic performance of a country. A range of theoretical and empirical studies have assessed how the institutional framework within which wage negotiations take place can affect wage developments. The institutional framework should be interpreted in a broad sense to include all bodies as well as implicit and explicit rules which may influence negotiating strength and the wage determination method, e.g. unionisation rate, coverage rate, degree of centralisation of negotiations, inter-sectoral coordination mechanisms, etc.

In general terms, the analysis of sectoral interaction is most often based on the distinction between two sectors, one where technological progress and productivity gains are significant (e.g. manufacturing) and another where such factors are almost entirely absent (services). Given that it significantly benefits from technological progress and productivity gains, the manufacturing sector is in a position to offer regular wage increases, whilst all the services sector can do is adjust to such developments. In the traditional neo-classical framework of perfect competition and perfect labour mobility, sectors with significant technological progress will automatically play a leading role. The Scandinavian Aukrust model (1970[7], 1977[8]) is a variant on this approach, adapted to small, open economies with fixed exchange rates distinguishing between exposed sectors ('leaders') and protected ones ('followers'). However, the existence of market imperfections renders the situation much more complex. When wages are negotiated, the wage negotiation method and the negotiating powers in each sector play a key role. For example, Calmfors and Seim (2013)[9] question the Scandinavian model and its implications and suggest that, in a fixed exchange rate system with standard wage agreements ('pattern bargaining'), leadership by a protected sector (as supposed to an exposed sector) should not be excluded and may lead to a greater degree of wage moderation. In general terms, the adapted Scandinavian model which accounts for labour market imperfections requires strong sectoral interaction without necessitating strict leadership by an exposed sector.

[7] Aukrust, O. (1970). PRIM I: A model of the price income distribution mechanism of an open economy, Review of Income Wealth 16 (1), 51–78

[8] Aukrust, O. (1977). Inflation in the Open Economy. A Norwegian Model. Artikler n°.96, Statistisk Sentralbyra, Oslo. Also reprinted in Klein, L. B. and W. S. Salant (eds.), World Wide Inflation. Theory and Recent Experience, Brookings, Washington D.C.

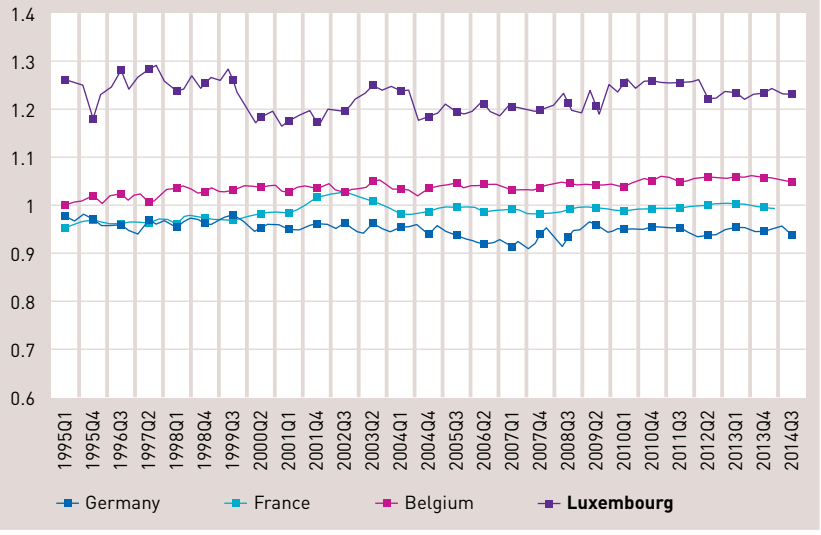
[9] Calmfors, L., and Seim, A. L. (2013). Pattern Bargaining and Wage Leadership in a Small Open Economy, Scandinavian Journal of Economics, 115 (1), 109-140.

The University of Luxembourg study focuses on analysing the sectoral interaction vis-a-vis wages in four European countries (Germany, Belgium, France and Luxembourg) between 1995 and 2015. Particular attention was paid to interaction between the private sector (exposed) and the public sector (protected), with a specific focus on the role of the financial sector in Luxembourg. The authors extended the model to cover two sectors and factor in the broader macroeconomic backdrop. Most of the studies available today use a VECM (Vector Error Collection Model) which only includes wage variables. The authors included in their model most of the variables that are traditionally found in structural wage equations, i.e. price index, productivity, unemployment and competitiveness in addition to the wages themselves. Furthermore, the analysis for Luxemburg was extended to cover three sectors as opposed to two, so as to assess the specific role that the financial sector can play. The financial sector according to its broad definition (i.e. including real estate and scientific and technological activities – NACE 1, section J and K – as well as financial activities) accounted for 30% of total employment and 48% of added value in 2015.

## International comparisons in the two-sector model (private-public)

The two-sector analysis (private vs. public, with the latter defined broadly so as to include non-market services) was carried out in four countries: Germany, Belgium, France and Luxembourg. The relative wage curves (public sector/private sector; see Chart 1) show a degree of stability over the entire period. An exceptionally high level was observed for Luxembourg.

Chart 1
**Relative hourly wages in the public sector**



The main conclusions that can be drawn are as follows:

- In Germany, Belgium and Luxembourg, overall long-term wage development in the public and private sectors is based on productivity, the unemployment rate and competitiveness (inverse relative unit wage cost). Real wages change in the long term in each sector at the same rate as the overall productivity of the economy. In France, sectoral interaction is weaker, although not inexistent. Private sector wages are largely determined by productivity as is the case in other countries, but public sector wages seem to follow their own logic, at least in the long term.

- In all countries, the unemployment rate has a negative impact on private sector wages, with a 1% increase in the unemployment rate reducing real private sector wages by around 2% in the long term. The long-term effect of an increase in the unemployment rate on relative public/private sector wages is negative in Germany and France and almost zero in Belgium. Conversely, the effect of an increase in the unemployment rate is overwhelmingly positive in the public sector in Luxembourg.

- Whilst the empirical literature refers to the traditional definitions of 'wage leadership', it transpires that there is no 'leader' or 'follower' sector in Germany, Belgium or Luxembourg. However, there is very strong and rapid reciprocal sectoral interaction for both short-term and long-term effects.

## Sectoral interaction on wages in Luxembourg

In Luxembourg, disaggregation in the two sectors (public and private) does not account for the importance or the specific nature of the financial sector and the activities directly linked to it. A finer breakdown distinguishing the financial sector from other sectors would enable the role of the financial sector in sectoral interaction to be analysed and would ascertain whether or not it plays a leadership role.

The main conclusions of the additional analysis based on the three sectors tallies with and expands upon the previous outcomes. The outcomes can be summarised as follows:

- Productivity has a direct, positive effect on private sector wages in the non-financial sector. As in the two-sector model, the long-term possibility of this effect spilling over into other sectors via sectoral wage interaction (overspill effects and wage imitation) cannot be ruled out.

- Unemployment only has a direct, negative effect on wages in the non-financial private sector. In this sector, ceteris paribus, a 1% increase in the unemployment rate causes a 2.8% drop in wages. In the long-term, the possibility of sectoral interaction and wage imitation amplifying and extending to all sectors cannot be ruled out, even if the effects of unemployment remain more pronounced in the non-financial private sector. In other words, an increase in unemployment has a negative long-term effect on relative wages in the non-financial private sector.

- Competitiveness (measured here as the inverse relative unit wage cost) has a direct positive influence on wages in the non-financial private sector. In other words, an increase (or decrease) in competitiveness increases (or decreases) relative wages in the non-financial private sector. Wages in the two other sectors are only indirectly affected, via sectoral wage interaction. The significance of such interaction means that the competitiveness effects being identical across all sectors is a possibility which cannot be ruled out. Mutatis mutandis, a 1% drop in competitiveness would over time reduce wages by 0.6%, a similar outcome to that of the other two sectors.

- The effects of a transitory wage shock in a specific sector will be quickly absorbed by the sector in question and will generate little wage variation in other sectors.

- Whilst the empirical literature refers to the traditional definitions of 'wage leadership', it transpires that there is no 'leader' or 'follower' sector, but there is a very strong level of reciprocal sectoral interaction.

- However, it should be stressed that, in Luxembourg, wage premiums in the public and financial sectors are quite high compared to the non-financial private sectors. Therefore, the non-financial private sector's 'leadership' should be considered with this in mind. It is as if wage variations in the non-financial private sector are a consequence of variations in productivity, competitiveness or unemployment being progressively borne out in other sectors so as to maintain wage premiums in these sectors.

## 6.3 Conclusion

This study assesses sectoral interaction in wage formation. The initial motivation for the study was the issue of whether the public or financial sector is the wage leader in Luxembourg. Both of these sectors are characterised by relatively high wages and strong job growth, and thus their attractiveness could potentially influence wage developments in other sectors. Do high wages in these two sectors have a decisive impact on wage developments in other sectors to the extent that they are disconnected from their own sectoral realities? Could this situation be seen as a specific characteristic of Luxembourg?

Econometric estimates show that there is no dominant sector in Luxembourg. However, there is dynamic sectoral interaction in wage developments. This outcome could open up new horizons for economic policy. If it became necessary to improve the country's cost competitiveness, it would be futile to merely focus on wage developments in a single sector. Such a situation would necessitate wage coordination across all major sectors.

The huge amount of work carried out by the University of Luxembourg provides food for thought on the issue of automatic indexation mechanisms and adds to the body of studies dedicated to price and wage formation in Luxembourg.

# 7 Thematic studies


| | | |
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# 7.1 Productivity and competitiveness in Luxembourg

Charles-Henri DiMaria

This article presents the overall evolution of two crucial performance indicators for the Luxembourg economy, namely labour productivity and total factor productivity. These indicators are important because they offer a view of the economy's performance and productive efficiency, and - from an economic growth perspective - they constitute a major source of economic growth and standard of living. The productivity indicators are constructed using National Accounts (NA) data compiled according to the new ESA2010 system. It is the first time that NA based productivity indicators are compiled after the revision of the accounting system.

## 7.1.1 Main results

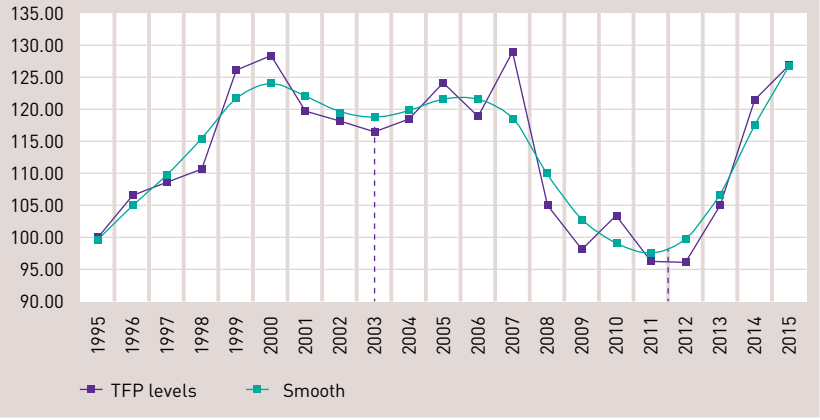
### 7.1.1.1. Catching-up with pre-crisis levels?

Luxembourg labour and total factor productivity (TFP) growth fell sharply in the aftermath of the global financial crisis of 2007-2009, but have since recovered to pre-crisis levels. This recovery was mainly service driven for the following reasons. First, despite improved performances of both services and manufacturing industries, the contribution of services to total value added is higher than manufacturing. Second, the crisis had a more severe impact on manufacturing rather than services. While labour productivity is a prominent indicator that depends on employment and hours worked, TFP captures efficiency in production and features of the technology.

Overall, the evolution of TFP from 1995 till the most recent observation (2015) reveals that the economy was characterised by several phases. The first one, characterised by an increasing productivity trend, from 1995 to 2003, includes the pre and post-IT bubble burst. The second one, from 2003 to 2012/2013 comprises the period preceding the financial crisis and its immediate aftermath; this phase was characterised by a marked fall in productivity rates. The last period, from 2013 onwards shows a marked recovery in productivity.

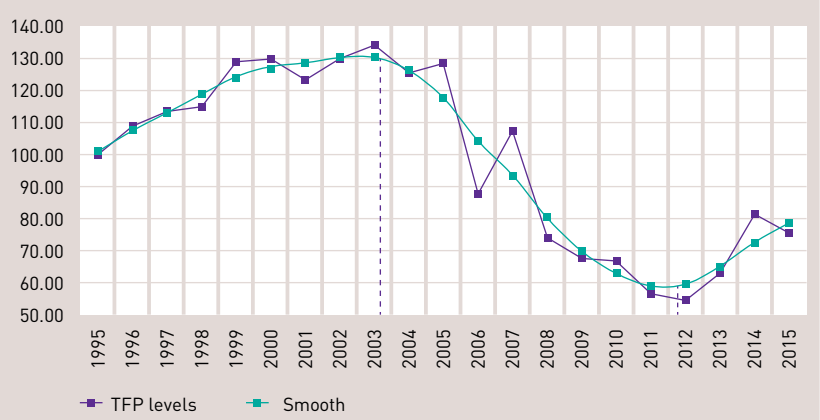
At a more disaggregated level of analysis, productivity trends in manufacturing and services (Figures 1, 2 and 3) show some similarities, but also striking differences. For example, one clearly observes the bursting of the IT bubble in services, an effect that is absent in manufacturing. Both services and manufacturing industries show a decline in TFP after 2007. However, this declining trend started in industries well before the crisis, since 2003, while services were characterised by continued productivity growth in the period just before the crisis. Both sectors exhibit large TFP gains in 2014 and 2015. Table 1 gives key figures on TFP growth rates for the IT bubble episode, the financial crisis and for 1995 to 2015.

Figure 1
**Total factor productivity evolution 1995-2015 – 1995=100 Luxembourg Whole Economy**



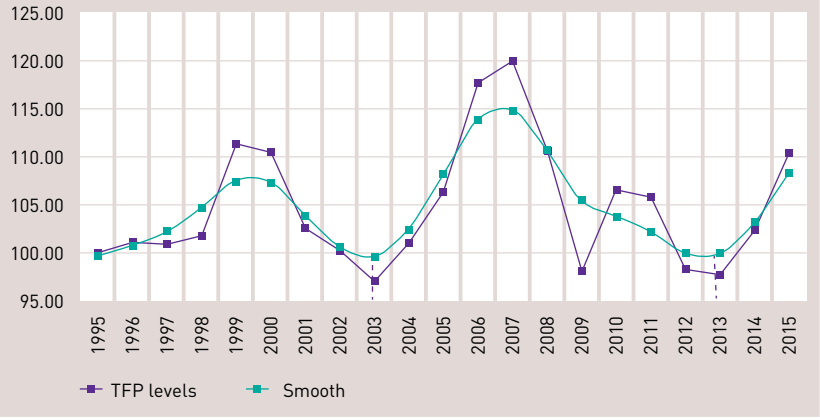

Source: author's calculation from STATEC data

Figure 2
**Total factor productivity evolution 1995-2015 – 1995=100 Luxembourg Industries**




Source: author's calculation from STATEC data

Figure 3
**Total factor productivity evolution 1995-2015 – 1995=100 Luxembourg Services**




Source: author's calculation from STATEC data

Table 1
**Average TFP growth rates: Services – Industries – Total Economy**

| | | | Services | Industries | Total Economy |
|---|---|---|---|---|---|
| **IT bubble episode** | Pre-IT bubble | 1995-2000 | 2.1% | 5.4% | 5.3% |
| | Post-IT bubble | 2000-2003 | -4.2% | 1.2% | -3.2% |
| **Financial crisis episode** | Pre-financial crisis | 2003-2007 | 5.5% | -3.2% | 2.7% |
| | Post financial crisis | 2007-2012 | -3.7% | -12.0% | -5.4% |
| **Recovery** | Recovery | 2012-2015 | 4.1% | 12.6% | 9.8% |
| | | 1995-2015 | 0.7% | -0.2% | 1.5% |

Source: author's calculation from STATEC data

### 7.1.1.2. Laggards and leaders Service-led productivity recovery after crisis?

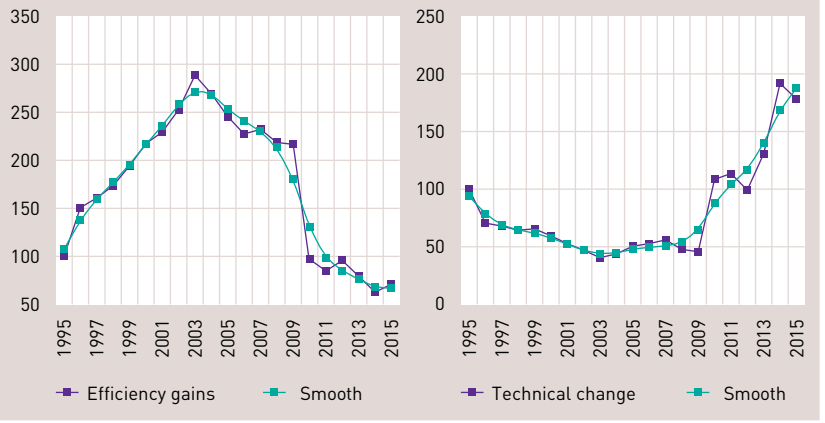
The evolution of TFP at the national level and at the industry level is explained by the evolution of two components of productivity. The first one is efficiency, which is defined as the ability of a country/industry to make the best use of inputs to production (capital and labour), given the technology to produce value added. In other words, efficiency indicates to what extent the country is able to reach the highest level of output which is feasible given the level of inputs (resources). The second element assesses the ability of a country/industry to produce more output than it was previously technically possible, given the level of resources used. When positive, this element is often labelled as technical progress. When negative, this element reflects constraints on demands, market saturation, etc. (however some authors continue to label this as technical regress).

Table 2 summarises evolution of technical change and efficiency gains (average yearly changes).

Overall, from 1995 to 2003 TFP growth resulted from gains in efficiency, then, after 2003, from technical progress.

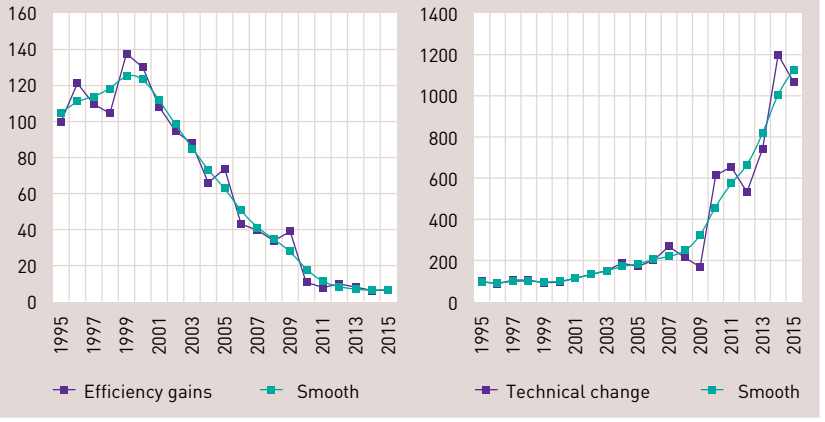
The analysis at the industry level (Figures 4, 5 and 6) reveals that services growth has largely been fuelled by gains in efficiency; technical change exhibits a U shape over the period. In contrast, manufacturing is characterised by a fall in efficiency since 2000 (some industries are falling behind the technological frontier - laggards), and by sustained technical change after the crisis (some industries are pushing the technological frontier - leaders). This suggests that the manufacturing sector is composed of industries producing high value added, with rapid technological change along with industries falling behind the technology frontier.

Figure 4
**Efficiency gains and Technical change 1995-2015 – (1995=100): Luxembourg Whole Economy**



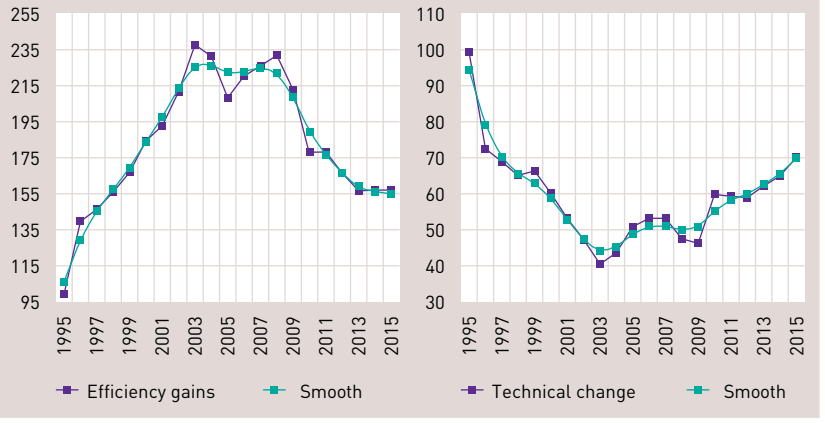

Source: author's calculation from STATEC data

Figure 5
**Efficiency gains and Technical change 1995-2015 (1995=100): Luxembourg manufacturing Industries**




Source: author's calculation from STATEC data

Figure 6
**Efficiency gains and Technical change 1995-2015 (1995=100): Luxembourg Services**




Source: author's calculation from STATEC data

Table 2
**Average efficiency and technical change: Services – Industries – Total Economy**

| | Efficiency change | | | Technical change | | |
|---|---|---|---|---|---|---|
| | **Services** | **Industries** | **Total Economy** | **Services** | **Industries** | **Total Economy** |
| 1995-2000 | 13.7% | 6.6% | 17.9% | -9.1% | 0.6% | -9.3% |
| 2000-2003 | 8.9% | -12.0% | 9.9% | -12.1% | 15.0% | -11.9% |
| 2003-2007 | -1.1% | -15.6% | -5.2% | 7.0% | 16.9% | 8.4% |
| 2007-2012 | -5.8% | -14.5% | -12.0% | 3.0% | 41.2% | 22.1% |
| 2012-2015 | -1.9% | -10.7% | -8.7% | 6.1% | 30.1% | 23.8% |
| 1995-2015 | 2.8% | -8.5% | 0.6% | -1.0% | 20.6% | 6.7% |

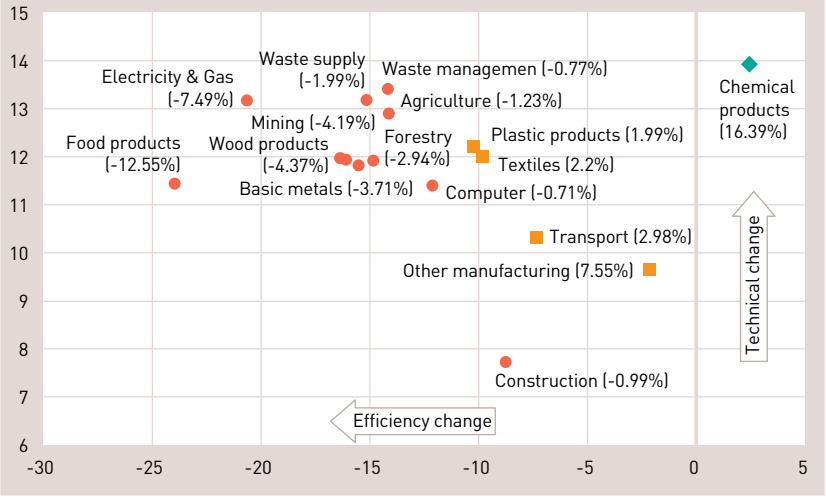
Source: author's calculation from STATEC data

The figures at the industry level (Figures 7 and 8) reveal that the manufacturing of chemical products was the only manufacturing industry to exhibit gains in productivity, resulting from positive efficiency gains and technical change. Thus, this industry drove the technological frontier. The remaining manufacturing industries can be grouped, respectively, into a group of "laggards" for which technical change is offset by efficiency losses, and a group of activities exhibiting positive TFP growth and characterised by consistent efficiency losses. The first group includes Agriculture, Forestry, Mining and Quarrying, Manufacture of food products, Manufacture of paper and wood products, Manufacture of basic metal products, Manufacture of computer, electrical equipment and machinery, Electricity and gas, Water supply, Waste management, Construction. The second group includes Manufacture of textiles, Manufacture of plastic products, Manufacture of transport equipment and other manufacturing industries. Noticeably, the business registry indicates that these industries host high technology firms such as Dupont de Nemours (Manufacture of textiles).

Patterns of productivity evolutions in services are more diversified compared to industry. If TFP is always positive when efficiency changes and technical changes are positives, and TFP is always negative when efficiency and technical changes are both negatives, there are intermediate cases. Indeed, large negative evolution of one element (efficiency or technical change) can offset positive changes of the other element. Auxiliaries to financial activities and wholesale trade are leading service activities with positive TFP resulting from, both, efficiency gains and technical progress. Another group of activities is characterised by TFP growth resulting from increased efficiency but gains are eroded by negative technical change: these are Insurance, reinsurance and pension funding, Publishing activities, Financial service activities, Sport activities, Rental and leasing activities and Telecommunications. Another group has positive TFP growth led by technical gains but eroded by efficiency losses, these are Travel agency and other business support activities, IT services, Social work activities and other personal service activities. The three remaining groups display negative TFP evolutions due, respectively, to efficiency losses and "negative" technical change (Real estate activities, Arts and entertainment activities, Households, Education, Employment activities). One of the remaining groups has negative TFP evolution because of "negative" technical change while recording efficiency gains (Post and Public Administration). The last group has technical change cancelled by large efficiency losses (Other personal service activities, Services to business and research and development, Repair of computers and personal and household goods, Retail trade, except of motor vehicles and motorcycles, Accommodation and food service activities, Wholesale and retail trade and repair of motor vehicles and motorcycles, Activities of membership organisations and Health services).

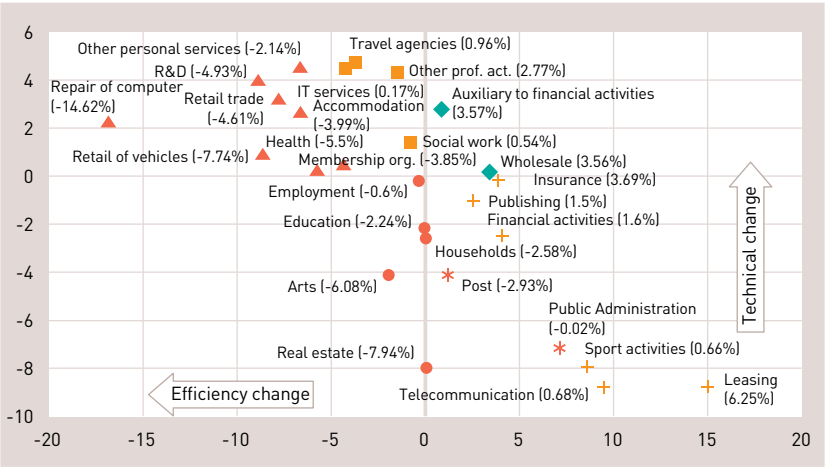
The remainder of this report presents the general framework of the analysis, the data used, and analyses in greater detail the productivity evolution in Luxembourg by industry. Finally, it presents some new features of the LUXKLEMS project, putting emphasis on the link between unit labour costs and the evolution of productivity. The appendix presents the methodology.

Figure 7
**Efficiency vs. technical change and total factor productivity**
**1995 – 2015 averages - Industry**




Source: author's calculation from STATEC data
Note: Productivity growth rates are reported in the parenthesis. The three groups are Diamond (green) positive efficiency change and positive technical change (TFP>0) – Square (orange) negative efficiency change and positive technical change (TFP>0) – Circle (red) negative efficiency change and positive technical change (TFP<0).

Figure 8
**Efficiency vs. technical change and TFP in services: 1995 – 2015 averages**




Source: author's calculation from STATEC data
Note: Diamond (green) positive efficiency change and positive technical change (TFP>0) – Square (orange) negative efficiency change and positive technical change (TFP>0) – Cross (orange) positive efficiency change and negative technical change (TFP>0) – Star (red) positive efficiency change and negative technical change (TFP<0) – Triangle (red) negative efficiency change and positive technical change (TFP<0) - Circle (red) negative efficiency change and positive technical change (TFP<0).

Table 3
**Average efficiency and technical change: Services – Industries 1995 - 2015**

| | TFP | Efficiency gains | Technical change |
|---|---|---|---|
| **Manufacturing industries** | | | |
| Agriculture | -1.23 | -14.15 | 12.92 |
| Forestry | -2.94 | -14.89 | 11.95 |
| Mining and Quarrying | -4.19 | -16.16 | 11.97 |
| Manufacture of food products | -12.55 | -24.02 | 11.47 |
| Manufacture of textiles | 2.2 | -9.82 | 12.03 |
| Manufacture of paper and wood products | -4.37 | -16.38 | 12.01 |
| Chemical products | 16.39 | 2.43 | 13.96 |
| Manufacture of plastic products | 1.99 | -10.26 | 12.24 |
| Manufacture of basic metal products | -3.71 | -15.55 | 11.85 |
| Manuf. of computer, electrical equip. machinery | -0.71 | -12.13 | 11.42 |
| Manufacture of transport equipment | 2.98 | -7.38 | 10.36 |
| Other manufacturing | 7.55 | -2.13 | 9.68 |
| Electricity and gas | -7.49 | -20.69 | 13.2 |
| Water supply | -1.99 | -15.18 | 13.2 |
| Waste management | -0.77 | -14.2 | 13.43 |
| Construction | -0.99 | -8.76 | 7.77 |
| **Services** | | | |
| Wholesale and retail trade of motor vehicles | -7.74 | -8.67 | 0.93 |
| Wholesale trade, except of motor vehicles | 3.56 | 3.38 | 0.19 |
| Retail trade, except of motor vehicles | -4.61 | -7.82 | 3.21 |
| Transport and postal activities | -2.93 | 1.18 | -4.11 |
| Accommodation and food service activities | -3.99 | -6.66 | 2.67 |
| Publishing activities | 1.5 | 2.53 | -1.03 |
| Telecommunications | 0.68 | 9.46 | -8.77 |
| IT services | 0.17 | -4.32 | 4.49 |
| Financial service activities | 1.6 | 4.07 | -2.47 |
| Insurance, reinsurance and pension funding, | 3.69 | 3.85 | -0.16 |
| Auxiliary to financial services and insurance | 3.57 | 0.8 | 2.78 |
| Real estate activities | -7.94 | 0 | -7.94 |
| Services to business and research and development | -4.93 | -8.91 | 3.99 |
| Other professional activities | 2.77 | -1.54 | 4.32 |
| Rental and leasing activities | 6.25 | 14.99 | -8.74 |
| Employment activities | -0.6 | -0.39 | -0.21 |
| Travel agency and other business support activities | 0.96 | -3.76 | 4.73 |
| Public administration | -0.02 | 7.12 | -7.14 |
| Education | -2.24 | -0.08 | -2.16 |
| Health services | -5.5 | -5.78 | 0.28 |
| Social work activities | 0.54 | -0.84 | 1.38 |
| arts and entertainment activities | -6.08 | -1.97 | -4.11 |
| Sport activities | 0.66 | 8.58 | -7.92 |
| Activities of membership organisations | -3.85 | -4.34 | 0.49 |
| Repair of computers and personal goods | -14.62 | -16.89 | 2.27 |
| Other personal service activities | -2.14 | -6.68 | 4.54 |
| Households | -2.58 | 0 | -2.58 |

Source: author's calculation from STATEC data

## 7.1.2. Labour Productivity and TFP in Luxembourg: new data and trends

Productivity growth indices are core indicators for the analysis of economic growth (OECD, 2001) and made their way to the general audience as well as policy fora. Productivity statistics are defined as the ratio of quantities of goods and services produced (outputs) to the quantities of resources used to produce those outputs (inputs). Productivity increases whenever the growth of outputs is larger than the growth of inputs.

If the indicator takes on board an indicator of labour only, then, one has a labour productivity index. In the other case, if more inputs are considered (for example capital, labour, energy, materials and services) then one has a total factor productivity index.

At the aggregate level, labour productivity and TFP are the most widely analysed measures of productivity. Labour productivity captures the use of the labour input, while TFP involves both labour and the stock of capital. (The stock of physical capital includes tangible assets to production such as equipment and infrastructure.) These two fundamental measures of productivity are closely related. Indeed, changes in labour productivity can be decomposed into changes in the capital intensity (capital per unit of labour), termed as capital deepening, and TFP gains. This indicates that both capital intensity and TFP can be regarded as labour productivity drivers.

The measurement of productivity growth remains high on the policy agenda. Indeed, productivity is often seen as the ultimate engine of growth (OECD, 2015) and gives information on long-term trends of living conditions and economic welfare. Furthermore, even if productivity is not synonymous with profitability (Grifell-Tatjé and Knox Lovell, 2015), under certain conditions (no changes in prices of inputs and outputs) improvements in productivity performances can lead to increased profitability.[1] Productivity is also linked to sustainability (Bleischwitz, 2001), because (with production processes unchanged) higher productivity means an improved use of resources, which impact the ecological footprint of countries. Lastly, TFP helps to assess the impact of changes in labour costs on the economy through the evolution of unit labour cost (DiMaria and Peroni, 2012).[2] In 2003, the Observatoire de la compétitivité and STATEC have launched a project on productivity measurement in Luxembourg, LUXKLEMS, aiming at comparing the country's productivity performance to other countries, and to assess the productivity performance at the industry level. This has resulted in the release of several reports and analyses. One can see Ciccone and DiMaria (2003), Ciccone and DiMaria (2006), Ciccone and DiMaria (2008), Peroni (2011) or Peroni (2012). This document fits in this initiative.

[1] Profitability is a concept related but not synonymous of productivity. One can see Grifell-Tatjé and Knox Lovell, 2015.

[2] Unit labour cost evolutions decompose into average labour cost changes, efficiency and technical change and capital deepening.

This report gives up-to-date productivity figures and implements several important improvements to the data. First of all, productivity indices use National Accounts data compiled according to the new ESA2010 regulation, whose introduction has marked an overhaul of National Accounts systems. In addition, indices are presented in the new NACE rev.2 definition of economic activities. Lastly, for the first time labour is not measured by full-time employment but by hours worked. All these new elements have led to major changes in the tools for computation; therefore this new report presents figures that should be considered as preliminary results from an ongoing project.

The following gives a brief overview of the major changes to the data sources.

### 7.1.2.1 The data sources: what changed?

What is the data source: National Accounts.

Data changes due to ESA2010 regulation.

The new regulation has introduced twenty-five major changes (Eurostat, 2014), some of these having a direct impact on productivity measurement through changes affecting the measurement of inputs and outputs to production. Some changes affect the measurement of output and value added. (An example is the change in the computation of Financial Services Indirectly Measured (FISIM) that has on average expanded GDP by +0.5 percent.) A major change, affecting the quantification of resources used to produce, is the introduction of research and development (RD) in the accounting of fixed capital. Overall, these changes have affected the measurement of both inputs and outputs to production.[3]

Major changes due to the NACE rev.2 classification:

The new classification has substantially increased the number of economic activities. Some economic activities have been divided into several new activities, part of output and intermediate consumptions have been re-allocated to different economic activities, some economic activities have been merged into new ones. An example of the latter cases is waste management and water treatment, now merged into a single economic activity. In retail activities, a new economic activity has been created: Repair of computers and personal and household goods. These are only a few examples among numerous changes (see STATEC, 2008, for more details on changes).

An important fact to keep in mind is that the changes implemented by ESA2010 and NACE rev.2 classification have an undesirable consequence: the lack of direct comparability between the statistics presented in this report with those in previous publications.[4]

[3] STATEC, 2014a, 2014b, 2014c presents some of the changes and impacts generated by the ESA2010.

[4] Nota Bene: to keep with usual practices in productivity measurement for example in terms of aggregation some indicators may deviate from ESA2010 regulation and some minor discrepancies might appear with official STATEC publication of National Accounts. Thanks are due to the National Accounts Unit in particular Nathalie Zellinger and Mike Bissener for extensive exchange of views on data during the drafting of this document.

Frame

**Measuring productivity: A brief history**

Assessment of economic performance in terms of productivity has a long-standing history. According to Griliches (1997) an early tentative productivity index was suggested by Copeland (1937) and traced its inspiration back to an indicator used by Kuznets (1930). Another early cornerstone reference is Tinbergen (1942). The field of productivity measurement gathered momentum with Solow (1956 and 1957) giving birth to the so-called "Solow Residual" that is often considered as the standard measurement of total factor productivity (Groth et al., 2003). In this framework, productivity is measured as the weighted sum of the growth rates of outputs minus the weighted sum of the growth rates of inputs. Basically, total factor productivity growth is the part of outputs growth that cannot be attributed to the growth of inputs.

In parallel, Farrell (1957) echoing Koopmans (1951) and Debreu (1951) proposed a new framework emphasizing the idea of economic efficiency that has set up the premises of a new era of empirical productivity measurement. The purpose of this framework is to assess to what extent a firm, an industry or a country, given a basket of inputs, is successful in achieving outputs. This was then operationalized by Charnes et al. (1978) making use of linear programming and data envelopment analysis. Few years after the publication of a paper by Caves et al. (1982) showing the usefulness of Malmquist indexes to compute productivity indexes, Fare et al. (1989) bridged the framework of Farrell (1957) using the tools developed by Charnes et al. (1978) and the proposal of Caves et al. (1982) to compute a Malmquist productivity index based on data envelopment analysis. In this framework productivity results from an increasing ability of countries (industries or firms) to make an efficient use of inputs to produce the highest level possible of outputs and the capacity from year to year to reach higher levels of outputs that were previously unattainable given the use of inputs, that is technical change. Productivity enhancement is the combination of efficiency gains and technical change. This popular framework (Cooper et al., 2001) is used in this document.

### 7.1.2.2 From labour productivity to total factor productivity

One of the main constraints to the compilation of productivity statistics is data availability. In previous reports on Luxembourg's productivity, labour input data refer to the full time equivalent of people employed (i.e. a measure of number of workers), as data on hours worked were not available. The introduction of the new National Accounts framework enabled a more accurate computation of labour using total hours worked. Ideally, as recommended by the OECD (OECD, 2015), total hours should be corrected to take into account the "quality" of the work force, for example taking into account qualifications levels of workers. Unfortunately at present such data are not available – but should deserve attention in the future. Output is computed as value added, that is, the difference between gross output and intermediate consumption. (Intermediate consumption refers to goods and services consumed as inputs in the production process, excluding fixed assets). Thus, labour productivity is given by the following ratio:

$$labour\ productivity = \frac{value\ added}{total\ hours\ worked}$$

The following analyses the evolution of labour productivity across industries, and also overviews the evolution of its components, namely inputs to production and value added.

**Manufacturing industries**

Table 4 shows that Labour productivity growth of manufacturing industries was driven by value added growth rather than changes in labour (correlation of 0.96 compared to 0.29). Value added growth exhibits wide variations across these industries. It ranges from -10.6 for the manufacturing of food products to 17.8 percent for chemical products. As for the labour input, Industries can be divided into two groups. The one with rising hours worked from 0.13 percent for Manufacture of computer, electrical equipment and machinery to 3.21 percent for Manufacture of transport equipment, and the second group with declining hours worked (-0.51% for Manufacturing of plastic products to -4.3% for Agriculture). The stock of capital increases in all manufacturing, exception made of two industries (Chemical products industry and Manufacture of basic metal products), which has resulted in sustained capital deepening (defined as the growth of physical capital per hours worked). These indicators are important because capital accumulation and capital deepening signal the introduction of new capital goods, which incorporate new technologies, in the production processes.

Table 4
**Average growth of value added, capital, labour and labour productivity 1995 – 2015 (%)**

| Industry | Value added | Capital | Labour | Capital deepening | Labour productivity |
|---|---|---|---|---|---|
| Agriculture | -4.95 | 2.44 | -4.3 | 6.74 | -0.65 |
| Forestry | -3.93 | 1.37 | -2.13 | 3.5 | -1.8 |
| Mining and Quarrying | -2.63 | 2.55 | -1.32 | 3.87 | -1.31 |
| Manufacture of food products | -10.62 | 2.94 | 0.9 | 2.04 | -11.52 |
| Manufacture of textiles | 2.7 | 0.9 | -0.56 | 1.46 | 3.26 |
| Manufacture of paper and wood products | -2.58 | 2.72 | 0.38 | 2.34 | -2.96 |
| Chemical products | 17.83 | -0.09 | 2 | -2.09 | 15.83 |
| Manufacture of plastic products | 2.56 | 1.33 | -0.51 | 1.84 | 3.08 |
| Manufacture of basic metal products | -4.7 | -0.82 | -2.23 | 1.41 | -2.47 |
| Manufacture of computer, electrical equipment and machinery | 0.81 | 2.46 | 0.13 | 2.33 | 0.69 |
| Manufacture of transport equipment | 6.8 | 2.94 | 3.21 | -0.27 | 3.59 |
| Other manufacturing | 10.39 | 2.69 | 2.81 | -0.12 | 7.57 |
| Electricity and gas | -6.75 | 4.73 | 0.9 | 3.83 | -7.41 |
| Water supply | -2.47 | 2.77 | -0.56 | 3.33 | -1.91 |
| Waste management | 1.22 | 2.19 | 2.06 | 0.13 | -0.84 |
| Construction | 2.45 | 3.55 | 2.25 | 1.3 | 0.19 |

Source: author's calculation from STATEC data

In 2002, Kumar and Russell (2002) proposed a useful decomposition of the labour productivity evolution into TFP and contribution of capital. In addition, TFP changes are decomposed into efficiency gains and technical change rates.

$$\begin{aligned} &Labour\ productivity\ change = TFP\ change + Capital\ deepening \\ &= Efficiency\ change + Technical\ change + Capital\ deepening \end{aligned}$$

In Luxembourg, two of these elements have often played one against the other. Indeed, vast efficiency losses have counterbalanced the positive rates of technical change. Table 5 and 6 show, respectively, the Kumar-Russell decomposition and the decomposition of TFP for Luxembourg manufacturing industries. With the exception of the manufacturing of chemical products and the waste management activities, capital deepening has contributed positively to labour productivity.

Table 5
**Labour productivity decomposition – averages yearly changes 1995-2015 (%)**

| Industry | Labour productivity | Efficiency gains | Technical change | Capital deepening |
|---|---|---|---|---|
| Agriculture | -0.65 | -14.15 | 12.92 | 0.58 |
| Forestry | -1.8 | -14.89 | 11.95 | 1.14 |
| Mining and Quarrying | -1.31 | -16.16 | 11.97 | 2.88 |
| Manufacture of food products | -11.52 | -24.02 | 11.47 | 1.03 |
| Manufacture of textiles | 3.26 | -9.82 | 12.03 | 1.06 |
| Manufacture of paper and wood products | -2.96 | -16.38 | 12.01 | 1.41 |
| Chemical products | 15.83 | 2.43 | 13.96 | -0.56 |
| Manufacture of plastic products | 3.08 | -10.26 | 12.24 | 1.09 |
| Manufacture of basic metal products | -2.47 | -15.55 | 11.85 | 1.23 |
| Manufacture of computer, electrical equipment and machinery | 0.69 | -12.13 | 11.42 | 1.4 |
| Manufacture of transport equipment | 3.59 | -7.38 | 10.36 | 0.61 |
| Other manufacturing | 7.57 | -2.13 | 9.68 | 0.02 |
| Electricity and gas | -7.41 | -20.69 | 13.2 | 0.08 |
| Water supply | -1.91 | -15.18 | 13.2 | 0.07 |
| Waste management | -0.84 | -14.2 | 13.43 | -0.08 |
| Construction | 0.19 | -8.76 | 7.77 | 1.18 |

Source: author's calculations from STATEC data
Rk: Labour productivity growth is the sum of (logs) efficiency gains, technical change and capital deepening contributions.

Table 6
**TFP decomposition – averages 1995-2015 (%)**

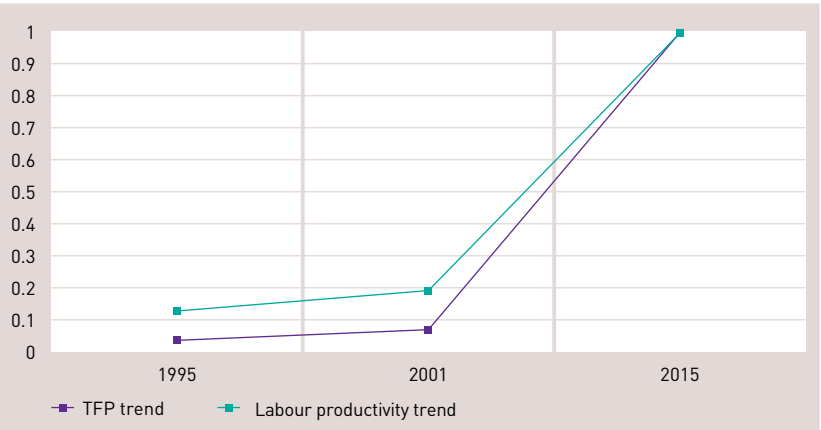
| Industry | TFP | Efficiency gains | Technical change |
|---|---|---|---|
| Agriculture | -1.23 | -14.15 | 12.92 |
| Forestry | -2.94 | -14.89 | 11.95 |
| Mining and Quarrying | -4.19 | -16.16 | 11.97 |
| Manufacture of food products | -12.55 | -24.02 | 11.47 |
| Manufacture of textiles | 2.2 | -9.82 | 12.03 |
| Manufacture of paper and wood products | -4.37 | -16.38 | 12.01 |
| Chemical products | 16.39 | 2.43 | 13.96 |
| Manufacture of plastic products | 1.99 | -10.26 | 12.24 |
| Manufacture of basic metal products | -3.71 | -15.55 | 11.85 |
| Manufacture of computer, electrical equipment and machinery | -0.71 | -12.13 | 11.42 |
| Manufacture of transport equipment | 2.98 | -7.38 | 10.36 |
| Other manufacturing | 7.55 | -2.13 | 9.68 |
| Electricity and gas | -7.49 | -20.69 | 13.2 |
| Water supply | -1.99 | -15.18 | 13.2 |
| Waste management | -0.77 | -14.2 | 13.43 |
| Construction | -0.99 | -8.76 | 7.77 |

Source: author's calculations from STATEC data
Note: TFP growth is the sum of efficiency gains and technical change.

It is worthwhile to take a closer look at some specific industries. Previously, it was mentioned that the manufacturing of chemical products is a "leader" industry, that is, one of those industries pushing/shaping the technological frontier. From 1995 to 2001, the role of leader was played by the textile industry, which was then replaced by the chemical product industry. As this activity is "on the frontier", that is, it makes the most efficient use of inputs to production, productivity gains can only be obtained through positive rates of technical changes. Indeed, the chemical products industry displays sustained rated of technical progress. Its rate of technical change during 1995-2001 was about 1.55 percent, which jumped to 19.28 percent in following years. This jump translated into TFP and labour productivity as a break in the trend.

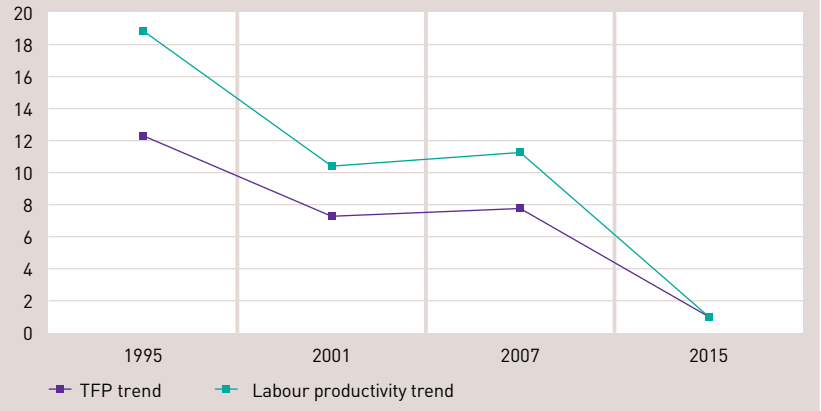
On the contrary, the manufacturing of food products shows the opposite evolution, with an impressive decline in both labour and total factor productivity (respectively -11.52% and -12.55%) mainly explained by large losses in efficiency (-24.02% over the period 1995-2015).

Figure 9
**Trends in TFP and labour productivity – 2015 =1 – Chemical products industry**




Source: author's calculations from STATEC data

Figure 10
**Trends in TFP and labour productivity – 2015 =1 – Manufacture of food products**




Source: author's calculations from STATEC data

## Services

As for manufacturing, services' labour productivity changes correlated more with value added (0.93) than with labour (0.19). Table 7 shows that service industries are also characterised by wide variations in productivity performances and the evolution of inputs and output. Value added increased in all services, with the exception of five economic activities where value added decreased (Wholesale and retail trade of vehicles, Retail trade, Accommodation and food service activities, Repair of computers and personal and household goods, and Households), all services show sustained increases in value added. This reached an impressive average growth rate of 20.85 percent for Leasing and rental activities or 10.38 percent for IT services. Overall, hours worked have increased in all service activities (exception made of repair of computers and personal and household goods and households).

Table 7
**Average growth of value added, capital, labour and labour productivity 1995 – 2015 (%)**

| Industry | Value added | Capital | Labour | Capital deepening | Labour productivity |
|---|---|---|---|---|---|
| Wholesale and retail trade and repair of motor vehicles and motorcycles | -3.82 | 5.68 | 2.16 | 3.52 | -5.98 |
| Wholesale trade, except of motor vehicles and motorcycles | 7.24 | 5.19 | 1.96 | 3.22 | 5.28 |
| Retail trade, except of motor vehicles and motorcycles | -1.5 | 4.57 | 1.95 | 2.62 | -3.45 |
| Transport and postal activities | 0.65 | 4.45 | 2.98 | 1.48 | -2.32 |
| Accommodation and food service activities | -0.4 | 4.2 | 2.25 | 1.94 | -2.65 |
| Publishing activities | 3.1 | 2.5 | 1.22 | 1.28 | 1.87 |
| Telecommunications | 7.59 | 8.17 | 3.57 | 4.6 | 4.02 |
| IT services | 10.38 | 12.62 | 8.87 | 3.75 | 1.51 |
| Financial service activities | 5.13 | 3.32 | 2.44 | 0.88 | 2.69 |
| Insurance, reinsurance and pension funding, | 8.32 | 3.38 | 4.96 | -1.58 | 3.36 |
| Activities auxiliary to financial services and insurance activities | 8.49 | 1.87 | 6.1 | -4.23 | 2.39 |
| Real estate activities | 2.86 | 13.58 | 8.72 | 4.86 | -5.86 |
| Services to business and research and development | 3.18 | 8.72 | 7.05 | 1.67 | -3.88 |
| Other professional activities | 7.51 | 4.67 | 4.96 | -0.3 | 2.55 |
| Rental and leasing activities | 20.85 | 16.47 | 7.2 | 9.27 | 13.65 |
| Employment activities | 5.48 | 7.78 | 5.93 | 1.85 | -0.45 |
| Travel agency and other business support activities | 4.89 | 3.56 | 4.36 | -0.8 | 0.53 |
| Public administration | 3.49 | 3.87 | 2.68 | 1.19 | 0.81 |
| Education | 1.84 | 4.92 | 3.43 | 1.48 | -1.59 |
| Health services | 2.27 | 9.72 | 3.71 | 6.01 | -1.44 |
| Social work activities | 7.55 | 5.48 | 8.45 | -2.97 | -0.91 |
| Arts and entertainment activities | 2.96 | 10.61 | 6.23 | 4.39 | -3.26 |
| Sport activities | 3.8 | 2.85 | 3.47 | -0.62 | 0.34 |
| Activities of membership organisations | 0.73 | 4.44 | 2.44 | 2.01 | -1.71 |
| Repair of computers and personal and household goods | -14.4 | -1.81 | 2.27 | -4.09 | -16.69 |
| Other personal service activities | 2.12 | 4.42 | 3.98 | 0.45 | -1.86 |
| Households | -3.27 | -2.88 | 1.51 | -4.39 | -4.78 |

Source: author's calculations from STATEC data

Table 8
**Labour productivity decomposition – averages 1995-2015 (%)**

| Industry | Labour productivity | Efficiency gains | Technical change | Capital deepening |
|---|---|---|---|---|
| Wholesale and retail trade and repair of motor vehicles and motorcycles | -5.98 | -8.67 | 0.93 | 1.76 |
| Wholesale trade, except of motor vehicles and motorcycles | 5.28 | 3.38 | 0.19 | 1.71 |
| Retail trade, except of motor vehicles and motorcycles | -3.45 | -7.82 | 3.21 | 1.16 |
| Transport and postal activities | -2.32 | 1.18 | -4.11 | 0.6 |
| Accommodation and food service activities | -2.65 | -6.66 | 2.67 | 1.33 |
| Publishing activities | 1.87 | 2.53 | -1.03 | 0.38 |
| Telecommunications | 4.02 | 9.46 | -8.77 | 3.34 |
| IT services | 1.51 | -4.32 | 4.49 | 1.34 |
| Financial service activities | 2.69 | 4.07 | -2.47 | 1.09 |
| Insurance, reinsurance and pension funding, | 3.36 | 3.85 | -0.16 | -0.32 |
| Activities auxiliary to financial services and insurance activities | 2.39 | 0.8 | 2.78 | -1.18 |
| Real estate activities | -5.86 | 0 | -7.94 | 2.08 |
| Services to business and research and development | -3.88 | -8.91 | 3.99 | 1.05 |
| Other professional activities | 2.55 | -1.54 | 4.32 | -0.22 |
| Rental and leasing activities | 13.65 | 14.99 | -8.74 | 7.4 |
| Employment activities | -0.45 | -0.39 | -0.21 | 0.15 |
| Travel agency and other business support activities | 0.53 | -3.76 | 4.73 | -0.43 |
| Public administration | 0.81 | 7.12 | -7.14 | 0.83 |
| Education | -1.59 | -0.08 | -2.16 | 0.64 |
| Health services | -1.44 | -5.78 | 0.28 | 4.06 |
| Social work activities | -0.91 | -0.84 | 1.38 | -1.44 |
| Arts and entertainment activities | -3.26 | -1.97 | -4.11 | 2.81 |
| Sport activities | 0.34 | 8.58 | -7.92 | -0.32 |
| Activities of membership organisations | -1.71 | -4.34 | 0.49 | 2.14 |
| Repair of computers and personal and household goods | -16.69 | -16.89 | 2.27 | -2.07 |
| Other personal service activities | -1.86 | -6.68 | 4.54 | 0.28 |
| Households | -4.78 | 0 | -2.58 | -2.2 |

Source: author's calculations from STATEC data

Table 9
**TFP decomposition – averages 1995-2015 (%)**

| Industry | TFP | Efficiency gains | Technical change |
|---|---|---|---|
| Wholesale and retail trade and repair of motor vehicles and motorcycles | -7.74 | -8.67 | 0.93 |
| Wholesale trade, except of motor vehicles and motorcycles | 3.56 | 3.38 | 0.19 |
| Retail trade, except of motor vehicles and motorcycles | -4.61 | -7.82 | 3.21 |
| Transport and postal activities | -2.93 | 1.18 | -4.11 |
| Accomodation and food service activities | -3.99 | -6.66 | 2.67 |
| Publishing activities | 1.5 | 2.53 | -1.03 |
| Telecommunications | 0.68 | 9.46 | -8.77 |
| IT services | 0.17 | -4.32 | 4.49 |
| Financial service activities | 1.6 | 4.07 | -2.47 |
| Insurance, reinsurance and pension funding, | 3.69 | 3.85 | -0.16 |
| Activities auxiliary to financial services and insurance activities | 3.57 | 0.8 | 2.78 |
| Real estate activities | -7.94 | 0 | -7.94 |
| Services to business and research and development | -4.93 | -8.91 | 3.99 |
| Other professional activities | 2.77 | -1.54 | 4.32 |
| Rental and leasing activities | 6.25 | 14.99 | -8.74 |
| Employment activities | -0.6 | -0.39 | -0.21 |
| Travel agency and other business support activities | 0.96 | -3.76 | 4.73 |
| Public administration | -0.02 | 7.12 | -7.14 |
| Education | -2.24 | -0.08 | -2.16 |
| Health services | -5.5 | -5.78 | 0.28 |
| Social work activities | 0.54 | -0.84 | 1.38 |
| Arts and entertainment activities | -6.08 | -1.97 | -4.11 |
| Sport activities | 0.66 | 8.58 | -7.92 |
| Activities of membership organisations | -3.85 | -4.34 | 0.49 |
| Repair of computers and personal and household goods | -14.62 | -16.89 | 2.27 |
| Other personal service activities | -2.14 | -6.68 | 4.54 |
| Households | -2.58 | 0 | -2.58 |

Source: author's calculations from STATEC data

As in most developed economies, the share of service activities in total value added is growing. Manufacturing is contributing less and less to growth. One of the striking features of Luxembourg economy is the size of the financial sector. Luxembourg is the largest financial industry of the eurozone and one of the most active in the world. Its strength as a financial centre has increased over the years, as it is also shown in recent OECD studies. The National Accounts classifies the financial sector in three activities: i) financial services that are banks, the Central Bank of Luxembourg, UCITS (Undertakings for Collective Investments in Transferable Securities) and other financial corporations, ii) Insurance, reinsurance and pension funds and iii) activities auxiliary to financial services and insurance activities such as wealth managers or insurance brokers.

Measuring financial sector output has been a major challenge for decades and still remains a difficult task. Burgess (2011) in a publication of the Bank of England states *"Policymakers need to understand the extent to which estimates of financial sector output may be subject to uncertainty"*, Basu et al. (2008) claim that *"our work suggests that Luxembourg's GDP could be overstated by about 11 percent"*. This document uses National Accounts data as these represent official figures compiled following internationally agreed standards and best practice. As a result, these data are regarded as the only reliable source of information for measuring productivity in the financial sector.

Output in the banking sector consists of two main elements: fees and commissions charged by banks; financial intermediation services indirectly measured (FISIM). FISIM is a margin of interest corrected by the cost of re-financing of banks. The Output of UCITS is proxied by the value of own funds. Insurances' total output is the sum of the premium paid by customers minus claims incurred (non-life insurance) or technical reserves (life insurance). In the case of financial auxiliaries, output is the sum of fees and commissions charged. Inputs are physical capital (only) and hours worked.[5] Table 10 presents the evolution of inputs and outputs in the financial industry.

Table 10
**Average growth of value added, capital, labour and labour productivity 1995 – 2015 (%)**

| Industry | Value added | Capital | Labour | Capital deepening | Labour productivity |
|---|---|---|---|---|---|
| Financial service activities | 5.13 | 3.32 | 2.44 | 0.88 | 2.69 |
| Insurance, reinsurance and pension funding | 8.32 | 3.38 | 4.96 | -1.58 | 3.36 |
| Activities auxiliary to financial services and insurance activities | 8.49 | 1.87 | 6.1 | -4.23 | 2.39 |

Source: author's calculations from STATEC data

[5] A large strand of the academic literature on productivity measurement is devoted to banks and makes extensive use of balance sheets to consider financial inputs.

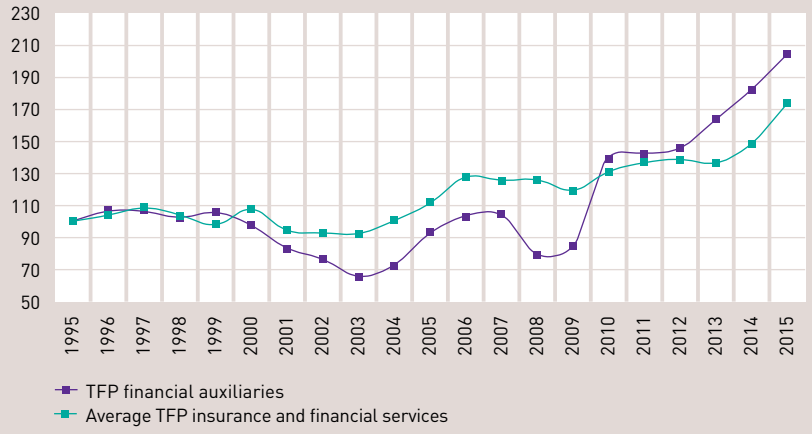
It is interesting to note that trends in TFP, for these economic activities, are rather similar especially the correlation of TFP of insurances and activities auxiliary to financial and insurance activities (Figure 11). However, drivers of productivity differ; for auxiliaries this is mainly technical change while for insurances and financial services it is efficiency gains.

Table 11
**TFP decomposition – averages 1995-2015 (%)**

| Industry | Labour productivity | Efficiency gains | Technical change | Capital deepening | TFP |
|---|---|---|---|---|---|
| Financial service activities | 2.69 | 4.07 | -2.47 | 1.09 | 1.60 |
| Insurance, reinsurance and pension funding | 3.36 | 3.85 | -0.16 | -0.32 | 3.69 |
| Activities auxiliary to financial services and insurance activities | 2.39 | 0.80 | 2.78 | -1.18 | 3.57 |

Source: author's calculations from STATEC data

Figure 11
**Evolution of TFP financial auxiliaries vs. average of TFP financial services and insurances**




Source: author's calculations from STATEC data

### 7.1.2.3 Unit labour costs: a competitiveness insight

The recent economic situation of countries like Greece, for example, has fuelled a heated debate about the role of cost competitiveness in the eurozone and how far austerity should go. The basic idea is that higher wages translate into higher export prices and consequently a competitive disadvantage on international markets. The European Commission monitors closely the evolution of unit labour cost to assess the competiveness of European countries, which is calculated as the total cost of labour per unit of value added.

Unit labour cost is:

$$ULC = \frac{Labour\ cost}{GDP} = \frac{Labour\ cost/_{Labour}}{GDP/_{Labour}}$$

Being a small open economy, maintaining export competitiveness for Luxembourg is high on the policy agenda. The main trading partners of Luxembourg are France, Belgium and Germany and are all members of the eurozone. Then, currency devaluation is useless, one way forward to boost international trade is then through wage moderation and unit labour cost (ULC) gains.

Monitoring the evolution of ULC is usually restricted to assessing the evolution of average labour cost compared to gains in labour productivity. As a consequence, the debate on ULC has mainly focussed on the idea that "*workers are too expensive, especially given their labour productivity*" (Felipe and Kumar, 2011). Therefore a number of economists have advocated the use of internal devaluation, downwards adjustments of labour costs to tackle losses in competitiveness especially in the eurozone where currency devaluation is impossible (e.g. Blanchard, 2007, Barkbu et al., 2012). In this line, the IMF (2012) has proposed "*direct measures to improve Greek competitiveness through internal devaluation. The program aims to make collective bargaining more effective, reduce the minimum wage (…)*". Relatively successful examples of internal devaluations are Ireland and Latvia after 2008 (Bara and Piton, 2012). However, the policy relevance of internal devaluation is more and more becoming subject to controversy. Recently, Decressin et al. (2015), show that internal devaluation actually has a positive effect on exports, while the effect on the local economy remains ambiguous. As presented by Decressin, et al. (2015) "*lower wage growth is likely to add to existing disinflation pressures, implying higher real interest rates, higher real public and private debt levels, and lower domestic demand*". It was previously mentioned that labour productivity changes can be further decomposed into technical change, efficiency change and capital deepening contribution. The following table summarizes the evolution of ULC and the decomposition.

Table 12
**ULC decomposition – averages 1995-2015 (%)**

| Industries & services | ULC | Labour cost | Labour productivity | Efficiency gains | Technical change | Capital deepening |
|---|---|---|---|---|---|---|
| **Manufacturing Industries** | | | | | | |
| Agriculture | 7.4 | 6.76 | -0.65 | -14.15 | 12.92 | 0.58 |
| Forestry | 4.32 | 2.52 | -1.8 | -14.89 | 11.95 | 1.14 |
| Mining and Quarrying | 4.08 | 2.77 | -1.31 | -16.16 | 11.97 | 2.88 |
| Manufacture of food products | 14.33 | 2.81 | -11.52 | -24.02 | 11.47 | 1.03 |
| Manufacture of textiles | -0.72 | 2.54 | 3.26 | -9.82 | 12.03 | 1.06 |
| Manufacture of paper and wood products | 5.76 | 2.8 | -2.96 | -16.38 | 12.01 | 1.41 |
| Chemical products | -13.59 | 2.24 | 15.83 | 2.43 | 13.96 | -0.56 |
| Manufacture of plastic products | -0.54 | 2.54 | 3.08 | -10.26 | 12.24 | 1.09 |
| Manufacture of basic metal products | 5.48 | 3 | -2.47 | -15.55 | 11.85 | 1.23 |
| Manufacture of computer, electrical equipment and machinery | 1.6 | 2.29 | 0.69 | -12.13 | 11.42 | 1.4 |
| Manufacture of transport equipment | -1.74 | 1.85 | 3.59 | -7.38 | 10.36 | 0.61 |
| Other manufacturing | -3.63 | 3.94 | 7.57 | -2.13 | 9.68 | 0.02 |
| Electricity and gas | 11.04 | 3.58 | -7.41 | -20.69 | 13.2 | 0.08 |
| Water supply | 3.36 | 1.45 | -1.91 | -15.18 | 13.2 | 0.07 |
| Waste management | 3.94 | 3.1 | -0.84 | -14.2 | 13.43 | -0.08 |
| Construction | 2.89 | 3.09 | 0.19 | -8.76 | 7.77 | 1.18 |
| **Services** | | | | | | |
| Wholesale and retail trade and repair of motor vehicles and motorcycles | 9.23 | 3.25 | -5.98 | -8.67 | 0.93 | 1.76 |
| Wholesale trade, except of motor vehicles and motorcycles | -1.84 | 3.43 | 5.28 | 3.38 | 0.19 | 1.71 |
| Retail trade, except of motor vehicles and motorcycles | 6.78 | 3.34 | -3.45 | -7.82 | 3.21 | 1.16 |
| Transport and postal activities | 4.59 | 2.27 | -2.32 | 1.18 | -4.11 | 0.6 |
| Accommodation and food service activities | 5.13 | 2.47 | -2.65 | -6.66 | 2.67 | 1.33 |
| Publishing activities | 0.56 | 2.44 | 1.87 | 2.53 | -1.03 | 0.38 |
| Telecommunications | -0.8 | 3.22 | 4.02 | 9.46 | -8.77 | 3.34 |
| IT services | 1.12 | 2.64 | 1.51 | -4.32 | 4.49 | 1.34 |
| Financial service activities | 0.08 | 2.77 | 2.69 | 4.07 | -2.47 | 1.09 |
| Insurance, reinsurance and pension funding | -0.66 | 2.7 | 3.36 | 3.85 | -0.16 | -0.32 |
| Activities auxiliary to financial services and insurance activities | 1.48 | 3.88 | 2.39 | 0.8 | 2.78 | -1.18 |
| Real estate activities | 10.06 | 4.2 | -5.86 | 0 | -7.94 | 2.08 |
| Services to business and research and development | 7.96 | 4.09 | -3.88 | -8.91 | 3.99 | 1.05 |
| Other professional activities | 0.1 | 2.65 | 2.55 | -1.54 | 4.32 | -0.22 |
| Rental and leasing activities | -9.34 | 4.31 | 13.65 | 14.99 | -8.74 | 7.4 |
| Employment activities | 2.78 | 2.34 | -0.45 | -0.39 | -0.21 | 0.15 |
| Travel agency and other business support activities | 2.14 | 2.67 | 0.53 | -3.76 | 4.73 | -0.43 |
| Public administration | 2.11 | 2.92 | 0.81 | 7.12 | -7.14 | 0.83 |
| Education | 4.24 | 2.64 | -1.59 | -0.08 | -2.16 | 0.64 |
| Health services | 5.03 | 3.6 | -1.44 | -5.78 | 0.28 | 4.06 |
| Social work activities | 2.99 | 2.09 | -0.91 | -0.84 | 1.38 | -1.44 |
| Arts and entertainment activities | 6.41 | 3.15 | -3.26 | -1.97 | -4.11 | 2.81 |
| Sport activities | 2.94 | 3.28 | 0.34 | 8.58 | -7.92 | -0.32 |
| Activities of membership organisations | 5.46 | 3.75 | -1.71 | -4.34 | 0.49 | 2.14 |
| Repair of computers and personal and household goods | 19.79 | 3.1 | -16.69 | -16.89 | 2.27 | -2.07 |
| Other personal service activities | 4.78 | 2.92 | -1.86 | -6.68 | 4.54 | 0.28 |
| Households | 6.88 | 2.1 | -4.78 | 0 | -2.58 | -2.2 |

Source: author's calculations from STATEC data

Unit labour costs have been increasing in most industries and services exception made of Chemical product industry (-13.59%), Rental and leasing activities (-9.34%) or Wholesale trade (-1.84%) for example. ULC unfavourable evolution is fuelled by increasing average labour cost and relatively low labour productivity gains.

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# Technical Appendix

Unit labour cost takes into account both the change in average labour compensation (total labour cost per employee) and labour productivity (GDP per employee). Unit labour cost can be defined by:

$$ULC_t = \frac{Labour\ cost/_{L_t}}{Y_t/_{L_t}} = \frac{Labour\ cost/_{L_t}}{y_t}$$

Changes in unit labour cost can be expressed by first difference of logarithm and one has a linear relationship between changes in average labour cost and labour productivity changes:

$$dln(ULC_t) = dln\left(labour\ cost/_{L_t}\right) - dln(y_t)$$

This expression can be rearranged to explicitly show the ratio of labour productivity between two consecutive time periods:

$$dln(ULC_t) = dln\left(labour\ cost/_{L_t}\right) - dln(y_t) = dln\left(labour\ cost/_{L_t}\right) - ln\left(\frac{y_t}{y_{t-1}}\right)$$

Therefore ULC changes are the difference between the changes in average labour cost and the logarithm of the ratio of labour productivity at time t and t+1.

But, labour productivity change can be further decomposed to introduce total factor productivity and capital deepening. This section borrowed from Kumar and Russell (2002), Chen and Yu (2012) and Fare et al (2001).

Each country produces a single output y using two inputs capital (K) and labour (L). Assume a convex production possibility set with freely disposable inputs and output. The output distance function at time t can be defined on the technology $P^t = \{(X_t, Y_t): X_t \text{ can produce } Y_t\}$ with $X_t = (K_t, L_t)$ as:

$$D_o^t(X_t, Y_t) = \inf\{\theta : (X_t, Y_t/\theta) \in P^t\}.$$

The distance function is the reciprocal of the maximum proportional expansion of output given the level of inputs. If $D_o^t(X_t, Y_t) = 1$ then the country is on the world production frontier and is said to be efficient as it is impossible to increase output given inputs. If $D_o^t(X_t, Y_t) < 1$ then the country is below the frontier and the country is said to be inefficient in the sense used by Farrell (1957) as it could be possible to produce more given the level of inputs used.

Under the assumption of constant returns to scale the distance functions can be rewritten in intensive form $D_o^t(x_t, y_t)$ where $x_t = (K_t/L_t, 1)$ and $y_t = (Y_t/L_t)$. Kumar and Russell (2002) in this framework show that labour productivity change $y_{t+1}/y_t$ can be decomposed into efficiency change, technical progress and capital deepening.

$$y_{t+1}/y_t = \text{efficiency change} \cdot \text{technical progress} \cdot \text{capital deepening}.$$

The product of the two first components is the Malmquist total factor productivity index. The reasoning is the following, doing simple manipulations (omitting the o subscript):

$$y_{t+1}/y_t = \frac{\frac{y_{t+1}}{D^{t+1}(x_{t+1}, y_{t+1})} D^{t+1}(x_{t+1}, y_{t+1})}{\frac{y_t}{D^t(x_t, y_t)} D^t(x_t, y_t)} = \frac{\frac{y_{t+1}}{D^{t+1}(x_{t+1}, y_{t+1})}}{\frac{y_t}{D^t(x_t, y_t)}} \frac{D^{t+1}(x_{t+1}, y_{t+1})}{D^t(x_t, y_t)}.$$

The first term is the optimal evolution of labour productivity while the second term is efficiency gain. Efficiency gains measure shift of countries toward the world production frontier, a value over one is an improvement while any value below one indicates a worsened situation. It is a catching up effect between period t and t+1. The optimal evolution of labour productivity can be further manipulated:

$$\frac{\frac{y_{t+1}}{D^{t+1}(x_{t+1}, q_{t+1})}}{\frac{y_t}{D^t(x_t, q_t)}} = \frac{y_{t+1}}{y_t} \frac{D^t(x_t, y_t)}{D^{t+1}(x_{t+1}, y_{t+1})} \frac{D^t(x_{t+1}, y_{t+1})}{D^t(x_{t+1}, y_{t+1})} \frac{D^{t+1}(x_t, y_t)}{D^{t+1}(x_t, y_t)}$$

$$= \frac{y_{t+1}}{y_t} \left[ \frac{D^t(x_t, y_t) D^t(x_{t+1}, y_{t+1})}{D^{t+1}(x_{t+1}, y_{t+1}) D^{t+1}(x_t, y_t)} \right]^{1/2} \left[ \frac{D^t(x_t, y_t) D^t(x_{t+1}, y_{t+1})}{D^{t+1}(x_{t+1}, y_{t+1}) D^{t+1}(x_t, y_t)} \right]^{1/2} \frac{D^{t+1}(x_t, y_t)}{D^t(x_{t+1}, y_{t+1})}$$

The first term into brackets is technical progress and indicates shift of the world production frontier. A value over unity indicates a positive technical progress while a value below one is a technical regress[6]. There is a remaining term:

$$\frac{y_{t+1}}{y_t} \left[ \frac{D^t(x_t, y_t) D^t(x_{t+1}, y_{t+1})}{D^{t+1}(x_{t+1}, y_{t+1}) D^{t+1}(x_t, y_t)} \right]^{1/2} \frac{D^{t+1}(x_t, y_t)}{D^t(x_{t+1}, y_{t+1})}.$$

It is possible to simplify this expression by $D^{t+1}(x_t, y_t)$ and $D^t(x_{t+1}, y_{t+1})$ and it becomes:

$$\frac{y_{t+1}}{y_t} \left[ \frac{D^t(x_t, y_t) D^{t+1}(x_t, y_t)}{D^{t+1}(x_{t+1}, y_{t+1}) D^t(x_{t+1}, y_{t+1})} \right]^{1/2}.$$

[6] Whereas awkward technical regress can be found in many studies, few authors have attempted to provide explanation of plausible causes for this result. Some authors have argued that it may results from errors in measuring inputs in not taking into account unobserved capital utilization (Basu, 1996, Bye et al., 2009). For Lee and Johnson (2012), technical regress is often attributed to production issues when in actuality it may result from lack of demand. Bontemps et al. (2012) emphasizes the negative effect of new regulations that generate negative technical progress. For Sena (2006) it is a consequence of sharp recessions. During recessions old techniques are substituted by new techniques. It may appear that the process of destruction of old techniques is faster than the creation of new techniques. Then countries are experiencing temporarily technical regress.

To understand the economic interpretation of this expression one can restrict the analysis to the case of the standard Cobb-Douglas with constant returns to scale, then:

$$D_o^t(x_t, y_t) = \inf\{\theta : y_t/\theta \le A_t k_t^{\alpha} \in P^t, 0 < \alpha < 1\} = \inf\{\theta : y_t/A_t k_t^{\alpha} \le \theta\} = y_t/A_t k_t^{\alpha}.$$

Replacing in the latter expression one has:

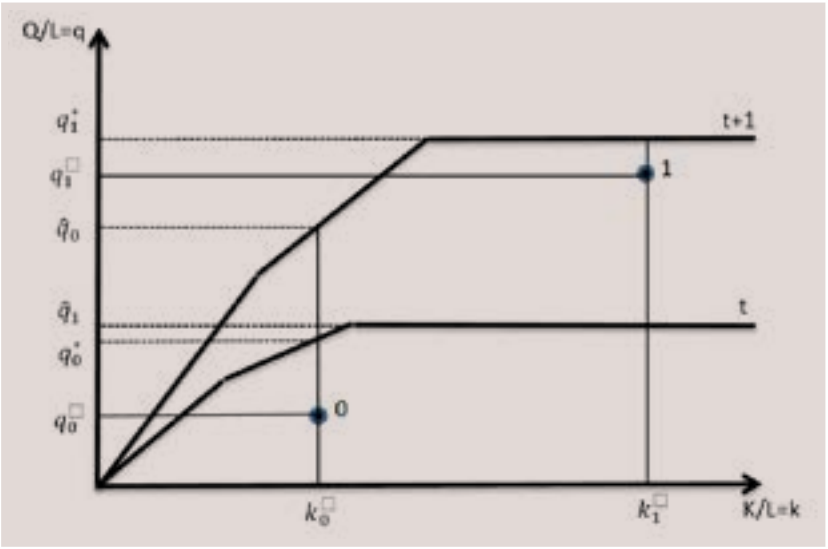
$$\left[\frac{y_{t+1}^2}{y_t^2}\frac{y_t/A_t k_t^{\alpha} \quad y_t/A_{t-1}k_t^{\alpha}}{y_{t+1}/A_{t+1}k_{t+1}^{\alpha} \quad y_{t+1}/A_t k_{t+1}^{\alpha}}\right]^{1/2} = \left(\frac{k_{t+1}}{k_t}\right)^{\alpha}.$$

The last term is capital deepening. To sum up labour productivity change is:

$$y_{t+1}/y_t = \frac{D^{t+1}(x_{t+1}, y_{t+1})}{D^t(x_t, y_t)}\left[\frac{D^t(x_t, y_t)D^t(x_{t+1}, y_{t+1})}{D^{t+1}(x_{t+1}, y_{t+1})D^{t+1}(x_t, y_t)}\right]^{1/2}\left[\left(\frac{y_{t+1}}{y_t}\right)^2\frac{D^t(x_t, y_t)D^{t+1}(x_t, y_t)}{D^{t+1}(x_{t+1}, y_{t+1})D^t(x_{t+1}, y_{t+1})}\right]^{1/2}$$

All distances can be computed using data envelopment analysis introduced by Charnes et al. (1978). This decomposition has a graphical representation:

Figure 12
**Production frontiers**




Replacing in the previous equation for period 0 and 1 one has:

$$q_1/q_0 = \frac{q_1/q_1^*}{q_0/q_0^*}\left[\frac{\hat{q}_0}{q_0^*}\frac{q_1^*}{\hat{q}_1}\right]^{1/2}\left[\left(\frac{q_1}{q_0}\right)^2\frac{q_0/q_0^* \quad \hat{q}_0/q_1}{q_0/q_1^* \quad \hat{q}_0/q_0}\right]^{1/2}$$

Rearranging the last term

$$\frac{q_1}{q_0} = \frac{\frac{q_1}{q_1^*}}{\frac{q_0}{q_0^*}} \left[ \frac{\dot{q}_0}{\dot{q}_0^*} \frac{q_1^*}{\dot{q}_1} \right]^{1/2} \left[ \frac{\dot{q}_1}{\dot{q}_0^*} \frac{q_1^*}{\dot{q}_0} \right]^{1/2}$$

Clearly the last term is the geometric average of gains in optimal labour productivity if capital deepening increases from $k_0$ to $k_1$ at period 0 and 1.

Replacing productivity changes by Kumar and Rusell (2002) decomposition into unit labour cost changes one has:

$$dln(ULC_t) = dln\left(\frac{labour\ cost}{L_t}\right) - ln(EFF_t) - ln(TECH_t) - ln(CAPD_t)$$

Where EFF are efficiency change, TECH is technical change and CAPD is capital deepening. In this framework aggregated ULC are not only affected by changes in labour cost and labour productivity but rather by changes in total factor productivity and capital deepening. The total factor productivity can be split in efficiency gains and technical change. Then unit labour cost increases if average labour cost increase but it decreases in case of efficiency gains, technical change and capital deepening. Each element indicates the magnitude of changes in percent point in unit labour cost for an about one percent change of each element (because logs the magnitude is not exactly one percent).

# 7.2 International Trade and Labour Demand in Luxembourg

Xi Chen

This document presents results from the research project LuxEmpTrade aimed at investigating the labour market implications of international trade for Luxembourg. The project, carried out by the Research Division of STATEC, ran for a period of 24 months between 2015 and 2017 and was supported financially by the Observatoire de la compétitivité and by Luxembourg National Research Fund. The main outcomes of the projects are documented in two working papers entitled "Productivity, Fair Wage and Offshoring Domestic Jobs", and "Trade in Intermediate Inputs, Absorptive Capacity and Employment: Theory and Evidence". In this short article, I focus on the motivation and discuss the main findings of our research.

## 7.2.1. Free trade and local employment

*"No extension of foreign trade will immediately increase the amount of value in a country, although it will very powerfully contribute to increase the mass of commodities, and therefore the sum of enjoyments."* These are the opening words of David Ricardo's famous chapter on foreign trade published on the 19th of April 1817 in his book: *On the Principles of Political Economy and Taxation*. Many economists consider this publication as the inception of modern trade studies. In the following two centuries, trade economists have built sophisticated models that draw on Ricardo's basic framework and convinced policymakers of the benefits of free trade. Recent events and economic developments, however, call into question the Ricardian views and marked the revival of old mercantilism.[1] This new environment led to a marking event: on the 18th of April 2017, the eve of the 200th anniversary of the publication of Ricardo's Principles, the President of the United States signed an executive order named "Buy American and Hire American".[2]

Recent economic literature shows that openness to international trade can affect the home country's economy through several channels. Exporting firms, for instance, tend to be more productive and grow rapidly upon the entry into international markets. This reallocates the resources of the home country towards more productive uses as well as intensifies competition (Melitz, 2003). Internationally trading firms also enjoy higher productivity growth rates due to technological diffusion and/or learning effects (De Loecker, 2013). The economic impact of international trade, however, does not only occur through exporting activities and is not only relevant for the economic growth. Many of the firms in open economies also offshore their production units or directly import inputs from foreign sources (Bernard et al., 2007). Both types of international engagements have consequences, positive as well as negative, for the home country's labour market.

[1] Mercantilism is a dominating economic theory in Europe from the 16th to the 18th centuries, especially in France under the rule of King Louis XIV. The main idea is that government should maximize the accumulation of wealth within the country through a positive balance-of-trade by imposing high tariffs.

[2] https://www.whitehouse.gov/the-press-office/2017/04/18/presidential-executive-order-buy-american-and-hire-american

Today, much of the public concern about free trade is related to its labour market consequences. Generally, it is believed that imported products replace some production activities in the home country, so that importing is often associated with further worker displacement. In response to this concern, decision-makers have set out a series of economic policies to minimise the adverse effects of free trade on employment. In 2014, the European Commission, for instance, set up the European Globalisation Adjustment Fund (EGF) whose activities are described as *"The EGF provides support to people losing their jobs as a result of major structural changes in world trade patterns due to globalisation, e.g. when a large company shuts down or production is moved outside the EU"*. However, if in a comprehensive joint report on trade-employment nexus by the ILO and WTO, it is stated that *"Exporting sectors would expand production and their demand for labour, while import competing sectors would reduce production and possibly lay off workers*." On the contrary, the OECD states that *"Terms like 'imports', 'outsourcing' and 'offshoring' often have negative connotations in the public mind, as they are associated with firm closures and job losses. Trade barriers are often justified as a means of reducing import competition and protecting jobs. But the reality is quite different*." Therefore, a deep understanding of the trade-employment relationship is needed to disentangle these different views. STATEC research division carried out a project that aims to contribute to this debate by focusing on the effect of imported intermediate inputs on local employment.

The remainder of the document is structured as follows. Section 2 provides a series of descriptive statistics on (i) the role of intermediate input and labours in the production; (ii) the trade in intermediate inputs. This allows us to compare Luxembourg with its direct neighbours, and to build a macroeconomic context where our research is set out. Section 3 outlines the methodology and the main results of our research, which focuses on the micro-mechanism.

## 7.2.2. A macroeconomic context

### 7.2.2.1. Evolution of intermediate input and employment in Luxembourg and the neighbouring countries

This section presents figures that depict how the use of production factors evolved in the Luxembourg manufacturing industry over the last two decades. Table 1 reports the manufacturing outputs of Luxembourg along with two types of production factors: intermediate inputs and labour.[3] The labour input is measured as the total hours worked. The total cost of labour inputs in monetary term (total wages) is also reported.

The most important stylized fact in this table is that: the industry demand for intermediate input grew alongside the expansion of manufacturing output, while at the same time the total hours worked declined. Figure 1 compares Luxembourg with its neighbouring countries. There, one observes a similar pattern: that intermediate input expanded, while labour demand stagnated or even declined. Based on this observation, different interpretations can be put forward: An optimist would argue that the industry expanded in terms of production outputs and intermediate consumptions, while a pessimist would argue that the industry declined in terms of employment. What these figures actually reveal is that the production technology evolved dramatically in the last two decades. In 2015, manufacturing firms in Luxembourg rely much more on intermediate inputs than they did 20 years earlier, which reduced the relative importance of labour inputs in the production process. Again, the optimist can use this result for celebrating the progress in terms of labour productivity, while the pessimist would argue that the distribution of national income between final good producers and intermediate producers was working against the social welfare. The latter position becomes an even more controversial issue when a good deal of intermediate producers is located in foreign countries (we shall come back to this point in the next subsection). In a simplistic way, one can say that an average manufacturing worker in 2015 can produce almost twice as many outputs per hour and handle twice as many intermediate inputs per hour than her/his older fellow workers 20 years earlier.[4] At the same time, manufacturing firms indeed spend more and more on intermediate inputs rather than on wages and salaries (per unit of output). This change had profound implications on the social welfare and lies at the heart of an enduring issue in public debates — why and how government should regulate trade in intermediate inputs.

[3] The statistical definition of intermediate inputs is the following: "Goods and services, other than fixed assets, used as inputs into the production process of an establishment that are produced elsewhere in the economy or are imported. They may be either transformed or used up by the production process. Land, labour, and capital are primary inputs and are not included among intermediate inputs." (Source: https://stats.oecd.org/glossary)

[4] Table 1 shows that the ratio of gross production outputs over hours worked in 2015 is 1.9 times larger than in 1995; the ratio of intermediate inputs over hours worked in 2015 is two times larger than in 1995.

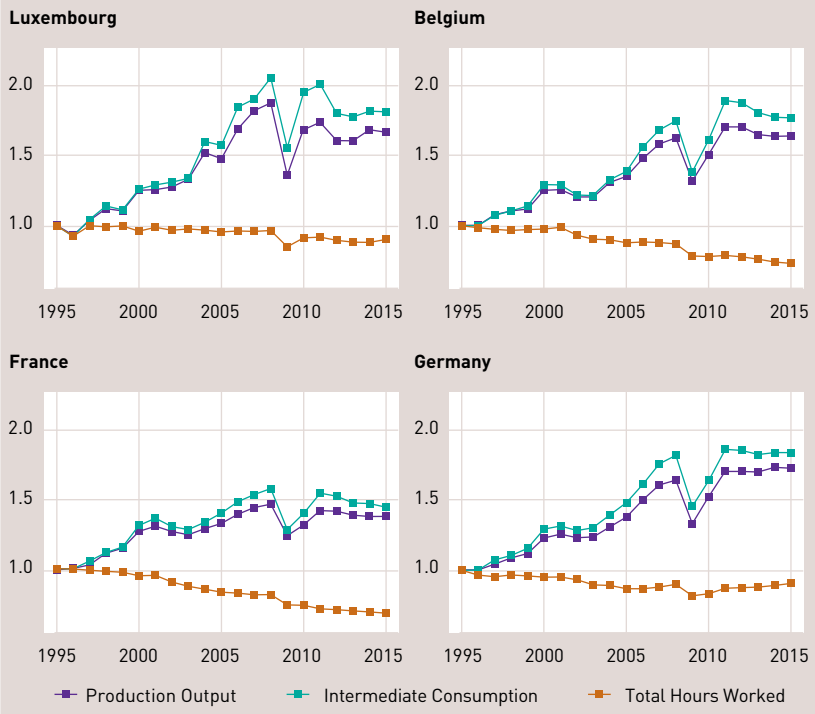
Table 1
**Production output and factors of Luxembourg manufacturing industry**

| Year | Gross production outputs | Intermediate inputs | Hours worked | Wage |
|---|---|---|---|---|
| | (current prices, million euros) | (current prices, million euros) | (million hours) | (current prices, million euros) |
| 1995 | 5511.93 | 3702.90 | 57.12 | 1011.72 |
| 2000 | 6882.21 | 4676.60 | 54.59 | 1182.71 |
| 2005 | 8100.40 | 5732.90 | 54.09 | 1350.15 |
| 2010 | 9286.72 | 7206.31 | 51.72 | 1433.62 |
| 2015 | 9185.48 | 6723.64 | 51.27 | 1541.95 |
| Average growth | 3.18% | 3.68% | -0.48% | 2.17% |

Source: OECD Structural Analysis (STAN) Databases, based on SNA 2008 and ISIC Revision 4.
Note: the annual growth rate is calculated as (current value - one period lagged value) / one period lagged value. The average growth rate (the last row) is calculated as the arithmetic mean of annual growth rates over the period of 1995-2015.

There are many reasons, from both demand and supply side that can explain evolutions of employment in manufacturing and the increasing use of intermediate goods. For instance, the stagnation of labour input may reflect a limited supply of labour for a variety of causes that range from demographical, to political as well as vocational. Similarly, the expansion of intermediate inputs may be due to the increasing supply of cheaper and more efficient inputs. The project LuxEmpTrade seeks to answer an important question highlighted by the facts depicted in Table 1: Does imported intermediate consumption imply lower local (national) labour demand?

Figure 1
**Evolution of inputs and outputs in the manufacturing industry**




Source: OECD Structural Analysis (STAN) Database.
Note: The series are normalized to one at the base year 1995.

### 7.2.2.2. Do rising imports of intermediate inputs cause lower manufacturing labour demand?

In the previous section, I started the discussion by considering the total input demands (intermediate consumption and labour) regardless of the origin of intermediate consumption goods. In this section, I make an explicit distinction between the domestic and imported intermediate input. Autor, Dorn and Hanson (2013) on "the China syndrome", present a figure that illustrates the "X" shape relationship between the China import penetration ratio and the US manufacturing employment rate (Autor et al., 2013, page 2122, Figure 1). This figure shows that, for the last 30 years, US manufacturing employment declined sharply, while the total spending on Chinese goods rose, with an inflection point in 2001. This has led to a large bulk of analysis in OECD countries where imports of Chinese intermediate goods has surged and Luxembourg is not an exception. In this section, I first present a series of statistics that highlight the increasing importance of imported intermediate inputs for the manufacturing industry, in particular, the imports from China. Then, by looking into the individual industries, the data show that the effects of imports on employment cannot be summarized by a single stylized fact, which motivates our investigation toward the micro-mechanism.

Table 2
**Imports of intermediate inputs in Luxembourg manufacturing industry**

| Year | Total intermediate import | | Imports from China | |
|---|---|---|---|---|
| | Values in thousand USD | Shares of end-use in % | Values in thousand USD | Shares of end-use in % |
| 2000 | 4133250.8 | 43.3 | 4408.6 | 10.5 |
| 2005 | 6651849.7 | 43 | 21440.7 | 29.1 |
| 2010 | 7027610.6 | 39.9 | 93769.6 | 26.8 |
| 2015 | 6861886.5 | 40.2 | 114373.8 | 26.5 |

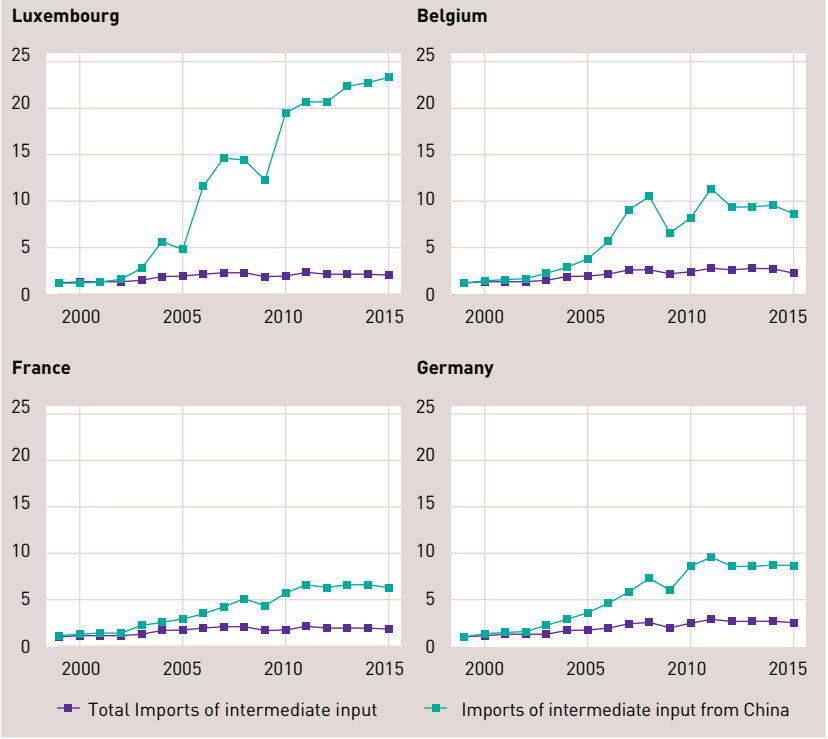
Source: OECD Structural Analysis (STAN) Bilateral Trade Database in goods, based on SNA 2008 and ISIC Revision 4.
Note: the share of end-use indicates the percentage of imported goods that are used as intermediate inputs. Other imported goods can be used for capital formation, household consumption or mixed purpose.

Table 2 reports two indicators of intermediate input imports toward Luxembourg for the period 1999-2015: (i) the total volume expressed in thousands of current US dollars, and (ii) the share of imported goods that is used as intermediate inputs. Figure 2 illustrates these statistics and compares Luxembourg with its neighbours. The imports of intermediate inputs by Luxembourg manufacturing industries have steadily expanded since 1999, to reach their peak in 2008. The financial crises of 2008 had a severe impact on imports, but the data show that a recovery is underway. We can also say that the imports of intermediate inputs constitute the largest portion of total imported goods with an average share of 41%, compared to 13.5% for the capital goods (source: OECD-STAN Bilateral Trade Database in goods). Thus, the high volume of trade in intermediate inputs in part justifies our focus on this particular type of goods.

Table 2 shows that the share of imports from China had a spectacular surge. In 2015, the volume of imported intermediate inputs from China in Luxembourg was almost 24 times larger than in 1999. Figure 2 shows that the rise of Chinese goods took place also in the neighbouring countries. It is important to note that the WTO granted its membership to China in 2001. Combining observations in Figure 1 and 2, one tend to establish a connection between the Chinese imports and the stagnation (or decline) of manufacturing labour in the developed economies.

In order to shed light on the debate over whether rising imports of intermediate goods cause lower manufacturing labour demand, we now turn our attention to the disaggregated data, which will reveal a more complicated picture that in some ways differs from the observation at the aggregate level. Figures 1 and 2 show that, the manufacturing industry as a whole, faces a declining employment and an increasing dependence on the intermediate inputs, especially the imported inputs. In Figures 3 and 4, I look at a more disaggregated level by focusing on two key manufacturing sectors in Luxembourg and compare them with their Belgian counterparts. The two sectors in question are the basic and fabricated metal industry (D24-D25, according to ISIC Revision 4 industry classification) and the chemical and pharmaceutical industry (D20-D21). On the one hand, Figure 3 shows that the imports of intermediate inputs from China increased dramatically in all industries after China's WTO entry, which is in line with the observation at the aggregate level (Figure 2). Note that the Chinese imports in the Belgian chemical and pharmaceutical industry grew with a relatively moderate pace. On the other hand, Figure 4 suggests that the degree of divergence between inputs (expanding intermediate input and declining labour) has little to do with the Chinese inputs competition. The two observations that support this claim are the following.

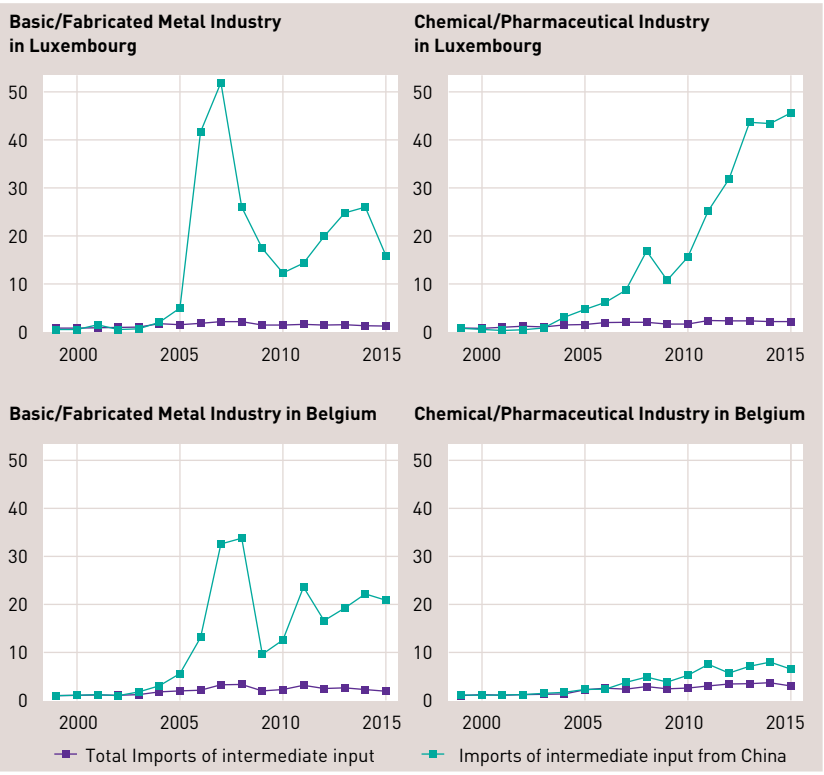
Figure 2
**Values of imports of intermediate inputs from World and China**




Source: OECD Structural Analysis (STAN) Bilateral Trade Database in goods.
Note: The series are normalized to one at the base year 1999.

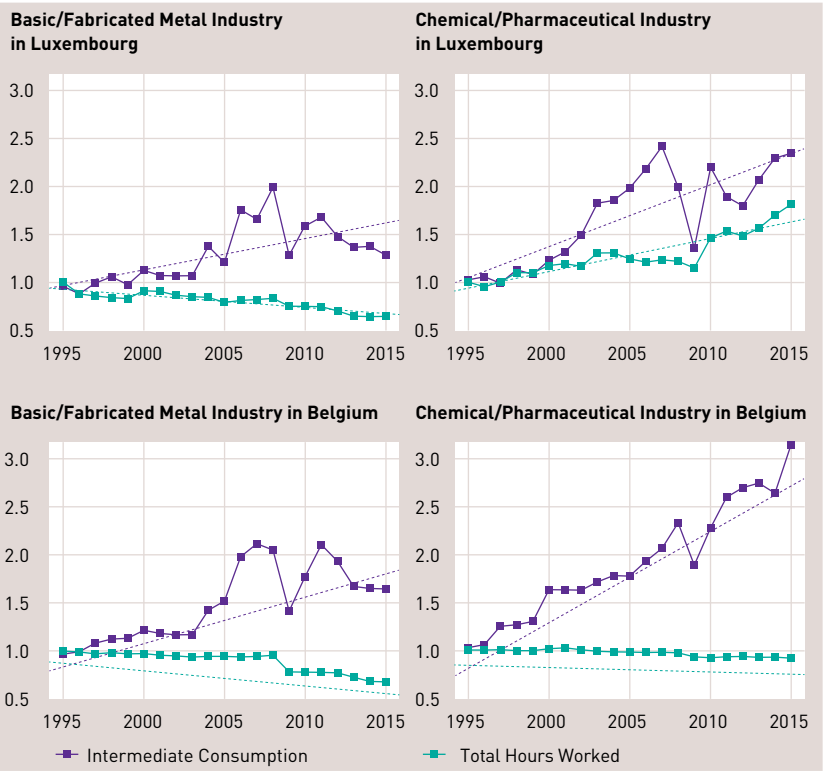
First, in Luxembourg, the chemical and pharmaceutical industry had a much more consistent growing demand for the Chinese inputs than the basic and fabricated metal industry. However, the labour input grew in the chemical and pharmaceutical industry, while it declined in the basic and fabricated metal industry. Second, I compare the chemical and pharmaceutical industry in Luxembourg with its counterpart in Belgium. Figure 4 shows the Belgian chemical and pharmaceutical industry encountered a loss in their labour employment, although the increase of Chinese imports toward this industry is much less pronounced than others (see Figure 3). In contrast, more workers have been hired in the Luxembourgish chemical and pharmaceutical industry alongside the increasing dependence on Chinese intermediate inputs. Thus, these examples suggest that there are other drivers affecting employment in the manufacturing industry and regulating the relationship between imported intermediate inputs and local labour demand. One could expect that the observed difference in the input demand dynamics between industries results from a number of underlying changes in economic, technological and societal conditions. The next section outlines a project carried out by STATEC research division that examines the dynamics of employment and imports by focusing on one potential force — technology.

Figure 3
**Values of imports of intermediate inputs in the two selected industries**




Source: OECD Structural Analysis (STAN) Bilateral Trade Database in goods.
Note: The series are normalized to one at the base year 1999.

Figure 4
**Labour v.s. Intermediate input in the two selected industries**




Source: OECD Structural Analysis (STAN) Database.
Note: The series are normalized to one at the base year 1995.

## 7.2.3. LuxEmpTrade: a micro-level investigation of the relation between trade and employment

Trade liberalization allows firms to access large varieties of cheaper foreign inputs, which leads to a fundamental change in how firms assemble their inputs into the final goods. This technological change is also seen as a threat to the domestic employment. Literature has identified two leading micro-mechanisms that link employment and importing. First, importing intermediate inputs may replace tasks that are previously done by domestic labour (the labour substitution effect of openness to international trade). Second, imported intermediate inputs may lower the marginal cost of production, so that firms can expand and hire more workers (the cost reduction effect). These two potentially opposite effects of importing intermediate inputs on domestic employment are often studied separately. For instance, Feenstra and Hanson (1995, 1997), Hummels et. al. (2014, 2016) focus on the labour substitution effect, while Grossman and Rossi-Hansberg (2008), Amiti and Konings (2007) and Kasahara and Rodrigue (2008) study the cost reduction effect. The project LuxEmpTrade proposes a single framework that captures the two opposite effects simultaneously, and investigates the labour implications of trade on both theoretical and empirical fronts.

Another important contribution of the project consisted in the analysis of largely unexplored data sources on Luxembourg's firms. The project combines several statistical datasets produced by STATEC, which include the Structural Business Statistics (SBS), the Business Register, and the International Trade in Goods Statistics (ITGS) of Luxembourg. The SBS provides information on nominal output and input expenditures of manufacturing firms for the period from 2000 to 2011. The Business Register data contains firm-level import, export and revenue records from the VAT as well as customs declarations. The ITGS includes the prices and the quantities of firms' imported intermediate inputs at the product-level.

The main outcome of the project is the development of a theoretical model that characterizes firms' production choices and technologies in open economies. The model treats the opening to trade in intermediate inputs as a shift in the production technology that favours intermediate inputs by increasing its relative productivity. This reduces the marginal cost, which allows firms to expand their production and hire more workers. At the same time, this technological change might generate a decrease in firms' labour demand, because the imported inputs can substitute the domestic labour. The model predicts that the overall effect on firms' demand for labour depends on the elasticity of substitution between labour and intermediate inputs at the industry level.[5]

[5] The elasticity of substitution measures to what degree two inputs can be substitutes for one another in the production. For instance, the higher the value of this elasticity means labour can be more easily substituted by intermediate input.

Moreover, the project features an empirical investigation that tests the theory and quantifies the relationship between trade in intermediate input and employment in Luxembourg's manufacturing industries. The empirical strategy consists of estimating the potential technological change from trade at the firm-level. This assesses to what extent importing can increase productivity of intermediate input of a given firm, which we refer to as the import gains. Then, we group the industries according to their elasticity of substitution. The results show that when the production technology allows for easy substitution between labour and intermediate inputs, it is more likely that firms' with high import gains use less labour in production. In this case, trade generates higher demand for foreign intermediate inputs in the industry that substitute labour. On the contrary, in the industries with lower levels of substitutability, higher import gains correspond to higher employment. This is the case where higher demand for foreign intermediate inputs reduces the production cost, raises outputs and boosts demand for domestic labour.

Now we can use the result to interpret the stylised facts described in the previous section. The chemical and pharmaceutical industry had a much more consistent growing demand for the Chinese inputs than the basic and fabricated metal industry (see, the upper panel of Figure 3). In contrast, the employment grew in the chemical and pharmaceutical industry, while declined in the basic and fabricated metal industry (see, the upper panel of Figure 4). According to our model, one explanation of these different dynamics is that the two industries exhibit very different production technology, which can be reflected in the elasticity of substitution. Indeed, our estimation suggests that the substitution between labour and intermediate inputs is easier in the basic and fabricated metal industry than in the chemical and pharmaceutical industry. Thus, the labour substitution effect of imports dominates the cost reduction effect in the basic and fabricated metal industry, while the opposite occurs in the chemical and pharmaceutical industry. Clearly, there are other driving forces behind these figures. Our project offers one of them, with the focus on the technological implication of trade. Future research in the area of industrial organization and labour market will allow us to generate further insights.

In conclusion, this research examined how firms' international activities affect the local labour market from a production perspective. It showed that the nature and degree of this effect are largely regulated by firms' production technology; in particular the elasticity of substitution between inputs. More generally, this research showed that monitoring firms' production technology as well as potential technical changes is crucial for the understanding of underlying drivers of the trade-employment relationship.

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