COMPETITIVENESS AND RESILIENCE REPORT 2021

A HIGHLY RESISTANT ECONOMY IN LUXEMBOURG

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Preface

The world is still facing a pandemic that is dissipating only with difficulty. Despite the scientific advances that have made it possible to develop vaccines in record time, some activities in the economy are still affected by the consequences of the virus and the measures in place to protect citizens as best as possible. It is, however, essential to move forward and focus on how best to deal with potential future risks.

In the face of the health and economic crisis linked to the COVID-19 pandemic, the Competitiveness and Resilience Report addresses the notion of resilience and highlights some of the dimensions that characterise it. In addition, the report newly assesses Luxembourg's competitive position in the European Union following an atypical year in 2020.

The structure of our economy, which is strongly based on services and features a large number of jobs that can be done remotely, has enabled us to withstand the shock in 2020 better than initially feared, especially in comparison with other European countries.

But more than ever we must not lose sight of the medium and long term. On 15 and 16 November, Luxembourg Stratégie, the new monitoring and foresight unit of the Ministry of the Economy, organised its first conference under the title of "Anticipating possible futures for Luxembourg's economy". The aim was to discuss the main megatrends as well as on the long-term strategies already in place and in preparation in different ministries in the country, with a view to laying the groundwork for building a more competitive and resilient economy for upcoming decades.

It is within this context that the concept of resilience will henceforth be framed as an integral part of the Report. It is indeed important to me to better understand the country's capacity to resist internal or external shocks, such as the ones we are experiencing with the coronavirus or the harmful effects of climate change. This is an essential, even vital, capacity for any company, organization or country.

Faced with the difficulties of recent months, and in particular the shortage of resources, the increase in the price of certain raw materials and supply adversities, companies have had to innovate and reorganise, both in terms of their operations and their production capacities.

Anticipating and developing a strategy of continuity and security in order to be as well prepared as possible for potential threats must be at the top of the country's strategic agenda. Luxembourg must aim for sustainable economic development, based particularly on the opportunities offered by the technological and environmental transitions, and continue developing concepts initiated as part of the third industrial revolution process, which are more relevant than ever.

As such, it is essential to continue discussions on the concept and measurement of resilience and to adapt them to the national context in order to best respond to the specific situation in Luxembourg. I therefore call on all ministries to work together and to take part in the work that our teams will continue to carry out over the coming months with the aim of contributing to building a sustainable future for Luxembourg collectively.

Franz Fayot
Minister of the Economy

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The use of the concept of resilience originates in materials science and psychology and has spread to ecology, sociology, geography and economics. Under the effect of recent economic and financial crises, health crises linked to COVID-19 and climatic crises that threaten more and more lives and infrastructures, it has now become a tendency to refer to resilience as a promising answer to all kinds of vulnerabilities and difficulties in risk management.

Accordingly, many definitions of resilience have emerged. The minimum definition of resilience might be "the ability to bounce back from a shock".

Resilience and sustainability are two distinct concepts, among others in the sense that the first concept refers to a specific moment linked to a disturbance, while the second strives for a long-term vocation. Resilience would refer to acuity, sustainability to a process. The debate also remains open on the nature and degree of *transformation* or *transition* (from simple reconstruction to a break and a systemic change), with both concepts targeting the same goal. There is a consensus that neither is a silver bullet. There is a need for realistic expectations of what a sustainable or resilient system can deliver, depending on the degree of risk a society is willing to accept.

This chapter then examines the European Commission's proposed Resilience Dashboards, published at the end of July 2021. Based on the definition adopted by the European Commission, these dashboards aim to assess the resilience of EU Member States, and to identify the strengths to be improved or replicated, as well as the vulnerabilities that Member States face.

The method proposed by the European Commission is then compared with other similar methods, in particular the one underlying the "Sustainable Development Goals" of the United Nations, which have been implemented at national level in the framework of the third National Plan for Sustainable Development. These supranational standards are then brought closer to the national framework for measuring the competitiveness of the economy.

It was concluded that it would be useful to adapt the measurement of resilience to the national environment, as has been done for assessments of sustainable development. Initial ideas are currently being discussed on how to better reflect the specific situation in Luxembourg when it comes to entrenching the resilience concept.

Chapter 2

In Luxembourg, as elsewhere, the debate on competitiveness is regularly revived with the publication of **international benchmarks** and **rankings of territories**. These analyses generally use composite indices for international comparisons, combining multiple pieces of information into a single numerical value. By synthesising a variety of characteristics, these indices give a compact and instantaneous picture of the theme, which however remains summary and approximate. While the final ranking is often the most publicised element, benchmarks tell a more complex story than the apparent simplicity of the ranking suggests.

This chapter first provides a descriptive summary of two benchmarks on territorial competitiveness, then summarises four benchmarks on digitalisation and innovation, while highlighting Luxembourg's performance and position. It appears that Luxembourg performs well in most of the respective rankings. Among the EU Member States, the Nordic countries generally lead the rankings, including Sweden, Denmark, Finland, the Netherlands and Ireland. Behind this leading group, the Western European countries are the next best, including Luxembourg and, among others, Germany, Belgium and France. The countries of Southern and Eastern Europe are mostly in the middle and bottom of the rankings.

In view of the importance of the financial centre to the Luxembourg economy, the chapter is rounded out by four benchmarks in this area. Luxembourg has managed to rank among the world's leading financial centres. Luxembourg is the largest investment fund centre in Europe and one of the most important exporters of financial services in the world. Luxembourg is also recognised as a leading international platform for sustainable finance. Although Luxembourg's financial centre enjoys a high level of attractiveness, it is not considered a very attractive country for direct venture capital and private equity investment.

Chapter 3

The third chapter is dedicated to the **national competitiveness scoreboard**, which is a central component in the analysis of competitiveness taking into account the specificities of the country.

Since its revision in 2016, the scoreboard is based on the three pillars of sustainable development, namely the economic, social and environmental dimensions. On the one hand, the data of the national indicator system are analysed according to the "scoreboard" approach, which analyses the position and performance of Luxembourg in relation to other EU Member States with regard to individual indicators, grouped from the perspective of their different dimensions. On the other hand, the "composite indicator" approach summarises the data from the different indicators into a single numerical value for each dimension, which is used to rank the countries in terms of competitiveness. As a result, the Observatory of Competitiveness (ODC) calculates four composite indicators: a general indicator grouping the 68 indicators of the Competitiveness Scoreboard and a specific composite indicator for each dimension, i.e. the economic, social and environmental dimensions.

In 2020, Luxembourg improved by one position in the overall ranking, moving from fourth to third place. The analysis of Luxembourg's performance in the economic dimension clearly indicates a positive evolution: Luxembourg gained six places compared to the previous year, ranking eighth. In the social dimension, Luxembourg is ranked second, maintaining its position from the previous year. In the environmental ranking, Luxembourg moved up one place from the previous year to fifth place.

Chapter 4

The **Europe 2020 strategy** was a central part of the EU's response to the economic crisis of a decade ago. The exit from the crisis was seen as the entry point to a social market economy that would be greener and smarter. Five key objectives were confirmed at EU level: boosting employment, improving conditions for innovation and R&D, addressing climate change and energy targets, improving education and promoting social inclusion. Each Member State subsequently set its own national targets. In summary, three national targets were not met, while one was met. For the remaining targets, it is currently not possible to draw any final conclusions due to a lack of data for 2020.

The years leading up to the 2008 global economic crisis were also characterised by macroeconomic developments creating imbalances amongst EU Member States. The European Commission has therefore also developed a **procedure for monitoring macroeconomic imbalances**. Accordingly, it publishes an annual scoreboard analysing each Member State in relation to alert thresholds. Since 2015, it includes fourteen headline indicators. In the most recent edition, the European Commission had noted in November 2020 that Luxembourg was not facing imbalances, even though the country exceeded various thresholds. Data has been updated in this Report (October 2021). It can be seen that Luxembourg exceeds three thresholds: growth in unit labour costs, growth in housing prices and private sector debt.

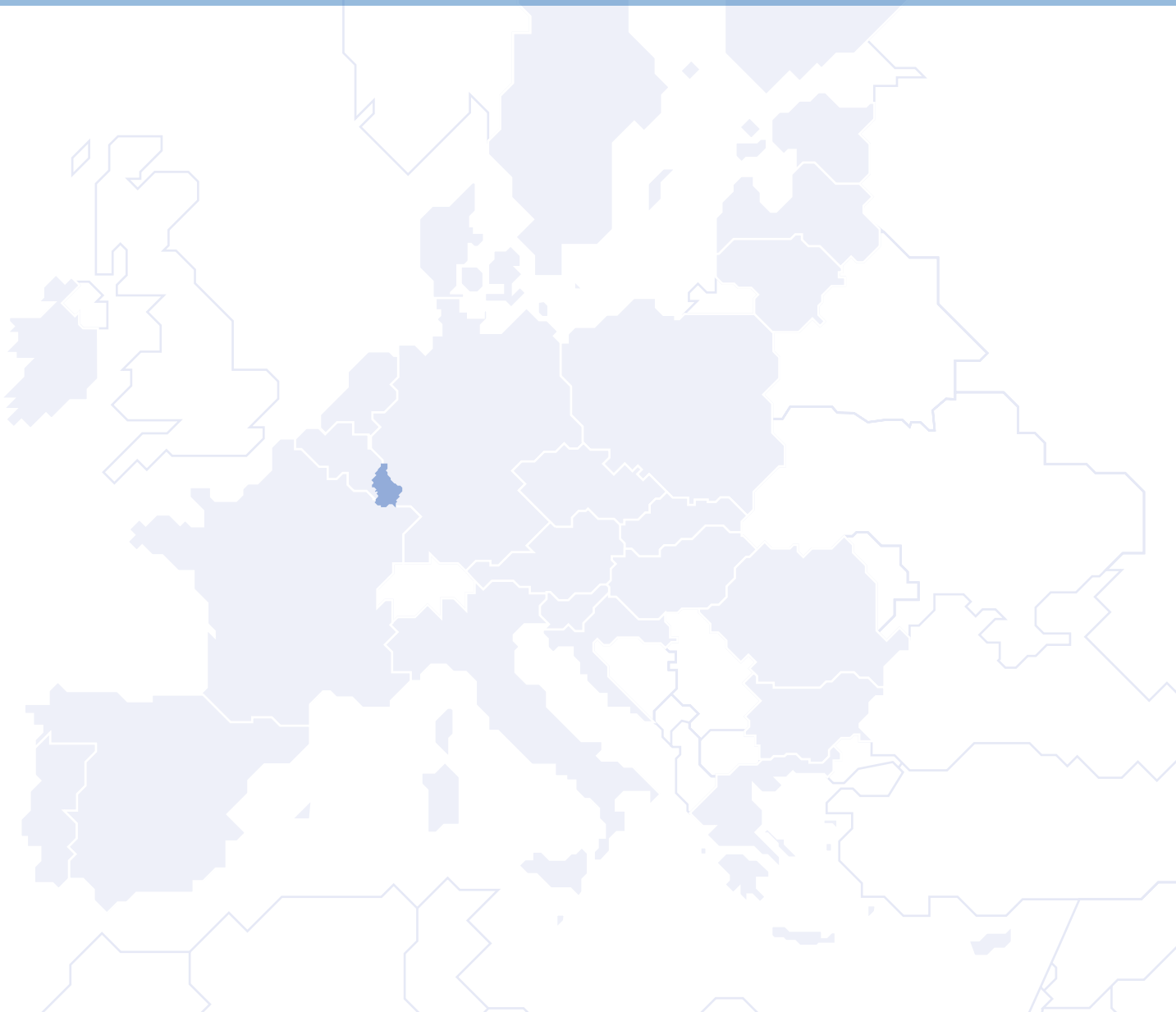
However, for Luxembourg, the private debt indicator should be interpreted with caution. While the bulk of the debt is contracted by non-financial companies, it should be noted that many companies often choose financing in Luxembourg not for their direct needs, but for other entities located abroad (e.g. intra-group loans). The European Commission considers that Luxembourg's very strong overshoot of the threshold is therefore linked to the structure of the country.

Chapter 5

This chapter presents a brief summary of the **studies conducted by STATEC Research ASBL** during the year. These studies seek to provide an overview of the social and economic reality of Luxembourg, focusing on relevant social science research and data analysis providing information for policy makers. The first section presents the results of two projects that explore new data and methods to study well-being, trust and compliance with health policies during the COVID-19 crisis. The second section summarizes the main results of a project aimed at "nowcasting" economic activity in Luxembourg. The third and final section presents the results of the latest version of *Luxembourg's Entrepreneurship Monitor*, which is part of the *Global Entrepreneurship Monitor* (GEM) research programme.

Chapter 1

Resilience, sustainability and competitiveness



1.1 Resilience, a popular concept used for many purposes

Since 2018, Luxembourg's Ministry of the Economy has been exploring the issue of "resilience" in conjunction with competitiveness. In 2018, an international conference on *Competitiveness Strategies for the Small States of the EU* organised by the Ministry's **Observatory for Competitiveness** (ODC) generated major insights on the subject matter.[1] In 2020, the notion of resilience appeared for the first time in the **Competitiveness Report** (*Bilan de la compétitivité*) prepared annually by the ODC.

The present chapter examines the concept of resilience by reviewing some of its definitions and by exploring, against the background issue of competitiveness, the links between resilience and sustainability. These are two resembling concepts, which hint at similar objectives and frameworks of evaluation: to improve or re-establish human well-being in a lasting and just manner. The chapter then discusses the way that the European Commission measures resilience and its implications for Luxembourg. The aim is to contribute to a common understanding of the concept of resilience and its measurement, to explore methodological limits, practical shortcomings and operational opportunities and to evaluate the conditions in which the notion could be adapted and applied to Luxembourg's economy. This is conducted in order to get a better sense for the economy's soundness and performance under the two complementary perspectives of competitiveness and resilience.

The term "resilience" stems from the Latin verb "*resilire*", which means "to bounce back" or "to jump back". It has gained prominence in recent years.

The notion has long existed as an academic concept. It was restricted to psychology and the material sciences before it expanded into the ecological sciences at the end of the 20th century, largely through the work of C. S. Holling.

Enduring and converging global crises, such as climate change, resource depletion and widening social inequality, have spurred interest in scientific and policy circles for systemic societal change. The ensuing calls for "transformation" and "transition" resonate a growing consensus that business-as-usual is insufficient for keeping humanity within a "safe operating space" (Hölscher 2018).

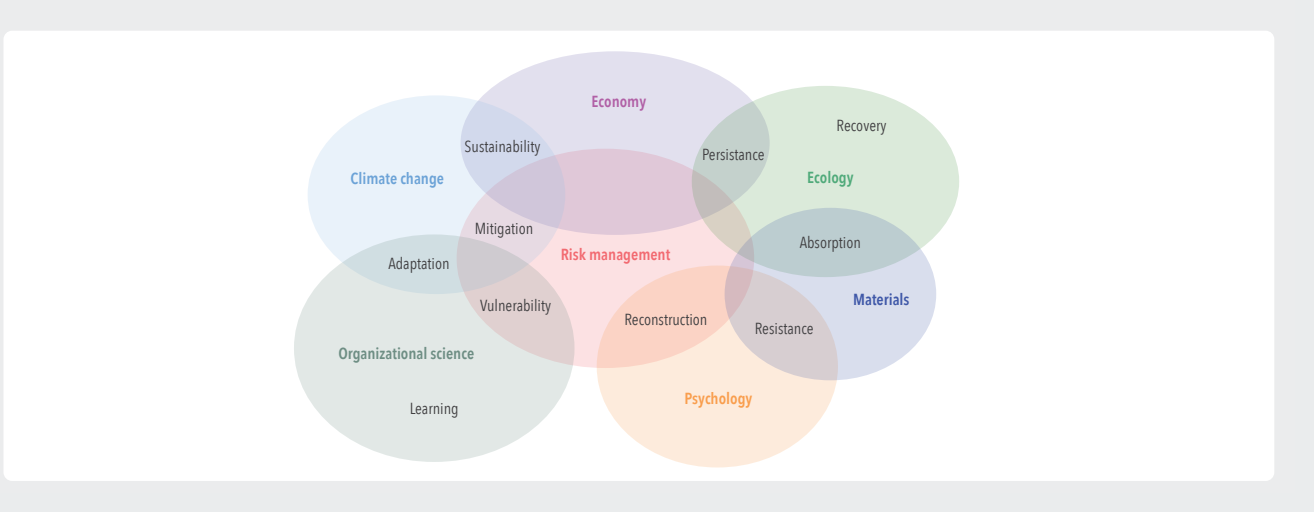
A new momentum arrived in 2020 with the global COVID-19 pandemic and the need for societies and economies to recover from its shock. Today resilience has spread outside the scientific domain to enter most sectors and managerial communities (see figure 1 below). Indeed, resilience is widely seen to be a promising response to systemic vulnerabilities and recurring difficulties in all types of risk management.

1.2 Defining resilience across time and fields: from sectors to systems

In the late 19th and in the early 20th century, resilience was commonly used in the **material sciences**. In this context, it describes the ability of a material to absorb energy (e.g. the energy that comes from a blow) and to release that energy as it springs back to its original shape (Merriam-Webster, 2021). As such, a rubber band is very resilient while a ceramic bowl is not, since it cannot regain its original shape once broken.

Figure 1

The multidisciplinary aspect of resilience



"(…) the polysemy [of the concept resilience] seems to legitimize a semantic blur that creates theoretical and operational dead ends. In view of occasional contrary injunctions, the concept ends up being 'inoperative', reduced to some sort of unattainable discursive utopia (…)."
Source of the figure and the quotation: Reghezza-Zitt et al. (2012)

1 See https://odc.gouvernement.lu/en/actualites/mes-actualites/2018/Conference-Small-States.html

The traumatic experiences of the First World War directed research interest towards psychological and emotional stability. In **psychology**, "resilience" is "the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress (…). As much as resilience involves 'bouncing back' from these difficult experiences, it can also involve profound personal growth" (American Psychological Association, 2021).

The definition designates the ability of a person to react to an unexpected event that might be deeply troubling for them. The level of resilience is however very subjective in the sense that it varies greatly from one person to another. How resilient one is depends on many factors: one's social background (family, income, friends…) or one's biological condition for instance. However, it is not a binary variable and rather a continuous variable that can vary over a lifetime (Southwick et al., 2014).

In **engineering**, resilience measures the ability of a system to withstand a shock and the time it takes to return to a steady state. It describes the ability of a system to continuously perform, even when put under pressure by different kind of shocks. In particular, this can be reached through the so-called "fail-safe design". The aim of that design is to minimize the losses and damages following an external shock and to optimize the time it takes for the system to return to its full capacity (Holling, 1996).

Ecologists have adopted a similar definition that focuses on stability near an equilibrium state, on the ability to absorb a shock while maintaining existing functionalities and on the speed at which the system recovers from the shock and returns to its steady state (Ibid.).

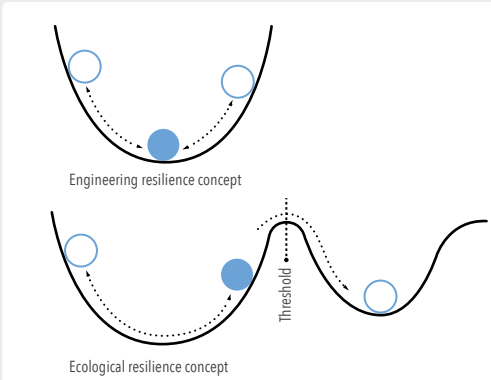
The hunter-prey relationship may be a good example to illustrate the early uses of the concept of resilience in or for ecology. It is assumed that the prey animal population oscillates around a certain equilibrium number of animals. If an external shock arises and the number of predators increases in the territory where the prey lives, then the population initially drops due to a more intense hunting and killing activity. However, nature tends to self-regulate and as predators run out of prey their population also shrinks. Eventually, the prey animal population will start increasing again: as predators starve to death, their number decreases and preys get more room to flourish.

Crawford S. Holling, a Canadian ecologist, criticized the static conception by which resilience is a system that oscillates around a static equilibrium in an ecological environment. He argued that this view insufficiently takes into account the possibility of a changing environment. The conditions under which an ecological system exists do change. He observed that severe instabilities could put a system on a radically different track by altering behavioural patterns and by remoulding relationships among the variables of that system.

Holling distinguished between **engineering resilience**, pointing at the efficiency of a system, and **ecological resilience** designating the overall existence of the system (Ibid.). Hence, the system could converge to a completely new equilibrium after a shock, once a certain tipping point is reached. Resilience is then a measure of the magnitude of effects that are tolerable before the system flips. Holling argued that "resilience determines the persistence of relationships within a system and is a measure of the ability of the system to absorb changes of state variables, driving variables, and parameters, and still persist" (Holling, 1973). Figure 2 below illustrates the different facets of resilience by contrasting engineering resilience and ecological resilience and by showing, under ecological resilience, how the equilibrium of a system can change once a certain tipping point is crossed.

Figure 2

Engineering and ecological resilience



Source: Liao (2012)

Sociologists have also been concerned with resilience in their investigations of human societies. Societies are systems of social interactions. Resilience, in a **sociological context**, then looks at the ability of a society to react to external shocks and adapt to new settings. The main difference between natural and social systems is that the latter can proactively adapt to changing circumstances by anticipating external shocks. While ecosystems cannot deliberately prepare for shocks, a society can actively take measures to mitigate the possible adverse consequences of unexpected events (Harendt & Heinemann, 2018).

Here is how the United Nations' Office for Disaster Risk Reduction (UNDRR) defines resilience in its discussion of societal **risk management**. Resilience is "the ability of a system, community or society exposed to **hazards** to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its **essential** basic structures and functions" (UNDRR, 2015, emphasis added). The focus is on the restoration and continuity of vital functions. For the UNDRR, practising resilience means anticipating, planning and acting.

In the field of **geography**, "resilience" refers to the ability of a system (social, spatial, economical, etc.) to reproduce itself: it is not a continuity without change but the ability of an element to maintain itself through a disruption or even to assimilate the disruption into its regular functioning (Reghezza-Zitt et al., 2012).

When looking at society and its parts, it is interesting to notice how the concept of resilience is applied to the **economy**.[2]

The World Bank, for instance, distinguishes between **macro- and microeconomic resilience** (Hallegatte, 2014). **Macroeconomic** resilience is the ability of an economy to minimize aggregate consumption losses. It combines instantaneous resilience, which is the capacity of an economy to limit the magnitude of immediate production losses for a given amount of asset losses, and dynamic resilience, which describes the economy's ability to reconstruct and recover from aggregate asset losses. **Microeconomic** resilience is more concerned with the distribution of the aggregate losses. One may for instance observe that, in the event of a shock, high-income households are more resilient than low-income and vulnerable ones. This comes with the assumptions that shocks can be overcome with money. However, in the case of a large-scale climate-related disaster resulting in food, electricity or water supply failures, monetary assets alone can do little to procure one with resilience.

Briguglio (2016) takes a closer look at the **economic vulnerability of small States** and concludes that the main factors, which make small open economies particularly exposed to external shocks, relate to:

- Trade openness;
- Export concentration;
- Dependence on strategic imports (food or fuel), which are very price and income inelastic;
- Proneness to disasters, which lead to economic shocks and exacerbate the effects of external shocks.

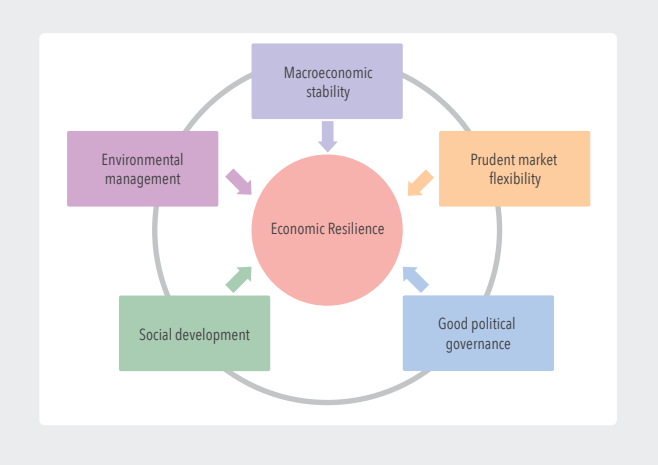
Consequently, Briguglio proposes the following policy measures to stimulate economic resilience:

- Macroeconomic stability which allows policy manoeuvre following an external shock;
- Prudent market flexibility enabling the economy to adjust following external shocks;
- Good political governance;
- Social development and cohesion, which enable the economy to function without the hindrance of civil unrest; and
- Environmental management, which generates stability through enforceable rules, economic instruments and moral suasion.

Based on this work, the author suggests an **economic resilience index**, illustrated in figure 3 below.

Figure 3

Components of an economic resilience index



Source: Briguglio (2018)

Harendt and Heinemann (2018), in their definition of economic resilience, insist on the ability of an economy to take **anticipative and precautionary measures** in order to deal with a crisis, to mitigate its immediate effects and to adapt to the new economic environment.

For Hybrid CoE, the European Centre of Excellence for countering hybrid threats,[3] it is key to regard the resilience of systems that are **vital for the livelihoods of populations** and the functioning of societal systems. In that context, they define economic resilience as "a broad systemic-level concept, which consists of the security of supply of critical services, products and raw materials, market-access security, access to finance and trade routes, overall socio-economic security and critical infrastructure[4] protection". Hybrid CoE usefully points at the more obvious vulnerabilities of open-market economic systems:

- The "just-in-time" delivery imperative, where stocks of all kinds of goods are reduced on purpose in order to avoid costs. In the event of a major disruption of market-guided logistical systems, reserves near the end user would be scarce;
- Globalisation, the lack of control over problems that arise abroad and the long delivery distances for many goods, acknowledging that few countries are self-sustaining in basic goods;
- The dependence on digitalised logistical systems, which are prone to failure;

2 The EU Joint Research Centre (JRC) has attempted to identify different country characteristics that might be associated with resilient behaviour in reaction to the economic and financial crisis that started in 2007. See also Lino Briguglio and Melchior Vella, from the University of Malta, and their presentation during the conference on *Competitiveness Strategies for the EU Small States, Observatory for Competitiveness*, Luxembourg, 19-20 April 2018, https://odc.gouvernement.lu/dam-assets/actualit%C3%A9s/events/2018/conference-small-states/session-4-4-briguglio-vella.pdf

3 https://www.hybridcoe.fi/coi-vulnerabilities-and-resilience/

4 Hybrid CoE classifies critical infrastructures as follows: energy production, nuclear power, water supply, food supply, waste management, critical health infrastructures, transmission and distribution systems, transport and logistics networks and services, data communication systems, networks and services of the digital society, payment and securities trading systems, space systems. www.hybridcoe.fi

- A general market dependence, where the public sector has no direct command or control over critical infrastructures or basic goods companies in normal situations. Nevertheless, the State can regulate or publicly fund measures of preparedness;

- Systemic and/or market disruptions that may very quickly lead to severe political consequences.

The need for a certain continuity during emergencies is also amplified in the context of climate change. **Climate resilience** "includes on the one hand the capacity to deal with a climate shock, to recover from a shock and return to pre-shock performance while limiting losses and damages from the shock. On the other hand, it also includes the ability to continue operating while witnessing gradual changes of climate conditions" (Jancovici et al., 2021).

In preparation of the 2021 G7 summit in Cornwall, which took place under the British presidency, the OECD highlighted three necessary qualities for achieving economic resilience (2021):

- Preventing the build-up of potential vulnerabilities;

- Preparing to absorb shocks when they occur; and

- Developing the ability to engineer a swift rebound from those shocks.

This raises the issue of knowing to what extent and under what circumstances economic resilience is deemed compatible with resource efficiency, sovereignty and scarcity. The Circularity Gap Reports challenge the assumption that economies are on track to achieve resources efficiency: in 2021, the world economy was only 8.6% circular. It extracted and consumed some 100 billion tonnes (Gt) of materials in a linear manner.[5] In Luxembourg, improving resource efficiency is also made difficult by the expansion of the population and its consumption aspirations (Junker, 2020). In an overall race towards producing more with less, increasing efficiency also often means minimizing redundancy and stock. This, in turn, can lead to a greater vulnerability as there will be no fall-back systems or spare capacities in the event of a shock. Overcapacities that can serve as a buffer are essential when a shock occurs. They can act as a safety net. A topical example here are spare hospital beds that have been used to accommodate patients in need during the COVID-19 pandemic.

Following Brinkmann and colleagues (2017), one may conclude that the concept of resilience can become a normative economic policy principle. That may be if resilience is not viewed too narrowly as a static concept, if it is applied to critical functions and to their continuity, if it is linked to the societal objectives within a given economy and if the interplay of different societal levels and environmental aspects is taken into account.

Humanity has now entered an era where it has a decisive impact on the Earth's climate and its ecological systems. Many scientists believe that for the first time in history, instead of the planet shaping humans, humans are knowingly shaping the planet. This is the Anthropocene – the Age of Humans – a new geologic epoch (UNDP 2020).

Scholars from the Stockholm Resilience Centre (SRC), and in particular Professor Folke, were among the first ones to work on a discipline-overarching definition of resilience that perceives humanity as an integral part of a socio-ecological system. In 2015, the SRC defined resilience as "the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. It is about the capacity to use shocks and disturbances, like a financial crisis or climate change, to spur renewal and innovative thinking" (SRC, 2015).

The definition was expanded in 2016 in a discussion of **socio-ecological resilience** that put additional emphasis on transformation: "Social-ecological resilience is the capacity to adapt or **transform** in the face of change in social-ecological systems, particularly unexpected change, in ways that continue to support human well-being (…). Adaptability refers to human actions that sustain, innovate, and improve development on current pathways, while transformability is about shifting development into new pathways and even creating novel ones" (Folke et al. 2016, emphasis added).

One may now consider further generic definitions that have recently been added.

The OECD defines "resilience" as "the ability of individuals, communities and States and their institutions to absorb and recover from shocks, whilst positively adapting and transforming their structures and means for living, in the face of long-term changes and uncertainty" (2013). Here, the definition brings added focus on the sense that one can actively take action in order to improve resilience.

In its *Strategic Foresight Report 2020*, the European Commission uses a similar definition: "Resilience refers to the ability not only to withstand and cope with challenges but also to transform in a sustainable, fair, and democratic manner" (2020a). It added in another report that every European citizen should be able to live in good health and prosperity and that no one should be left behind during the transitions lying ahead (2020b).

One of the most exhaustive definitions currently in circulation is one by CEREMA, a French think tank that specialises on risk, mobility and environmental issues:

"[Resilience is] the capacity to anticipate changes, abrupt or slow, through continuous surveillance and prospective thinking, to minimize the effects, to recover and grow thanks to learning processes, adaptation strategies and innovation, to dynamically converge to a new equilibrium while keeping the level of functionality which existed before the shock. This state of resilience should be achieved through democratic processes. It aims to preserve the well-being,

5 See https://www.circularity-gap.world/2021

social cohesion and basic supply (food safety, water supply, energy safety…)." (Villar & David, 2014)

The scope of systems or sectors covered (from parts to whole-of-society), the time horizons (from shorter to longer terms), the types of disturbances (partial or radical) or the nature and depth of the responses (from adaptation to transformation) change across definitions. There are also great variations in the understanding of what it means to return to "normality", of what degree of discontinuity a "transformation" or a "transition" implies or of what makes a crisis a crisis.

Different kinds of shocks need to be distinguished (Comfort et al., 2010; Le Blanc & Zwarterook, 2013). There are those that can occur rather regularly and that do not pose any existential threat to the entirety of the system. These may be labelled "routine emergencies". And there are shocks that represent a serious threat to the integrity of a system but that are not very likely to occur. These are low-chance-high-impact types of events. Resilience would mostly relate to sudden shocks, such as a flood, and relatively rarely address slow and gradual changes, such as global warming (Harendt & Heinemann, 2018).

As a result of borrowings and transfers between disciplines, resilience became a **holistic and interdisciplinary** concept with multiple uses, consisting of numerous elements and depending on many variables. There is no consensus among research communities or practitioners on what resilience means. It varies considerably depending on the authors and the objects to which it is applied. To some, resilience is a property, to others it is a process or an outcome. This raises the question of whether the overall resilience of a system (a country, a sector, a community…), on a large scale and over a long period can be achieved. Or is it that resilience can only be achieved for parts of a system (be it infrastructures, food system or health facilities), on a limited scale and for a short while? Can subsystems or peripheral parts of systems adapt and transform while the core remains invariant?

Despite the fact that there is a wide variety of approaches, some common features may be distinguished:[6] first, there is the **absorptive capacity** of a system. This means that a system or a society can react to a shock by resisting to it up to a certain degree. Second, the **adaptive capacity** measures the ability of a society or a system to implement small, incremental changes to itself in order to deal with the shock. It appears that comparatively healthier and stronger societies or systems have higher absorptive and adaptive capacities. Third, there is the **transformative capacity**. Some events can be particularly significant and have profound consequences so that small, incremental changes will likely be insufficient. This means that the society or the system will require a reset and necessitate a transformation into a new state of being (Manca et al., 2017). Reghezza-Zitt and colleagues observe that "in a very schematic way, after an impact, three states can be observed: a definitive disappearance, the survival of the system as it was, and a radical structural change of the system" (2012). Steffen and colleagues (2015) have set minds in a particular direction of transformation by discussing the concept of "planetary boundaries". It defines and quantifies the global biophysical limits within which humanity can strive, safely and sustainably, while maintaining a stable planet Earth. If one also considers here a set of social boundaries (Raworth, 2012), then one gets the picture of a desirable societal transformation that would allow humanity to prosper within a "safe and just operating space".

A rigorous definition and a consistent use of the terminology are indispensable for the concept to be applied in such a way that is could benefit economic decision-making.

1.3 Resilience and sustainability: different labels forthe same concept?

In talks about the future of society and the economy, "resilience" and "sustainability" are often confused or used as synonyms. However, the terms point at distinct, although related concepts. Contrary to resilience, sustainability is not directly related to the idea of a shock that occurs at one moment in time.

Brundtland's 1987 definition of sustainable development,[7] sought to reconcile economic development with the protection of social and environmental aspects. Yet, it seems to have been both too vague for a common understanding to emerge and too general for a practical and local application to be effectively carried. The ultimate aim of sustainability is to ensure that every human can live in prosperity and safety without depleting the natural resources (UN Secretary General, 1987). The recent 17 UN Sustainable Development Goals (SDGs) propose 231 indicators to measure the achievement of "a better and more sustainable future for all" by 2030 (United Nations, 2017).

The SDG framework does not distinguish among economic sectors and activities and it does not include quantitative thresholds. In the absence of these elements, the 231 indicators may prove inadequate for guiding decision-makers and investors in the direction of what a "sustainable" activity is and what it is not. 35 years after having adopted the Brundtland report's definition, the EU is currently defining its own all-encompassing taxonomy in order to apply a common set of definitions and quantifiable indicators and to clearly establish what makes activities and investments sustainable. Even if resilience and sustainability point at different concepts that should not be confused, they are related. Three different categories of frameworks on how the concepts relate can be identified in the literature.[8] In the first case, the ultimate goal of a system is to be sustainable. Resilience is then only a means for reaching sustainability. Intuitively, a system cannot be sustainable if it collapses when confronted with a shock. Hence, being resilient is a necessary condition for being sustainable. The European Commission regards resilience to be a path towards sustainability and thus falls into that category of frameworks (European Commission, 2021a). Interestingly, the Commission's work goes beyond the link

6 Additional work from the Joint Research Centre (JRC) on the concept of resilience and its definition has been made (Manca et al., 2017)
7 Sustainable development was defined in the World Commission on Environment and Development's 1987 Brundtland report "Our Common Future" as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".
8 For a more in-depth analysis on that issue, see Marchese et al. (2018).

between resilience and shocks by defining resilience also in relation to **transitions and long-term structural changes**.[9]

The second kind of framework takes the opposite view, considering resilience as the ultimate end of a system with sustainability being a part of resilience. Under that view, by making a system more sustainable, one makes it less prone to shocks and thereby increases its resilience.

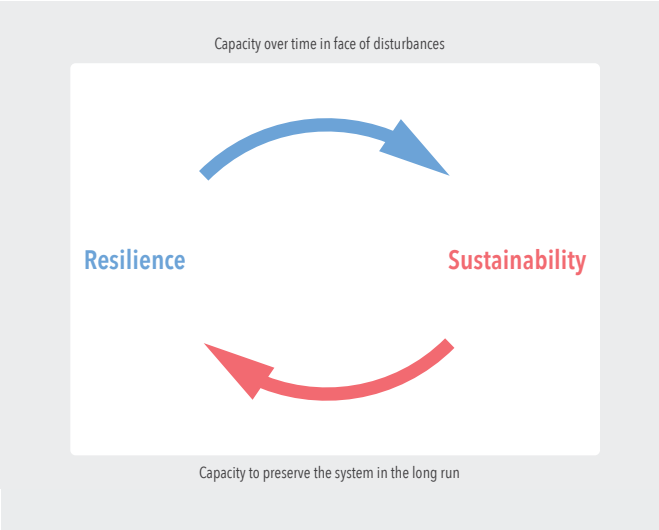
Finally, for the third kind of framework, resilience and sustainability are two different concepts pointing in two different directions. These may be related but not by a relation of hierarchy. Hence, a policy intervention can improve the resilience and the sustainability of a system or it can improve only one of the two aspects. It could also, for instance, improve resilience and neglect sustainability at the same time. As such, under this perception, both aspects need to be taken into consideration and to be balanced out through a case-by-case analysis.

By comparing definitions, it becomes apparent that the concept of resilience is strongly related to the reaction of a system faced with disturbances, while sustainability is rather referring to the ability of a system to carry on its operation in the long run. That includes ensuring societal well-being without depleting resources for the future generations. Figure 4 graphically illustrates the difference.

One may note at this juncture that resilience could suffer from the same limitations that have afflicted sustainability. That includes the tension between ambitious overall goals and the need for a specific and more practical definition to ensure its local application. Failure to address that might result in a heterogeneous set of applications (e.g. that of the UN SDGs, the EU SDGs or National SDGs). It might also maintain uncertainty about desired transformational pathways. Is it "back to normality" or "onwards to a new way of being"? Is it economic "expansion" or "slowdown"? On that note, Bartolini and colleague argue that promoting social capital would mean expanding well-being and enabling the economy to shift towards a more sustainable development path characterised by "slower economic growth" (2021). Another issue might relate to the formation of unrealistic expectations about the concept in the face of biophysical, temporal and territorial boundaries. Recent research (Fanning et al., 2021; Fang, 2021) indicates that historical and future trends in sustainability performance show that the world's countries have substantially overshot their fair share of most planetary boundaries, without proportional social achievements. Disappointment may come from monitoring data issues and the partial implementation of the concept that would prevent a systemic, long-term transformation and do little in the way of bringing about a "real, true" paradigm shift.

Figure 4

Difference between resilience and sustainability



Source: Tendall et al. (2015)

Reghezza-Zitt and colleagues (2012) suggest that no system can simultaneously be redundant, efficient, diversified, participative, flexible, robust, adaptable, local, global, etc. They go on to say that tensions, conflicts, contradictions and lack of common understanding introduce subjectivity and norm. From a methodological perspective and to avoid all sorts of abuses, it is therefore crucial to clearly set out from the start, what it is that is deemed to become resilient, who declares that resilience is attained, according to what criteria, on what scales and at which levels. This would go hand in hand with the promotion of "hazard acceptance, not as fatalism or as the acceptance of the disaster, but as the price that a society is willing to pay when this society takes a risk" (Reghezza-Zitt et al., 2012).

"It is tempting to describe apparent success in terms of resilience and apparent failure in terms of a shopping list of explanatory variables. Resilience then becomes the synonym for survival and the prescribed antidote for administrative shortcomings. This is too simple (…)
Far from a fix-it-and-forget-it approach, resilience is the outcome of a long-term process, enduring resilience is a balancing act between risk and resources, between vulnerabilities and escalating or unmanageable risk" (Comfort et al. 2010a: 272-273).

9 For more information see https://ec.europa.eu/info/publications/resilience-dashboards-report-and-annex_en and https://publications.jrc.ec.europa.eu/repository/handle/JRC120489

1.4 Objectifying resilience: the Resilience Dashboards of the European Commission

There are ways to measure resilience and several initiatives have been put in place to do that.[10] For the purpose and scope of this year's Competitiveness and Resilience Report, the following section concentrates on the resilience dashboards prepared by the European Commission, accessed in the draft version of July 2021.[11] The dashboards are the result of an extensive consultation process with representatives of the Commission services, the Member States, the civil society and other relevant stakeholders.[12] The EU resilience dashboards monitor performance on a wide range of indicators that are used to apprehend resilience. Their main purpose is "not to rank countries but to highlight strengths to be nurtured and areas for improvement, in view of further country-specific analysis and policy action" (European Commission 2021a). To avoid duplications and highlight synergies, the Commission also sought to compare its approach with other existing multidimensional (e.g. with the SDG indicators or the Transition Performance Index) and thematic indicator frameworks (e.g. with the Circular Economy Scoreboard, the Digital Economy and Society Index, the Social Scoreboard, the Environmental Action Programme, etc.) (Ibid.). The EU resilience dashboards are aligned with the **EU definition of resilience**. According to that definition, resilience is "the ability not only to withstand and cope with challenges but also to transform in a sustainable, fair and democratic manner" (European Commission, 2020b).

The global COVID-19 pandemic laid bare how vulnerable and fragile fundamental freedoms and vital systems, such as industrial production or basic healthcare services, are. This situation, combined with other looming systemic perturbations (e.g. the climate and biodiversity crises), has generated a public demand to stress test these systems for their resilience in the face of multiple crises. As a response, the European Commission has decided to integrate **strategic foresight** into the EU policy-making.

In 2020, a first *Strategic Foresight Report* was published and promoted a more forward-looking perspective into European policy-making centred on the concept of resilience (European Commission, 2020). In its report, the Commission describes foresight as the "discipline of exploring, anticipating and shaping the future". Strategic foresight aims to explore plausible future scenarios and problems. Identifying major trends might then help to pre-emptively develop some understanding of and responses to arising problems.

1.4.1 A preliminary description of the method behind the EU resilience dashboards and its four dimensions

Figure 5 on the next page illustrates the four thematic group areas that were identified in order to evaluate and monitor the resilience of Member States: the "social and economic", the "geopolitical", the "green" and the "digital" dimensions.

The social and economic dimension designates the capacity of an economy to deal with a shock and to manage the required adjustments in a fair and inclusive way. The geopolitical dimension refers to Europe's strengthening of its "strategic autonomy and global leadership". The "green" part of resilience is "about reaching climate neutrality by 2050, while mitigating and adapting to climate change, reducing pollution and restoring the capacity of ecological systems to sustain our ability to live well within planetary boundaries." Finally, "digital resilience is about ensuring that the fundamental rights and values such as dignity, freedom, equality, security and democracy are preserved and enhanced in this digital age".

For each dimension, a dashboard of around 30 indicators is proposed to quantify and monitor the different aspects of resilience, which sums up to a total of **124 indicators** for the four dimensions. The computation of the indicators draws on publicly accessible data sources (from Eurostat, the OECD or the World Bank) in the most recent available years (usually 2018-2020). The large number of indicators is a sign of the underlying aspiration to represent the holistic and complex nature of resilience. It allows to cover the many different facets that could potentially influence economic and societal resilience.

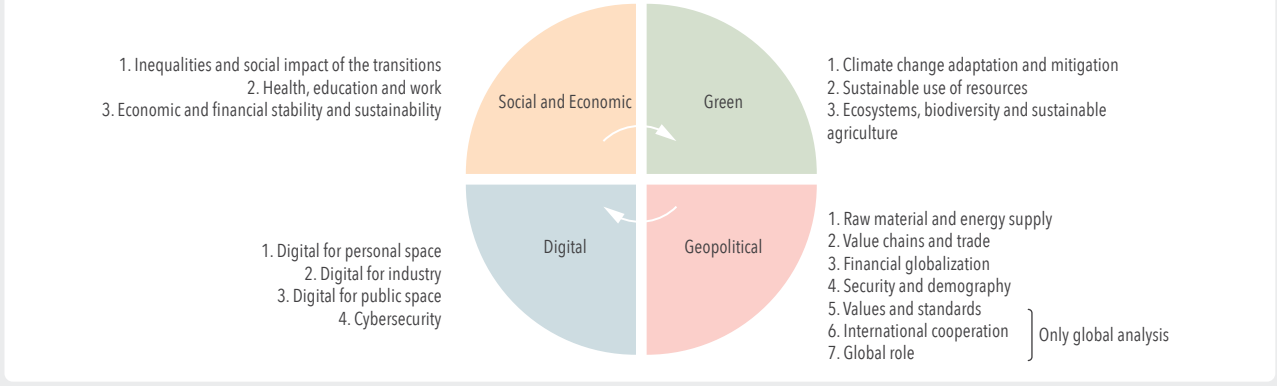
10 The OECD for example has developed a COVID-19 recovery dashboard, in which resilience, along with three other dimensions ("strong", "inclusive", "green"), is monitored through five indicators that relate to vaccination, capital formation, internet access, trust in government and debt.

11 The resilience dashboards presented here are based on the draft versions, dated 26 July 2021, of the Commission's dashboards that were available at the time of editing the current Competitiveness and Resilience Report 2021. Hence, the resilience dashboards as they are presented here might be subject to further changes. A final version has been published on the 29th November 2021. See European Commission (2021b).

12 This participatory approach makes sure that expert knowledge is used. It is complemented with the use of objective data. The goal is to get an impartial view on resilience and to reduce subjectivity. However, some degrees of subjectivity will always remain (e.g. in the choice of variables).

Figure 5

The four dimensions of the resilience dashboards



Source: European Commission (2021b)

Member States are compared on the basis of their **relative performance** against each indicator. The classification does not make any statement on the absolute performance of a country but on its performance relative to the 26 other Member States across time.[13] Member States are associated with one colour out of five that reflects their relative performance. Arrows within a box indicate the trend that the country has been following over the preceding five years. If the arrow points upward, then there has been sizeable improvement over the period. A downward pointing arrow then suggests that there has been significant worsening of the situation. In addition to the national evaluations, the level of resilience of the EU27 is also assessed.

Figure 6 gives a snapshot of the dashboard for social and economic issues with all its indices and arrows. It shows how the dashboard assesses the relative performance of individual Member States and of the EU27 (by calculating an average).

To further stress the holistic ambition, the EU resilience dashboards also classify indicators in two categories: those relating to a "**capacity**" and those relating to a "**vulnerability**".

A capacity is "a country's structural feature that points to elements of its system (economic, social, and environmental) underpinning its ability to cope with shocks/structural changes and achieve transitions successfully" (European Commission, 2021b). Such a capacity could for example be human capital, which includes a well-educated workforce, but it could also be infrastructural capacities fostering for instance high waste recycling.

A vulnerability, on the other hand, is "a country's structural feature that points to elements of its systems (economic, social, and environmental) that can be disproportionally hit in case of shocks/structural changes, or can hinder the transitions (e.g., an obstacle to the transition)" (Ibid.). Such vulnerabilities include the number of employees who risk losing their jobs due to the shift to less carbon intensive production processes or due to raw material shortages. That is a vulnerability in the sense that a shock (here a sudden breakdown of conventional processes) might make many people redundant, if the shift was not anticipated and prepared through, say, reskilling.

13 The relevant timeframe spans from 2007 to 2017.

Social and economic dashboard of EU Member States

			BE	BG	CZ	DK	DE	EE	IE	EL	ES	FR	HR	IT	CY	LV	LT	**LU**	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	EU27
At risk of poverty or social exclusion rate (AROPE)	V	Inequalities and social impact of the transitions	•	↗	•	•	•	•	↗	↗	•	•	↗	↗	↗	↗	↗	•	↗	↗	•	•	↗	↗	↗	↗	•	•	•	↗
Income quintile share ratio S80/S20	V		•	↘	•	•	•	↗	↗	↗	↗	•	↗	•	↗	•	•	↘	•	•	•	•	↗	↗	↗	•	•	•	•	•
Employment in energy intensive sectors	V		↗	•	•	•	•	•	•	•	•	•	•	•	•		•	↗	↘		•	•	•	•	•	↘	↘	•	•	•
Employment in manufacturing with high automation risk	V		↗	↘	•	•	•	↘	↗	↘	•	↗	•	•	↘	•	•	↗	•	↗	•	•	•	•	↘	↗	↘	•	↗	•
Regional dispersion in household income	V		•	↘	↘	•	•		↘	•	•	•	•	↘			↘		•		•	•	•	•	↘	•	↗	•	•	
Impact of social transfers (other than pensions) on poverty reduction	C		•	•	•	•	•	↗	•	↗	↘	•	↘	•	•	•	•	↘	•	↘	↘	•	↗	•	•	•	•	•	•	•
Household net saving rate	C		•		•	↗	↗	↗	↗	•	•	•	↗	↗	↗	↗	↗	•	•		•	•	•	↗		↗	↗	↗	↗	↗
Government social expenditures on education, health, social protection and long term care, as % of GDP	C		↘	•	•	↘	•	↗	↘	•	•	•	•	•	•	↗	•	•	↘	•	↘	•	•	↘	↗	↘	•	↘	•	•
Active citizenship	C																													
Antimicrobial resistance	V	Health, education and work	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Self-reported unmet need for medical care	V		•	↗	•	•	•	•	↗	↗	•	↗	↗	↗	↗	↗	•	•	↗	↗	•	•	↗	↗	↗	•	•	•	↗	↗
Years of life lost due to PM2.5	V		•	•	•	•	•	•	•	•	•	•	↘	•	•	•	•	•	↘	•	•	•	•	•	↘	•	•	•	•	•
*Variation in performance explained by students' socio-economic status	V		•	•	↘	↗	↘	↘	•	↗	↗	↘	↗	↗	•	↗	•	↘	↗	•	↘	•	↘	•	↘	•	•	↘	↘	•
Macroeconomic skills mismatch rate	V		•	↗	↗	•	•	•	↗	•	↗	•	•	•	↗	↗	↗	•	↗	↗	↗	•	↗	•	↗	•	↗	↗	•	↗
Gender employment gap	V		•	↘	↗	•	↗	•	•	•	•	•	•	•	↘	•	•	↗	↘	↗	↗	•	•	•	↘	↗	↗	•	•	•
Young people neither in employment nor in education and training	V		↗	↗	↗	↘	•	↗	↗	↗	↗	•	↗	↗	↗	↗	•	•	↗	↗	•	•	↗	↗	↗	↗	↗	•	•	↗
Long-term unemployment rate	V		↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	↗	•	↗	↗	↗	•	↗	↗	↗	↗	↗	•	•	↗
Standardised preventable and treatable mortality (low rate)	C		•	•	•	•	•	↗	•	•	•	•	•	•	•	↗	↗	•	•	•	•	•	•	•	•	•	↗	•	•	•
Healthy life years in absolute value at birth	C		↘	↗	•	•	↗	•	↗	•	↗	•	↘	↗	↘	•	•	•	↗	•	•	↘	•	•	•	↗	•	•	↗	↗
Children aged less than 3 years in formal childcare	C		↗	•	•	•	•	↗	↗	↗	↗	↗	•	•	↗	•	↗	↗	•	↗	↗	•	•	↗	•	↗	•	↗	•	↗
Average scores in the PISA test, reading, mathematics and science	C		↘	↘	•	•	↘	•	↘	↘	•	•	↘	↘	•	•	•	↘	•	•	↘	↘	•	•	↘	•	•	↘	↗	•
Adult participation in learning during the last 12 months	C																													
Employment rate	C		↗	↗	↗	↗	↗	↗	↗	↗	↗	•	↗	↗	↗	↗	↗	•	↗	↗	↗	•	↗	↗	↗	↗	↗	↗	•	↗
Active labour market policies per person wanting to work	C		•	•	↗	↗	•	↗	•	•	•	•	↗	•	•	•	•	↗	↗	•	•	•	•	•	•	•	•	•	•	•
Government debt	V	Economic and financial stability and sustainability	•	•	•	•	•	•	↗	↘	↘	↘	•	↘	↘	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
*Projected old-age dependency ratio	V																													
Degree of specialization of the economy	V		•	•	•	•	•	•	↘	↗	↗	•	•	↘	↗	•	•	•	•	•	•	•	•	•	•	•	↘	•	•	↘
Non-financial corporations funding structure	V		↘	•	•	↗	•	•	↗	↗	↗	↗	↗	↗	•	↗	↗	↘	↗	•	↗	↗	•	↗	•	↗	•	↗	↗	↗
Automatic stabilisation of the tax-benefit system	C		•	•	•	•	•	•	•	↗	•	•	•	•	•	•	↗	•	•	•	•	•	•	•	↗	•	•	•	•	•
Banking sector total capital ratio	C		↗	↗	↗	↗	•	↗	↗	↗	↗	↗	↗	↗	↗	↗	•	•	•	↘	↗	↗	↗	↗	↗	↗	↗	↗	↗
*Insurance sector solvency capital ratio	C																													
*Share of innovative enterprises	C																													
Intangible investment	C			↗	•	•	•	•	↗	•	•	↗		•		•	↗	•	•	•	↘	↗	•	•	•	•	•	↘	•	•
Government investment to GDP ratio	C		•	↘	•	•	↗	↘	•	↘	•	•	↗	•	•	•	↘	•	↗	↘	•	•	•	•	↘	↘	↘	↗	↗	•

Resilience

- Highest capacities/ Lowest vulnerabilities
- Medium-high capacities/ Medium-low vulnerabilities
- Medium capacities/ vulnerabilities
- Medium-low capacities/ Medium-high vulnerabilities
- Lowest capacities/ Highest vulnerabilities
- Not available

Change with respect to 2015

- • Not sizable
- → Sizable improvement (up) or worsening (down)

V Vulnerabilities

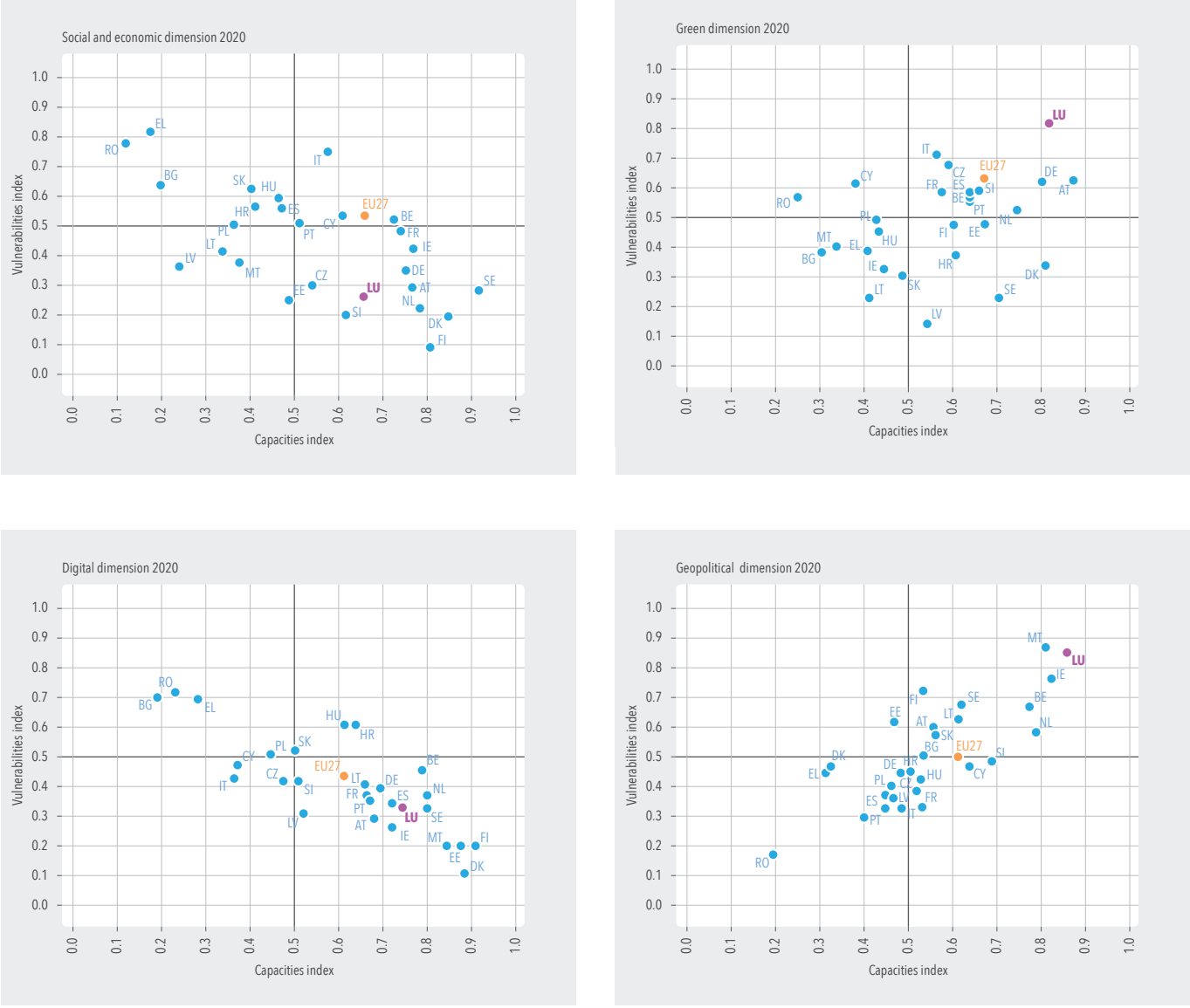
C Capacities

Source: European Commission (2021b)

The dashboard is accompanied by two **synthetic indices**. One is for resilience capacities and the other for resilience vulnerabilities. The indices are aggregates of the relative positions of Member States across all indicators within one of the four dimensions. They enable to compare the countries among themselves on the basis of their relative resilience. The higher the capacity (or vulnerability) index, the higher the relative capacity (or vulnerability). The synthetic indices of capacities and vulnerabilities of Member States and the composite index of the EU27 are illustrated for each of the four dimensions by figure 7 on the previous page. The figure reflects the most up-to-date pieces of information at the point of publication.

Figure 7

Vulnerabilities and Capacities: Synthetic indices of EU Member States



Source: European Commission (2021b)

For the EU as a whole and by comparison to third countries, the dashboards show a mitigated picture in matters of resilience capacities and vulnerabilities: for the socio-economic and digital dashboards, the EU27 median resilience suggests a medium-high capacity and a medium vulnerability. For the green dashboard, the EU27 median resilience indicates a medium-high capacity and a medium-low vulnerability. The geopolitical dimension seems related to the lowest of all resilience capacities and to a medium vulnerability throughout the EU. Although the dashboards are not intended to rank countries, the results can be taken to detect best practices and to highlight potential areas of improvement. Under this angle, the Nordic countries (SE, DK and FI) stand out as a group of countries with low vulnerabilities and high capacities across three dimensions of socio-economic, green and digital issues. Luxembourg distinguishes itself as the country with one of the highest capacities and the highest vulnerability among its peers for the green dimension.

The dashboards seek to strike a balance between the numbers of areas covered and the number of indicators used to describe them, given the availability of quality and historical data for all Member States. This partly explains why, for instance, there are no indicators to measure food security apart from indirect agriculture indicators (i.e. farm income variability, soil carbon content, organic farming). The same can be said for behavioural aspects (and personal resilience in the event of disaster) or governance aspects relating to resilience (i.e. political system and institutions, leadership, gender equality, traditional knowledge,[14] collective empowerment…).

To assess the methodological limitations of the approach, the Commission dedicated a detailed section on the gap analysis, where it discusses missing indicators, dimension by dimension. These concern aspects such as equal opportunities, efficiency of governance, food safety, green renovation, frugality, sustainable farming and forest management, responsible consumption, e-health, open data, digital democracy and dependency, cybersecurity, manufacturing capacity or demographic change (European Commission, 2021a).

Depending on the underlying assumptions, indicators may seem equivocal or not. And some are clearly related to political choices. Consider a few examples: hydrogen passenger fleets are mainly seen to have a positive influence on resilience. That point tends to neglect the on-going research debate on the overall opportunity costs of hydrogen supply for transport. While trains and buses seem to be supportive of resilience, cycling or walking are missing. The digital transition is presented as being essential for resilience. Little heed is paid to the benefits that low-tech, low-energy, manual, technical, repair competences could have for many to get back on their feet after a shock. Mathevet and colleagues (2014) point out that technological developments that depend on electricity and on communication networks leave few adaptation options when a blackout occurs or a disaster strikes.

For the Commission, it is fundamental to read the indicators together in order to form a bigger picture. In the case of hydrogen and active mobility, this would mean combining the two indicators with the "use of public transport" indicator. To complement the picture, Member States are also invited to contextualise dashboard results with information they have locally on aspects covered in the EU gap analysis. The purpose of the resilience dashboards is to trigger an internal discussion on the strengths and weaknesses a country has in this or that area. The dashboards provide a general indication, which could be made more specific by the countries' experts.

1.4.2 Luxembourg's performance by the standard of the EU resilience dashboards

Before proceeding to assess the performance of Luxembourg, it is important to remember that Member States are compared with each other. A "good" or "poor" performance in the dashboards does not mean that a country is doing particularly well or badly in absolute terms.[15]

At this point, one can notice that for the social and economic aspects, Luxembourg compares favourably with most of the other EU Members States.[16] Luxembourg is among the top performers in nine out of the 34 indicators in total and among the better performers in 10 cases. It performs particularly well in the "Projected old age dependency ratio", which means that the ratio between the number of people aged 65 and over (people of that age are generally retired and do not work anymore) and the number of persons aged between 15 and 64, is relatively low. Moreover, a relatively large part of all the very young children in the country (60%) is in formal childcare. On the flipside, Luxembourg is one of the worst performing Member States in three cases. It is one of the lower performing countries in two cases. One issue is that the performance of students depends relatively strongly on their socio-economic background. Luxembourg also scores low on average PISA results. Another issue is the high degree of specialisation and lack of economic diversification of Luxembourg's economy in comparison to the other Member States. These characteristics are considered to be unfavourable signs of resilience. On the socio-economic side of things, Luxembourg shows medium-high capacities and medium-low vulnerabilities in the face of distresses (figure 7 on the previous page).

For the "green" part, Luxembourg's performance is more balanced. Out of 30 indicators in total, it is among the best performing Member States for nine, and among the least performing countries for five indicators. Resource and energy productivity is comparatively high and Luxembourg is one of the countries in the EU where the use of electric vehicles is the most widespread. Luxembourg also stands out for its high share of insured losses from climate extremes. On the other side, Luxembourg has a particularly high rate of greenhouse gas emissions per capita, especially in the road transport area. Luxembourg is among the most built-up countries in Europe, one of the reason for its comparably high loss of biodiversity rates. Renewable energies are marginal in the country's energy mix. In 2019, the share of renewable energy in the final energy consumption amounted only to about 7%, which compares to an EU-wide share of almost 20%.

14 Traditional knowledge is "knowledge, innovations and practices of indigenous and local communities around the world. Developed from experience gained over the centuries and adapted to the local culture and environment, traditional knowledge is transmitted orally from generation to generation." (CBD, 2021).
15 The rationale behind each indicator (i.e. responses to the questions of why is it relevant, positive or negative for resilience?) can be found in the European Commission report (2021a).
16 The data used in the following is the same data that was used in the computation of the resilience dashboards. The exact data sources are listed in European Commission (2021a).

Luxembourg performs quite well with respect to the digital indicators. It is among the best performers in six out of the 30 indicators and stands nine times amongst the better performing Member States. The difference in broadband access between rural and urban areas is one of the lowest out of the EU27. Luxembourg is also one of the countries where telework is the most widespread. In 2020, only 52,4% of the workforce reported to have never worked from home, while almost 80% of the employees of the EU27 report that they have never worked from home. The lack of possibilities to work from home is considered a vulnerability in the event of a lockdown due to a pandemic.

The country stands among the lowest performers for only two indicators and among the lesser performing countries on four in that category. Research and development intensity in the Information and Communication Technologies (ICT) is comparatively low in the country and cybersecurity seems to be a problematic issue for individuals as well as for companies. According to several Eurobarometer surveys, a comparatively high share of citizens, and to a lesser extent, of companies, has experienced cybersecurity incidents at least once. These developments might discourage individuals and firms to go digital. Yet, the Global Cybersecurity Index seems to suggest that, at the same time, Luxembourg is well equipped to deal with these threats.

Finally, Luxembourg's performance on the geopolitical front is mixed. While it is among the best performers on eight indicators, it is simultaneously one of the worst performing Member States in nine out of the 30 indicators. The country has one of the highest metal footprints per capita in the EU and a large part of its energy is imported. Suppliers' concentration is quite high for base metals such as iron or zinc. Luxembourg's low fertility rate is negative for resilience. The fact that the country also has one of the highest net migration rates does not seem to be factored in. However, the country is also very open to international trade with many ties both inside and outside the EU. Furthermore, Luxembourg has a growing international workforce and one of the highest net-migration rates. Additionally, the employment gap between EU and the non-EU nationals is one of the lowest in the EU.

1.4.3 The EU resilience dashboards: a variation on a theme?

The development of another architecture and governance for measuring resilience needs to be carefully weighted and designed in order to convincingly establish its potential for generating new insights and added value.

When exploring overlaps and novelties in the different approaches, it is useful to compare the EU resilience dashboards (124 indicators) first with the UN SDG monitoring framework defined in the UN Agenda 2030. The following comparison is not based on the full set of the 231 UN indicators but on a subset of 102 EU-specific UN SDG indicators. In fact, UN SDGs have been tailored to the EU with an EU SDG indicator set of 102 indicators (Eurostat, 2021). Their monitoring has been entrusted with Eurostat.

In what comes next, the indicators from the EU Resilience Dashboards are also compared to the set of national sustainability indicators derived from the third National Sustainable Development Plan (MECDD, 2019). This "*Plan national pour un développement durable*" (PNDD) for the period 2018-2030 translates the UN SDGs into the national context. It defines 10 priority fields of action for Luxembourg's government. Progress towards sustainability there is monitored by means of a set of 110 indicators.[17]

Finally, the EU resilience indicators are also put in contrast with the annual competitiveness scoreboard (*Tableau de bord de la compétitivité* or *TBCO*) of Luxembourg's Ministry of the Economy. The scoreboard consists of 68 indicators that are exposed in detail elsewhere in the present publication. The aim is to understand the interconnections between the EU resilience dashboards and the national competitiveness scoreboard. This means understanding what they have in common and what distinguishes them. That is conducted also with a view to identify potential areas of adjustments.

The set of indicators in the EU Resilience Dashboards is compared pairwise with each of the three other indicator sets to reveal possible matches. Two indicators are considered to be matching if (a) they are identical, (b) they are very similar with slightly different specifications or (c) they relate to the same concepts or are similar at a conceptual level.[18] This allows one to see what value the resilience dashboards add to the existing monitoring measures and if there are areas that are relatively neglected in some of the existing frameworks.

The results of these cross-comparisons are presented in what follows.

For the "social and economic" dimension, the EU resilience and the **EU SDG frameworks** overlap on 94% of their indicators. The overlap is even greater in the "green" dimension, where every indicator contained in the resilience dashboard is simultaneously represented in the EU SDGs framework.

17 See STATEC (2018). The full set of PNDD indicators, adopted by the "*Commission interministérielle du développement durable*", is available on STATEC's website under https://statistiques.public.lu/en/index.html

18 The inspiration for this kind of comparison comes from the European Commission itself. A comparison between the indicators from the resilience dashboards and the EU SDGs appears in the appendix to the resilience dashboards (European Commission (2021a)). We take the indicators to be matching if one of the three mentioned criteria apply. The European Commission uses other criteria.

Similarities are less pronounced for the "digital" dimension. Here, 25 out of the 30 indicators in total (80%) have a matching counterpart. Noticeably, those are all conceptual similarities and there is no exact match. The fewest matches between the two indicator sets appear in the "geopolitical" dimension where 60%, that is, 18 of the 30 indicators from the EU resilience dashboards link directly to EU SDG indicators.

Moving on in the comparison, the EU resilience dashboards are compared to the two national frameworks. One relates to sustainability and the other to competitiveness. The **PNDD** set overlaps by approximately 41% (14 out of 34) with the EU dashboard indicators in the "social and economic" domain. The overlap increases to 50% (15 out of 30) in the "green" field. Some disconnect appears in the "digital" and the "geopolitical" dimensions that are not addressed in the PNDD. The **Luxembourg competitiveness scoreboard** overlaps conceptually by 29% (10 out of 34) with the EU social and economic dashboard. Ten indicators out of the 30 that define the "green" dimension in the dashboard (33%) are also found in the scoreboard. The "digital" and "geopolitical" dimensions do not exist in the scoreboard.

Overall, the resilience dashboards overlap the most with the other dashboards in measures of "greenness", which monitor the environmental impact. The limited overlap in some areas with the national competitiveness scoreboard can be partly attributed to the more general fact that the competitiveness scoreboard contains only 68 indicators, while the resilience dashboards consist of 124 indicators.

Table 1

Synthesis of the overlap between the resilience dashboards and the different indicator sets

OVERLAPS	EU SDG	PNDD	TBCO
Social and Economic Dimension	94%	41%	29%
Green dimension	100%	50%	33%
Digital dimension	80%	0%	0%
Geopolitical dimension	60%	0%	0%

Source: Author's own visualisation

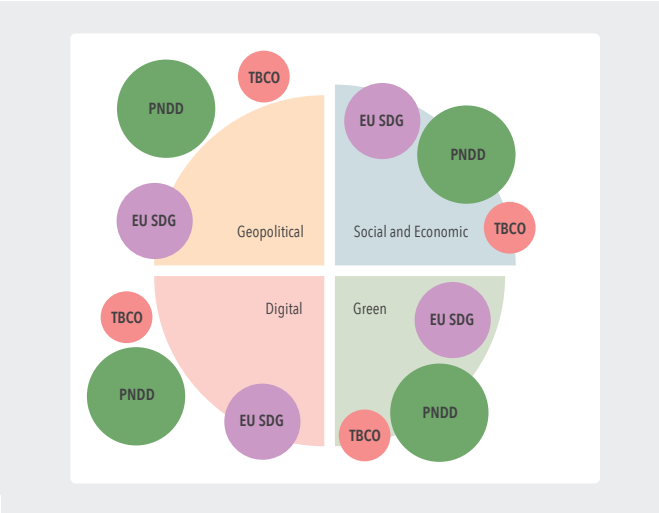
The findings can be represented graphically. Figure 8 is a visual exposition of the overlaps between the resilience dashboards and the other indicator sets. The circle in the middle of the figure represents the four dimensions of the EU resilience dashboards. The section of the circle that represents the "social and economic" dimension is slightly larger than the other sections since 34 indicators serve to describe that dimension while 30 indicators describe each of the other dimensions.

For each dimension, bubbles are used to depict each of the three indicator sets to which the EU dashboard is compared. The sizes of the bubbles, likewise, represent the sizes of the sets. The larger a set, the bigger the corresponding bubble.

The overlap between the central sections of the circle and the different bubbles represent the extent to which the associated indicators sets are conceptually similar. When a resilience dashboard and an indicator set have nothing in common, then the bubble lies outside of the section. That is for instance the case for the TBCO and the digital resilience dashboard. If there is a partial or complete overlap between the resilience dashboards and the indicator sets, then the bubbles lie partly or fully within the sections of the circle. Hence, since the overlap between the two sets is of 50%, half of the PNDD bubble lies within the "green" area of the EU circle.

Figure 8

Visual representation of the overlaps



Source: Author's own visualisation; EU resilience dashboards = 124 indicators (Social and economic = 34 indicators; Green = 30 indicators; Digital = 30 indicators; Geopolitical = 30 indicators); Luxembourg PNDD = 110 indicators; EU SDGs = 102 indicators; Luxembourg competitiveness scoreboard = 68 indicators.

1.5 What does it all mean for Luxembourg? From shocks to stocks?

Overall, there is a significant overlap between the EU resilience dashboards and the EU SDG frameworks. Both measure almost exactly the same things in order to grasp social, economic and green issues.

However, on geopolitical and digital matters, the EU resilience dashboard overlaps only partially with the EU SDGs. There is even a disconnection with the national indicators sets. At a national level, these two dimensions introduced by the EU resilience dashboards are a novelty.

These are currently being debated both publicly and within the network of "Ministries for the Future" that was set up between the European Commission and Member States as part of the EU's strategic foresight work.

When considering digitalisation, it is widely recognized that the teleworking of up to 2/3 of Luxembourg's resident workforce allowed a broad range of companies – notably financial and banking ones – to continue to serve their clients during the COVID-19 pandemic. The resilience of global services, based on a robust ICT infrastructure, avoided a sharp economic recession and a surge of unemployment.

However, some scholars question the role of digital technologies in helping to achieve resilience.[19] The digital and green dimensions may be seen to work on different levels (means and ends), or even to be incompatible if digitalisation implies to increase energy and resource uses. There remain open empirical questions. In a disaster situation, do new technologies tend to increase or to decrease vulnerability? Are they disaster-proof? And when are hi-tech ICT solutions preferable to low-tech solutions (ICLEI, 2018)? Planned obsolescence, the rebound effect and technological failures seem to have reinforced rather than mitigated ecological pressures (UNEP, 2011). Indeed the planned obsolescence of devices and online shopping generate significant amounts of waste. Similarly, the power of telecommunication networks and the development of the Internet of Things maintain an exponential growth of energy demand. Digitalisation, which is commonly associated with dematerialisation, has in fact a strong material, carbon, energy and even territorial footprint.

Concerning geopolitical aspects, small, import-dependent and raw material-deprived countries such as Luxembourg appear to be penalised. Luxembourg is highly dependent on the good operation of the European single market. As was developed earlier, Luxembourg is an open economy with a limited number of industrial facilities or skills pools. In that context, it is challenging to avoid a concentration of supplier or value chain partners. An obvious tension also lies in the supply and governance of critical raw materials that are indispensable for technological deployment.

Notwithstanding its exceptionally high international workforce ratio and net-migration rates, Luxembourg managed to keep one of the lowest employment gaps between EU and the non-EU nationals in the European comparison. When looking at the economy's reliance on non-resident workers from neighbouring and other countries, it is hoped that digitalisation, by delivering on its promise to significantly increase productivity by automation and robotisation, could help reduce this dependency. On the other hand, the country is currently short of high-qualified skills needed to lead the digital transition.

For all these reasons, the case of Luxembourg deserves a special consideration. Small open economies are per se more vulnerable but they also have a higher potential to bounce back in the event of a shock. A consistent strand of literature on small economies has shown their inherent vulnerabilities.[20] Briguglio (2018) argues that **small States**, with limited natural resource endowments, need to have a resilient economy, much more than other groups of countries. For it would pay off for small States to integrate resilience-building measures in their plans and strategies by promoting macroeconomic stability, market flexibility and good social and environmental governance. These measures also enhance competitiveness. For the author, building clusters at the level of resources (such as building materials, water, energy, food…) or regions (such as within the *Grande Région*) is another way for small countries to remain competitive. Clustering can stimulate economies of scale, the sharing of knowledge, access to particular resources while mitigating competition and scale disadvantages.

In the course of designing the EU resilience dashboards, Luxembourg argued in favour of adopting a single market approach to EU resilience since it has mitigating effects on almost all the vulnerabilities identified in the Strategic Foresight Report. The dashboards should better reflect the wide-ranging and well-known cross-border phenomena present within the EU.[21]

The two national frameworks (for sustainability and competitiveness) are as of now unconcerned by the supranational geopolitical and digital dimensions. Their overlap with the European socio-economic dashboard is, however, significant.

By nature, the SDGs and the PNDD indicators overlap greatly. The latter is a national adaptation and synthetic version of the former, reflecting locally available data.

This chapter recognises the importance of resilience but also stresses the importance to adapt the measuring framework in order to better fit the specific circumstances of a small, open economy. A national approach of resilience could be developed together with all the relevant stakeholders, as it has already been the case for issues of sustainability and competitiveness.

Now, what could be expected from a Luxembourg-specific resilience scoreboard?

To avoid an inflation of indicators or the duplication of already existing socio-economic and environmental indicators, the economic resilience scoreboard should be fundamentally distinct from the competitiveness scoreboard, concentrated on a sizeable and absorbable number of indicators, and integrate the specificities of relevant sub-branches of the economy. Junker (2020) develops such a discussion of potential indicators in *Le Luxembourg en 2050*.

It appears that the physical state of the strategic, vital stocks available to "bounce forward better", that is a fundamental piece of information, is addressed neither by the sustainability framework nor by the resilience framework. This should not be confused with the widespread just-in-time conception of supplying ordinary goods and services. Luxembourg is not self-sustaining when it

19 "The mere introduction of digital technologies alone does not automatically lead to the desired structural change in institutions, organisations or companies. Against the background of the pandemic, however—and aiming for a recovery, which establishes a new 'normal'—it becomes clear that incremental and cautious innovation steps are far from sufficient. A broader perspective on the social prerequisites of successful implementation and utilisation of digital technologies is absent" (Social Europe, 2021).

20 See for instance the proceedings of the International Conference on *Competitiveness Strategies for the Small States of the EU*, organised in 2018 by the Luxembourg Observatory for Competitiveness, https://odc.gouvernement.lu/en/actualites/mes-actualites/2018/Conference-Small-States.html

21 That is in line with the view of Luxembourg's Ministry of Foreign Affairs, which represents Luxembourg in the EU Commission Foresight unit (2021).

comes to supplying goods to ensure a basic standard of living. The aim here is to improve the security of vital supplies, functions and services over the entire territory and in anticipation of the next crisis. This would include an assessment of the criticality, robustness and redundancy of essential infrastructures or supply chains. Digital tools to optimise inventories and flow management can be useful. The notion of **emergency stock**, supported by the International Energy Agency (IEA) or the EU and widely used in the energy sector, could be an example for developing a broader resilience indicator. Such an indicator might look like something of this sort:

emergency stocks equivalent to at least xx days of imports, for food, fertilisers, seeds, water and water purification products, energy (primary, or as in pumped storage, batteries, gen sets…), medication and health equipment, machinery spare parts…

More consideration could also be given to the enhancement of human capital or the regeneration of natural capital. By human capital it is made reference here to resilience-related issues related to traditional knowledge, psychological, physical and mental health, technical and manual education and training, governance combining State and non-State actors, the continuity of the functioning of the State, time-risk-uncertainty-complexity-anticipation management competences… Regenerated natural capital (rebuilt biodiversity, enhanced carbon sinks, recreated landscapes, preserved genetic resources, restocked woodlands and water resources, restored soils and fishing grounds, etc) could act as a back-up or buffer in the face of disaster.

Given the smallness of Luxembourg's territory, other resilience indicators to consider may include the number of persons fed in a healthy and regenerative manner from one hectare of land or the status of habitat fragmentation. As for economic resilience, it might be interesting to reconsider the indicator of "economic losses from environmental pressures and climate related events", proposed in 2020 by the prototype EU dashboards (European Commission 2020).

This chapter has shown that, just like for the concepts of sustainability, transition or transformation, resilience thinking and practice depend on perceptions, values and cognition. In order to objectify resilience and make it more palpable, this chapter finds that it would be useful for the resilience indicator framework to:

- Be based on clearly stated underlying assumptions, definition of resilience and characteristics of the transformation to be conducted;
- Add value by being clearly articulated to other existing, thematically similar, multi-dimensional, supra-national frameworks;
- Be adapted to local contexts and national particularities;
- Be tied up with realistic expectations;
- Address the occurrence of extreme events, emergency responses, vital functions, goods and services, in a context of growing uncertainty and risks.

At a national level, a next step would be to stimulate a broader discussion on the general concept of resilience, its underlying assumptions, the change it is to bring about and the ways to apply it in Luxembourg. In conjunction with STATEC, Luxembourg Strategy, the foresight unit of the Ministry of the Economy, proposes to initiate this process with all the stakeholders involved. Luxembourg Strategy, created in November 2020, assists the Ministry in its long-term strategic planning efforts and in its design of a resilient pathway for the economy by 2050. Megatrend analysis, scenario-building, biophysical stress tests and modelling are ways to cement the ongoing debates. In that context, the annual Competitiveness and Resilience Report of the Ministry may prove to be a suitable platform to feedback on the evolution of the analysis and contribute to a national consensus building around the concept of resilience.

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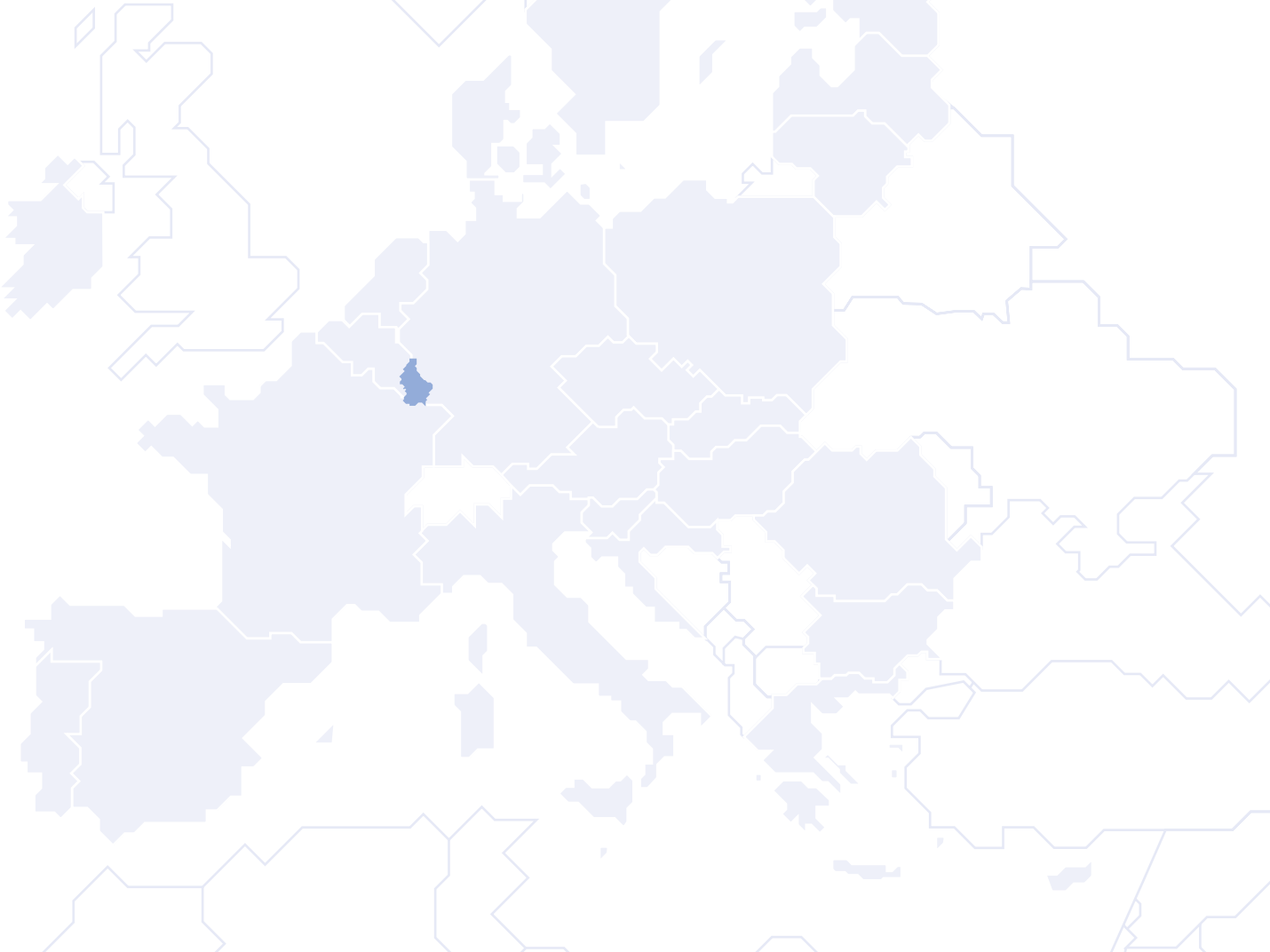
Chapter 2

Luxembourg in international benchmarks



Luxembourg in international benchmarks

2.1 Introduction

In Luxembourg, as in any country, the debate on competitiveness is regularly revived whenever international benchmarks and territory rankings are published. These analyses generally use composite indices for international comparisons, combining multiple pieces of information into a single numerical value[1]. By consolidating a variety of characteristics, these indices give a concise and instant view of the topic, although they remain broad and approximate. In general, benchmarks tell a more complex story than the apparent simplicity of a ranking would suggest. As such, when analysing benchmarks, it is important not to lose sight of the intrinsic limits of such an exercise. First of all, in these international comparisons, rankings are by nature always relative. Accordingly, a rise or fall in the rankings does not mean that a country's performance has necessarily improved or deteriorated in absolute terms; such a development may also be due to the fact that the performance of other countries has developed more or less strongly than that of the country in question. Moreover, in these rankings, there are often countries or groups of countries for which the overall performance and scores are almost similar, i.e. the numerical values of the composite indices are close to each other. Ranking countries alone does not usually reflect this situation. All other things being equal, a small change in the value of a composite index can therefore result in a significant change in the ranking. Consequently, the ranking of a territory should not be assessed in isolation without taking into account the value of the composite index. It should also be noted that the number of countries analysed in the different benchmarks varies greatly, which obviously impacts the relative position of countries in the respective rankings. Finally, the various benchmarks are commonly criticised for suffering from methodological weaknesses in three areas: the quality of the data and sources, the indicators used and the method for calculating a composite index. For example, the principle of "one size fits all", which involves the use of the same indicators for all territories analysed, is naturally followed to ensure comparability; but this simultaneously makes it impossible to consider the specific characteristics of each country.

With that in mind, how much importance should be lend to these benchmarks and international rankings? While these analyses are frequently met with scepticism, they serve to put useful performance indicators in the same setting, and deserve to be monitored. On the one hand, benchmarks summarise complex problems using one sole value, making for formidable communication tools, encouraging political debate and allowing authorities to assess their policies by comparing them with best practices. On the other hand, due to their widespread media coverage, benchmarks also have a significant impact on a territory's brand image, and may therefore influence the views of potential investors.

This chapter provides a descriptive summary of different benchmarks in the field of territorial competitiveness, digitalisation and innovation while highlighting Luxembourg's performance and position in the respective rankings[2]. In order to circumvent the comparability problem due to the divergent number of countries analysed, the chapter additionally proposes an adjusted EU-27 ranking for these benchmarks in order to analyse the position of Luxembourg in relation to a fixed reference group consisting of the European Union Member States. In view of the importance of the financial centre to the Luxembourg economy, the chapter is completed by four benchmarks relating to international financial centres.

2.2 Territorial competitiveness

This section summarises the 2021 editions of the two best-known and recognised benchmarks in the field of territorial competitiveness: the *World Competitiveness Ranking* produced by the International Institute for Management Development, and the *Index of Economic Freedom* of the American think tank The Heritage Foundation.[3]

2.2.1 World Competitiveness Ranking (IMD)

A. General

In June 2021, the International Institute for Management Development (IMD) published the new edition of its annual report on the competitiveness of countries: the *World Competitiveness Yearbook*[4,5]. The 2021 edition analyses 64 countries through a multitude of criteria that are partly quantitative (statistical indicators) and partly qualitative (opinion surveys of economic decision-makers and business leaders). The criteria are divided into four pillars: economic performance, government efficiency, business efficiency and infrastructure.

B. General ranking

The general ranking of the *World Competitiveness Yearbook 2021* is led by Switzerland ahead of Sweden, Denmark, the Netherlands and Singapore.

Luxembourg gains three positions compared to last year and is ranked 12th in the world. Germany ranks 15th, Belgium 24th and France 29th in the global ranking.

1 For more information on composite indicators, see Competence Centre on Composite Indicators and Scoreboards: https://ec.europa.eu/knowledge4policy/composite-indica-tors_en
2 The Observatory for Competitiveness website provides information on a range of benchmarks: https://odc.gouvernement.lu/fr/statistiques/benchmarks-internationaux.html
3 Traditionally, the *Global Competitiveness Index* of the World Economic Forum (WEF) is also presented in the chapter on international benchmarks of the Competitiveness Report. However, because no current edition was available at the time of writing, this leading benchmark of territorial competitiveness is not included in the benchmarks analysed this year.
4 For more information see: IMD *World Competitiveness Ranking*, https://www.imd.org/centers/world-competitiveness-center/rankings/world-competitiveness/
5 For more information see: IMD Country Profile Luxembourg, https://worldcompetitiveness.imd.org/countryprofile/overview/LU

Table 1

Top 15 of the IMD World Competitiveness Yearbook 2021

OVERALL RANKING		PILLAR RANKING			
		ECONOMIC PERFORMANCE	GOVERNMENT EFFICIENCY	BUSINESS EFFICIENCY	INFRASTRUC-TURE
1	Switzerland	7	2	5	1
2	Sweden	16	9	2	2
3	Denmark	17	7	1	3
4	Netherlands	2	12	4	7
5	Singapore	1	5	9	11
6	Norway	25	4	6	4
7	Hong Kong SAR	30	1	3	16
8	Taiwan, China	6	8	7	14
9	United Arab Emirates	9	3	8	28
10	USA	5	28	10	6
11	Finland	34	14	12	5
12	**Luxembourg**	**10**	**10**	**13**	**24**
13	Ireland	22	13	11	20
14	Canada	14	15	16	8
15	Germany	3	23	23	10

Source: IMD World Competitiveness Yearbook 2021

C. Luxembourg's performance in each pillar

In terms of the four pillars of the overall ranking, Luxembourg is ranked as follows:

- Economic performance
  Luxembourg drops two positions and is ranked 10th in the world in the "economic performance" pillar. For the sub-factors of this domain, Luxembourg shows high performances for international trade (7th), employment (10th) and the domestic economy (11th). Its performance is average for international investment (23rd). On the other hand, the country remains in a poor position as regards prices (44th).

- Government efficiency
  The country moved up two places to 10th position in the "government efficiency" pillar, with good performance in public finance (6th), business legislation (6th), societal framework (7th) and institutional framework (8th). The tax policy sub-factor (41st) remains one of Luxembourg's competitive weaknesses.

- Business efficiency
  Luxembourg has moved up four places to 13th position in the "business efficiency" pillar. Its performance improved in all sub-factors of this domain, namely productivity and efficiency (6th), finance (10th), labour market (13th), attitudes and values (16th) and management practices (20th).

- Infrastructure
  Luxembourg remains in 24th position in the "infrastructure" pillar, which thus remains the least favourable pillar to Luxembourg's competitiveness. In detail, the country's performance is rather high for basic infrastructure (9th), education (11th) and health and environment (19th), but only average for the scientific infrastructure (27th) and technological infrastructure (31st) sub-factors.

D. Challenges for Luxembourg's competitiveness

According to the IMD report, the main challenges in 2021 for Luxembourg's competitiveness are:

- Mitigate the effects of the COVID-19 pandemic crisis on business profitability by ensuring the continuation of aid programmes as long as necessary;

- Consolidate the existing health system and build a national health industry ecosystem to further diversify the economy;

- Transition towards a data-based economy by developing an adequate infrastructure to strengthen cybersecurity and fostering digital upskilling and reskilling;

- Promote a circular and sustainable economy based on green energy and ecological transitions;

- Ensure robust growth based on productivity gains.

2.2.2 Index of Economic Freedom (The Heritage Foundation)

A. General

The American think tank The Heritage Foundation published in March the 2021 edition of its annual *Index of Economic Freedom*[6,7]. The current edition covers 184 countries around the world. For this report, economic freedom is defined as the absence of any capacity for government coercion or constraint on the production, distribution, or consumption of goods and services beyond what is necessary to protect and maintain the freedom of citizens. Economic freedom is believed to promote productivity and economic growth by encouraging entrepreneurship and the creation of value added. The freer an economy is deemed to be, the better the country is ranked. Economic freedom is measured through a multitude of indicators divided into four categories that are further divided 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;
- Open markets: trade freedom, investment freedom, financial freedom.

B. General ranking

The global ranking of the *Index of Economic Freedom* 2021 is led by Singapore (89.7/100), ahead of New Zealand (83.9) and Australia (82.4). Switzerland (81.9) and Ireland (81.4) round out the top five.

Luxembourg (76.0), which is among the countries considered "mostly free", ranks 18th in the world and 11th in the regional ranking of European countries. Compared to the 2020 edition, Luxembourg gains one position in the global ranking and improves its overall score by 0.2 points.

As for Luxembourg's neighbours, the Netherlands ranks 16th (76.8), Germany 29th (72.5), Belgium 37th (70.1) and France 64th (65.7) worldwide.

C. Luxembourg's performance

The report shows that Luxembourg performs well in the categories of "rule of law" and "open markets". The Grand Duchy's performance is mixed in the categories "government size" and "regulatory efficiency". In more detail, Luxembourg's strengths are the country's fiscal position, the integrity of government institutions and the freedom to invest. On the negative side, the tax burden, freedom to work and the level of government spending as a proportion of GDP are of concern.

In particular, Luxembourg performs as follows in the twelve sub-categories:

- Rule of law: property rights (85.7), judicial effectiveness (77.6), government integrity (92.5);
- Government size: tax burden (63.4), government spending (46.2), fiscal health (99.0);
- Regulatory efficiency: business freedom (66.1), labour freedom (45.9), monetary freedom (76.5);
- Open markets: trade freedom (84.0), investment freedom (95.0), financial freedom (80.0).

To conclude, the following observation is made about Luxembourg in terms of economic freedom: *"Luxembourg's economic freedom score is 76.0, making its economy the 18th freest in the 2021 Index. Its overall score has increased by 0.2 point, primarily because of an improvement in judicial effectiveness. Luxembourg is ranked 11th among 45 countries in the Europe region, and its overall score is above the regional and world averages. Luxembourg's economy remains in the mostly free category where it has been for more than two decades. Greater economic freedom continues to be impeded by the unsustainably high rate of government spending. Unfortunately, spending in 2020 was on track to exceed spending in 2019, again putting off a reckoning with looming demands on the pension and health care funds from the country's aging population."*

6 For more information see: The Heritage Foundation, *Index of Economic Freedom*: https://www.heritage.org/index/
7 For more information see: The Heritage Foundation – Luxembourg (country profile): https://www.heritage.org/index/country/luxembourg

Table 2

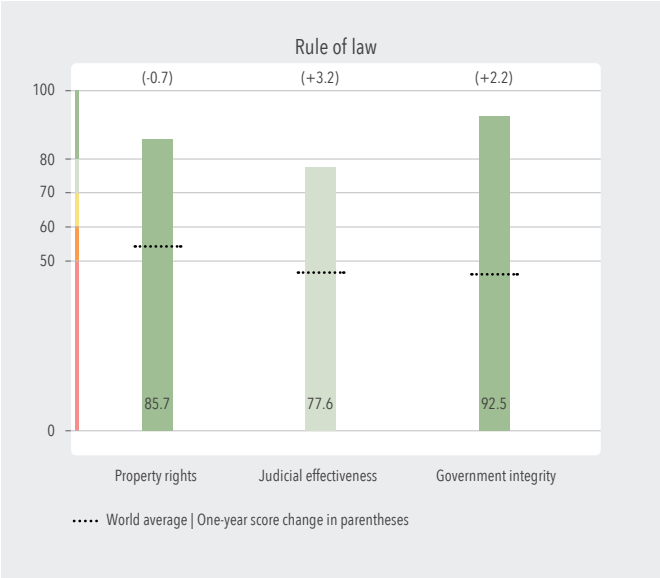
Top 30 Index of Economic Freedom 2021

OVERALL				SCORE BY COMPONENT											
World Rank	*Region Rank*	Country	2021 Score	Property Rights	Judicial Effectiveness	Government Integrity	Tax Burden	Government Spending	Fiscal Health	Business Freedom	Labor Freedom	Monetary Freedom	Trade Freedom	Investment Freedom	Financial Freedom
1	*1*	Singapore	89.7	97.5	90.8	93.2	90.5	94.1	80.0	93.8	91.5	85.4	95.0	85.0	80.0
2	*2*	New Zealand	83.9	91.3	80.5	95.3	70.6	58.1	98.2	89.9	86.3	86.9	90.2	80.0	80.0
3	*3*	Australia	82.4	81.5	90.0	89.8	62.6	58.1	88.7	87.4	84.1	86.7	89.8	80.0	90.0
4	*1*	Switzerland	81.9	85.4	82.2	87.9	70.4	67.6	96.9	73.6	72.5	85.4	86.0	85.0	90.0
5	*2*	Ireland	81.4	86.0	72.4	82.0	76.6	81.1	93.1	81.5	76.1	84.4	84.0	90.0	70.0
6	*4*	Taiwan	78.6	87.3	72.9	74.5	79.2	91.0	93.7	93.4	60.4	84.3	86.0	60.0	60.0
7	*3*	United Kingdom	78.4	87.6	76.7	86.5	64.9	54.8	77.3	94.4	73.2	81.0	84.0	80.0	80.0
8	*4*	Estonia	78.2	81.8	80.8	86.4	81.0	54.4	99.6	72.7	57.8	79.7	84.0	90.0	70.0
9	*1*	Canada	77.9	84.5	73.3	87.9	76.0	49.8	84.2	81.4	72.4	76.1	88.8	80.0	80.0
10	*5*	Denmark	77.8	86.7	86.9	93.4	43.7	23.1	98.2	88.8	73.8	84.5	84.0	90.0	80.0
11	*6*	Iceland	77.4	87.0	72.6	90.6	72.4	46.2	97.6	83.6	62.0	79.4	86.8	80.0	70.0
12	*7*	Georgia	77.2	66.9	59.3	64.6	89.1	76.9	94.9	84.9	76.7	76.7	86.0	80.0	70.0
13	*1*	Mauritius	77.0	78.4	73.6	55.0	91.6	78.0	73.5	83.7	74.6	77.4	88.0	80.0	70.0
14	*1*	United Arab Emirates	76.9	80.8	81.1	66.0	100.0	73.0	98.5	80.0	81.6	80.6	81.4	40.0	60.0
15	*8*	Lithuania	76.9	78.9	68.7	74.5	84.6	66.8	97.2	73.1	74.4	80.1	84.0	70.0	70.0
16	*9*	Netherlands	76.8	88.9	72.8	90.6	51.7	47.7	95.3	80.5	60.1	80.4	84.0	90.0	80.0
17	*10*	Finland	76.1	91.9	82.2	97.2	68.0	14.3	91.4	85.8	50.5	83.3	84.0	85.0	80.0
18	***11***	**Luxembourg**	**76.0**	**85.7**	**77.6**	**92.5**	**63.4**	**46.2**	**99.0**	**66.1**	**45.9**	**76.5**	**84.0**	**95.0**	**80.0**
19	*2*	Chile	75.2	70.2	68.4	74.5	72.3	80.4	90.4	75.1	62.5	85.5	83.0	70.0	70.0
20	*3*	United States	74.8	79.7	72.4	76.8	76.0	62.2	34.9	82.5	87.1	81.1	80.4	85.0	80.0
21	*12*	Sweden	74.7	86.6	79.1	92.5	43.6	29.5	97.6	83.2	53.9	81.5	84.0	85.0	80.0
22	*5*	Malaysia	74.4	85.1	70.5	53.2	83.8	84.3	79.4	86.7	73.9	83.6	82.4	60.0	50.0
23	*6*	Japan	74.1	87.8	75.5	82.0	67.8	57.8	67.5	85.9	79.0	85.1	80.4	60.0	60.0
24	*7*	Korea. South	74.0	80.7	63.4	68.9	63.0	86.9	96.7	89.5	55.8	84.4	79.0	60.0	60.0
25	*13*	Austria	73.9	86.8	83.5	84.8	45.7	29.1	90.0	72.6	68.4	81.7	84.0	90.0	70.0
26	*2*	Israel	73.8	83.6	79.8	76.8	60.0	53.8	79.2	73.9	65.1	84.4	84.2	75.0	70.0
27	*14*	Czech Republic	73.8	76.2	56.8	64.4	79.1	51.4	98.1	68.8	77.1	79.7	84.0	70.0	80.0
28	*15*	Norway	73.4	82.4	86.3	95.8	57.1	25.3	96.6	85.5	57.8	75.4	84.0	75.0	60.0
29	*16*	Germany	72.5	78.8	69.8	81.5	60.4	40.3	92.8	82.4	53.0	77.2	84.0	80.0	70.0
30	*17*	Latvia	72.3	74.7	55.9	47.7	76.7	57.6	96.6	76.5	73.8	79.6	84.0	85.0	60.0

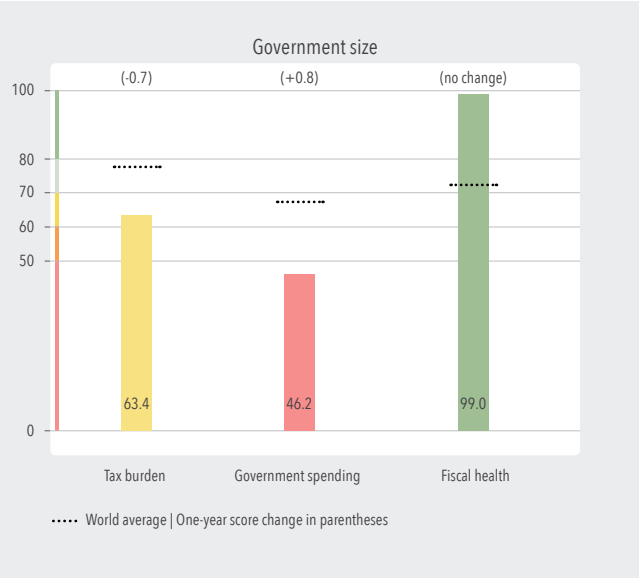
Source: The Heritage Foundation, Index of Economic Freedom 2021

Figure 1

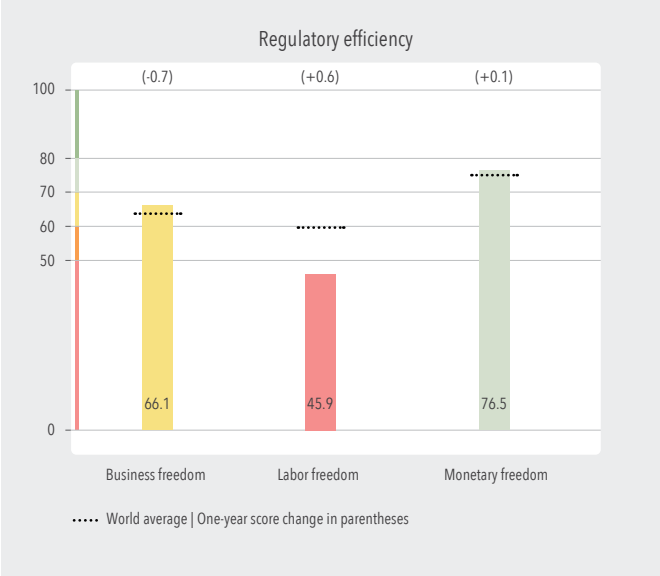
Country profile Luxembourg, Index of Economic Freedom 2021



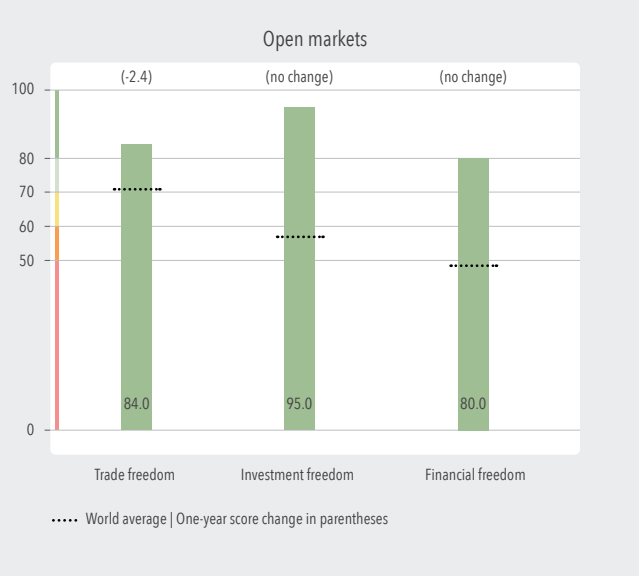
The legal system protects and facilitates the acquisition and disposition of all property rights. A land registry cadaster records ownership of land and buildings. The open and transparent economy has no restrictions on foreign ownership. Contracts are secure. The judiciary is independent, albeit slow, and a well-functioning legal framework strongly supports the rule of law. Laws, regulations, and penalties are enforced impartially to combat corruption.



The top individual income tax rate is 42 percent, and the top corporate tax rate has been reduced to 17 percent. The overall tax burden equals 40.1 percent of total domestic income. Government spending has amounted to 42.4 percent of total output (GDP) over the past three years, and budget surpluses have averaged 2.2 percent of GDP. Public debt is equivalent to 22.0 percent of GDP.



The freedom to start, operate, and close a business is well protected, and business freedom has changed little over the past year. Luxembourg recently changed the amount of paid annual leave that some workers receive. Monetary stability has been well maintained, but subsidies included in the government budget for 2020 are equivalent to about 1.2 percent of GDP.



As a member of the EU, Luxembourg has 45 preferential trade agreements in force. The trade-weighted average tariff rate (common among EU members) is 3 percent, with 639 EU-mandated nontariff measures in force. Overall investment activity is sustained by the solid institutional foundations of an open-market system. The sophisticated financial sector is well capitalized and competitive.

Source: The Heritage Foundation, Index of Economic Freedom 2021

2.3 Digitalisation and innovation

The ability to adopt and explore digital technologies, together with the quality of national research and innovation systems, are commonly regarded as key factors of competitiveness. Four corresponding benchmarks are presented here: the *Digital Economy and Society Index* and the *European Innovation Scoreboard* both developed by the European Commission, the IMD *World Digital Competitiveness Ranking* and finally the *Global Innovation Index* of the World Intellectual Property Organization.

2.3.1 Digital Economy and Society Index (European Commission)

A. General

In November 2021, the European Commission published a new edition of its annual report on the digital economy and society: the *Digital Economy and Society Index* (DESI)[8]. DESI is a composite index that tracks Member States' progress in the digital arena.

The European Commission has made a number of changes to the 2021 edition of the DESI in order to align the index with the four cardinal points and the targets under the Digital Compass, to improve the methodology and to take into account the latest technological and policy developments. As such, the DESI 2021 results cannot be readily compared to those of previous editions. However, DESI scores and rankings from previous years have been recalculated to allow for an analysis of trends in country performance.

The DESI index is now structured into four interrelated dimensions that are assessed using 33 individual indicators. Each dimension has the same weighting in the index.

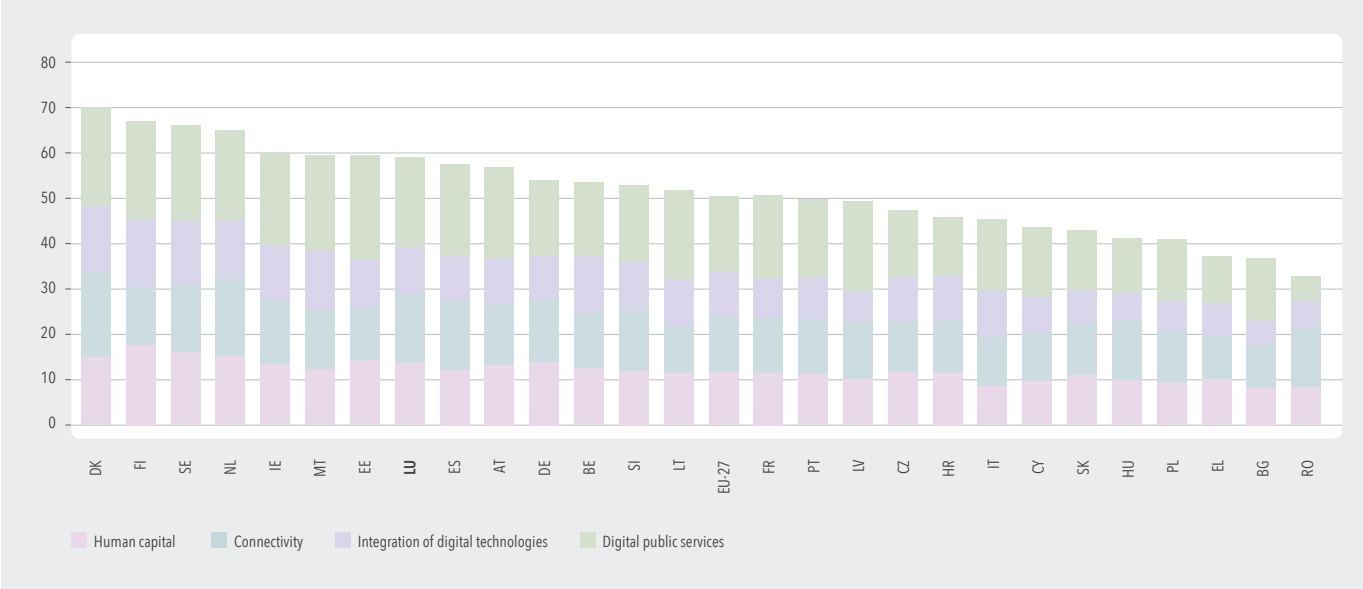
- Human capital (digital skills, ICT specialization);
- Connectivity (fixed and mobile broadband coverage and take-up, broadband prices);
- Integration of digital technologies (digital intensity of SMEs, business digitisation, e-commerce);
- Digital public services (e-government).

B. General ranking

The overall DESI 2021 ranking is led by Denmark (score of 70.1/100) ahead of Finland (67.1), Sweden (66.1), the Netherlands (65.1) and Ireland (60.3). Luxembourg ranks 8th (59.0), Germany 11th (54.1), Belgium 12th (53.7) and France 15th (50.6).

Figure 2

Ranking of the Digital Economy and Society Index 2021



Source: European Commission, Digital Scoreboard

8 For more information see: European Commission, *The Digital Economy and Society Index*, https://digital-strategy.ec.europa.eu/en/policies/desi

C. Luxembourg's performance

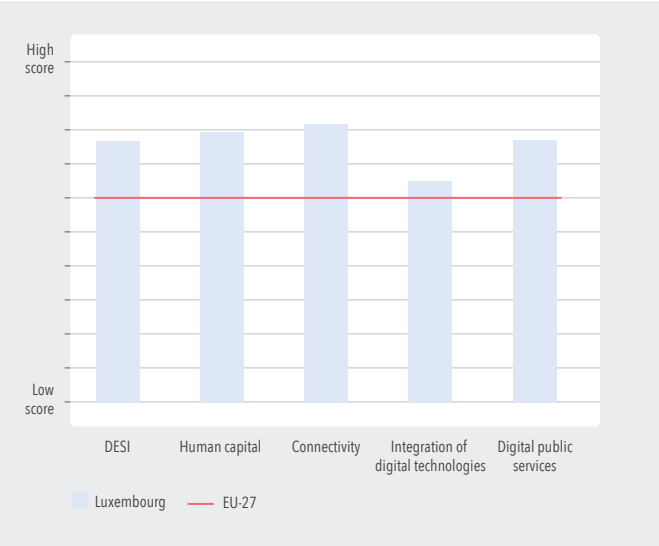
In detail, Luxembourg's performance in the four dimensions of the DESI 2021 is as follows (ranking/score):

- Human capital (6th/56.2): Luxembourg is above the EU average for both digital skills and ICT specialisation indicators;
- Connectivity (4th/61.0): Luxembourg performs particularly well in terms of fixed and mobile broadband take-up and coverage. In terms of broadband price, Luxembourg's score is close to the EU average. The country is also well prepared for 5G and the commercial launch of 5G services took place in 2020;
- Digital technology integration (14th/39.4): Luxembourg outperforms the European average in the percentage of SMEs with at least a basic level of digital intensity. In terms of the use of digital technologies in business, Luxembourg performs well in electronic information exchange, social networks, mega data and artificial intelligence. However, electronic invoicing is not widespread in Luxembourg and few SMEs sell their goods and services online;
- Digital public services (11th/79.4): Luxembourg has made significant progress in the area of digital public services. The results are particularly good in terms of public services available online for businesses and individuals. The level of online interaction between public authorities and the general public is average. In contrast, Luxembourg's score is well below the European average for open data.

Overall, Luxembourg exceeds the European average in each dimension of the DESI 2021. Analysis of the trends in the overall index shows that Luxembourg's score is consistently above that of the EU as a whole and that the two scores evolve more or less in parallel. In more detail, Luxembourg has made continuous progress in all four DESI dimensions between 2016 and 2021.

Figure 3

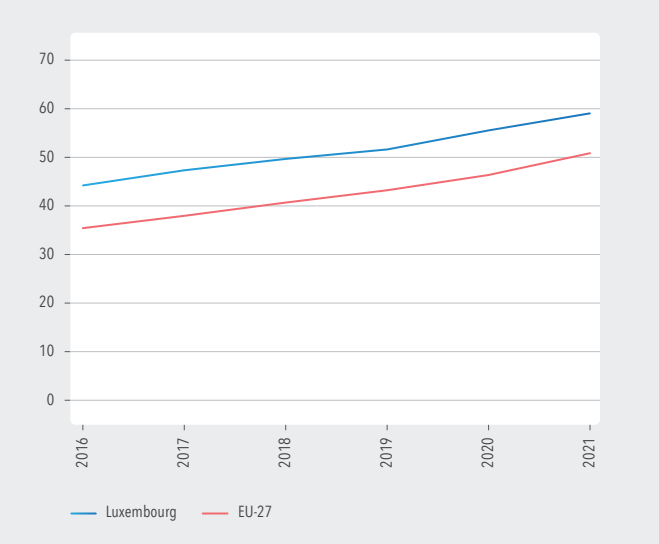
DESI 2021, relative performance by dimension



Source: European Commission, Digital Scoreboard

Figure 4

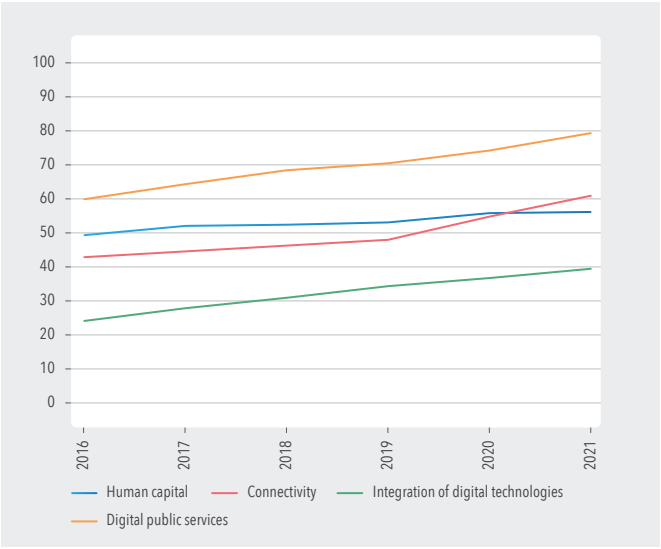
DESI - evolution over time



Source: European Commission, Digital Scoreboard

Figure 5

Evolution of Luxembourg's performance in DESI, by dimension



Source: European Commission, Digital Scoreboard

In its assessment, the European Commission states that Luxembourg is doing well in terms of human capital. While there is still a shortage of ICT specialists, Luxembourg is implementing a range of strategies and initiatives to strengthen the digital skills of its population. Luxembourg performs very well in terms of connectivity. The country is almost entirely covered by fast fixed broadband networks and also has very good coverage of very high-capacity networks. In addition, broadband services are slightly more affordable than the EU average. Luxembourg is also well prepared for 5G. As regards the integration of digital technologies, the European Commission notes that Luxembourg has made major progress in the adoption of digital innovations, in line with its ambition to move to a data-driven economy. The European Commission also refers to Luxembourg's commitment at the European level, notably its participation in the European High-Performance Computing Joint Undertaking (EuroHPC) and its signature of the declaration establishing a European Blockchain Partnership. Finally, the European Commission reports that Luxembourg has made significant progress in the area of digital public services, which has enabled it to improve its score considerably in this dimension of the DESI.

2.3.2 World Digital Competitiveness Ranking (IMD)

A. General

In September 2021, the International Institute for Management Development (IMD) published the fifth edition of its annual report on the digital competitiveness of countries: the *World Digital Competitiveness Ranking* 2021[9] (WDCR). This report measures the capacity and readiness of economies across the globe to adopt and explore digital technologies as a key driver for economic transformation in business, public administrations and society.

In this latest edition, 64 countries are analysed across 52 criteria which are partly quantitative (32 criteria taken from national and international statistical sources) and partly qualitative (20 criteria taken from opinion survey of a panel of international experts). The criteria are split into three pillars and nine sub-pillars:

- The "Knowledge" pillar concerns the know-how needed to discover, understand and build new technologies and digital tools. Its sub-pillars are "Talent", "Training and education", and "Scientific concentration/R&D";
- The "Technology" pillar analyses the general context enabling digital technologies to be developed. Its sub-pillars are "Regulatory framework", "Capital" and "Technological framework";
- The "Future readiness" pillar assesses the potential capacity of countries to harness digital transformation. Its sub-pillars are "Adaptive attitudes", "Business agility" and "IT integration".

B. General ranking

The overall WDCR 2021 ranking is led by the United States (score of 100/100) ahead of Hong Kong SAR (96.58), Sweden (95.19), Denmark (95.16) and Singapore (95.14).

Luxembourg (77.36) improves its score, moving up six places from last year and now ranks 22nd in the world. Regionally, Luxembourg ranks 12th among European countries and 8th among EU Member States.

As for the Grand Duchy's neighbours, the Netherlands ranks 7th (93.31), Germany 18th (79.33), France 24th (75.66) and Belgium 26th (75.26) worldwide.

9 For more information see: IMD *World Digital Competitiveness Ranking*, https://www.imd.org/centers/world-competitiveness-center/rankings/world-digital-competitiveness/

Table 3

IMD World Digital Competitiveness Ranking 2021

RANKING 2021		1 YEAR RANKING CHANGE	RANKING 2021		1 YEAR RANKING CHANGE
1	USA	-	33	Czech Republic	+2
2	Hong Kong SAR	+3	34	Portugal	+3
3	Sweden	+1	35	Slovenia	-4
4	Denmark	-1	36	Saudi Arabia	-2
5	Singapore	-3	37	Latvia	+1
6	Switzerland	-	38	Thailand	+1
7	Netherlands	-	39	Chile	+2
8	Taiwan, China	+3	40	Italy	+2
9	Norway	-	41	Poland	-9
10	UAE	+4	42	Russia	+1
11	Finland	-1	43	Cyprus	-3
12	Korea Rep.	-4	44	Greece	+2
13	Canada	-1	45	Hungary	+2
14	United Kingdom	-1	46	India	+2
15	China	+1	47	Slovak Republic	+3
16	Austria	+1	48	Turkey	-4
17	Israel	+2	49	Jordan	+4
18	Germany	-	50	Romania	-1
19	Ireland	+1	51	Brazil	-
20	Australia	-5	52	Bulgaria	-7
21	Iceland	+2	53	Indonesia	+3
22	**Luxembourg**	**+6**	54	Ukraine	+4
23	New Zealand	-1	55	Croatia	-3
24	France	-	56	Mexico	-2
25	Estonia	-4	57	Peru	-2
26	Belgium	-1	58	Philippines	-1
27	Malaysia	-1	59	Colombia	+2
28	Japan	-1	60	South Africa	-
29	Qatar	+1	61	Argentina	-2
30	Lithuania	-1	62	Mongolia	-
31	Spain	+2	63	Botswana	New
32	Kazakhstan	+4	64	Venezuela	-1

Source: IMD World Digital Competitiveness Ranking 2021

C. Luxembourg's performance

Compared to the previous edition, Luxembourg has made progress in the rankings of the three pillars and the nine corresponding sub-pillars and is now ranked as follows:

- "Knowledge" pillar: Luxembourg ranks 29th in the world (33rd in Talent, 20th in training and education 20th and 38th in scientific concentration/R&D);
- "Technology" pillar: Luxembourg ranks 14th globally (8th in regulatory framework, 8th in capital and investment and 25th in technological framework);
- "Future readiness" pillar: Luxembourg ranks 24th globally (38th for adaptive attitudes, 22nd in business agility, and 12th in ICT integration).

In terms of individual criteria, Luxembourg excels in credit rating, immigration laws and market capitalisation in the technology and media sectors. Favourable legislation in the area of scientific research and the attractiveness of the country for a highly qualified foreign workforce are other assets of Luxembourg. However, there is still room for improvement in the areas of graduates in science & engineering, investment in telecommunications, e-government and e-participation of citizens, and fear of failure among entrepreneurs.

Figure 6

Luxembourg's ranking by pillar, IMD WDCR 2021

Source: IMD World Digital Competitiveness Ranking 2021

2.3.3 European Innovation Scoreboard (European Commission)

A. General

The European Commission published a new edition of its *European Innovation Scoreboard* (EIS)[10] in June 2021. The EIS scoreboard measures and compares the relative innovation performance of the 27 EU Member States. The EIS accordingly provides an analysis of the strengths and weaknesses of national research and innovation systems and helps Member States and the EU as a whole to assess where efforts should be concentrated. As a complement, the assessment also measures the performance of the EU as a whole against its main competitors at global level.

The measurement framework distinguishes between four types of activities, covers 12 dimensions of innovation and includes a total of 32 indicators.

- "Framework conditions" account for the main drivers of innovation that are external to companies: human resources, attractive research systems and digitalisation;
- "Investments" take into account public- and private-sector R&D investment: finance and support, firm investments and use of ICT;
- "Innovation activities" are linked to innovation efforts by businesses: innovators, linkages and intellectual assets;
- "Impacts" cover how business activities affect innovation: impacts on employment, effects on sales and environmental sustainability.

The performance of national innovation systems is measured by a composite index, the Summary Innovation Index (SII), which is obtained by taking a non-weighted average of the 32 indicators. Based on the results against the current EU average, Member States are then divided into four performance groups:

- Innovation Leaders, whose innovation results are 125% above the EU average;
- Strong Innovators, whose results are between 100% and 125% of the EU average;
- Moderate Innovators, whose results are between 70% and 100% of the EU average;
- Emerging Innovators, whose results are below 70% of the EU average.

Due to methodological changes, including the addition of new dimensions of innovation, the integration of new indicators and revised thresholds for defining performance groups, the results of the 2021 EIS are not comparable to the results of previous editions.

10 For more information see: *European Innovation Scoreboard*, https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/european-innovation-scoreboard_en

B. General ranking

The EIS 2021 ranking of EU Member States is led by Sweden (score of 139.0) followed by Finland (134.5) and Denmark (131.1).

Luxembourg (121.3) ranks 7th and is in the Strong Innovators group. As for Luxembourg's neighbours, Belgium ranks 4th (127.5), the Netherlands 5th (121.1), Germany 6th (122.6) and France 10th (108.7).

C. Luxembourg's performance

With regard to the twelve dimensions of innovation, Luxembourg features the following results (score/ranking):

- Framework conditions
  - human resources (170.6/3rd)
  - attractive research systems (184.5/1st)
  - digitalisation (122.0/6th)

- Investments
  - finance and support (94.2/8th)
  - firm investment (45.1/23rd)
  - use of ICT (145.3/5th)

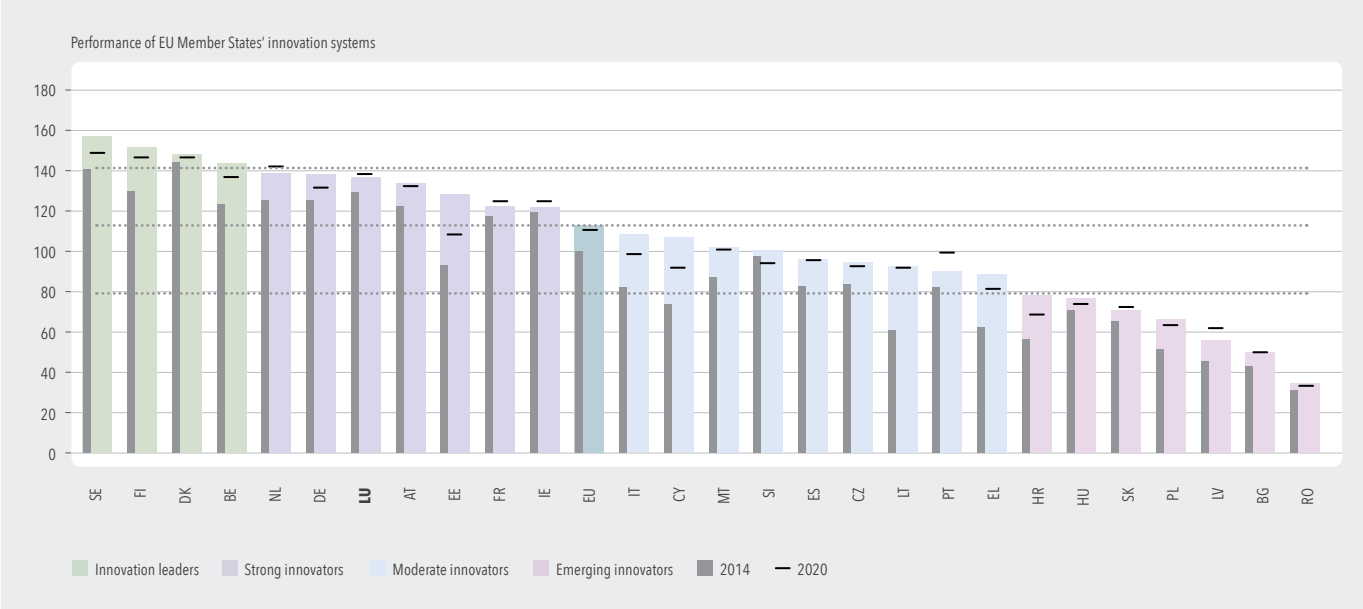
- Innovation activities
  - innovators (98.6/16th)
  - linkages (145.2/9th)
  - intellectual assets (145.8/6th);

- Impacts
  - employment impacts (144.5/4th)
  - sales impacts (95.6/8th)
  - environmental sustainability (116.9/7th)

To conclude, the European Commission makes the following observation about Luxembourg: *"Luxembourg is a Strong Innovator. Over time, performance relative to the EU has decreased. Luxembourg's strengths are in Attractive research systems, Human resources and Intellectual assets. The top-3 indicators include foreign doctorate students, Trademark applications, and International scientific co- publications. The increase in innovation performance between 2019 and 2020 was due to a strong increase in Doctorate graduates and Job-to-job mobility of HRST. The decrease in 2021 is mainly caused by a strong decline in Employment in innovative enterprises. Luxembourg is showing above average scores on the Climate change related indicators."*

Figure 7

European Commission, European innovation scoreboard 2021



Coloured columns show countries' performance in 2021, using the most recent data for 32 indicators, relative to that of the EU in 2014. The horizontal hyphens show performance in 2020, using the next most recent data, relative to that of the EU in 2014. Grey columns show countries' performance in 2014 relative to that of the EU 2014. For all years, the same measurement methodology has been used. The dashed lines show the threshold values between the performance groups, where the threshold values of 70%, 100%, and 125% have been adjusted upward to reflect the performance increase of the EU between 2014 and 2021.
Source: European Commission, European innovation scoreboard 2021

Table 4

Detailed performance of Luxembourg, European Innovation Scoreboard 2021

LUXEMBOURG	RELATIVE TO EU 2021 IN 2021	RELATIVE TO EU 2014 IN 2014	RELATIVE TO EU 2014 IN 2021
SUMMARY INNOVATION INDEX	121.3	128.8	136.5
Human resources	**170.6**	**132.8**	**180.8**
Doctorate graduates	126.0	42.6	111.5
Population with tertiary education	207.1	219.0	266.9
Lifelong learning	183.8	190.0	202.2
Attractive research systems	**184.5**	**185.2**	**207.7**
International scientific co-publications	173.0	185.6	226.8
Most cited publications	128.9	104.9	126.7
Foreign doctorate students	297.3	353.1	353.1
Digitalisation	**122.0**	**130.3**	**168.8**
Broadband penetration	121.6	114.0	184.4
People with above basic overall digital skills	122.7	150.0	150.0
Finance and support	**94.2**	**110.1**	**112.2**
R&D expenditures in the public sector	74.5	66.7	71.9
Venture capital expenditures	180.8	304.1	304.1
Government support for business R&D	28.3	33.3	32.7
Firm investments	**45.1**	**39.8**	**54.5**
R&D expenditure in the business sector	39.0	51.2	43.3
Non-R&D Innovation expenditures	29.7	9.8	33.7
Innovation expenditures per employee	65.0	52.4	85.8
Use of information technologies	**145.3**	**147.0**	**167.9**
Enterprises providing ICT training	106.7	113.3	106.7
Employed ICT specialists	178.6	185.7	238.1
Innovative SMEs collaborating with others	105.6	101.9	154.8
Innovators	**98.6**	**163.8**	**134.9**
Product innovators (SMEs)	100.0	140.7	141.1
Business process innovators (SMEs)	97.2	184.2	129.3
Linkages	**145.2**	**153.8**	**195.8**
Innovative SMEs collaborating with others	105.6	101.9	154.8
Public-private co-publications	198.1	172.4	222.1
Job-to-job mobility of HRST	142.9	176.9	205.1
Intellectual assets	**145.8**	**154.1**	**126.4**
PCT patent applications	55.9	49.9	48.5
Trademark applications	192.6	202.2	202.2
Design applications	175.8	198.9	120.5
Employment impacts	**144.5**	**172.2**	**147.2**
Employment in knowledge-intensive activities	229.3	229.3	250.7
Employment in innovative enterprises	76.5	131.8	73.8
Sales impacts	**95.6**	**99.5**	**97.4**
Medium and high tech goods exports	77.8	88.6	85.3
Knowledge-intensive services exports	148.7	148.4	157.4
Sales of innovative products	48.4	55.6	42.1
Environmental sustainability	**116.9**	**121.6**	**121.8**
Resource productivity	184.6	248.6	273.4
Air emissions by fine particulate matter	90.1	71.0	95.8
Environment-related technologies	86.5	111.0	65.0

The colours show normalised performance in 2021 relative to that of the EU in 2021: dark green: above 125%; light green: between 100% and 125%; yellow: between 70% and 100%; orange: below 70%. Normalised performance uses the data after a possible imputation of missing data and transformation of the data.
Source: European Commission, European innovation scoreboard 2021

2.3.4 Global Innovation Index (WIPO)

A. General

The World Intellectual Property Organization (WIPO) published the fourteenth edition of its *Global Innovation Index* (GII) in September 2021[11]. The current report, entitled "Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis" reports on the performance of innovation ecosystems and tracks the latest global trends in innovation.

The GII highlights innovation strengths and weaknesses and particular disparities in innovation indicators. GII is a tool to help policy-makers, business leaders and other interested parties to design effective policies for innovation and creativity and to target investments accordingly. Given the fundamental role of innovation for competitiveness and economic prosperity, GII includes innovation in the broad sense and accordingly considers multiple facets in presenting a comprehensive picture of innovation.

11 For more information see: *Global Innovation Index*, https://www.globalinnovationindex.org/home

The *Global Innovation Index* ranks countries according to their innovation capabilities and performance. The 2021 edition of GII covers 132 economies around the world. The overall GII index is based on two sub-indices, "Innovation Inputs" and "Innovation Outputs", both of which have the same weighting in the overall index. In more detail, the sub-indices are further divided into seven pillars and twenty-one sub-pillars. In total, the GII is composed of 81 individual indicators. In calculating the indices, values of the indicators are normalised and then aggregated at the top level. As such, the overall GII index can take on a score between 0 (worst performance) and 100 (best performance).

- The "Innovation Inputs" sub-index evaluates the resources implemented in innovation and can be used to assess elements of the national economy that support innovative activities based on five pillars: 1) Institutions, 2) Human capital and research, 3) Infrastructure, 4) Market sophistication and 5) Business sophistication;

- The Innovation Outputs sub-index assesses the results of innovation activities based on two pillars: 6) Results in Knowledge and technology outputs and 7) Creative outputs.

B. General ranking

The GII 2021 world ranking is led by Switzerland (score of 65.5/100) ahead of Sweden (63.1), the United States (61.3), the United Kingdom (59.8) and South Korea (59.3).

Luxembourg (49.0) drops five places compared to the previous edition and is now ranked 23rd in the world, equivalent to 15th in the regional ranking of European countries. As for Luxembourg's neighbours, the Netherlands ranks 6th (58.6), Germany 10th (57.3), France 11th (55.0) and Belgium 22nd (49.2) globally.

C. Luxembourg's performance

Luxembourg is assessed in the two sub-indices and the seven pillars as follows:

- In the Innovation Inputs sub-index, Luxembourg ranks 26th worldwide with a score of 55.8. In detail, Luxembourg ranks 27th in the institutions pillar (79.8), 40th in human capital and research (40.0), 33rd in infrastructure (52.5), 53rd in market sophistication (49.0) and 9th in business sophistication (57.8);

- In the Innovation Inputs sub-index, Luxembourg ranks 26th worldwide with a score of 42.3. In the two pillars of this domain, Luxembourg ranks 38th for knowledge and technology outputs (30.1) and 3rd for creative outputs (54.4).

Despite a slight drop in performance, Luxembourg remains in the Top 25 of the *Global Innovation Index* and thus maintains its place in the group of innovation leaders. The GII states that Luxembourg's performance is better than expected given its level of development. GII also notes that Luxembourg produces more outputs relative to its level of investment in innovation (inputs) and therefore has an effective innovation ecosystem.

Table 5

Top 25 of the Global Innovation Index 2021

GII RANK	ECONOMY	SCORE	INCOME GROUP RANK	REGION RANK
1	Switzerland	65.5	1	1
2	Sweden	63.1	2	2
3	United States of America	61.3	3	1
4	United Kingdom	59.8	4	3
5	Republic of Korea	59.3	5	1
6	Netherlands	58.6	6	4
7	Finland	58.4	7	5
8	Singapore	57.8	8	2
9	Denmark	57.3	9	6
10	Germany	57.3	10	7
11	France	55.0	11	8
12	China	54.8	1	3
13	Japan	54.5	12	4
14	Hong Kong, China	53.7	13	5
15	Israel	53.4	14	1
16	Canada	53.1	15	2
17	Iceland	51.8	16	9
18	Austria	50.9	17	10
19	Ireland	50.7	18	11
20	Norway	50.4	19	12
21	Estonia	49.9	20	13
22	Belgium	49.2	21	14
23	**Luxembourg**	**49.0**	**22**	**15**
24	Czech Republic	49.0	23	16
25	Australia	48.3	24	6

High-income
Uper middle-income
Lower middle-income
Low-income

Europe
Northern America
South East Asia, East Asia, and Oceania
Northern Africa and Western Asia

Source: Global Innovation Index Database, WIPO, 2021

Table 6

Global Innovation Index 2021, Luxembourg in detail

Pillar/Indicator		Score/ Value	Rank
Institutions		**79.8**	**27**
1.1	**Political environment**	**90.4**	**6**
1.1.1	Political and operational stability*	92.9	4 ● ◆
1.1.2	Government effectiveness*	89.2	9
1.2	**Regulatory environment**	**81.9**	**26**
1.2.1	Regulatory quality*	87.9	11
1.2.2	Rule of law*	94.0	10
1.2.3	Cost of redundancy dismissal	21.7	93 ○ ◇
1.3	**Business environment**	**67.2**	**77** ◇
1.3.1	Ease of starting a business*	88.8	61
1.3.2	Ease of resolving insolvency*	45.5	84 ◇
Human capital and research		**40.0**	**40** ◇
2.1	**Education**	**48.3**	**70** ◇
2.1.1	Expenditure on education, % GDP	3.6	83 ○ ◇
2.1.2	Government funding/pupil, secondary, % GDP/cap	19.4	51
2.1.3	School life expectancy, years	14.3	65 ◇
2.1.4	PISA scales in reading, maths and science	476.7	35 ◇
2.1.5	Pupil-teacher ratio, secondary	◴ 8.9	19 ◆
2.2	**Tertiary education**	**35.8**	**55**
2.2.1	Tertiary enrolment, % gross	18.6	100 ○ ◇
2.2.2	Graduates in science and engineering, %	18.8	80
2.2.3	Tertiary inbound mobility, %	47.7	1 ● ◆
2.3	**Research and development (R&D)**	**36.0**	**31** ◇
2.3.1	Researchers, FTE/mn pop.	5,128.9	16
2.3.2	Gross expenditure on R&D, % GDP	1.2	33 ◇
2.3.3	Global corporate R&D investors, top 3, mn US$	59.2	23
2.3.4	QS university ranking, top 3*	0.0	74 ○ ◇

Pillar/Indicator		Score/ Value	Rank
Infrastructure		**52.5**	**33** ◇
3.1	**Information and communication technologies (ICTs)**	**82.1**	26
3.1.1	ICT access*	95.1	1 ● ◆
3.1.2	ICT use*	86.4	8
3.1.3	Government's online service*	76.5	49 ◇
3.1.4	E-participation*	70.2	70 ◇
3.2	**General infrastructure**	**28.6**	**66** ◇
3.2.1	Electricity output, GWh/mn pop.	1,719.4	87 ◇
3.2.2	Logistics performance*	73.5	24
3.2.3	Gross capital formation, % GDP	16.8	105 ○ ◇
3.3	**Ecological sustainability**	**46.7**	**22**
3.3.1	GDP/unit of energy use	16.8	15
3.3.2	Environmental performance*	82.3	2 ●
3.3.3	ISO 14001 environmental certificates/ bn PPP$ GDP	1.6	54
Market sophistication		**49.0**	**53** ◇
4.1	**Credit**	**29.6**	**107** ○ ◇
4.1.1	Ease of getting credit*	15.0	127 ○ ◇
4.1.2	Domestic credit to private sector, % GDP	107.3	22
4.1.3	Microfinance gross loans, % GDP	n/a	n/a
4.2	**Investment**	**49.0**	20
4.2.1	Ease of protecting minority investors*	54.0	88 ◇
4.2.2	Market capitalization, % GDP	79.6	20
4.2.3	Venture capital investors, deals/ bn PPP$ GDP	1.2	1 ● ◆
4.3	**Trade, diversification, and market scale**	**68.3**	**69** ◇
4.3.1	Applied tariff rate, weighted avg., %	1.8	25
4.3.2	Domestic industry diversification	84.2	68
4.3.3	Domestic market scale, bn PPP$	70.7	93 ◇

Table continues on next page

Pillar/Indicator		Score/ Value	Rank
Business sophistication		65.4	9
5.1	**Knowledge workers**	**60.7**	**1 ● ◆**
5.1.1	Knowledge-intensive employment, %	66.1	5
5.1.2	Firms offering formal training, %	0.6	35 ◇
5.1.3	GERD performed by business, % GDP	49.6	27
5.1.4	GERD financed by business, %	◴ 24.3	16
5.1.5	Females employed w/advanced degrees, %	59.2	6
5.2	**Innovation linkages**	**65.8**	13
5.2.1	University-industry R&D collaboration†	67.2	11
5.2.2	State of cluster development and depth†	0.1	47
5.2.3	GERD financed by abroad, % GDP	◴ 0.2	8
5.2.4	Joint venture/strategic alliance deals/ bn PPP$ GDP	5.4	7 ◆
5.2.5	Patent families/bn PPP$ GDP	49.0	14
5.3	**Knowledge absorption**	**4.5**	**1 ● ◆**
5.3.1	Intellectual property payments, % total trade	1.6	131 ○ ◇
5.3.2	High-tech imports, % total trade	4.4	1 ● ◆
5.3.3	ICT services imports, % total trade	–16.8	132 ○ ◇
5.3.4	FDI net inflows, % GDP	37.7	36 ◇
5.3.5	Research talent, % in businesses		
Knowledge and technology outputs		**54.4**	**3 ● ◆**
6.1	**Knowledge creation**	**39.1**	**24**
6.1.1	Patents by origin/bn PPP$ GDP	7.3	14
6.1.2	PCT patents by origin/bn PPP$ GDP	4.5	8
6.1.3	Utility models by origin/bn PPP$ GDP	n/a	n/a
6.1.4	Scientific and technical articles/ bn PPP$ GDP	18.7	48 ◇
6.1.5	Citable documents H-index	11.6	66 ◇
6.2	**Knowledge impact**	**27.0**	**76** ◇
6.2.1	Labor productivity growth, %	–1.7	97 ○
6.2.2	New businesses/th pop. 15–64	17.2	7 ◆
6.2.3	Software spending, % GDP	**0.2**	73 ◇
6.2.4	ISO 9001 quality certificates/bn PPP$ GDP	**3.3**	**71**
6.2.5	High-tech manufacturing, %	**16.4**	**69** ◇
6.3	**Knowledge diffusion**	**24.3**	**49** ◇
6.3.1	Intellectual property receipts, % total trade	2.1	11
6.3.2	Production and export complexity	n/a	n/a
6.3.3	High-tech exports, % total trade	0.6	86 ◇
6.3.4	ICT services exports, % total trade	3.0	35
Creative outputs		**54.4**	**3 ● ◆**
7.1	**Intangible assets**	**52.2**	**15**
7.1.1	Trademarks by origin/bn PPP$ GDP	69.2	24
7.1.2	Global brand value, top 5.000, % GDP	112.3	17
7.1.3	Industrial designs by origin/bn PPP$ GDP	6.9	19
7.1.4	ICTs and organizational model creation†	72.2	15
7.2	**Creative goods and services**	**42.8**	**8**
7.2.1	Cultural and creative services exports, % total trade	6.6	1 ● ◆
7.2.2	National feature films/mn pop. 15–69	29.6	1 ● ◆
7.2.3	Entertainment and media market/th pop. 15–69	n/a	n/a
7.2.4	Printing and other media, % manufacturing	0.7	73
7.2.5	Creative goods exports, % total trade	0.1	102 ○
7.3	**Online creativity**	**70.1**	**2 ● ◆**
7.3.1	Generic top-level domains (TLDs)/th pop. 15–69	84.3	4 ● ◆
7.3.2	Country-code TLDs/th pop. 15–69	68.7	9
7.3.3	Wikipedia edits/mn pop. 15–69	78.8	13
7.3.4	Mobile app creation/bn PPP$ GDP	44.8	11

NOTES: ● indicates a strength; ○ a weakness; ◆ an income group strength; ◇ an income group weakness; * an index; † a survey question. ◴ indicates that the economy's data are older than the base year; see appendices for details, including the year of the data, at http://globalinnovationindex.org. Square brackets [ ] indicate that the data minimum coverage (DMC) requirements were not met at the sub-pillar or pillar level.
Source: Global Innovation Index 2021

2.4 Luxembourg's position in the adjusted EU-27 rankings

To allow for a better comparison, this section offers an adjusted EU-27 ranking for the six benchmarks presented in the field of territorial competitiveness, digitalisation and innovation. Luxembourg's position is analysed here in relation to a fixed reference group made up of the Member States of the European Union.

First of all, it is useful to analyse the degree of concordance between the rankings of the six benchmarks. Kendall's concordance coefficient lends itself to this type of analysis, as it measures whether evaluators apply the same overall standard in assessing the samples. It takes a value between 0 (when there is no relationship) and 1 (when there is perfect accordance between the ratings and the judges). For the six benchmarks selected for analysis, Kendall's coefficient is 0.8476 and it appears that the rankings show a high degree of concordance[12].

Table 7

Overview of adjusted rankings of EU Member States

	TERRITORIAL COMPETITIVENESS		DIGITALISATION AND INNOVATION			
	World Competitiveness Ranking 2021 (IMD)	Index of Economic Freedom 2021 (The Heritage Foundation)	Digital Economy and Society Index 2021 (European Commission)	World Digital Competitiveness Ranking 2021 (IMD)	European Innovation Scoreboard 2021 (European Commission)	Global Innovation Index 2021 (WIPO)
Belgium	9	16	12	11	4	10
Bulgaria	25	14	26	25	26	20
Czechia	14	10	18	14	17	12
Denmark	2	3	1	2	3	4
Germany	7	11	11	6	6	5
Estonia	10	2	7	10	9	9
Ireland	6	1	5	7	11	8
Greece	21	27	25	21	20	26
Spain	17	17	9	13	16	16
France	11	24	15	9	10	6
Croatia	26	26	19	26	21	25
Italy	19	25	20	18	12	15
Cyprus	13	13	21	20	13	14
Latvia	16	12	17	17	25	22
Lithuania	12	4	14	12	18	23
Luxembourg	**5**	**7**	**8**	**8**	**7**	**11**
Hungary	20	22	23	22	22	19
Malta	n/a	15	6	n/a	14	13
Netherlands	3	5	4	3	5	2
Austria	8	9	10	5	8	7
Poland	22	18	24	19	24	24
Portugal	15	21	16	15	19	17
Romania	23	19	27	24	27	27
Slovenia	18	20	13	16	15	18
Slovakia	24	23	22	23	23	21
Finland	4	6	2	4	2	3
Sweden	1	8	3	1	1	1

Note: The table shows the order of EU Member States in the general rankings in the various benchmarks presented in this chapter. If a country is not assessed by a specific benchmark, "n/a" is written in the table.
Source: Table compiled by the Observatory for Competitiveness

12 As Malta is not considered in the two benchmarks published by IMD, the Kendall concordance coefficient is calculated excluding Malta. The six benchmarks considered here also show a high degree of concordance with the composite index of the National Competitiveness Scoreboard (TBCO, see chapter 3 of this Competitiveness Report). Indeed, if the TBCO is included in the calculations, Kendall's concordance coefficient is 0.8296.

Table 8

Trend in Luxembourg's position in the adjusted EU-27 rankings (2017-2021)

LUXEMBOURG		2017	2018	2019	2020	2021
Territorial competitiveness	World Competitiveness Ranking (IMD)	4	4	5	6	5
	Index of Economic Freedom (The Heritage Foundation)	3	4	5	6	7
Digitalisation and innovation	Digital Economy and Society Index (European Commission)	5	5	7	6	8
	World Digital Competitiveness Ranking (IMD)	7	7	8	11	8
	European Innovation Scoreboard (European Commission)	3	6	7	5	7
	Global Innovation Index (WIPO)	7	7	8	8	11

Note: The time series that show the evolution of positions in the different benchmarks should be consulted with caution and a degree of hindsight. Methodological changes may have been made to the way in which the indices in question are calculated, without the indices and rankings being recalculated for all previous years.
Source: Table compiled by the Observatory for Competitiveness

In 2021, Luxembourg remains well ranked among EU Member States in terms of territorial competitiveness, with a 5th place in the *World Competitiveness Ranking* and a 7th place in the *Index of Economic Freedom*. In terms of digitalisation and innovation, Luxembourg's performance is somewhat less good, with an 8th place in the *Digital Economy and Society Index* and the *World Digital Competitiveness Ranking*, a 7th place in the *European Innovation Scoreboard* and an 11th place in the *Global Innovation Index*.

However, an analysis of changes over time shows that Luxembourg's competitive position has deteriorated over the last five years. Compared to 2017, the country has lost between one and four places in each of the different EU-27 adjusted rankings. Even though Luxembourg's performance is still relatively good in the various benchmarks, it seems appropriate to act now to reverse the current negative trend.

2.5 The attractiveness of the financial centre

In view of the importance of financial activities in the Luxembourg economy, four benchmarks regarding the attractiveness of the financial centre are presented here: the *Global Financial Centres Index* and the *Global Green Finance Index*, both published by the British think-tank Z/Yen, the *New Financial Global Financial Centres Index* drawn up by New Financial, a think-tank specialising in the capital markets, as well as the *Venture Capital and Private Equity Country Attractiveness Index* drawn up by the IESE Business School.

2.5.1 The Global Financial Centres Index (Z/Yen)

A. General

In an increasingly globalised and interdependent world through information and communication technologies, financial centres face more intense competition than other sectors. Financial services are at the heart of the global economy, acting as a facilitator for international trade and overseas investment.

The British think tank Z/Yen publishes its twice-yearly index of the competitiveness of financial centres around the world, the *Global Financial Centres Index* (GFCI)[13]. The GFCI is compiled by Long Finance, an initiative established by Z/Yen that aims to improve society's understanding and use of finance in the long term. The current edition, GFCI 30, was published in September 2021 in collaboration with the China Development Institute.

The GFCI 30 uses two types of sources to assess the competitiveness of over 100 financial centres. The study uses 146 quantitative determinants (statistical data), to which it adds an assessment barometer based on online surveys of industry professionals. As defined in this study, the competitiveness of a financial centre is composed of five categories of indicators:

- Business Environment: political stability, regulation, macroeconomic environment, etc.;
- Human Capital: skilled labour, labour market flexibility, education and training, etc.;
- Infrastructure: built infrastructure, ICT, transport, etc.;
- Financial Sector Development: depth and breadth of industrial clusters, capital availability, market liquidity, etc.;
- Reputation: perception as a good place to live, degree of innovation, attractiveness, etc.

13 For more information see: *The Global Financial Centres Index*, https://www.longfinance.net/programmes/financial-centre-futures/global-financial-centres-index/

B. Results and rankings

The global ranking of this GFCI 30 edition is led by New York (score of 762/1000), ahead of London (740), Hong Kong (716), Singapore (715) and San Francisco (714).

Luxembourg's score (688) has dropped and the country is now ranked 23rd in the world, six places lower than in the previous edition (March 2021). This performance ranks Luxembourg 8th in the Western European regional ranking, and 4th among the EU financial centres.

Table 9

GFCI 30 - Top 25 overall

	GFCI 30		GFCI 29			
CENTRE	RANK	RATING	RANK	RATING	CHANGE IN RANK	CHANGE IN RATING
New York	1	762	1	764	- 0	↘ 2
London	2	740	2	743	- 0	↘ 3
Hong Kong	3	716	4	741	↗ 1	↘ 25
Singapore	4	715	5	740	↗ 1	↘ 25
San Francisco	5	714	12	718	↗ 7	↘ 4
Shanghai	6	713	3	742	↘ 3	↘ 29
Los Angeles	7	712	13	716	↗ 6	↘ 4
Beijing	8	711	6	737	↘ 2	↘ 26
Tokyo	9	706	7	736	↘ 2	↘ 30
Paris	10	705	25	699	↗ 15	↗ 6
Chicago	11	704	15	714	↗ 4	↘ 10
Boston	12	703	24	703	↗ 12	- 0
Seoul	13	702	16	713	↗ 3	↘ 11
Frankfurt	14	701	9	727	↘ 5	↘ 26
Washington DC	15	700	14	715	↘ 1	↘ 15
Shenzhen	16	699	8	731	↘ 8	↘ 32
Amsterdam	17	698	28	695	↗ 11	↗ 3
Dubai	18	694	19	710	↗ 1	↘ 16
Toronto	19	693	29	694	↗ 10	↘ 1
Geneva	20	692	20	709	- 0	↘ 17
Zurich	21	690	10	720	↘ 11	↘ 30
Edinburgh	22	689	21	708	↘ 1	↘ 19
Luxembourg	**23**	**688**	**17**	**712**	↘ **6**	↘ **24**
Madrid	24	687	33	683	↗ 9	↗ 4
Sydney	25	686	18	711	↘ 7	↘ 25

Source: Z/Yen, GFCI 30

Table 10

GFCI 30 – Top 15 by category

RANK	BUSINESS ENVIRONMENT	HUMAN CAPITAL	INFRASTRUCTURE	FINANCIAL SECTOR DEVELOPMENT	REPUTATIONAL & GENERAL
1	New York	New York	New York	New York	New York
2	London	Singapore	London	London	London
3	San Francisco	London	Singapore	San Francisco	Singapore
4	Chicago	Hong Kong	Hong Kong	Shanghai	Hong Kong
5	Singapore	San Francisco	Paris	Hong Kong	Chicago
6	Boston	Chicago	Frankfurt	Singapore	San Francisco
7	Hong Kong	Paris	Shanghai	Chicago	Edinburgh
8	Washington DC	Dubai	Los Angeles	Beijing	Seoul
9	Amsterdam	**Luxembourg**	Beijing	Boston	Toronto
10	Edinburgh	Los Angeles	Tokyo	Los Angeles	Washington DC
11	Copenhagen	Boston	Seoul	Seoul	Stockholm
12	Frankfurt	Geneva	San Francisco	Washington DC	Zurich
13	Tokyo	Tokyo	Amsterdam	**Luxembourg**	Tokyo
14	Shanghai	Stuttgart	Oslo	Paris	Paris
15	Geneva	Washington DC	Edinburgh	Frankfurt	Shanghai

Source: Z/Yen, GFCI 30

Table 11

GFCI 30 – Top 15 by industry

RANK	BANKING	INVESTMENT MANAGEMENT	INSURANCE	PROFESSIONAL SERVICES	GOVERNMENT & REGULATORY	FINANCE	FINTECH	TRADING
1	New York	New York	Singapore	New York	New York	New York	New York	New York
2	Hong Kong	London	Hong Kong	London	London	Shanghai	Singapore	London
3	Singapore	Singapore	Shanghai	Singapore	Singapore	Beijing	London	Hong Kong
4	Shanghai	Beijing	New York	Hong Kong	Zurich	Tokyo	Shanghai	Shanghai
5	London	Shanghai	Beijing	Shanghai	Hong Kong	Hong Kong	Wellington	Singapore
6	Beijing	Hong Kong	London	**Luxembourg**	Geneva	London	Shenzhen	Beijing
7	Shenzhen	Taipei	Shenzhen	Shenzhen	Shanghai	Shenzhen	Hong Kong	Chicago
8	Guangzhou	Shenzhen	**Luxembourg**	Zurich	**Luxembourg**	Singapore	GIFT City-Gujarat	Los Angeles
9	San Francisco	**Luxembourg**	Frankfurt	San Francisco	Seoul	**Luxembourg**	Beijing	Frankfurt
10	Zurich	Sydney	Zurich	Seoul	Frankfurt	Frankfurt	San Francisco	Zurich
11	Paris	Dubai	Paris	Geneva	Dubai	San Francisco	**Luxembourg**	San Francisco
12	Tokyo	San Francisco	Seoul	Frankfurt	Los Angeles	Los Angeles	Seoul	Washington DC
13	Wellington	Chicago	Sydney	Los Angeles	San Francisco	Guangzhou	Boston	Tokyo
14	Los Angeles	Zurich	Dubai	Dubai	Vancouver	Dubai	Los Angeles	Shenzhen
15	Chicago	Frankfurt	Washington DC	Toronto	Munich	Qingdao	Chicago	Vancouver

Source: Z/Yen, GFCI 30

In terms of individual categories, Luxembourg is well ranked for its human capital (9th) and financial sector development (13th). On the other hand, Luxembourg fails to rank in the top 15 for business environment, infrastructure and reputation.

Finally, the authors of the GFCI 30 report have established sub-indices for different activities in the financial sector and Luxembourg regularly appears among the best. Luxembourg ranks 9th in "Investment Management", 8th in "Insurance", 6th in "Professional Services", 8th in the "Government & Regulatory" sub-index, 9th in "Finance" and 11th in the "FinTech" section.

2.5.2 The Global Green Finance Index (Z/Yen)

A. General

In addition to its *Global Financial Centre Competitiveness Index*, Z/Yen also publishes the *Global Green Finance Index* (GGFI)[14]. Sustainability and green transition are increasingly important criteria in the financial sector. Green finance includes financial instruments and services that have a positive long-term impact on the environment and society. For the 80 listed financial centres, the GGFI composite index analyses two dimensions of green finance: market depth and quality of offerings. The current edition, GGFI 8, was published in October 2021.

The *Global Green Finance Index* relies on two types of sources to assess green finance. The study uses 143 quantitative determinants (statistical data), to which it adds an assessment barometer based on online surveys of industry professionals. As defined in this study, the competitiveness of financial centres in the field of green finance is composed of four categories of indicators:

- Sustainability: green finance activities, environment and biodiversity, renewable energy, quality of life;
- Infrastructure: built infrastructure, ICT infrastructure, transport infrastructure, fossil fuel use;
- Human capital: availability of skilled labour, labour market flexibility, wealth and economy, governance;
- Business factors: political stability and rule of law, institutional and regulatory environment, tax and cost competitiveness, economic environment.

B. Results and rankings

The overall ranking of the GGFI 8 is led by London (score of 571) ahead of Amsterdam (562) and San Francisco (549).

Table 12

GGFI 8 – Top 15 overall and rankings by dimension

GGFI 8 RANK	CENTRE	GGFI DIMENSIONS			
		GREEN FINANCE DEPTH		GREEN FINANCE QUALITY	
		RANK	RATING	RANK	RATING
1	London	2	280	1	291
2	Amsterdam	1	281	3	281
3	San Francisco	3	274	5	275
4	Zurich	17	266	2	282
5	**Luxembourg**	**4**	**273**	**7**	**272**
6	Geneva	8	270	6	274
7	Stockholm	5	272	9	271
8	Los Angeles	6	271	9	271
9	Oslo	23	263	4	278
10	Paris	6	271	12	269
11	Beijing	15	267	7	272
12	Copenhagen	8	270	13	268
13	New York	11	269	13	268
14	Shanghai	8	270	17	266
15	Washington DC	11	269	21	265

Source: Z/Yen, GGFI 8

14 For more information see: *The Global Green Finance Index*, https://www.longfinance.net/programmes/financial-centre-futures/global-green-finance-index/

Luxembourg (545) slightly improves its score and is now ranked 5th in the world. As for the financial centre profile, Luxembourg is considered a Global Specialist thanks to the depth of green activities in the financial centre's business.

Looking at the two GGFI dimensions in more detail, Luxembourg ranks 4th for the depth of green finance in the market and 7th for the quality of green finance offerings.

2.5.3 The New Financial Global Financial Centres Index (New Financial)

A. General

In June 2021, the think tank New Financial published its *Global Financial Centres Index*[15] which analyses the size and growth of financial markets in more than 60 countries around the world. For its analyses, New Financial collects data on 73 indicators from public sources (IMF, World Bank, OECD, United Nations, etc.) and private sources (Dealogic, Preqin, etc.). In order to eliminate the annual volatility of financial markets, the analysis is based on a rolling three-year average for each indicator. The data is then normalised on a scale of 0 to 100 to calculate the different rankings.

In its report, New Financial primarily uses indicators that measure the size and volume of financial activities, unlike many other studies on financial centres that often use qualitative factors in their analyses. In fact, New Financial believes that the value of financial activities best reflects the attractiveness of a financial centre.

B. The world's leading financial centres

The main index on *Global Financial Centres* includes 42 variables in total, including 21 indicators that measure market size and domestic activities and 21 indicators that measure each country's international financial activities.

The ranking is dominated by the United States (1st, 84/100) ahead of the United Kingdom (2nd, 35/100), China (3rd, 29/100), Japan (4th, 29/100) and Hong Kong (5th, 14/100). Luxembourg loses one position compared to the previous edition and now ranks 8th (11/100), just behind France (6th, 13/100) and Germany (7th, 12/100).

On both single aspects, Luxembourg ranks 3rd for international activities with a score of 22/100 and 41st for domestic activities with a score of 1/100.

Table 13

The New Financial Global Financial Centres Index – Top 20 (Ranking and scores)

RANK				SCORE		
2019	2016	TREND	COUNTRY	MAIN INDEX	DOMESTIC	INTERNATIONAL
1	1	-	US	84	93	76
2	2	-	UK	35	14	56
3	3	-	China	29	47	9
4	4	-	Japan	19	25	12
5	8	↗	Hong Kong	14	7	21
6	5	↘	France	13	14	11
7	6	↘	Germany	12	11	12
8	**7**	↘	**Luxembourg**	**11**	**1**	**22**
9	9	-	Canada	10	10	9
10	11	↗	Singapore	8	3	14
11	10	↘	Netherlands	7	4	10
12	12	-	India	7	12	1
13	14	↗	Switzerland	6	4	9
14	13	↘	Australia	6	7	5
15	16	↗	South Korea	5	8	1
16	18	↗	Ireland	4	1	8
17	15	↘	Italy	4	5	2
18	17	↘	Spain	4	5	2
19	19	-	Taiwan	3	4	2
20	20	-	Brazil	3	5	1

Source: New Financial

15 For more information see: *The New Financial Global Financial Centres Index*, https://newfinancial.org/report-driving-growth-the-new-financial-global-financial-centres-index-2/

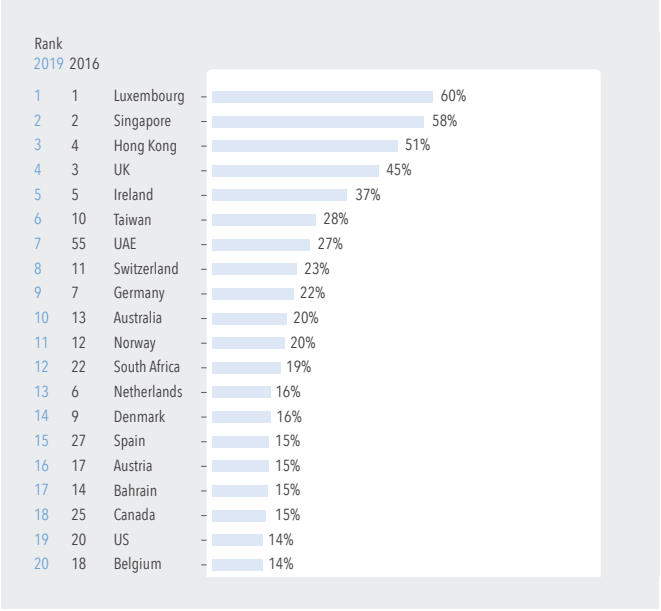
C. Internationalisation of financial centres

In a complementary approach, New Financial also analyses the level of internationalisation of the different financial centres by measuring for 13 indicators the average share of international activities in total activities.

The internationalisation ranking is led by Luxembourg (1st), ahead of Singapore (2nd), Hong Kong (3rd), the UK (4th) and Ireland (5th).

Figure 8

The New Financial Global Financial Centres Index – Internationalization of financial centres



Source: New Financial

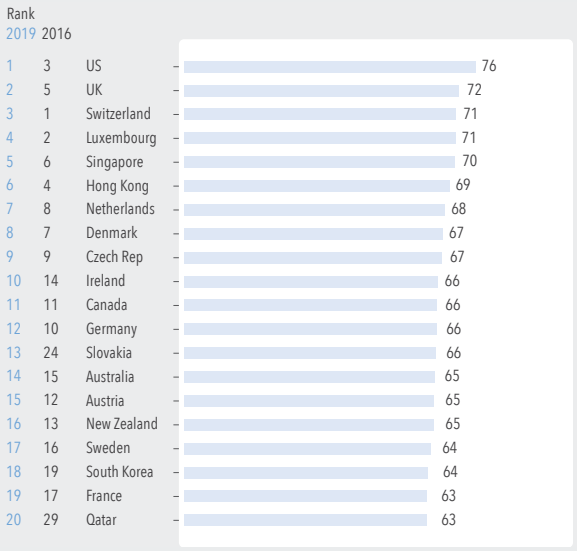
D. The wider business environment

In addition to the analysis of the size and volume of domestic and international business, New Financial uses other metrics to analyse the wider business environment. The 18 indicators in this area include economic, financial, political, legal, regulatory and social aspects.

The ranking for the wider business environment is led by the US (1st), ahead of the UK (2nd), Switzerland (3rd), Luxembourg (4th) and Singapore (5th).

Figure 9

The New Financial Global Financial Centres Index – Business environment (Ranking and scores)



Source: New Financial

E. Luxembourg – Key points

In summary, New Financial identifies the following key points for Luxembourg:

- *Ranks 3rd in the world and 2nd in Europe for international activity, but very small domestic market;*
- *Global leader in corporate bond issuance and issuance of green, social and sustainable bonds by foreign companies;*
- *The most international of any financial centre with international activity representing 60% of total;*
- *4th in the world for wider economic, financial, business and regulatory environment;*
- *2nd biggest hub for investment funds, 2nd biggest recipient of FDIs in the financial sector and 3rd larger exporter of financial services in the world.*

2.5.4 The Venture Capital and Private Equity Country Attractiveness Index (IESE)

A. General

The IESE Business School published the tenth edition of its *Venture Capital and Private Equity Country Attractiveness Index*[16] in July 2021. The purpose of this composite index is to measure the attractiveness of a country for venture capital (VC) and private equity (PE, which generally refers to investment in unlisted companies). The index compares the attractiveness of 125 countries from the perspective of the institutional investor, based on various socio-economic parameters. The index assesses six determinants to measure the VC/PE attractiveness of a country:

1) Economic Activity, 2) Depth of Capital Market, 3) Taxation, 4) Investor Protection and Corporate Governance, 5) Human and Social Environment and 6) Entrepreneurial Culture and Deal Opportunities. These six key drivers are decomposed into a total of 21 equally weighted subcategories.

B. Results

The overall ranking of the VC/PE Country Attractiveness 2021 is led by the United States (score of 100/100) ahead of the United Kingdom (90.3), Japan (87.4), Germany (87.3) and Canada (87.2). With a score of 61.4, Luxembourg remains in 36th place worldwide.

C. Luxembourg's performance in detail

In comparison with the regional reference group of twenty Western European countries, Luxembourg performs worse both on the overall index and on the six individual determinants of VC/PE attractiveness. While Luxembourg's score is close to the regional average for Economic Activity, Taxation, and Investor Protection and Corporate Governance, the Grand Duchy's performance is well below average for the Depth of Capital Market, Human and Social Environment, and Entrepreneurial Culture and Deal Opportunities.

Table 14

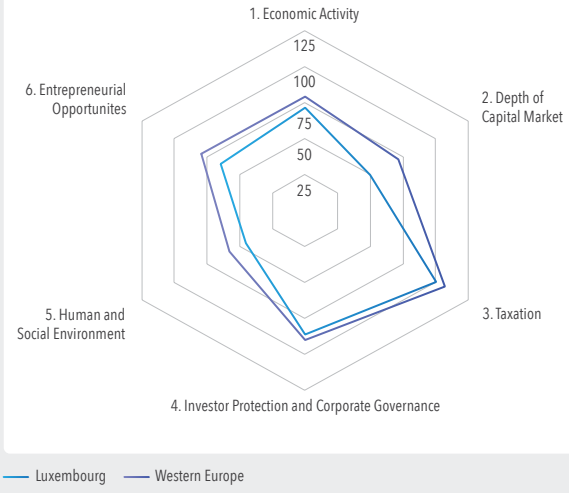
VC/PE Country Attractiveness 2021 – Top 50

RANK	COUNTRY	SCORE	RANK	COUNTRY	SCORE
1	United States	100.0	26	India	71.0
2	United Kingdom	90.3	27	Italy	70.8
3	Japan	87.4	28	Poland	67.8
4	Germany	87.3	29	Thailand	66.3
5	Canada	87.2	30	Russian Federation	66.1
6	Singapore	85.0	31	Portugal	65.4
7	China	84.7	32	United Arab Emirates	64.8
8	Australia	84.0	33	Czech Republic	64.1
9	Korea, South	83.8	34	Chile	64.0
10	France	83.6	35	Mexico	61.4
11	Hong Kong	82.4	**36**	**Luxembourg**	**61.4**
12	Netherlands	81.7	37	Saudi Arabia	61.4
13	Sweden	81.0	38	Estonia	61.0
14	Denmark	80.8	39	Turkey	60.8
15	Switzerland	79.5	40	South Africa	60.3
16	Finland	78.9	41	Romania	58.8
17	Norway	78.1	42	Hungary	58.8
18	New Zealand	76.7	43	Indonesia	57.8
19	Israel	76.5	44	Cyprus	57.4
20	Spain	76.1	45	Lithuania	57.3
21	Belgium	75.0	46	Vietnam	56.9
22	Austria	75.0	47	Brazil	56.5
23	Malaysia	74.8	48	Bulgaria	56.5
24	Ireland	73.9	49	Slovenia	56.5
25	Taiwan	71.9	50	Greece	55.5

Source: IESE, The Venture Capital and Private Equity Country Attractiveness Index 2021

Figure 10

VC/PE Country Attractiveness 2021 – Peer group comparison Luxembourg



Source: IESE, The Venture Capital and Private Equity Country Attractiveness Index 2021

16 For more information see: IESE, *The Venture Capital and Private Equity Country Attractiveness Index*, https://blog.iese.edu/vcpeindex/

In detail, Luxembourg achieves the following performance for the 6 drivers and 21 sub-categories:

Table 15

VC/PE Country Attractiveness 2021 – Details Luxembourg

INDICATOR		RANK	SCORE
VC/PE Country Attractiveness Index		36	61.4
1	Economic Activity	65	71.3
1.1	*Size of the Economy (GDP)*	*68*	*37.7*
1.2	*Expected Real GDP Growth*	*64*	*100.4*
1.3	*Unemployment*	*59*	*95.7*
2	Depth of Capital Market	61	49.6
2.1	*Size and Liquidity of the Stock Market*	*73*	*50.3*
2.2	*Total Trading Volume*	*78*	*57.9*
2.3	*IPOs and Public Issuing Activity*	*34*	*50.5*
2.4	*M&A Market*	*44*	*51.2*
2.5	*Debt and Credit Market*	*113*	*19.8*
2.6	*Bank Non-Performing Loans*	*8*	*100.3*
3	Taxation	36	99.7
3.1	*Tax Incentives and Administrative Burden*	*36*	*99.7*
4	Investor Protection and Corporate Governance	27	86.1
4.1	*Quality of Corporate Governance*	*95*	*52.8*
4.2	*Security of Property Rights*	*5*	*108.4*
4.3	*Quality of Legal Enforcement*	*3*	*111.4*
5	Human and Social Environment	27	45.2
5.1	*Education and Human Capital*	*52*	*10.2*
5.2	*Labor Regulations*	*41*	*72.2*
5.3	*Bribing and Corruption*	*8*	*124.8*
6	Entrepreneurial Opportunities	34	64.4
6.1	*Innovation*	*18*	*81.6*
6.2	*Scientific and Technical Journal Articles*	*76*	*39.6*
6.3	*Burdens of Starting and Running a Business*	*49*	*100.6*
6.4	*Simplicity of Closing a Business*	*53*	*73.4*
6.5	*Corporate R&D*	*33*	*46.4*

Source: IESE, The Venture Capital and Private Equity Country Attractiveness Index 2021

2.6 Conclusions

Overall, Luxembourg's performance is judged to be fairly good in the various benchmarks of competitiveness and territorial attractiveness, digitalisation and innovation. The Grand Duchy is most often ranked in the first third among EU Member States. In this reference group (EU-27), it is the Nordic countries (Sweden, Denmark, Finland, the Netherlands and Ireland) regularly dominate the rankings. Behind this leading group, the Western European countries are in second place (especially Luxembourg, with Germany, Belgium, France and Austria among others). The countries of Southern and Eastern Europe are mostly in the middle and bottom of the rankings.

The *World Competitiveness Ranking* validates Luxembourg's continued good territorial competitiveness. Among others, the country's political and macroeconomic stability, a favourable business environment and a good regulatory framework, international openness, the high level of productivity, as well as the efficiency of the public authorities are heralded as strengths. Among Luxembourg's weak points, labour costs, tax competitiveness, the volume of international investment, price developments, and technological and scientific infrastructure are considered greatest causes for concern. Luxembourg's main challenges concern the green, digital and inclusive transition, economic diversification and boosting productivity of the domestic economy. The *Index of Economic Freedom* attests to Luxembourg's good performance in terms of rule of law and open markets, while the country's performance is rated as mixed in terms of size of government and regulatory efficiency. Luxembourg's particular strengths are the fiscal position of the state, the integrity of government institutions and the freedom to invest. On the negative side, the tax burden, freedom of labour and the level of government expenditure as a proportion of GDP are seen as causes for concern.

Luxembourg improved its performance in the *Digital Economy and Society Index*. The country performs particularly well on connectivity and is also above the EU average on indicators related to e-skills and on indicators of ICT specialisation. Luxembourg is in the middle of the pack in terms of digital integration by businesses. The country performs well in the use of new technologies, but few companies sell their goods and services online. Luxembourg has made progress in the area of digital public services. While many public services are available online for businesses and individuals, the number of Internet users using e-government is relatively low in European comparison.

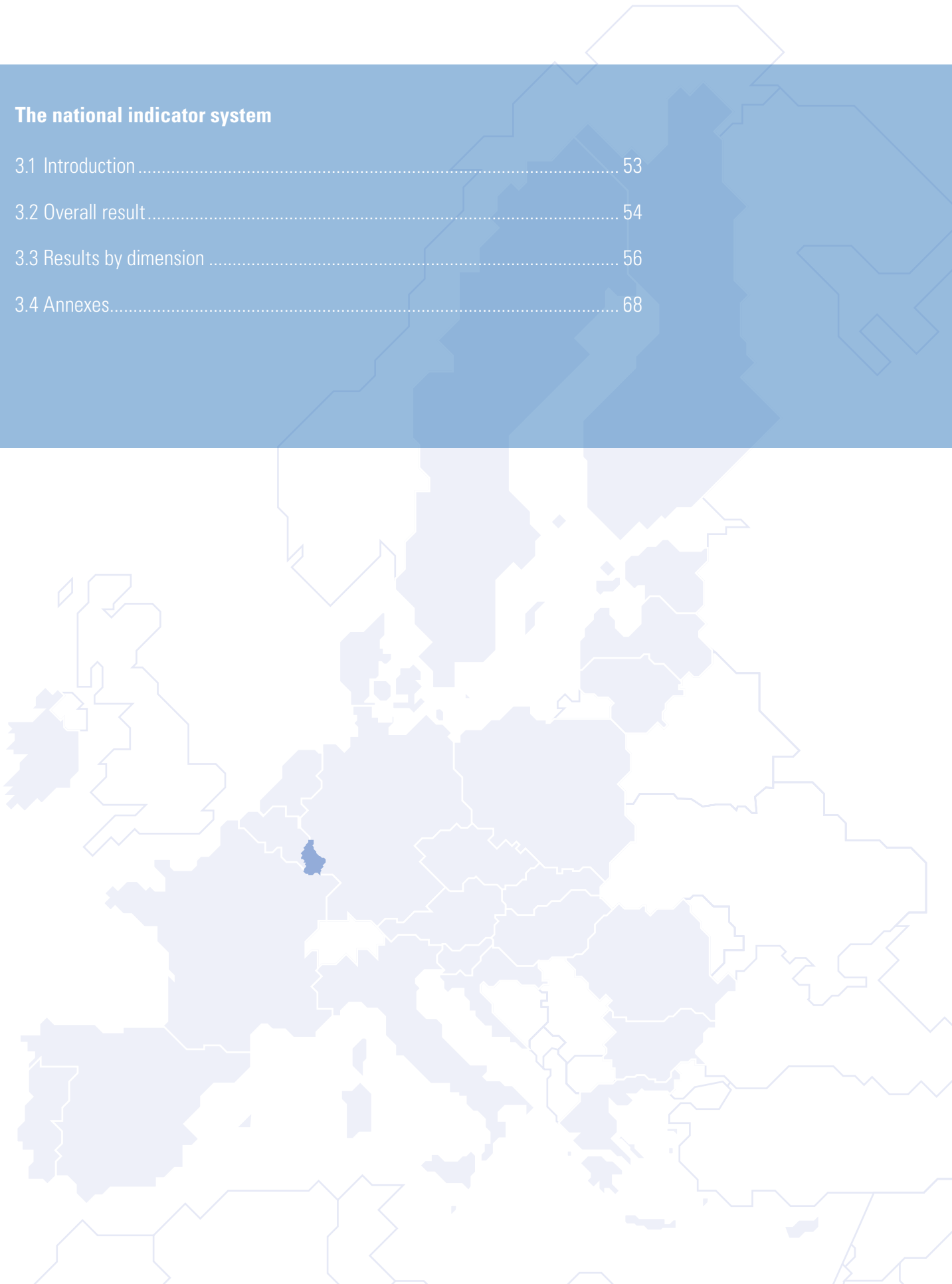
Although the country has improved in the rankings of the three pillars of the *World Digital Competitiveness Ranking* compared to last year, over the five-year period from 2017 to 2021, Luxembourg's position has deteriorated in the three pillars of knowledge and skills, technology and future readiness. In terms of individual criteria, Luxembourg stands out in particular in market capitalisation in the technology and media sectors, as well as in the number of R&D employees. Favourable legislation in the area of scientific research and the attractiveness of the country for a highly qualified foreign workforce are other assets of Luxembourg. However, there is still room for improvement in terms of science graduates, investment in telecommunications, e-government and e-participation of citizens.

According to the *European Innovation Scoreboard* and the *Global Innovation Index*, Luxembourg performs relatively well in this area. The country has an attractive research environment with a regulatory framework conducive to innovation. The high level of education of the population and the importance that companies give to training are other assets that favour innovation. The volume of venture capital invested is high in relation to the country's GDP, which supports the dynamism in creation and development of companies and especially in innovative start-ups. Research and innovation also seem to be efficient in Luxembourg. However, this is mitigated by the fact that R&D spending is low in both the public and private sectors. Another drawback is that research and innovation efforts seem to have difficulty penetrating markets. Thus, the turnover achieved by innovative firms through the sale of new or significantly improved products is low compared to the total turnover of all firms. Similarly, the share of high- and medium-high-tech products in exports is low. This is compensated, at least in part, by significant exports of knowledge-intensive services.

In the area of attractiveness of financial centres, Luxembourg ranks firmly among the world's leading centres. Luxembourg not only offers a favourable regulatory framework and business environment, but also has a high level of expertise in international financial business thanks to its large multilingual talent pool. These strengths have enabled it to become the largest investment fund centre in Europe (and the second largest investment fund centre in the world after the US), as well as one of the most significant exporters of financial services. In green finance, Luxembourg is recognised as a global specialist thanks to the depth of green activities in the financial centre's business. Luxembourg is a leading international platform for sustainable finance, especially in green bonds and responsible and impact investment funds. While the Luxembourg financial centre enjoys a high level of attractiveness, Luxembourg is not considered a very attractive country for direct investment in venture capital and private equity.

Chapter 3

The national indicator system



The national indicator system
The competitiveness scoreboard

3.1 Introduction

3.1.1 General

The Observatory for Competitiveness (ODC) is committed to sustainability and has embraced the definition of competitiveness used by the Social and Economic Council (CES): "A nation's ability to sustainably improve the quality of life of its residents and to provide them with a high level of employment and social cohesion, while protecting the environment"[1].

Since the competitiveness scoreboard (hereafter TBCO) was revised in 2016 in close collaboration with the Economic and Social Council, it has been based on three sustainable development pillars, namely the economic dimension, the social dimension and the environmental dimension. Although each dimension deals with a specific area, the three dimensions remain interconnected to provide a general overview of the country's sustainable competitiveness.

The scoreboard aims to establish a working reference tool for social dialogue and to enrich public debate. Furthermore, it should help to shed light on the areas where Luxembourg's performance has room for improvement. Accordingly, the general diagnosis of Luxembourg's competitiveness determined by the indicator system could be followed up by a road map of actions with precise, quantifiable and measurable objectives determined in cooperation with all of the social partners.

However, it should be noted that the scoreboard can be adapted if needed and thus may change over time. The scoreboard is currently made up of 68 individual indicators. Both the economic and social dimensions include 25 indicators. However, the environmental dimension consists of only 18 indicators, partly due to a lack of internationally comparable data. The next challenge for the Observatory for Competitiveness (hereafter ODC) is to supplement this dimension in consultation with the ESC.

The 2021 edition represents an opportunity to provide an indication of the effects of the COVID-19 crisis on changes in the TBCO indicators, bearing in mind that the most recent data available is for 2020[2]. The economic recovery is certainly a crucial opportunity to lay the foundations for future competitiveness.

3.1.2 Methodology

The data in the national indicator system is analysed using two different approaches. The "composite indicator" approach summarises the data from the different indicators into a single numerical value which is used to rank the countries in terms of competitiveness. Furthermore, it should be noted that the detailed methodology for the calculation of the summary indicator can be downloaded from the Observatory for Competitiveness website, as is the robustness analysis, the tables of secondary indicators and other information supplementing the 2021 edition[3].

The "scoreboard" approach analyses Luxembourg's position and performance in relation to the other EU Member States in individual indicators, divided into different dimensions.

3.1.2.1 The "composite indicator" approach

Calculation of a composite indicator makes it possible to summarise the performance of countries using a set of indicators, with all the advantages and disadvantages that this implies. A composite indicator with country rankings is often appreciated by the media, as it allows for compact and instant information. However, it is no substitute for a more serious and in-depth analysis of each dimension considering individual indicators. To the contrary, a composite indicator inevitably requires a more detailed look at the baseline data used.

In total, ODC calculates four composite indicators: a general composite indicator that groups all 68 TBCO indicators and serves as a basis for the general ranking of countries, and a specific composite indicator for each dimension of the national indicator system (i.e. economic, social and environmental).

3.1.2.2 The "scoreboard" approach

The analytical method remains unchanged from previous editions of the scoreboard.

Firstly, Luxembourg's position is highlighted in relation to the average for European Union Member States.

1 Avis du CES, Le système d'indicateurs national, https://ces.public.lu/dam-assets/fr/avis/politique-generale/avis-8716-.pdf
2 Closing date of statistics: 29 October 2021.
3 For more information see: https://odc.gouvernement.lu/fr/domaines-activite/Outils-evaluation_competitivite/tableau-bord-national-de-la-competitivite.html

If Luxembourg's performance is more than 20% better than the EU average, the indicator is classified as "green" (favourable position).

If Luxembourg's performance is up to 20% above or below the EU average, the indicator is classified as "orange" (neutral position).

If Luxembourg's performance is more than 20% worse than the EU average, the indicator is classified as "red" (unfavourable position).

If Luxembourg's performance has improved since the last edition of the scoreboard, the indicator in question will be marked with an upward arrow.

If Luxembourg's performance has remained stable since the last edition of the scoreboard, the indicator in question will be marked with a horizontal arrow.

If Luxembourg's performance has worsened since the last edition of the scoreboard, the indicator in question will be marked with a downward arrow.

This rating is a purely visual tool to see quickly where Luxembourg is in comparison with the EU average. It should be noted that some indicators may be classified as "blank". In this case, the EU average cannot be calculated, either because of lack of data or for methodological reasons.

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

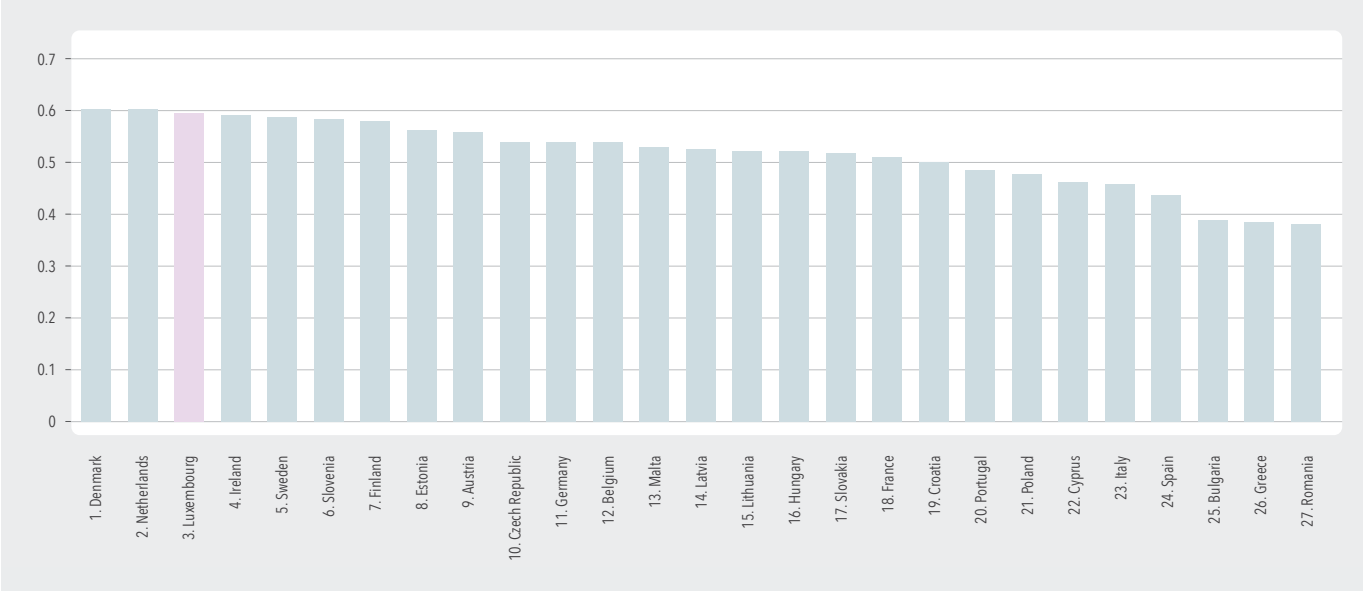
In addition to the comparison with the EU average, Luxembourg is compared with the best- and worst-performing EU Member States.

3.2 Overall result

According to the composite index calculated by the Observatory for Competitiveness based on the 2020 national indicator system, Luxembourg is in third place in the EU-27[4], ahead of Denmark (1st) and the Netherlands (2nd). Germany is 11th, Belgium is 12th and France is 18th in the global ranking.

Figure 1

Overall result 2020



4 With the UK's exit from the EU effective 31 January 2020, the United Kingdom is no longer a Member State. It should be noted that this impacts the EU average, as well as the ranking of Member States.

It is important to note that the values for some countries are extremely close to one another; this is the case, for example, for Denmark and the Netherlands or the group of countries comprising Sweden, Ireland, Finland and Slovenia. Therefore, minimal variations in one sole indicator in one of the three dimensions may result in a slight increase or decrease in the overall composite index, and may thus change the overall rankings.

As every year, the Observatory for Competitiveness has recalculated the overall ranking for the last ten years in order to take regular revisions of statistical data into account . During this period, Denmark is the country that has most often topped the rankings.

Box 1

Data revisions

As mentioned earlier, the update of the Scoreboard and rankings takes into account regular revisions of statistical data for previous years (from 2011 to 2019 for the current edition). Revisions to national accounts by national statistical institutes in the respective Member States have had an impact on some indicators, especially those using GDP in the denominator. In addition, the data for some indicators is published with varying time lapses. This explains why the results published in previous Report may differ from the results published in this 2021 edition.

Table 1

Overall ranking from 2011 to 2020

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Germany	9	8	7	9	10	10	10	10	12	11
Austria	6	3	4	5	7	9	8	7	9	9
Belgium	8	9	10	13	13	13	14	15	14	12
Bulgaria	27	26	26	26	26	27	26	27	26	25
Cyprus	22	25	25	25	25	24	24	22	20	22
Croatia	21	20	20	20	20	20	18	18	18	19
Denmark	1	1	1	2	2	1	2	6	2	1
Spain	23	21	22	21	22	23	23	23	23	24
Estonia	13	12	15	15	12	11	12	11	8	8
Finland	5	4	5	4	5	5	6	8	6	7
France	11	11	9	12	11	12	13	13	15	18
Greece	26	27	27	27	27	26	27	26	25	26
Hungary	15	19	17	16	15	17	19	16	16	16
Ireland	14	14	13	10	3	3	4	1	5	4
Italy	16	18	19	19	19	19	20	24	24	23
Latvia	19	16	16	17	16	16	17	19	17	14
Lithuania	18	13	14	14	14	14	15	14	13	15
Luxembourg	3	6	3	3	4	6	7	2	4	3
Malta	12	15	8	11	17	15	11	12	11	13
Netherlands	4	5	6	6	6	4	3	4	3	2
Poland	20	22	23	24	23	22	22	21	22	21
Portugal	24	23	21	22	21	21	21	20	21	20
Romania	25	24	24	23	24	25	25	25	27	27
Czech Republic	10	10	11	8	9	7	9	9	10	10
Slovakia	17	17	18	18	18	18	16	17	19	17
Slovenia	7	7	12	7	8	8	5	3	1	6
Sweden	2	2	2	1	1	2	1	5	7	5

In 2020, Luxembourg moves up one place compared to the previous year. Slovenia is the biggest loser in terms of positions (-5), as it drops from 1st place in 2019 to 6th in 2020. Conversely, Latvia's position improves the most (+3) in the ranking compared to the 2020 edition.

Then, when comparing the 2020 situation to that of 2011, the biggest negative changes occurred in the rankings of France and Italy (-7). However, some countries have particularly improved their rankings: Ireland, for example, has improved by ten places.

3.3 Results by dimension

This section will split the general composite indicator into its three dimensions, making it possible to assess the performances of the EU Member States in each dimension.

As already explained in the introduction, this assessment is based on two approaches: the "composite indicator" approach and the "national scoreboard" (TBCO) approach. The national scoreboard approach is based on a summary table that gives an overall view of the values of the individual indicators and of Luxembourg's position in the Member State rankings, taking into account changes in values and positions. For each individual indicator in the table, the EU average is indicated, as well as the highest- and lowest-ranking countries.

3.3.1 Economic dimension

3.3.1.1 The "composite indicator" approach

According to the composite economic indicator, Luxembourg ranks 8th in 2020, ahead of Belgium (9th) and France (18th). Germany ranks 7th. The top three are Ireland (1st), Sweden (2nd) and Denmark (3rd).

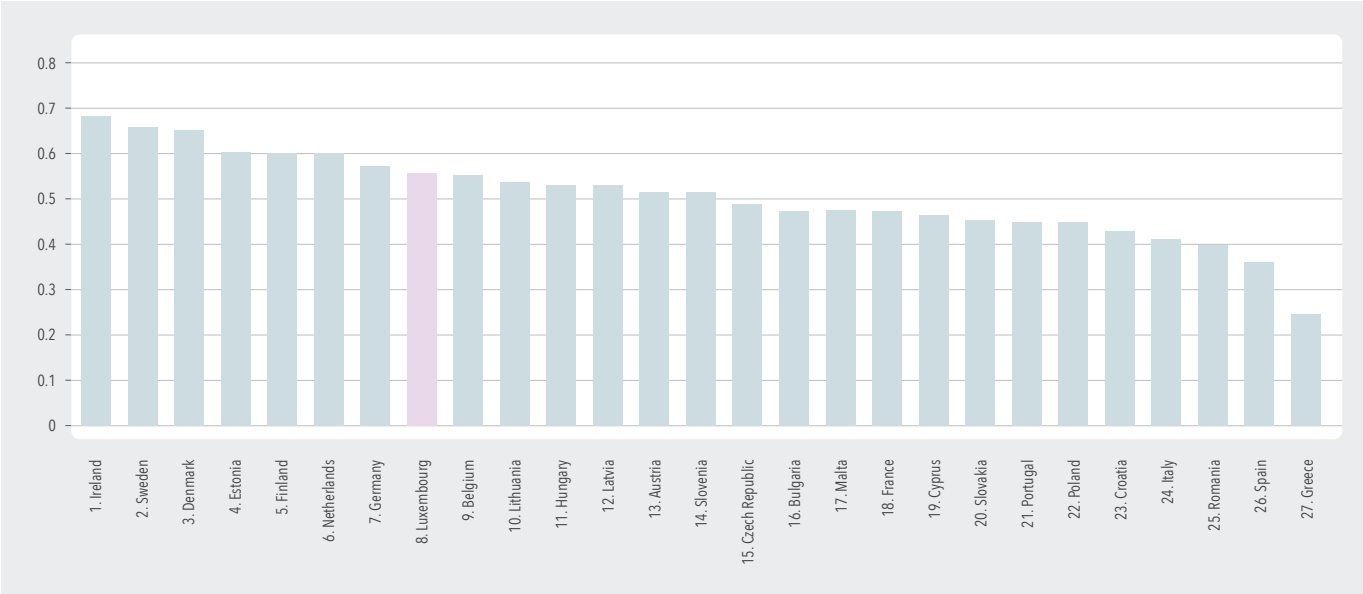
Box 2

Relative nature of rankings

From a methodological perspective, it is worth remembering that the rankings are relative by design, meaning that Luxembourg's ranking also depends on the performances of other countries. Regardless of whether Luxembourg performs well or badly, other countries might perform even better or even worse, and so Luxembourg's position will ultimately increase or decrease depending on that. The rankings reveal nothing about a country's absolute performance. That is why the Observatory for Competitiveness always recommends providing a more detailed description of the scoreboard's individual base indicators.

Figure 2

Results for the economic dimension in 2020



Ireland, which leads the economic rankings, has been in first place since 2015, with the exception of 2019. However, it should be remembered that these results still include the dramatic increase in Irish GDP in 2015 linked to the relocation to Ireland of the activities of several major foreign economic operators.

Luxembourg's performance has been mixed. The positions range from 3rd in 2013 to 14th in 2019. In 2020, Luxembourg moves up six places compared to the previous year.

Comparing the results of the most recent data to the previous year, Slovenia and Poland lost the most positions (-9), while Belgium, Hungary, Latvia and Luxembourg moved up the most positions (+6).

After this, comparing the performance of the economic dimension between 2011 and 2020, Ireland shows the best performance in gaining 14 positions. In contrast, the worst performing country is Poland, which dropped 11 positions.

3.3.1.2 The national scoreboard approach

In order to gain a deeper understanding of these "relative" rankings, it is important to determine how changes in position have occurred. It is difficult, if not impossible, to assess a country's performance in a general way by looking at the composite indicators alone. Accordingly, it is worth analysing the basic data and the individual indicators used in more detail in order to understand the performance of Luxembourg's composite indicators.

Comparing Luxembourg's economic performance with that of the EU, it is apparent that Luxembourg is 20% above the EU average in six indicators. Seven indicators are orange and are thus in the average range, while six Luxembourg indicators feature performance 20% below the EU-27 average. It was not possible to calculate an EU average for the remaining six indicators.

Table 2

Rankings for the economic dimension from 2011 to 2020

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Germany	2	3	2	6	8	7	8	8	9	7
Austria	8	4	6	15	13	12	11	10	10	13
Belgium	6	8	9	9	9	15	13	16	15	9
Bulgaria	23	18	22	24	20	20	20	19	20	16
Cyprus	20	24	26	26	24	21	19	21	16	19
Croatia	24	22	21	22	25	23	22	20	22	23
Denmark	1	1	1	1	4	3	3	3	1	3
Spain	26	26	25	25	26	26	26	25	25	26
Estonia	3	2	4	3	5	8	10	5	4	4
Finland	4	5	10	13	10	6	5	7	6	5
France	13	14	12	17	15	14	15	18	19	18
Greece	27	27	27	27	27	27	27	27	27	27
Hungary	17	23	17	19	16	17	17	17	17	11
Ireland	15	13	8	4	1	1	1	1	2	1
Italy	21	21	23	21	23	25	25	26	26	24
Latvia	14	6	13	14	12	11	16	15	18	12
Lithuania	18	9	5	8	14	18	21	14	7	10
Luxembourg	9	10	3	7	7	9	12	11	14	8
Malta	16	16	14	12	11	13	7	12	12	17
Netherlands	5	7	11	10	6	5	4	6	8	6
Poland	11	20	19	20	21	19	18	13	13	22
Portugal	25	25	24	23	22	24	24	22	21	21
Romania	19	19	16	11	17	16	14	24	23	25
Czech Republic	10	15	7	5	3	4	6	9	11	15
Slovakia	22	17	20	18	19	22	23	23	24	20
Slovenia	12	12	18	16	18	10	9	4	5	14
Sweden	7	11	15	2	2	2	2	2	3	2

Table 3

Data for the economic dimension

			LUXEMBOURG					INTERNATIONAL COMPARISON		
		YEAR	VALUE	TREND[5]	Δ_V[6]	POSITION	Δ_P[7]	EU	FIRST	LAST
A1	Public debt (% of GDP)	2020	24.80	↘	+2.50	3/27	0	90.10	EE: 19.00	EL: 206.30
A2	Government balance (% of GDP)	2020	-3.50	↘	-5.80	3/27	-1	-6.90	DK: -0.20	ES: -11.00
A3	Current account balance, % of GDP (average over 3 years)[8]	2020	4.50	↗	-0.20	18/27	+1	N/A	EE: 1.00	NL: 9.10
A4	Market share of world exports (% change over 5 years)	2020	20.63	↗	+9.96	6/27	+4	N/A	IE: 49.97	EL: -10.10
A5	Net international investment position (% of GDP)	2020	39.90	↘	-18.30	6/27	-2	N/A	NL: 113.90	EL: -175.00
A6	Real effective exchange rate (42 trade partners, % change over 3 years)	2020	1.50	↗	-0.50	12/27	+4	N/A	HU: -4.90	BG: 7.10
A7	Real GDP growth (%; average over 3 years)	2020	1.17	↘	-1.03	8/27	+11	-0.67	IE: 6.60	IT: -2.53
A8	Inflation rate (%)[9]	2020	0.80	↗	-0.20	2/27	+4	0.70	SE: 0.70	PL: 3.70
A9	Long-term government bond yields (%)	2020	-0.41	↗	-0.29	2/27	+1	0.32	DE: -0.51	RO: 3.89
A10	Regulatory capital for risk-weighted assets (%)	2020	24.32	↗	+2.41	6/24	+2	N/A	EE: 26.53	EL: 16.66
A11	GDP/hour worked (US=100)	2019	138.13	↘	-0.04	1/27	0	N/A	LU: 138.00	BG: 38.00
A12	Real labour productivity per hour worked (%; average growth rate over 3 years)	2020	0.23	↗	+1.27	21/27	+6	0.67	IE: 5.70	EL: -2.70
A13	Average annual level of variation in total factor productivity in the economy overall (%)	2020	-3.02	↘	-2.32	7/27	+19	-4.94	IE: 3.44	MT: -10.26
A14	Nominal unit labour costs (% change over 3 years)	2020	11.10	↗	-1.30	11/27	+9	8.20	IE: -6.30	RO: 26.10
A15	Gross domestic R&D expenditure (% of GDP)	2019	1.16	↘	-0.01	19/27	-1	2.23	SE: 3.39	RO: 0.48
A16	Share of jobs in medium-high and high-tech manufacturing sectors (% of total jobs)	2020	0.70	↘	-0.10	27/27	-1	6.20	CZ: 11.50	LU: 0.70
A17	Profitability of non-financial companies (%)	2018	5.90	↘	-0.50	27/27	0	10.20	IE: 23.20	LU: 5.90
A18	Corporate tax rates (%)	2020	24.94	→	0.00	18/27	-1	21.53	BG: 10.00	MT: 35.00
A19	Time required to set up a company (days)	2019	16.50	→	0.00	19/27	0	12.17	DK: 3.50	PL: 37.00
A20	Entrepreneurial intensions (%)	2020	11.10	↘	-1.80	8/14	0	11.59	HR: 24.30	AT: 4.10
A21	Availability of financial resources for entrepreneurs (score from 1 to 5)	2020	2.61	↘	-0.10	12/14	+1	2.83	NL: 3.61	CY: 2.32
A22	Unemployment rate (%)	2020	6.80	↘	+1.20	15/27	0	7.10	CZ: 2.60	EL: 16.30
A23	Employment rate of population aged 20-64 (%)	2020	72.10	↘	-0.70	20/27	0	72.50	SE: 80.80	EL: 61.10
A24	Skillset of graduates (average score; 1 to 7)	2019	5.27	↗	+0.26	3/27	+6	4.56	FI: 5.62	HR: 3.35
A25	Life-long learning as a % of the population aged 25-64	2020	16.30	↘	-2.80	6/27	+1	9.20	SE: 28.60	RO: 1.00

According to the latest available data, Luxembourg's performance has improved in nine of the twenty-five indicators of the economic dimension of this edition of the TBCO. Fourteen indicators show inferior performance and the remaining two indicators, that dealing with the tax rate on non-financial corporations (%) **(A18)** and the one stating the time needed to start a business (days) **(A19)**, performance remained stable compared to the previous year's performance.

Among the 25 indicators in this dimension, Luxembourg came in first in the labour productivity indicator **(A11)**. In contrast, Luxembourg was ranked last twice, namely for the indicator of the share of jobs in medium-high and high-tech manufacturing sectors (as a % of total employment) **(A16)** and the profitability of non-financial companies (%) **(A17)**.

5 Luxembourg's change in indicator performance compared to the previous year.
6 Δ_V: Change in the indicator value.
7 Δ_P: Position change in the rankings.
8 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).
9 Countries are ranked in terms of the extent to which they vary from the EU average inflation rate.

Detailed description of the indicators of the economic dimension

In terms of public finances, Luxembourg has been able to prove its resilience to the crisis. Indeed, together with the government balance (indicator **A2**), the public debt **(A1)** provides information on the robustness of Member States' public finances. During the crisis, Luxembourg is among the European countries with the least growth in public debt (+2.5 percentage points in 2020), attaining 24.8% of GDP in 2020. Luxembourg ranks third among the other Member States, after Estonia and Bulgaria, which have public debts of 19% and 24.7% of GDP respectively. Greece is in the cellar, with a public debt of 206.3% of GDP. With regard to the government balance **(A2)**, Luxembourg has a deficit of EUR 2.280 million, which represents -3.5% of GDP. Despite this record public deficit, Luxembourg was able to rank third in an international comparison and loses only one place in the ranking among the twenty-seven Member States of the Union compared to 2019. Denmark's deficit balance of -0.2% tops the ranking, while Spain is in the cellar with a balance of -11%.

The current account balance **(A3)** gives an indication of the competitive and business health of a country vis-à-vis its main trading partners. In 2020, the three-year average of the Luxembourg current account balance amounts to 4.5% of GDP. Luxembourg therefore remains between the two thresholds set (-4% and +6%) by the European Commission in the context of the procedure concerning macroeconomic imbalances[10]. The first place is occupied by Estonia with a balance of 1%, while the Netherlands occupies the last position with a balance of 9.1%.

The 5-year change in Luxembourg's market share in world exports **(A4)** amounted to 20.63% in 2020. The largest 5-year change (+49.97%) in market share in world exports was observed in Ireland. The last position is occupied by Greece, which recorded a decrease of -10.10% in the market share of world exports over 5 years. This indicator, which is also part of the MIP procedure's system of indicators, takes into account the structural losses in competitiveness that can accumulate. It should be stressed that a country can lose export market share not only if its exports decline, but also if its exports do not grow in line with world exports, and thus its relative position on the global scale declines.

The net positive (negative) international investment position indicator, expressed as a % of GDP **(A5)**, is also part of the MIP procedure indicators. This is the stock of foreign assets greater or less than the stock of domestic assets held by foreign investors. The country is then either a creditor or debtor to the rest of the world. Luxembourg reaches a positive level of 39.9% in 2020 and ranks sixth among the 27 EU Member States. With a positive level of 113.9%, the Netherlands ranks first, while Greece is in last place (-175%).

The real effective exchange rate, in % change over three years **(A6)**, provides a measure of price competitiveness or cost competitiveness by comparing domestic and foreign prices at the macroeconomic level expressed in a common currency, while deflating by a price or cost indicator. For this indicator, the MIP procedure considers that a country is potentially at risk if it comes in below -5% or higher than +5%. With Luxembourg remaining within this range most years (with a variation of 1.5% over 3 years in 2020), no risk of imbalance is considered. With a rate of -4.9%, Hungary heads the ranking, while Bulgaria is in last place (7.1%).

In 2020, the three-year average of the real GDP growth rate **(A7)** in Luxembourg is +1.17%, ranking eighth among the 27 EU Member States. Ireland has the highest average (6.6%) and, with an average of -2.5%, Italy is the biggest loser in this indicator.

Member States are assessed against the EU average when it comes to the inflation rate **(A8)**. In this case, Luxembourg is in second place with an inflation rate of 0.8% in 2020, ahead of Sweden which records an inflation rate of 0.7%, being equal to the EU average. With an inflation rate of 3.7%, Poland is the furthest away from the EU inflation rate and thus ranks last.

The indicator "long-term government bond yield (%)" **(A9)** refers to the yields of long-term government bonds on the secondary market, including taxes, with a residual maturity of around ten years. In 2020, Luxembourg exceeded the EU-27 average while being among the countries offering a negative rate of -0.41%. Germany is the best performer (-0.5%), while Romania is the worst on this indicator (3.9%).

In order to ensure the soundness and stability of the banking system, banking regulators have introduced requirements for the solvency of banks. The indicator of regulatory capital on risk-weighted assets **(A10)** reflects a bank's capital requirements with regard to their credit risk. Each asset is assigned a risk weighting so that a bank does not take on more risk than it is able to bear. This ratio was 24.3% in 2020 in Luxembourg. Estonia has the highest regulatory capital to risk-weighted assets (26.5%) and Greece the lowest (16.7%).

As for the indicators reflecting price and cost competitiveness, 2020 was an exceptional year for Luxembourg insofar as it was able to improve significantly in terms of positions. With regard to the level of labour productivity **(A11)**, Luxembourg was able to maintain its top position in the ranking. Then, be it the real labour productivity per hour worked (average growth rate over 3 years) **(A12)**, the average annual level of variation in total factor productivity in the economy overall **(A13)** or the nominal unit labour costs **(A14)**, Luxembourg gained between 6 and 19 places.

Secondly, Luxembourg has a relatively low level of gross domestic R&D expenditure **(A15)** with 1.2% of GDP in 2019[11]. The share of employment in medium-high and high-tech manufacturing **(A16)** amounts to only 0.7% in 2020, the worst performance in the EU-27. The high- and medium-tech sectors are defined as sectors that require a relatively high R&D intensity. These include sectors such as aerospace manufacturing, pharmaceuticals, office machinery, office and computer equipment, electronics and communications and scientific instruments for high technology.

10 For more information, please consult Macroeconomic Imbalances Procedure | European Commission (europa.eu).
11 Data for 2020 were not yet available at the time of the data update.

As for the profitability of non-financial companies **(A17)**, Luxembourg is the EU's worst performer with a rate of only 5.9% in 2018. According to STATEC (Bulletin No. 3/2018), this result reflects, among other things, the fact that a small number of multinational companies have a significant weight in the Luxembourg economy.[12] Ireland ranks first with a rate of 23.2%.

With a corporate tax rate **(A18)** of 24.9% in 2020, Luxembourg ranks in the middle of the European Union (18 out of 27). It should be noted that this is the nominal and not the effective tax rate. Bulgaria is in first place with a rate of 10% and Malta in last place (35%).

The number of days it takes to start a business **(A19)** is one of the indicators used by the World Bank for its *Doing Business* project, which measures business regulation and its effective application. This project is currently suspended, which is why the most recent data are for 2019. In 2019, Luxembourg performed rather poorly compared to other EU Member States: in Luxembourg, it takes an average of 16.5 days to obtain all the necessary authorisations to start a business. By comparison, in Denmark it takes an average of only 3.5 days to start a business. Poland is the worst performing country, at 37 days.

The indicators "Entrepreneurial intentions (%)" **(A20)** and "Availability of financial resources for entrepreneurs" **(A21)** are taken from the *Global Entrepreneurship Monitor* (GEM)[13]. In 2020, the percentage of entrepreneurial intentions decreased in almost all participating countries, including Luxembourg (11.1% entrepreneurial intentions in Luxembourg in 2020 compared to 12.9% in 2019). This could be partly explained by the uncertainty related to the COVID-19 crisis. In terms of availability of financial resources for small and medium-sized enterprises, Luxembourg ranked 12th out of 14 countries in 2020.

As for the unemployment rate **(A22)**, the COVID-19 health and economic crisis has led to an increase in unemployment (6.8% in 2020 compared to 5.6% in 2019), which remains low by international standards. This is due in particular to the dynamism of the financial services sector, which is the main driver of the Grand Duchy's economy. The lowest unemployment rate is observed in the Czech Republic (2.6%) while the highest rate is recorded in Greece (16.3%).

Concerning the employment rate of population aged 20-64 **(A23)**, Luxembourg logs in at the EU average with a rate of 72.1%. Sweden has the highest level with a rate of 80.8% in 2020, while Greece has the lowest level with a rate of 61.1%.

The indicator "Skillset of graduates (average score 1-7)" **(A24)** is taken from the *Global competitiveness report* published by the World Economic Forum (WEF) and is used in particular to measure the quality of the education system. As data for this indicator are not available for the year 2020, the values and ranking remain unchanged from the previous edition. As a reminder, with a score of 5.27 out of a maximum of 7, Luxembourg ranked third among the 27 EU Member States in 2019 while moving up six positions compared to 2018. Finland had the highest score (5.6), while Croatia had the lowest (3.4) in 2019.

Lifelong learning, as a % of the population aged 25-64 **(A25)**, is important both for employees to maintain their employability and for companies, who seek to remain competitive. Nordic countries such as Sweden, Finland and Denmark make the most use of lifelong learning (28.6%, 27.3% and 20% respectively in 2020). Luxembourg was rated at 16.3% in 2020, but this is a come down compared to 2019 (-2.8%). Romania ranked last with only 1%.

Data availability at the economic level

We observe that the majority of the data for the economic dimension is readily available. In general, these are well established indicators. The indicators concerning the percentage of entrepreneurial intentions **(A20)** and the availability of financial resources for entrepreneurs **(A21)** originate from the *Global Entrepreneurship Monitor* (GEM). It should be noted that the GEM database only includes information from 14 of the 27 EU Member States for 2020. Luxembourg has only been participating in this effort since 2013, while other countries such as the Netherlands and Spain have participated in this study every year since 2005.

Out of the 25 indicators, 17 indicators come from Eurostat. Eurostat has developed a European Statistics Code of Practice that sets a standard for the development, production and dissemination of European statistics. The sources for the other eight indicators are the World Bank, the *Global Entrepreneurship Monitor* (GEM), the European Commission's AMECO database, the WEF and the International Monetary Fund (IMF). Of the 25 indicators selected in the economic dimension, seven indicators, A1, A3, A4, A5, A6, A15 and A22, are indicators that the European Commission uses in the framework of the Macroeconomic Imbalance Procedure (MIP).

Table 4

Missing data for the economic dimension (%)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Economic dimension	7.1	5.6	6.1	5.5	6.2	5.9	3.1	3.3	7.9	24.3

12 For more information, please see https://statistiques.public.lu/catalogue-publications/bulletin-Statec/2018/PDF-Bulletin3-2018.pdf et https://statistiques.public.lu/fr/actualites/entreprises/entreprises/2018/07/20180724/20180724.pdf

13 For more information, please see: https://www.gemconsortium.org/report/global-entrepreneurship-monitor-luxembourg-20202021

3.3.2 Social dimension

3.3.2.1 The "composite indicator" approach

According to the composite indicator of the social dimension, Luxembourg ranks in the top three (2nd), with Slovenia (1st) and the Czech Republic (3rd). As for the results of neighbouring countries, Belgium (10th) is ahead of Germany (20th), with France trailing (22nd).

Luxembourg, which ranked first in the social dimension every year between 2011 and 2018, has been overtaken by Slovenia since 2019. Thus, Luxembourg has ranked second for the last two years. Spain dropped three positions to occupy the last position in this dimension in 2020.

Between 2019 and 2020, Poland improved the most among Member States moving up 7 slots. Conversely, Finland's position worsened the most, falling eight places.

Between 2011 and 2020, Finland suffered the biggest drop in position (-11) followed by France (-10). The countries that gained the most positions were Poland and Lithuania with +10 and +9 positions.

Figure 3

Results for the social dimension 2020

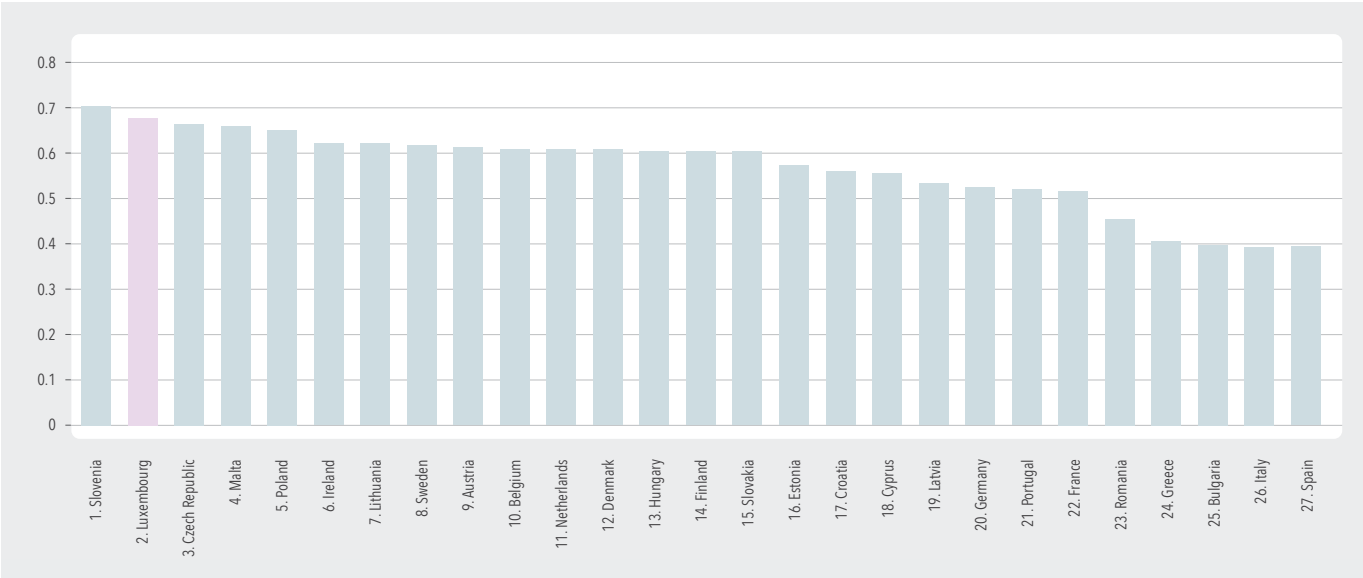


Table 5

Rankings for the social dimension from 2011 to 2020

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Germany	13	13	14	14	13	14	15	18	17	20
Austria	8	7	7	7	7	8	8	10	8	9
Belgium	9	8	8	8	11	12	12	16	14	10
Bulgaria	27	24	23	22	24	27	24	27	25	25
Cyprus	11	16	20	21	21	19	19	17	16	18
Croatia	21	20	21	19	20	21	20	20	19	17
Denmark	6	9	5	5	5	5	6	12	13	12
Spain	25	26	26	26	25	25	26	25	24	27
Estonia	17	15	15	15	15	13	9	14	11	16
Finland	3	3	3	4	6	7	7	7	6	14
France	12	12	12	11	14	15	16	19	20	22
Greece	26	27	27	27	27	26	27	24	27	24
Hungary	19	19	19	18	17	16	17	11	10	13
Ireland	14	14	11	12	8	10	11	5	5	6
Italy	20	21	22	23	22	23	25	26	26	26

Table continues on next page

Table 5 (Continued)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Latvia	24	22	18	20	19	20	21	21	21	19
Lithuania	16	11	13	9	10	9	13	8	7	7
Luxembourg	1	1	1	1	1	1	1	1	2	2
Malta	5	4	4	3	4	3	2	3	4	4
Netherlands	10	10	10	13	12	11	10	15	15	11
Poland	15	17	16	16	16	17	14	9	12	5
Portugal	23	25	24	25	23	22	23	23	22	21
Romania	22	23	25	24	26	24	22	22	23	23
Czech Republic	7	6	9	10	9	6	4	2	3	3
Slovakia	18	18	17	17	18	18	18	13	18	15
Slovenia	4	5	6	6	3	4	3	4	1	1
Sweden	2	2	2	2	2	2	5	6	9	8

3.3.2.2 The national scoreboard approach

As for the EU comparison, nine of the twenty-five indicators are rated green, with Luxembourg's performance in these areas being at least 20% better than the EU average. Five indicators are classified as orange and one as red. Ten indicators are displayed in white.

Among the 25 indicators of the social dimension, Luxembourg has improved its performance in thirteen indicators, while in twelve indicators its performance has worsened compared to the previous year.

The main aim of the social dimension is to evaluate the state and development of a country's quality of life, well-being and social cohesion. The relevant indicators primarily cover the labour market, education, income, private wealth and debt, social inequality and living conditions.

In this respect, Luxembourg is in first place for the following indicators: serious material deprivation rate **(B10)**, median income in purchasing power standards (in euros) **(B11)**, gender pay gap (in %) **(B14)**, net worth per household (in thousands of euros) **(B16)** and level of higher education amongst 30 to 34-year-olds **(B20)**.

Regarding the indicators of inequality and poverty in Luxembourg shown in the TBCO, whose data are taken from the annual STATEC survey on household income and living conditions (EU-SILC), it should be noted that several methodological changes took place in 2020. The income data collected in the survey generally lag the publication

Table 6

Data for the social dimension

			LUXEMBOURG					INTERNATIONAL COMPARISON		
		YEAR	VALUE	TREND[14]	Δ_v[15]	POSITION	Δ_p[16]	EU	FIRST	LAST
B1	Long-term unemployment rate (%)	2020	1.70	↘	+0.40	14/27	-2	2.40	CZ: 0.60	EL: 10.90
B2	Change in employment rate compared to the previous year (%)	2020	1.90	↘	-1.60	2/27	+1	-1.40	MT: 2.70	ES: -4.10
B3	Persons living in households with low work intensity (as a % of the population under the age of 60)	2020	7.90	↘	+0.40	13/25	-2	8.50	PL: 4.30	EL: 12.80
B4	Involuntary part-time work (%)	2020	11.80	↗	-1.50	9/27	+1	25.00	CZ: 4.50	IT: 66.20
B5	Long working hours in main job (%)	2020	3.90	↗	-0.30	8/27	-1	7.50	LT: 0.90	EL: 16.10
B6	Fixed-term contracts (%)	2020	6.50	↗	-1.40	11/27	+1	10.50	RO: 0.90	ES: 20.10
B7	Proportion of employees with poverty (%)	2020	11.80	↗	-0.20	23/25	+2	N/A	FI: 3.20	RO: 14.70
B8	At-risk-of-poverty rate after social transfers (%)	2020	17.40	↗	-0.10	16/25	+2	17.10	CZ: 9.50	BG: 23.80

Table continues on next page

14 Luxembourg's change in indicator performance compared to the previous year.
15 Δ_v: Change in the indicator value.
16 Δ_p: Position change in the rankings.

Table 6 (Continued)

			LUXEMBOURG					INTERNATIONAL COMPARISON		
		YEAR	VALUE	TREND[14]	Δ_v[15]	POSITION	Δ_p[16]	EU	FIRST	LAST
B9	Effectiveness of social transfers (difference between the at-risk-of-poverty rate before and after social transfers) (in percentage points)	2020	30.00	↗	+1.40	4/25	+2	N/A	FR: 33.70	LV: 16.80
B10	Serious material deprivation rate (%)	2020	1.70	↘	+0.40	1/25	0	6.30	LU: 1.70	BG: 19.40
B11	Median income expressed in purchasing power standard (euros)	2020	28,675	↘	-268.00	1/25	0	N/A	LU: 28,675.00	RO: 7,724.00
B12	Median income (% change compared to the previous year)	2020	4.10	↘	-1.36	18/25	-4	N/A	LT: 13.45	FR: -3.71
B13	Wage changes (%) in the economy (real ULC), over 3 years	2020	0.40	↘	-0.88	21/27	-13	1.03	LV: 4.09	IE: -2.57
B14	Gender wage gap (%)	2019	1.30	↗	-0.10	1/25	0	14.10	LU: 1.30	EE: 21.70
B15	Gini index of income inequality (0 to 100)	2020	31.20	↗	-1.10	18/25	+3	N/A	SK: 20.90	BG: 40.00
B16	Net worth per household (in EUR thousands)	2017	897.90	↗	+129.50	1/22	0	N/A	LU: 897.90	LV: 43.00
B17	Household debt (consolidated) (%)	2020	69.10	↘	+2.30	23/27	0	60.40	RO: 16.20	DK: 110.90
B18	Housing cost burden over 25% of disposable household income (owners and tenants) (%)	2020	24.42	↘	+0.68	18/24	-5	N/A	HU: 8.49	EL: 68.19
B19	Individuals living in over-crowded accommodation (% of the total population)	2020	8.50	↘	+1.40	7/25	0	N/A	CY: 2.50	RO: 45.10
B20	Level of higher education amongst 30 to 34-year-olds	2020	62.20	↗	+6.00	1/27	+2	41.00	LU: 62.20	RO: 26.40
B21	School year repetition rate (%)	2015	30.90	↗	-3.60	24/27	+1	N/A	HR: 1.60	BE: 34.00
B22	Individuals having prematurely left education and training (%)	2020	8.20	↘	+1.00	16/27	-7	9.90	HR: 2.20	ES: 16.00
B23	Young people not in employment, education or training (NEET) (%)	2020	6.60	↘	+1.00	3/27	0	11.10	NL: 4.50	IT: 19.00
B24	Delinquency, violence or vandalism in the surrounding area (%)	2020	11.00	↗	-0.20	17/24	0	N/A	HR: 2.40	BG: 19.10
B25	Healthy life expectancy (years)	2019	62.60	↗	+1.90	10/26	+5	64.60	SE: 73.30	LV: 53.10

date of the survey results by almost two years. However, in order to assess the impact of the COVID-19 health crisis on household incomes[17], STATEC collaborated with the General Inspectorate of Social Security (IGSS) to forecast household incomes in 2020. Subsequently, the collection of survey data was strongly impacted following the pandemic. In particular, the sample did not change, contrary to previous years when the practice was to renew a quarter of the sample each year. It should also be noted that the collection method also underwent changes following the implementation of containment measures and the restriction of interpersonal contacts. Accordingly, the collection was carried out by telephone to the detriment of the traditionally used face-to-face mode.

It should therefore be stressed that all these changes lead to an inevitable break in the series, which calls for caution in interpreting survey results. For the income inequality indicators, breaks in the series have also been reported on Eurostat by other EU Member States, namely Germany, Italy, Spain and Portugal.

Detailed description of the social dimension indicators

In Luxembourg, the long-term unemployment rate **(B1)**, i.e. the number of jobseekers registered for at least 12 months, reached 1.7% in 2020 and is below the European average (2.4%). It is particularly low-skilled job seekers who are affected by long-term unemployment. For comparison purposes, this rate is 1.9% in France, 1.1% in Germany and 2.3% in Belgium.

With regard to the change in employment **(B2)**, Luxembourg ranks second among the other Member States. In fact, employment increased in 2020 by +1.9% compared to the previous year. Only Malta is ahead of Luxembourg, with a +2.7% increase in employment in 2020. In Spain, employment decreased the most in 2020, by -4.1%.

The indicator "Persons living in households with low work intensity" **(B3)** gives the percentage of people living in households where the working age members worked at less than 20% of their potential in the previous 12 months. In 2020, Luxembourg ranks thirteenth with a rate of 7.9%, which is below the EU average (8.5%). Poland ranks first (4.3%), while Greece ranks last (12.8%).

17 For more information, please see: https://statistiques.public.lu/catalogue-publications/analyses/2021/PDF-Analyses-05-2021.pdf

In the Involuntary part-time work (in %) **(B4)** category, the rate for Luxembourg in 2020 was 11.8%. The Czech Republic has the lowest rate at 4.5%. Italy has the highest rate among the 27 EU countries at 66.2% in 2020.

In 2020, 3.9% of employed persons usually worked 49 hours or more per week in Luxembourg **(B5)**. This rate is below the EU-27 average of 7.5%. In Lithuania the rate is 0.9%, which is the lowest in the EU. In contrast, the highest rate is observed in Greece (16.1%).

The proportion of employees with fixed-term contracts **(B6)** was recorded at 10.5% in the EU-27 in 2020. In France, 11.2% of employees were in temporary employment; the ratio was 8.5% in Germany, while in Belgium and Luxembourg the rate was 8% and 6.5% respectively in 2020. In the other EU-27 Member States, the proportion of workers employed on a fixed-term contract ranged from 20.1% in Spain to only 0.9% in Romania. The wide differences between EU Member States are explained by labour supply and demand, employers' growth expectations and labour law procedures for hiring and firing staff.

As for the at-risk-of-poverty rate **(B7)**, Luxembourg ranks 23rd with a rate of 11.8% in 2020. The at-risk-of-poverty rate at work assesses the proportion of people who work and have an equivalent disposable income that is below the at-risk-of-poverty threshold, set at 60% of the national median equivalent disposable income, after transfers social. The at-risk-of-poverty rate after social transfers **(B8)** is 17.4% in Luxembourg in 2020, which places Luxembourg in 16th place. The effectiveness of social transfers **(B9)**, which is obtained by subtracting the at-risk-of-poverty rate after social transfers (17.4% in 2020) from the at-risk-of-poverty rate before social transfers (47.4% in 2020), amounted to 30 percentage points in 2020. Luxembourg ranks fourth among the 25 EU Member States for which data are available.

In the framework of the EU-SILC survey, the material deprivation rate **(B10)** is an indicator that designates the inability to obtain certain goods/services considered by most individuals as desirable or even necessary to achieve an acceptable standard of living. As such, it distinguishes between individuals who are unable to obtain a given good/service and those who are deprived of it for other reasons, for example because they do not want it or because they feel they do not need it. Luxembourg ranks first with a rate of 1.7% in 2020. Bulgaria is in last place with a rate of 19.4%.

According to the indicator on median income in purchasing power standards **(B11)**, Luxembourg has the highest median income in the EU (EUR 28,675 in purchasing power standards). In one year, this has increased by 4.1% **(B12)**. The change in the real unit labour costs, in % over 3 years **(B13)**, has decreased slightly compared to the previous year with a change of 0.4% in 2020 (compared to a change of 1.28% in 2019). In this indicator, which compares real wage costs to productivity in value terms, Luxembourg ranks 21st. In the gender pay gap **(B14)**, Luxembourg ranks first with a rate of 1.3% compared to the EU average of 14.1% in 2019. The largest gender pay gap is observed in Estonia (21.7%). It should be noted that the data only consider industry, construction and services and not public administration, defence and compulsory social security.

The Gini index of income inequality **(B15)** equal to 0% means that the entire population has the same income (a situation of perfect equality), whereas a Gini coefficient equal to 100% corresponds to the situation in which one individual would have all the income, while the others would have an income equal to 0 (situation of total inequality). In 2020, the Gini coefficient of Luxembourg is 31.2%. Slovakia has the lowest Gini coefficient (20.9%), while Bulgaria (40%) has the highest income inequality in the EU.

Net worth per household **(B16)** measures the difference between real and financial assets versus liabilities such as mortgages and loans. The data come from the European Central Bank's *Household Finance and Consumption Survey*, which last collected data in 2017. Accordingly, with regard to the position in 2017, Luxembourg leads the pack with a net worth per household of EUR 897,900. With a net worth per household of EUR 43,000, Latvia is in last place.

Household debt **(B17)** is the outstanding liabilities of households. The measuring instruments used in calculating private sector debt are loans. The data are presented in consolidated terms, i.e. excluding transactions between units of the same sector. In 2020, Luxembourg ranks 23rd with a rate of 69.1%. In Romania, household debt amounts to 16.2%, while it is highest in Denmark with 110.9%.

In Luxembourg, for 24.4% of the population in 2020, the housing cost burden is over 25% of disposable household income (owners and tenants) **(B18)**. In Hungary it is only 8.5%, while in Greece it is 68.2%.

In 2020, 8.5% of the population of Luxembourg lived in overcrowded accommodation **(B19)**. The highest rates of overcrowding among EU Member States were recorded in Romania (46.3%) and Poland (39.2%), while Cyprus (2.5%) and Ireland (2.8%) had the lowest rates.

In 2020, the level of higher education attained in the 30-34 age group **(B20)** is 62.2% in Luxembourg, which ranks the country first among the 27 Member States. The lowest rate is measured in 2020 in Romania (26.4%).

The data for the indicator 'School year repetition rate' **(B21)** come from the PISA study, for which the most recent data available are from 2015. This indicator shows a rate of 30.9% in Luxembourg in 2015. For comparison, the highest rate in the same year was observed in Belgium (34%), while the lowest rate was observed in Croatia with 1.6%.

As for 'Individuals having prematurely left education and training' **(B22)**, Luxembourg sits in the middle of the EU average with a rate of 8.2% in 2020. The lowest rate is observed in Croatia (2.2%) and the highest in Spain (16%).

Although the proportion of young people not in employment, education or training (NEET) **(B23)** has remained relatively stable in the EU, there have been significant changes over the past decade in some Member States. The most significant declines were recorded in Latvia (-8.9 pp), Bulgaria (-7.4 pp), Ireland (-7.1 pp), Spain (-4.3 pp), Greece and in Croatia (-4 pp).

Although Luxembourg is in third place in the ranking with a rate of 6.6%, it has increased by 1.9 pp over the last ten years.

The indicator 'Delinquency, violence or vandalism in the surrounding area' **(B24)**, which measures the feeling of insecurity, is derived from the EU-SILC survey on well-being and contains variables on satisfaction in various specific areas of life. In Luxembourg, this indicator was 11% in 2020. In Bulgaria, this feeling of insecurity is the highest among EU countries with a rate of 19.1%. The lowest rate in 2020 is observed in Croatia (2.4%).

Healthy life expectancy **(B25)** in Luxembourg is 62.6 years in 2019, which ranks tenth in the EU-27. In Sweden, health expectancy is the highest among EU Member States (73.7 years), while in Latvia it is only 53.1 years.

This indicator measures the number of years a person can expect to live at birth without serious or moderate health problems. The indicator is also called "disability-free life expectancy". Thus, it is a composite indicator that combines mortality data with health status data.

Data availability at the social level

The majority of the data for the social dimension comes from the EU-SILC[18] survey. There is a delay in the availability of data, which is the main reason why 19.6% of the 2020 data is missing. In addition, two indicators, 'Net worth per household' **(B16)** and 'School year repetition rate' **(B21)**, are taken from the ECB's *Household Finance and Consumption Network* (HFCN) and the OECD's PISA survey respectively, which are not provided annually.

Table 7

Missing data for the social dimension (%)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Social dimension	13.0	8.7	12.4	9.2	8.0	12.3	9.0	12.1	8.4	19.6

3.3.3 Environmental dimension

3.3.3.1 The "composite indicator" approach

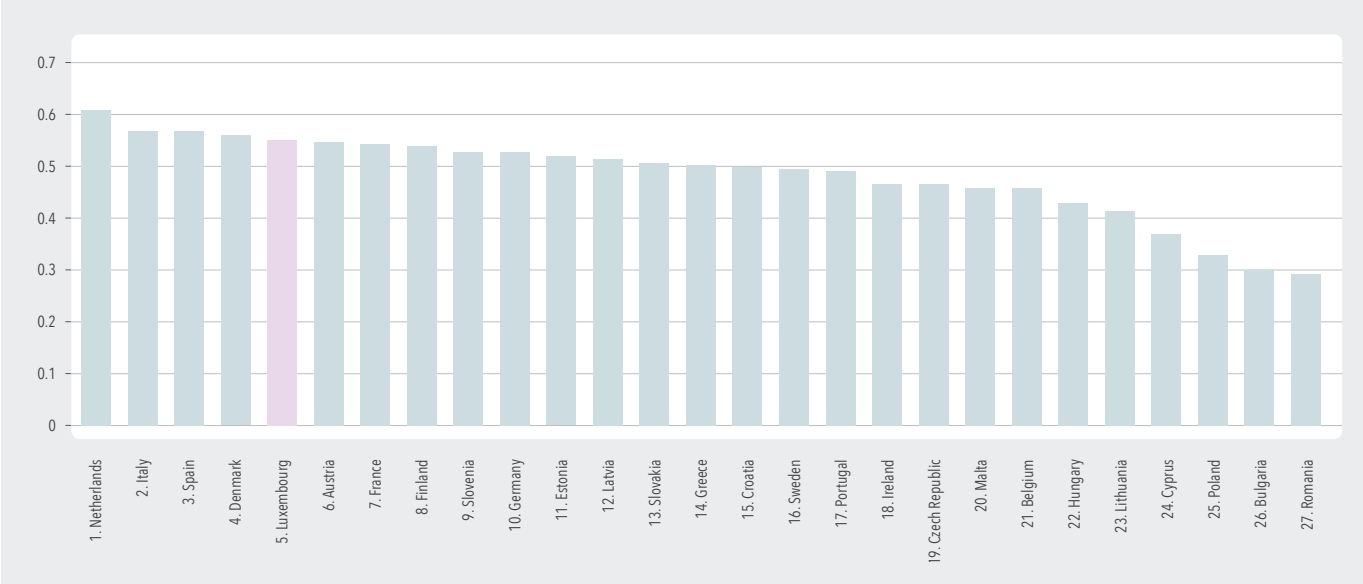
According to the composite indicator of the environmental dimension, Luxembourg ranks 5th in 2020. The top three positions in this aspect are occupied by the Netherlands (1st), Italy (2nd) and Spain (3rd). France is 7th, Germany 10th and Belgium 21st.

Luxembourg's position in the ranking of this aspect is rather volatile and varies between 17th in 2014 and 4th in 2018. In 2020, Luxembourg moved up one position in the ranking compared to the previous year and is now in 5th position.

Comparing 2019 to 2020, Belgium loses the greatest number of positions (-3) and Ireland gains the most (+3). Between 2020 and 2011, Sweden is among the biggest losers, dropping -12 places in the ranking. At the same time, Estonia rose 11 positions.

Figure 4

Results for the environmental dimension 2020



18 For more information please see: https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions

Table 8

Rankings for the environmental dimension from 2011 to 2020

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Germany	13	9	11	12	10	8	8	8	10	10
Austria	3	2	5	5	3	5	5	7	5	6
Belgium	14	15	17	18	22	19	18	21	18	21
Bulgaria	27	27	27	27	27	27	27	26	27	26
Cyprus	26	26	25	26	25	24	24	24	24	24
Croatia	15	17	19	16	17	14	12	13	14	15
Denmark	2	4	4	3	1	2	2	5	4	4
Spain	5	5	2	1	2	1	6	3	3	3
Estonia	22	21	22	23	20	17	17	17	12	11
Finland	6	6	7	9	9	9	4	10	8	8
France	8	10	10	7	5	6	9	6	7	7
Greece	19	18	9	13	15	12	21	11	15	14
Hungary	16	12	12	10	11	22	22	23	22	22
Ireland	17	20	21	19	16	18	16	18	21	18
Italy	7	7	6	2	4	3	3	2	2	2
Latvia	11	11	14	14	13	15	11	15	11	12
Lithuania	23	22	23	22	21	21	20	20	23	23
Luxembourg	10	14	16	17	14	16	15	4	6	5
Malta	18	24	18	20	23	23	23	22	19	20
Netherlands	1	1	1	4	6	4	1	1	1	1
Poland	25	25	26	25	26	26	26	27	25	25
Portugal	12	13	8	11	12	11	13	14	16	17
Romania	24	23	24	24	24	25	25	25	26	27
Czech Republic	20	16	20	21	18	20	19	19	20	19
Slovakia	21	19	15	15	19	13	14	16	13	13
Slovenia	9	8	13	8	7	10	7	9	9	9
Sweden	4	3	3	6	8	7	10	12	17	16

3.3.3.2 The national scoreboard approach

A country's development, which is fostered at the expense of the environment is not only unsustainable 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 the environmental dimension is therefore an integral part of the new system of indicators. A range of relevant indicators cover issues such as raw materials, energy efficiency, renewable energies, harmful emissions, waste processing, energy efficiency, renewable energy, harmful emissions, waste processing, nature and the ecosystem, biodiversity and the transition towards a green economy. The circular economy, which aims at a paradigm shift from the so-called linear economy and which is certainly indispensable in the process of the green transition, is a very complex subject.

Referring to Table 9, it can be seen that Luxembourg is 20% above the EU average for six indicators, while the performance of four of its indicators is 20% below. Seven indicators appear in orange and one in white. As for changes in indicator performance, eleven indicators have improved, while performance in four indicators has worsened. The performance of two indicators, namely 'Total expenditure on environmental protection' (as % of GDP) **(C17)** and 'Land protected (%)' **(C18)** remains unchanged from the previous year.

Detailed description of the environmental dimension indicators

The energy intensity **(C1)** that appears first in the summary table of the environmental dimension is the ratio between energy consumption and gross domestic product. In 2019 Luxembourg (3rd position) has, together with Ireland (1st position) and Denmark (2nd position), the lowest energy intensity among the EU countries with results of 87.3, 50.9 and 62.4 kilograms of oil equivalent per thousand euros respectively. Bulgaria occupies the last position with 396.4 kilograms of oil equivalent per thousand euros.

Indicator **C2** presents the share of crude oil and oil products in total energy consumption of the residential sector. In Luxembourg, this share amounted to 25.31% in 2019, which places Luxembourg

Table 9

Data for the environmental dimension

			LUXEMBOURG					INTERNATIONAL COMPARISON		
		YEAR	VALUE	TREND[19]	Δ_V[20]	POSITION	Δ_P[21]	EU	FIRST	LAST
C1	Energy intensity (energy consumption per GDP unit) (kilograms of oil equivalents per euro)	2019	87.33	↗	-1.32	3/27	0	119.48	IE: 50.93	BG: 396.43
C2	Share of crude oil and petroleum products in total household energy consumption (%)	2019	25.31	↗	-4.01	23/27	+2	11.79	SK: 0.25	IE: 40.99
C3	Renewable energy share (%)	2019	7.05	↘	-1.93	27/27	-2	19.73	SE: 56.39	LU: 7.05
C4	Resource productivity (euros (PPS) per kilogram)	2020	3.88	↗	+0.34	2/27	+1	2.23	NL: 4.66	RO: 0.73
C5	Non-energetic material productivity (EUR per kilogram)	2019	4.77	↗	+0.23	3/27	0	2.87	NL: 7.22	RO: 0.88
C6	Domestic raw material consumption (RMC) (in tonnes per head)	2020	20.61	↗	-2.39	21/27	0	13.36	IT: 7.45	FI: 31.35
C7	Waste production per head (kilograms per person)	2018	14,828	↗	-2,389.00	24/27	+1	5,234	LV: 920.00	FI: 23,253.00
C8	Municipal waste recycling rate (%)	2019	48.90	↘	-0.10	9/27	0	47.70	DE: 66.70	MT: 8.90
C9	E-waste recycling rate (%)	2018	44.10	↘	-1.40	11/27	+1	38.90	HR: 83.40	SI: 33.60
C10	Greenhouse gas emission intensity (index 100 in 2000)	2019	92.40	↘	+1.00	23/27	-1	82.80	MT: 58.70	LT: 102.60
C11	Exposure to air pollution by fine particles (< 2.5 µm)	2019	10.20	↗	-0.90	7/27	0	12.60	EE: 4.80	BG: 19.60
C12	Exposure to air pollution by fine particles (< 10 µm)	2019	20.30	↗	-0.80	14/27	-2	20.50	FI: 10.20	HR: 30.90
C13	Biochemical oxygen demand in rivers (mg O_2/l)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C14	Production of environmental goods and services sector (% of GDP)	2018	6.53	↗	+1.51	8/27	+5	5.60	FI: 17.08	MT: 2.11
C15	Employment in the environmental goods and services sector (as % of total employment)	2018	3.81	↗	+0.54	4/27	0	2.11	FI: 4.96	BE: 0.85
C16	Eco-innovation Index (EU index = 100)	2019	165.00	↗	+27.00	1/27	0	100.00	LU: 165.00	BG: 34.00
C17	Total expenditure on environmental protection (% of GDP)	2019	0.90	→	0.00	6/27	0	0.80	EL: 1.40	FI: 0.20
C18	Land protected (%)	2019	27.00	→	0.00	6/27	0	18.00	SI: 38.00	DK: 8.00

in 23rd place among the EU Member States. The first position is occupied by Slovakia (0.3%), while Ireland (41%) ranks last.

According to the indicator for renewable energy share **(C3)**, Luxembourg had the lowest proportion in the EU and thus ranked last in 2019. Indeed, only 7.05% of energy in Luxembourg comes from renewable sources in gross consumption of energy. By comparison, in Sweden, which is in first place in the ranking, 56.4% of energy comes from renewable sources. It should be emphasised that increasing the share of renewable energy is essential to achieving the EU's climate and energy goals. In 2019, the share of energy from renewable sources in the EU amounted to 19.7%. The EU target is to reach 20% by 2020 (data not yet available) and at least 32% by 2030.

In terms of resource productivity **(C4)**, which divides gross domestic product (GDP) by domestic material consumption, Luxembourg showed a slight increase, with a result of 3.88 euros (PPS) per kilogram in 2019 and is in second place in the ranking. With 4.7 euros per kilogram, the Netherlands tops the list. In contrast, Romania is in last place with only 0.9 euros per kilogram.

Secondly, 'Non-energetic material productivity' **(C5)** provides information on the total amount of non-energy materials (non-fossil fuel materials) directly used by an economy in relation to GDP. The gross domestic product (GDP) is divided by the domestic consumption of non-energetic materials (DMC). In 2020, Luxembourg ranked third with a result of EUR 4.8 (PPS) per kilogram. For comparison purposes, the EU average is EUR 2.9 per kilogram in 2019.

The indicator for 'Domestic raw material consumption'**(C6)**, which compiles inputs of solid, gaseous and liquid materials, excluding water and air, was 20.6 tonnes per capita in Luxembourg in 2020. Italy has the lowest domestic material consumption with 7.5 tonnes per capita, while the highest domestic material consumption is observed in Finland (31.4 tonnes).

19 Luxembourg's change in indicator performance compared to the previous year.
20 Δ_v: Change in the indicator value.
21 Δ_p: Position change in the rankings.

In terms of waste generation per capita **(C7)**, Luxembourg performs relatively poorly. In 2018, Luxembourg produced about 14.8 tonnes of waste per capita. Other countries such as Finland, Estonia and Bulgaria produce even more waste. Latvia, with 920 kg per capita, produces the least in the European Union. In terms of municipal waste recycling **(C8)**, Luxembourg achieved a rate of 48.9% in 2019, slightly above the EU average (47.7%), but still far from the performance of Germany, whose recycling rate was 66.7% in 2019. As for the recycling of waste electrical and electronic equipment **(C9)**, Luxembourg's performance was also slightly higher (44.1%) than the EU average (38.9%) in 2018. With 83.4%, Croatia tops the list among Member States in 2018. Slovenia is in last place with a rate of 33.6%.

'Greenhouse gas emission intensity' **(C10)** is the ratio of energy-related greenhouse gas emissions (carbon dioxide, methane and nitrous oxide) to gross domestic energy consumption. It is an index (2000 = 100) that shows that several Member States have been able to reduce their GHG emissions since 2000. However, this index does not provide any information on the different Member States' initial level of consumption. Luxembourg ranks in the EU average (82.8) with an index of 92.4 in 2019.

In terms of 'Exposure to air pollution by fine particles', a distinction is made between fine particles PM2.5 and PM10, i.e. particles with a diameter of less than 2.5 µm and 10 µm respectively. In Luxembourg, a concentration of 10.2 micrograms per cubic metre of fine particles PM2.5 **(C11)** was observed in 2019. In comparison, Bulgaria, which occupies the last position in the ranking, has a concentration almost twice as high (19.6 µm). As for the fine particles PM10 **(C12)**, which can cause irritation of the upper respiratory tract and bronchial tubes, but which are still not as unhealthy as PM2.5, a concentration of 20.3 micrograms per cubic metre was recorded in Luxembourg in 2019.

In order to include the water quality aspect in the environmental aspect, monitoring is done on the indicator for 'Biochemical oxygen demand in rivers (mg O_2/l)' **(C13)**. However, Luxembourg's data on this indicator is no longer available on Eurostat, which is why no values are shown in Table 9.

The fight against climate change and the efficient use of natural resources are not only necessary to ensure sustainable development, but they also offer new opportunities for the economy. Production of environmental goods and services sector as a percentage of GDP **(C14)** was 6.5% in Luxembourg in 2018. Finland has the highest level with 17.1% and Malta the lowest with 2.1%. New sectors of activity in the environmental economy are being created, and with them potentially jobs in the environmental goods and services sector.

The number of jobs in the environmental goods and services sector (as a % of total employment) **(C15)**, i.e. those created by the commitment to the environment and the protection of natural resources, was 3.8% in Luxembourg in 2018. Finland and Estonia are the leading countries with rates of 5% and 4.6% respectively in 2018.

The Eco-Innovation observatory (EIO) defines eco-innovation as a type of innovation that reduces the use of natural resources and decreases the release of harmful substances during an entire life cycle. The Eco-innovation Index **(C16)** and its associated scorecard aim to capture the different aspects of eco-innovation through the application of 16 indicators grouped into five thematic areas[22]: (1) measure the financial and human resource inputs that are aimed at triggering eco-innovation activities, (2) illustrate the extent to which firms in a given country are active in eco-innovation, (3) quantify the efficiency results of eco-innovation activities in terms of patents, academic contributions to the literature and media coverage, (4) measure efficiency while placing eco-innovation performance in the context of a country's resource efficiency (material energy, water) and GHG emission efficiency and intensity, (5) quantify the socio-economic benefit illustrating the return to which eco-innovation generates positive outcomes for social aspects (employment) and economic aspects (turnover, exports). In 2019, Luxembourg maintained its lead rank with a score of 165. The last position was occupied by Bulgaria. In comparison, Germany ranks 6th, ahead of France (9th) and Belgium (16th).

Next, in Luxembourg, 'Total expenditure on environmental protection' **(C17)** was among the highest in the EU at 0.9% of GDP, or 2.1% of total government expenditure in 2019. Internationally, Greece, Malta and the Netherlands are at the top of the list with a rate of 1.4% of GDP.

Finally, in terms of protected land area **(C18)**, Luxembourg ranks sixth in the EU in 2019 with a rate of 27%, ahead of Bulgaria, Cyprus, Croatia, Romania and Slovakia. Denmark ranks last with a protected land area of 8%.

Data availability at the environmental level

For the environmental aspect, the majority of data, i.e. 81.2%, was not available for 2020, which is mainly due to the significant time lag that characterises its publication. For example, only the data for the indicators "Resource productivity **(C4)**" and "Domestic material consumption **(C6)**" are fully available for 2020. Data for the indicator "Waste production per head **(C7)**" are only available every two years. Secondly, data for the indicator "Biochemical oxygen demand in rivers - mg O_2/l" **(C13)** are not available for twelve countries, including Luxembourg.

Table 10

Missing data for the environmental dimension (%)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Environmental dimension	17.3	11.5	14.7	4.7	9.6	4.5	9.6	5.1	25.0	81.2

22 Source : https://ec.europa.eu/environment/ecoap/scoreboard_en

3.4 Annexes

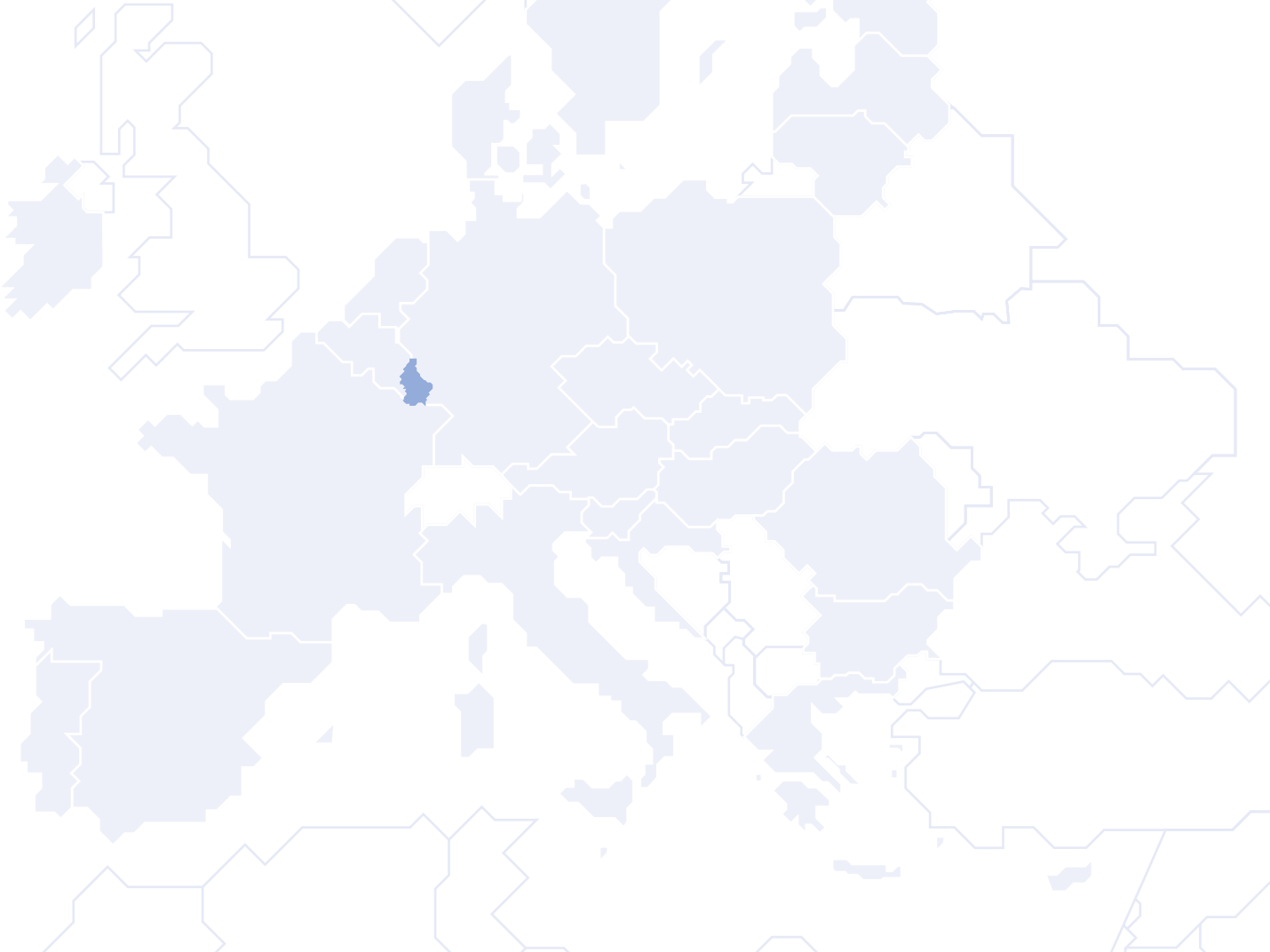
The annex to this chapter, which includes the secondary indicators, as well as the robustness test and the methodology of the synthetic indicator, can be downloaded at the following link: https://odc.gouvernement.lu/fr/domaines-activite/Outils-evaluation_competitivite/tableau-bord-national-de-la-competitivite.html.

The secondary indicators selected by the ESC in order to enrich the various fields with specific information and to refine the analysis as necessary, are not integrated into the calculations of the composite indicators so as not to overload what is the central element of the system of indicators.

The statistical robustness test consists of excluding the 68 indicators one by one, and recalculating the overall ranking each time, thus testing the robustness of the composite indicator ranking.

Chapter 4

The European Semester



The European Semester

The aim of this chapter is to monitor Luxembourg's indicators and targets as part of the European Union strategy for growth and jobs (Europe 2020) and the Macroeconomic Imbalance Procedure.[1]

This chapter focuses mainly on Luxembourg's national performance and targets, and is therefore not intended to provide an assessment of indicators and targets at European Union (EU) level.

4.1 The Europe 2020 strategy: awaiting a final assessment

4.1.1 Introduction

The Europe 2020 strategy was a central element of the EU's response to the global economic and financial crisis of 2008 and beyond. It was designed to succeed the Lisbon Strategy[2] launched in March 2000 and renewed in 2005 as the European Strategy for Growth and Jobs. This new strategy involved closer coordination of economic policies and focused on key areas where action was needed to boost the potential for sustainable and inclusive growth and competitiveness in Europe. In this strategy, the exit from the crisis was seen as the entry point to a social market economy, a greener and smarter economy, where prosperity is the result of innovation and better use of resources, and where knowledge is a key element.

Five main objectives, grouped into three priorities, formed the basis of this strategy. These shared objectives were to guide Member State and EU action in terms of promoting employment, improving conditions for innovation and R&D, meeting climate change and energy targets, improving education levels and promoting social inclusion, notably by reducing poverty.

Given the diversity of EU Member States, and their widely varying levels of development, applying the same targets and criteria to all Member States, as was done initially under the Lisbon Strategy, has not proved to be the right approach. As a result, under Europe 2020, the broad European targets no longer applied uniformly to all Member States. They were European targets, broken down into national targets, depending on the initial situation and the characteristics specific to each Member State, in dialogue with the European Commission.

In 2014-2015, the European Commission carried out a mid-term review[3] of the Europe 2020 strategy and found that the strategy still provided an appropriate framework for promoting growth and jobs. The European Commission therefore decided to continue pushing the strategy forward while ensuring its monitoring within the European Semester.

So far, the European Commission has not yet drawn up a final assessment of this strategy, which ended in 2020, and it has not yet decided on direct follow-up measures to the Europe 2020 strategy. Over the next few years, more and more data will gradually become available to better assess the results of the strategy.

In the meantime, in December 2019, the Commission presented a new growth strategy: the Green Deal for Europe[4]. It is a roadmap to make the EU's economy more modern, competitive and resource-efficient, turning climate and environmental challenges into opportunities in all policy areas and ensuring a just and inclusive transition for all. This strategy integrates several specific strategies, such as the "Farm to Fork" strategy and the EU Biodiversity Strategy for 2030. Moreover, the new strategy is more closely aligned with the Sustainable Development Goals of the 2030 Agenda for Sustainable Development, which was adopted by world leaders at a UN summit in 2015 and came into force on 1 January 2016. Countries must act to end all forms of poverty, combat inequality and tackle climate change[5]. Progress in the EU context can be monitored through a set of indicators identified by Eurostat[6].

Indeed, the UN Sustainable Development Goals (SDGs) have recently been integrated into the European Semester. In this context, the National Reform Programme 2021 refers to a number of SDGs by tracking progress and documenting several of the flagship measures that were implemented.

1 The analysis of Luxembourg's situation in the coordination of budgetary policies (SGP) does not however fall within the scope of this document.
2 For more information see: http://ec.europa.eu/archives/growthandjobs_2009/
3 For more details see: http://ec.europa.eu/transparency/regdoc/rep/1/2014/EN/1-2014-130-EN-F2-1.Pdf
4 For more details see: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal
5 For more information see: https://www.un.org/sustainabledevelopment/development-agenda/
6 For more information see: https://ec.europa.eu/eurostat/web/sdi/overview

Table 1

European and national targets

		EUROPEAN OBJECTIVE 2020	LUXEMBOURG TARGET 2020
Priority 1 *"Smart growth"*	Objective 1	*"(...) to raise the cumulative level of investment to **3%** of GDP public and private"*	**2.3-2.6%**
	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 years who graduated from higher education or reached an equivalent education to **at least 40%"***	**66 %** (b)
Priority 2 *"Sustainable growth"*	Objective3	*"(…) **reducing** greenhouse gas emissions by **20 %"***	Reducing non-ETS emissions by **20%** compared to 2005 (approximately **8,117 Mt CO_2e** in 2020)[7] (c)
		*"(…) increasing the share of renewable energy sources in final energy consumption to **20%"***	**11%** (c)
		*"(…) moving towards a **20%** increase in energy efficiency"*	Final energy consumption of **49,292 GWh**, i.e. around **4.2 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** by 2020

Notes: (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 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 foreign 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 people originally from the country concerned than among foreign residents.
(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 emission reduction objective is compared to the level of 2005.

7 A carbon dioxide equivalent (CO_2e) is a metric measure used to compare the emissions of various greenhouse gases on the basis of their global warming potential (GWP), by converting the amounts of other gases into equivalent amounts of carbon dioxide with the same global warming potential. For more information see: https://ec.europa. eu/eurostat/statistics-explained/index.php?title=Glossary:Carbon_dioxide_equivalent

4.1.2 Situational analysis[8,9]

Before going into further detail on the monitoring indicators, it is appropriate to provide an analytical overview of the situation in Luxembourg in relation to its national objectives as part of the Europe 2020 strategy.

Table 2

Situational analysis

	UNIT	2010	CHANGE (2010 – 2020)	2020*	NATIONAL OBJECTIVE 2020
Smart growth					
Improving the conditions for innovation and R&D					
R&D expenditures	% of GDP	1.50%	↘	1.19% (2019)	2.3 % – 2.6%
Improving education levels					
Leaving school prematurely	%	7.10%	↘	8.20%	< 10%
Higher education	% of persons aged 30-34	46.10%	↗	62.20 %	66%
Sustainable growth					
Achieving climate change/energy targets					
GHG emissions	Mt CO_2e	9.63	↗	9.23 (2019)	8.12
Renewable energies	%	2.85%	↗	7.05 % (2019)	11%
Energy efficiency	Mtoe	4.33	↘	4.39 (2019)	4.2
Inclusive growth					
Promoting employment					
Employment rate	% of persons aged 20-64	70.7	↗	72.1	73%
Reducing poverty					
At-risk-of-poverty or social exclusion	Persons	83,000	↘	125,000	66,000

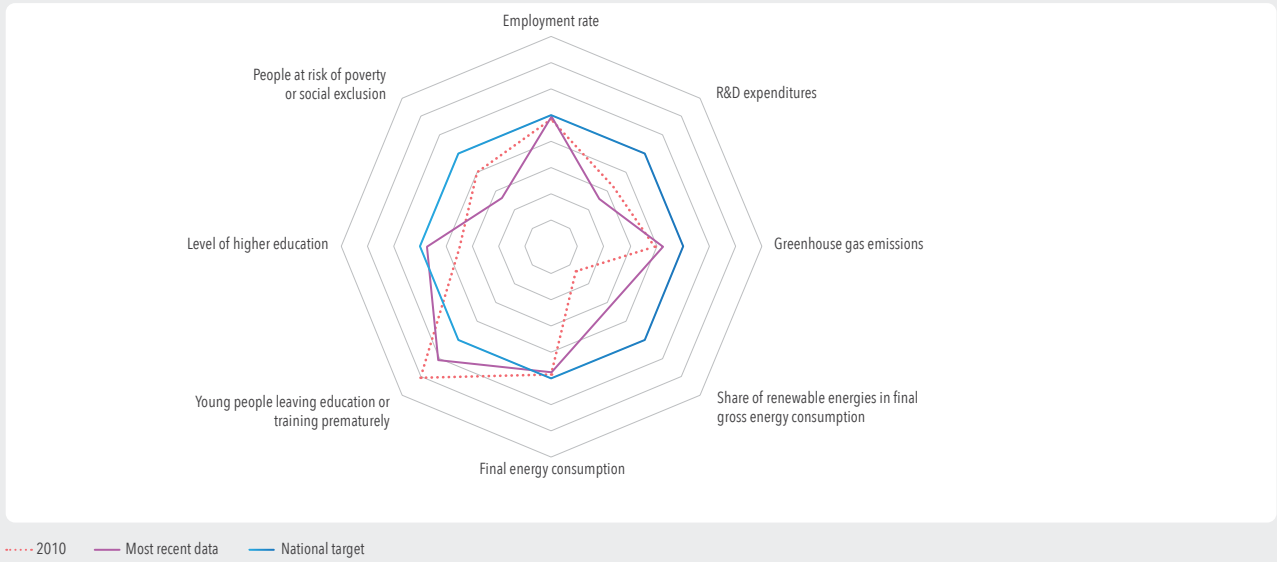
* Or the most recent data available

Notes: Where Luxembourg's performance has improved in 2020 compared to 2010, the indicator in question is marked with a green upward arrow. Otherwise, the indicator in question is marked with a red downward arrow.
The colour coding of the 2020 values indicates whether the national Europe 2020 target has been met or not. If so, the values are marked in green, otherwise in red.

8 Based on data downloaded on 19 October 2021.
9 Where data for 2020 is not yet available, the analysis includes the UK, which left the EU on 31 January 2020.

Figure 1

Developments since 2010 in relation to the national Europe 2020 targets



On the basis of the available data, it can be concluded that three national targets of the Europe 2020 strategy have not been met, namely the proportion of university graduates, the employment rate and the number of people at risk of poverty or social exclusion. However, the target for early school leaving rate was met. As regards the proportion of people with a university degree, this has increased significantly between 2010 and 2020 and Luxembourg is now at the top of the EU ranking with a rate of 62.2%. The employment rate also increased from 70.7% in 2010 to 72.1% in 2020 and just missed the target of 73%.

For the other four indicators, it is not possible to draw final conclusions regarding the achievement of the respective targets at this time, as data for 2020 is not yet available.

The remainder of this sub-chapter is devoted to detailed descriptions of the monitoring indicators. However, the present situational analysis, which was carried out within the framework of the Competitiveness Report 2021, should be considered as a provisional exercise, as there is a significant time lag for some of the indicators.

A. Smart growth

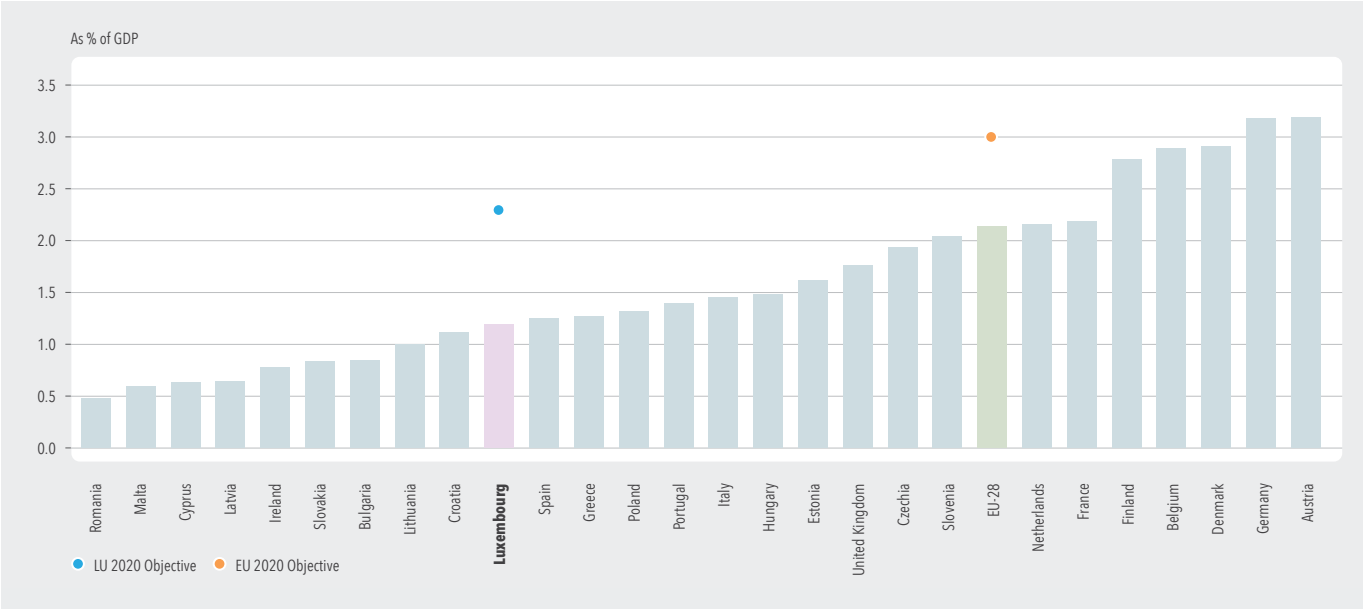
A.1 Improving conditions for innovation and R&D

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. 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. Regarding the indicator itself, it should be noted that its trajectory largely depend on structural factors and public policies promoting R&D.

In its NRP, Luxembourg had set a national target to be reached in 2020 in the range of 2.3% to 2.6% of GDP, with a share of 1.5-1.9% for the private sector and 0.7-0.8% of GDP for the public sector.

Figure 2

Gross domestic expenditure on R&D, as a % of GDP (2019)



Source: Eurostat
Note: The point indicating the Luxembourg 2020 target is at the lower end of the range of 2.3% to 2.6% of GDP.

The most recent data indicate that the average R&D expenditure for the EU-28 was 2.1% in 2019. With a rate of 1.2%, Luxembourg is significantly below the EU average in terms of R&D expenditure.

As in the previous year, Luxembourg is one of the Member States whose private business expenditure on R&D is well below the EU-28 average. However, as the European Commission noted in its 2018 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[10]: *"The structure of the Luxembourg economy partly explains the low business R&D intensity. Sectors that account for the bulk of the Luxembourg GDP (services, in particular financial sector) invest traditionally less in R&D, and even less in Luxembourg than in the rest of the EU. In Luxembourg, the ratio R&D investments on added-value is 0.1% in financial and insurance services (EU average: 0.4%) and 0.7% in non-financial businesses (EU average: 1.5 %). By contrast, for the industry (including energy), this ratio is higher in Luxembourg (7.2%) than the EU average (5.6%)."*

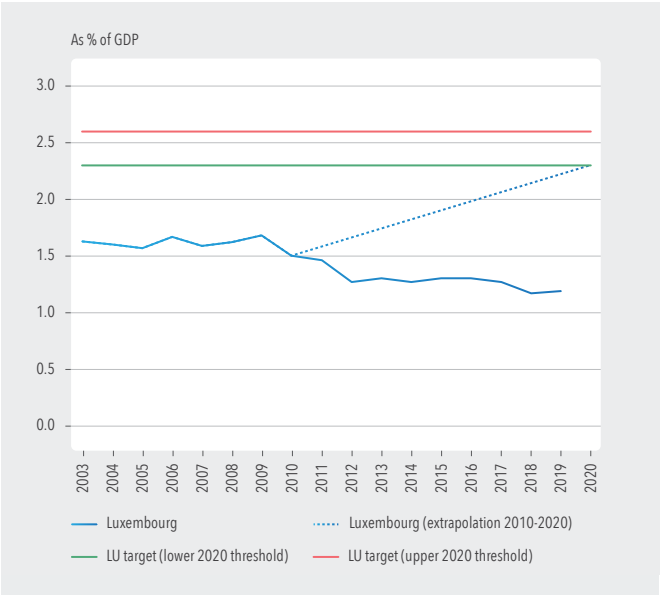
Despite that, in 2019, Luxembourg was among the countries whose public R&D expenditure was close to the EU-28. Public spending on R&D and innovation in Luxembourg has risen year on year since 2000, whereas private R&D expenditure[11], in EUR millions, fell between 2008 and 2012, only to begin slowly climbing again from 2013 onwards. The share of overall R&D expenditure spent on public research in Luxembourg has therefore increased from 7% in 2000 to about 50% at present (of which public research represents 28% and higher education 22%). R&D activities carried out by companies in the private sector therefore currently still account for just over 50% of total expenditure.

In 2019, Luxembourg was thus far from its national 2020 target, and also well below the linear trend for achieving this national target.

10 For more details see: https://ec.europa.eu/info/sites/info/files/2018-european-semester-country-report-luxembourg-en.pdf
11 The R&D expenditure of companies with a commercial economic activity employing at least 10 people.

Figure 3

Gross domestic expenditure on R&D, as a % of GDP[12]



Source: Eurostat
Note: The dotted 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 the national target set for 2020. In this specific case of gross expenditure on R&D, the lower threshold limit is the national target set for 2020, i.e. 2.3%.

In order to analyse the evolution of domestic R&D expenditure (as a % of GDP) in Luxembourg, it may be useful to study the two variables' curves individually. Indeed, Luxembourg's economy is very dynamic, and the country has experienced high GDP growth in the last few decades. However, if GDP grows faster than domestic R&D expenditure, the R&D expenditure indicator as a % of GDP (ratio) automatically drops. This is what has occurred since 2010. Since then, R&D expenditure has increased by 25.4%, while GDP has increased by about 58%. As a result, R&D expenditure as a percentage of GDP has decreased over time although in absolute terms the amounts have increased, albeit less rapidly than GDP.[13]

Box 1

Domestic R&D expenditure in Luxembourg

The rate of 1.2% of GDP suggests that Luxembourg is lagging behind in R&D spending. Indeed, overall, R&D spending is relatively low compared to EU Member States. However, this observation needs to be qualified. Firstly, it should be noted that public R&D expenditure is close to the European average. It represents about 0.6% of GDP and thus constitutes 50% of total R&D expenditure in Luxembourg.

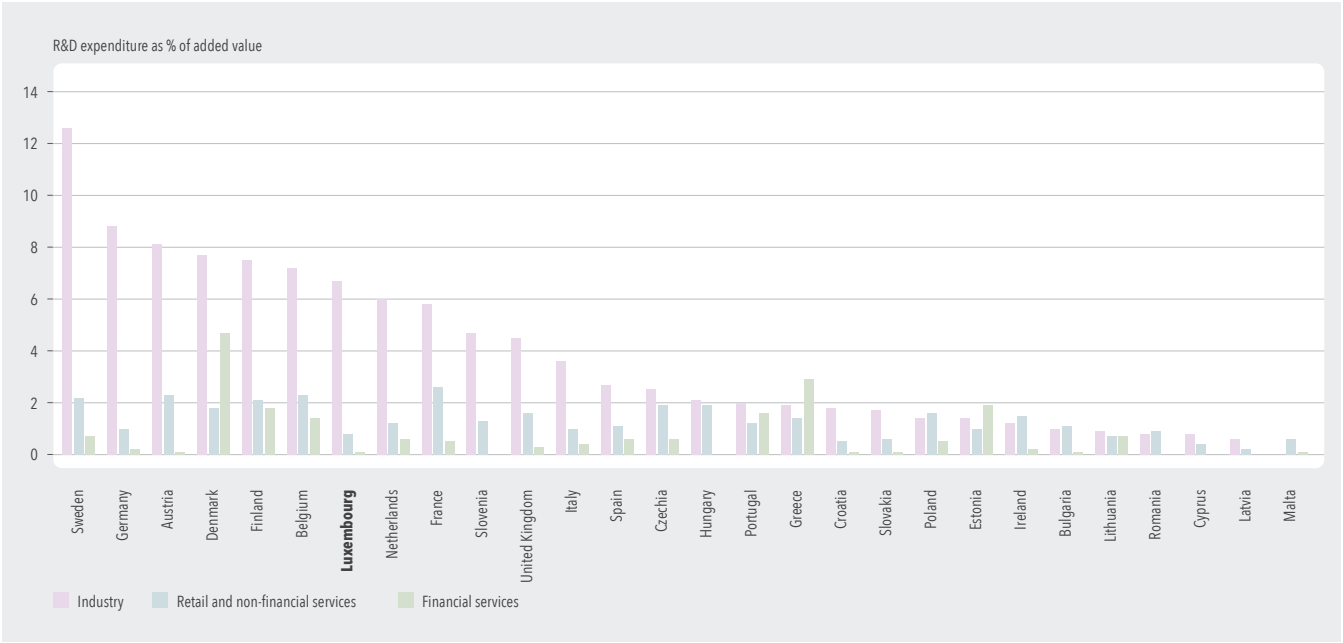
As for the rate of private R&D expenditure, it is relatively low in Luxembourg but nevertheless represents half of total R&D expenditure. It is therefore important to go more in detail with the analysis at branch level to understand where the causes lie.

In its publication "R&D and innovation performance of companies" of March 2021[14], STATEC found that in 2017 industry accounted for more than 60% of companies' R&D expenditure in Luxembourg. Furthermore, in relation to the value added created that same year by the respective sectors, R&D expenditure amounted to 6.7% in industry, 0.8% in trade and non-financial services, and 0.1% in financial services.

12 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 impor- tant to trace the flow of R&D funds.
13 For more details: see Box 1 "Developments in domestic R&D expenditure and GDP in Luxembourg", p. 96 of the 2020 Competitiveness Report.
14 For more details see: https://statistiques.public.lu/catalogue-publications/analyses/2021/PDF-Analyses-02-2021.pdf

Figure 4

R&D expenditure by industry and by country in the EU (2017)



Source: STATEC

In 2017, these rates ranked Luxembourg 7th in the EU for R&D expenditure in industry, 22nd in the trade and non-financial services sector and 20th in the financial services sector. It should also be noted that there was a wide difference in the ranges between the three branches mentioned above. While in industry the rate ranged from 12.6% to 0.6% (median 2.5%), the range was 2.6% to 0.2% (median 1.2%) in retail and non-financial services, and 4.7% to 0% (median 0.35%) in financial services.

The financial sector contributed to a quarter of Luxembourg's gross value added in 2020[15], but R&D expenditure in the field is limited. Conversely, industry, the most important contributor in terms of business R&D expenditure, contributes only 6% of the country's value added. Accordingly, in view of the preponderant weight of the financial sector in the Luxembourg economy, it is not surprising that private R&D spending is relatively low in aggregate.

A.2 Improve educational and skills 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, with two objectives 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 cyclical fluctuations.

A.2.1 Early school leavers

The EU target was to achieve a rate of persons leaving school prematurely less than 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.

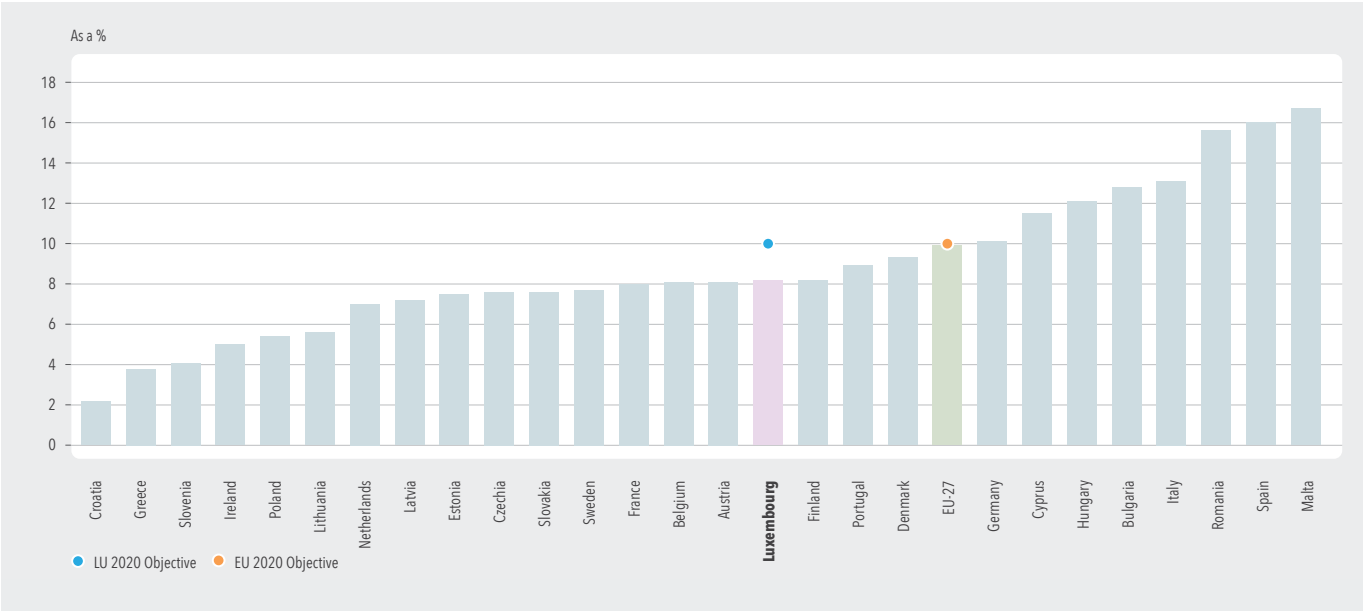
The EU-27 average rate[16] for this indicator was 9.9% in 2020, compared to 8.2% in Luxembourg.

15 By way of comparison, the weight of financial services in the other EU Member States reached a maximum of 10% of value added in 2020 (EU average: 4.5 %).

16 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.

Figure 5

Persons leaving education and training prematurely, % of 18–24-year-olds not in education and training and with education up to lower secondary level (2020)



Source: Eurostat

The breakdown by gender shows that this rate is 10.7% for men and 5.7% for women in Luxembourg. The gender gap has increased by 1.6 percentage points compared to the previous year. As regards how early school leavers fare with regard to the employment status, a total of 4.3% of school leavers were employed and 3.7% were unemployed but wanted to work[17]: in Luxembourg, there are therefore more employed persons without school certificates than unemployed ones who wanted to work.

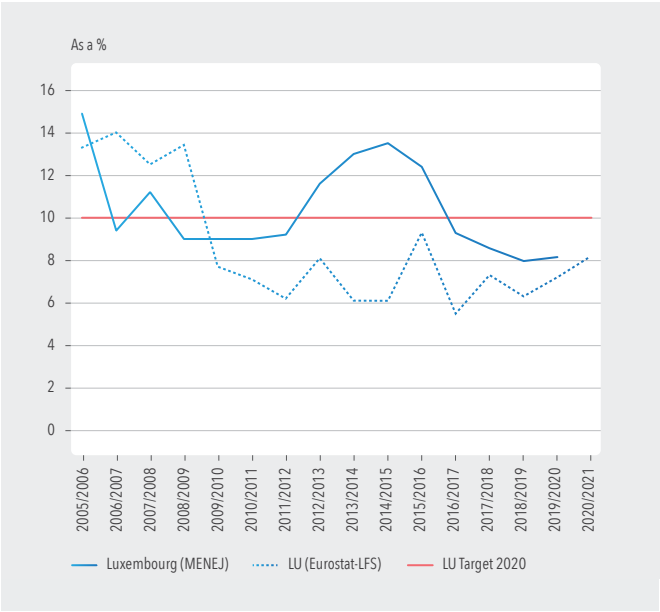
The underlying statistics of this indicator are calculated by Eurostat and taken from the Labour Force Survey (LFS) and are prone to considerable yearly variations for Luxembourg, due to the limited size of the survey sample for a small country such as Luxembourg. The Ministry of Education, Children and Youth (MENEJ) 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. The approach of this analysis acts as a complement to that of the LFS, because it focuses on students having prematurely left the Luxembourgish school system during a specific reference period. The LFS, however, bases its assessment on the entire population residing in Luxembourg, which includes a high percentage of residents who did not attend school in the Luxembourgish school system.

A new methodology has recently been applied to calculate the national early school leaving rate. It allows for a more direct calculation of the early leaving rate, making it possible to quickly measure the impact of policy implemented to combat the problem of leaving school prematurely. According to this new method, the early school leaving rates for 2017/2018 and 2018/2019 are 5.8% and 6.0% respectively. In conclusion, Luxembourg was below the target of 10% according to both methods and therefore achieved the national objective for 2020.

17 For more details see: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Early_leavers_from_education_and_training

Figure 6

Trend in early leaving from education in Luxembourg



Sources: Eurostat; Ministry of Education, Children and Youth

In 2020, the percentage of the population aged 30-34 with a higher education qualification was 41% for the EU-27. With a rate of 62.2%, Luxembourg is one of the best-performing Member States in this regard.

Luxembourg has experienced a significant increase in this indicator, which rose from 46.1% in 2010 to 62.2% in 2020.The gender gap has reduced compared to the previous year. In more detail, the rate of individuals having obtained a higher education diploma is currently 58.7% for men and 65.7% for women. Compared to the previous year, the gender gap has doubled. Thus, Luxembourg already clearly exceeds the European objective at this stage, while still below its national target, although it shows a positive mid- and long-term trend.

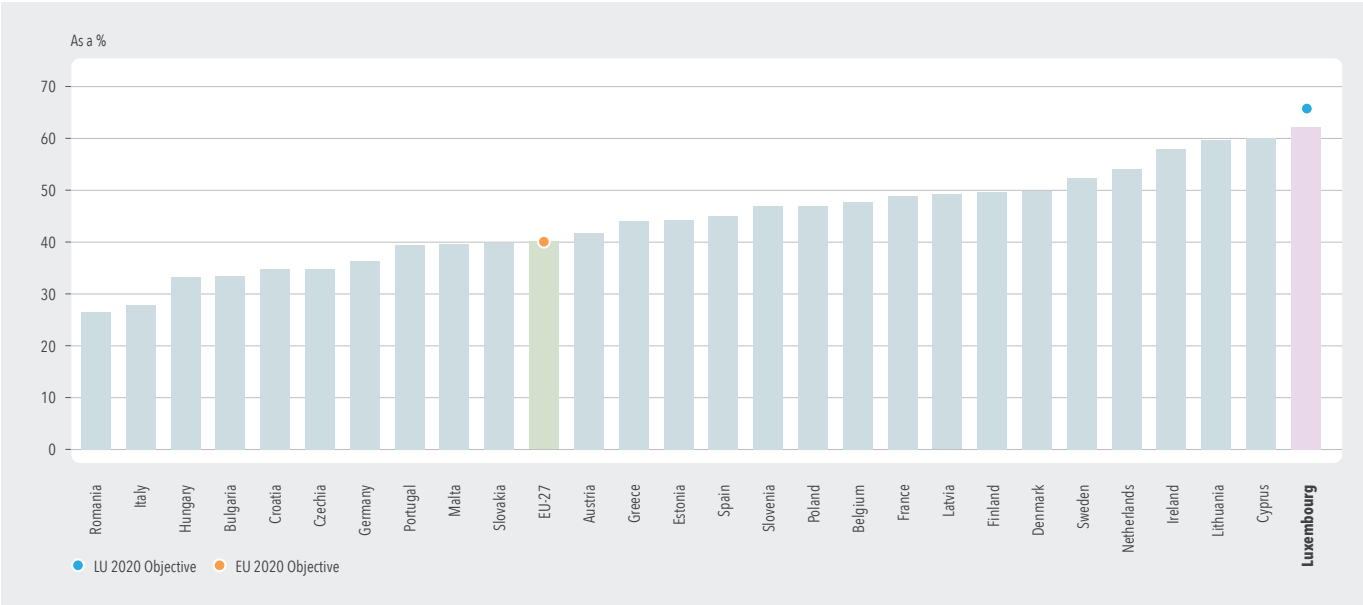
This indicator, like the one for early school leaving, comes from the Labour Force Survey (LFS), and is not entirely representative for Luxembourg. On the one hand, it includes foreign graduates living and working in Luxembourg (around 47% of residents in Luxembourg do not have Luxembourg nationality). On the other hand, this indicator can capture neither nationals from Luxembourg who graduated and work abroad, nor the numerous cross-border workers coming to Luxembourg (around 46% of the total workforce in Luxembourg).

A.2.2 Share of higher education graduates

The overall EU objective is to achieve a rate of 40% of people aged 30-34 graduated in higher education by 2020. Luxembourg has set a much higher objective in its NRP (66%).

Figure 7

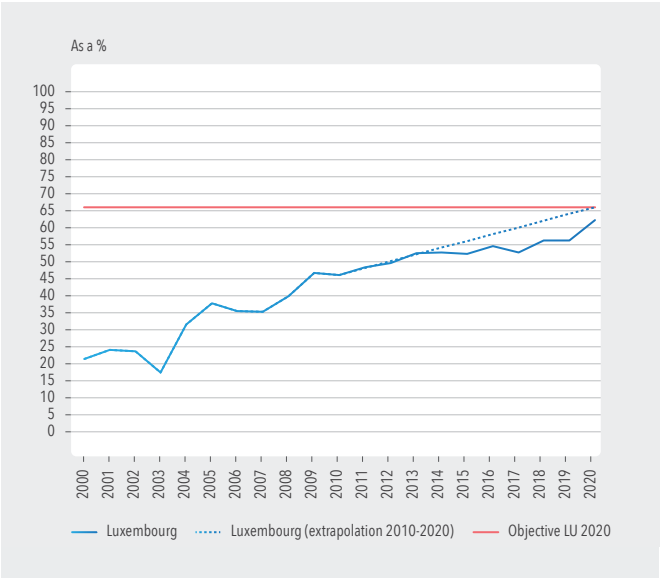
Level of higher education graduates in the 30-34 age group (%) (2020)



Source: Eurostat

Figure 8

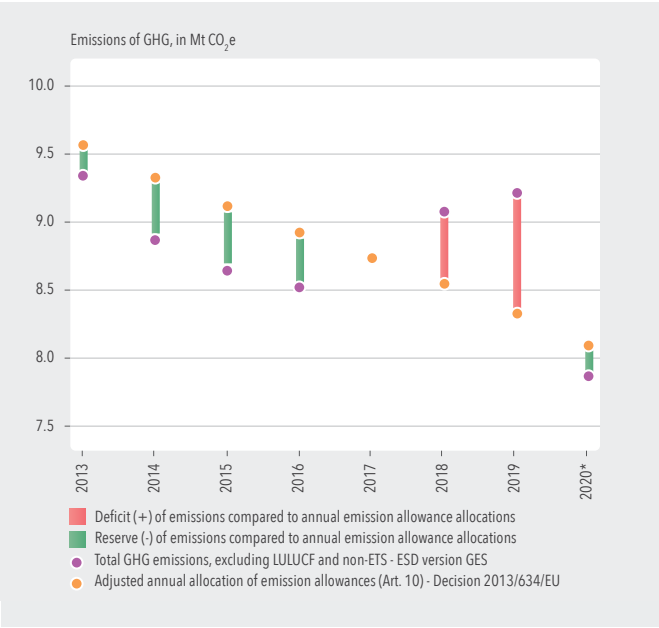
Level of higher education graduates in the 30-34 age group (%)[18]



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

Figure 9

GHG emissions, excluding LULUCF and ETS (2013-2020)



Sources: Eurostat, STATEC
Note: Provisional figures for 2020.

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 emission reduction targets and the share of renewable energy in the total energy consumption are legally binding[19]. Moreover, such binding targets are also part of Luxembourg's Integrated National Energy and Climate Plan for the period 2021-2030.

B.1.1 Greenhouse gas emissions

In the 2013-2020 post-Kyoto period, only the sectors that fall outside the scope of the EU Emissions Trading System (EU ETS) have objectives that are set at Member State level. In Luxembourg, the 2020 target for those sectors' emissions ("non-EU ETS emissions") is a 20% reduction from the 2005 reference level – a target to be met 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. These annual budgets are based on annual emissions quotas. In 2020, non-EU ETS emissions should be limited to 8.12 Mt CO_2e.

According to Eurostat data, the accumulated GHG emission reserves between 2013 and 2016 amounted to 1.6 Mt CO_2e. In contrast, accumulated deficits in 2018 and 2019 amounted to 1.46 Mt CO_2e. These figures show that Luxembourg still had a reserve of 0.14 Mt CO_2e, and 2020 emissions should therefore not exceed 8.26 Mt CO_2e in order to achieve the national target. According to STATEC forecasts published in the June 2021 Economic Outlook[20], GHG emissions appear to have decreased in 2020 in such a way that the final balance is a negative -0.4 Mt CO_2e. As such, Luxembourg will have reached its 2020 target.

B.1.2 Share of renewable energies in final

The EU has set a target of 20% renewable energy by 2020. Luxembourg has set an overall target of 11% renewable energy in its final energy consumption, with a series of intermediate targets.

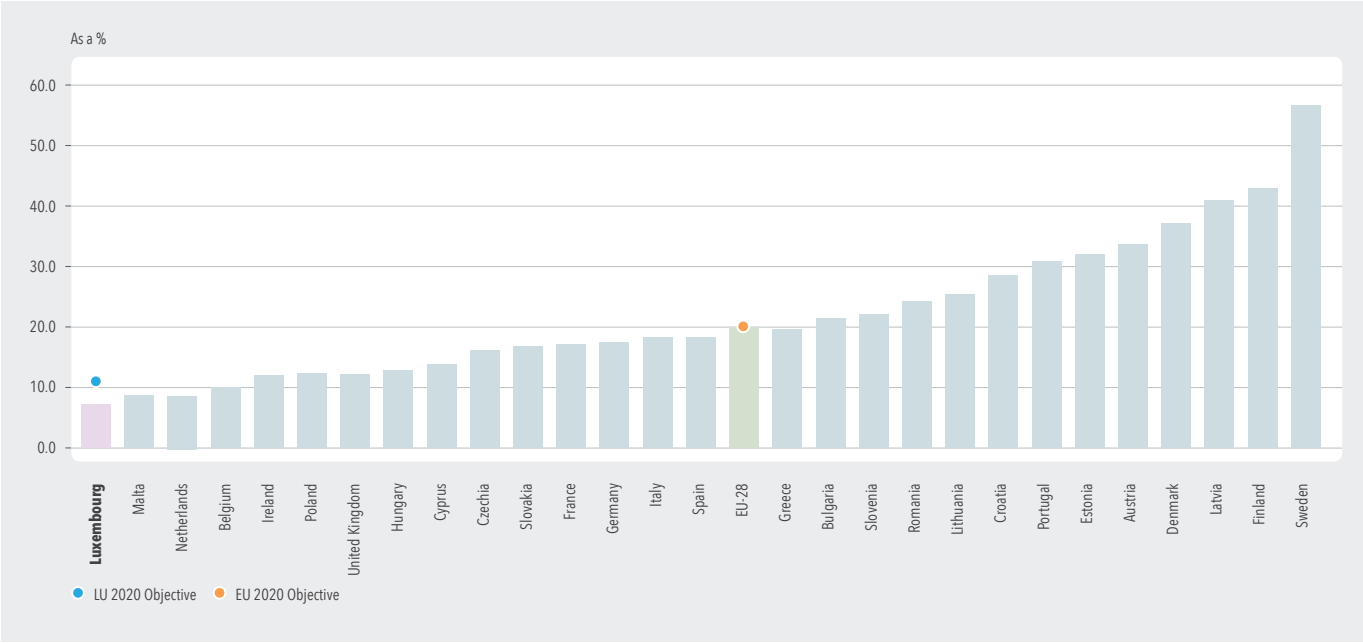
In 2019, the share of renewable energies in gross final energy consumption averaged 18.9% in the EU-28. Luxembourg posted a rate of 7% and thus found itself in last position in the ranking.

In terms of fulfilling its commitment, Luxembourg was below the projected intermediate trajectory after a setback in 2018.

18 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.
19 See European Directive 2006/32/EC. The reduction of energy consumption is a political objective endorsed by the Member States in their individual Energy efficiency action plan.
20 For more details see: https://statistiques.public.lu/catalogue-publications/note-conjoncture-en/2021/NDC1-2021_EN_Web.pdf

Figure 10

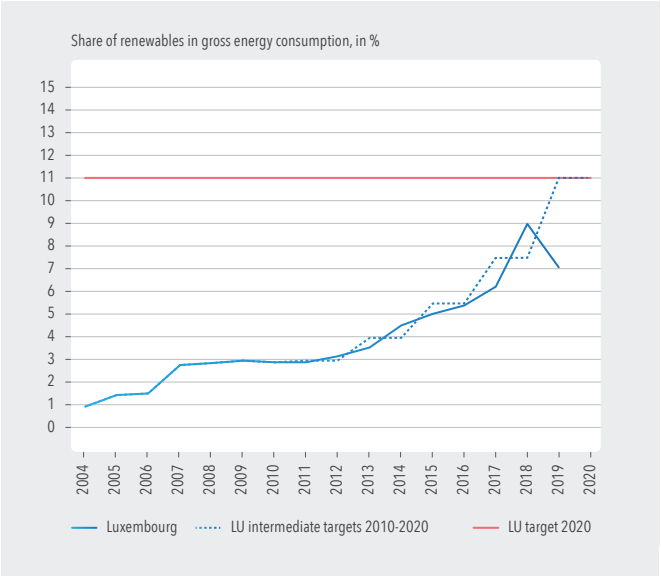
Renewable energy in gross final energy consumption (2019)



Source: Eurostat

Figure 11

Renewable energy in gross final energy consumption[21]



Source: Eurostat
Note: The dotted line is the intermediate path set by the government after 2010 to achieve the national target set for 2020.

B.1.3 Energy efficiency

For 2020, the Energy Efficiency Directive set an energy efficiency target at EU level. The EU has set a target of a 20% increase in energy efficiency by 2020. With the exception of the EU as a whole, the Europe 2020 indicator does not provide information on the national energy efficiency of the Member States themselves. Indeed, the Europe 2020 indicator only takes into account the EU's energy savings compared to a business-as-usual scenario, based on economic forecasts, dating from 2007. Member States had to set themselves a national indicative target in terms of primary and/or final energy consumption levels. For comparability purposes, on the basis of this energy consumption information, Eurostat subsequently calculates a primary and final energy consumption expressed in tonnes of oil equivalent[22] to measure the progress made in energy efficiency at national level. It should be noted that the economic and financial crisis that started in 2008, and the subsequent economic downturn, had a significant impact on energy consumption during this period.

21 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.

22 Definition: This quantity is relevant for measuring actual energy consumption. The "percentage savings" is calculated using these 2005 values and their forecast for 2020. The Europe 2020 target will be met when this value reaches the 20% level.

Fluctuations in energy volumes over the last few years, both at EU and Member State level, were therefore not necessarily the result of energy efficiency alone, but also of changes in economic activity.

Luxembourg set a national target for 2020 that annual final energy consumption should not exceed 49,292 GWh (i.e. approximately 4.24 Mtoe). In 2019, Luxembourg was above this target with a consumption of 4.39 Mtoe. In addition to the energy efficiency target, Luxembourg has also set an energy savings target of 5,993 GWh to be achieved by the end of 2020 through an energy efficiency obligation mechanism introduced in 2015. The first period (2015-2020) of this obligation mechanism ended on 31 December 2020.

All factors considered, final energy consumption in Luxembourg decreased less between 2005-2019 (index of 97.94, 2005 = base 100) than in the EU as a whole (93.64). This means that final energy consumption in Luxembourg has decreased by about 2% in 2019 compared to 2005. It follows that at this stage the national target has not yet been reached.

C. Inclusive growth[23]

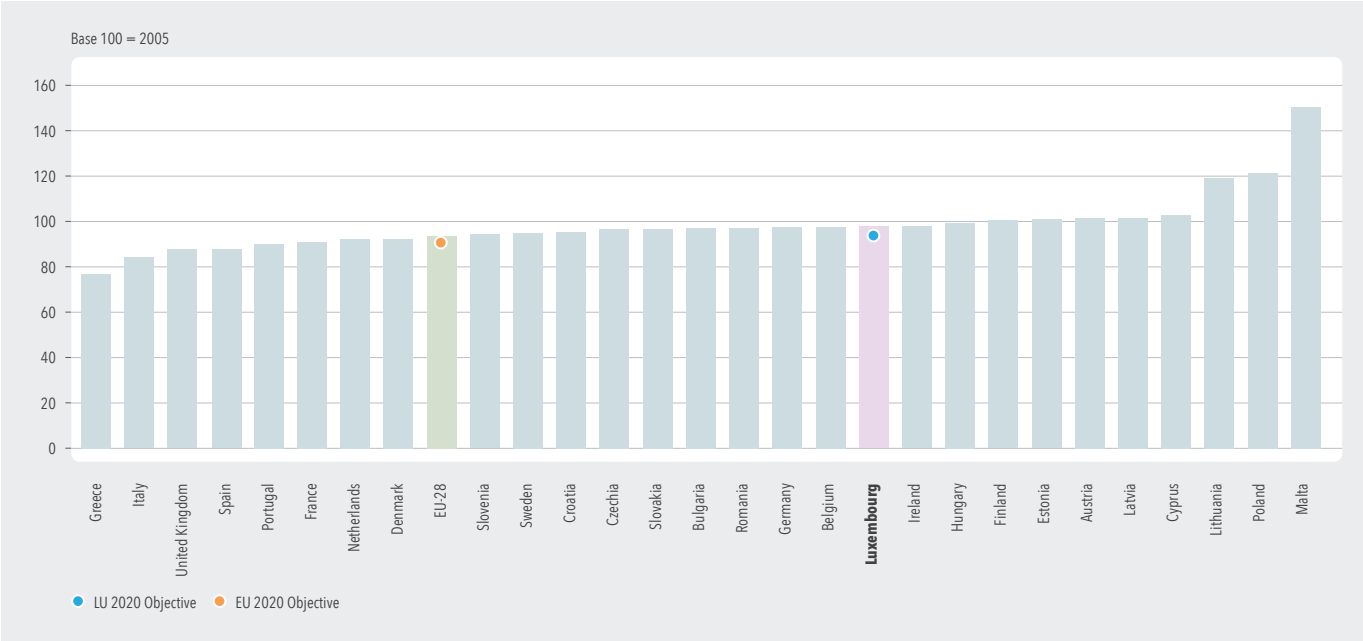
C.1 Promoting employment

The Lisbon Strategy (2000-2010) already included a target related to employment policies, namely the employment rate. The Europe 2020 target showed two major changes compared to the former Lisbon target. Firstly, the age range considered for the indicator (20-64 years for 2020 instead of 15-64 years for 2010) in order to reduce possible conflicts between employment and education policies, and secondly the benchmark to be reached (75% for 2020 instead of 70% for 2010). It should also be noted that changes to the employment rate depend on many uncertainties, which had to be taken into account when setting the numerical targets for the Europe 2020 strategy. Indeed, the employment rate indicator is very sensitive to the economic cycle.

Luxembourg has set a national target of a 73% employment rate to be achieved by 2020.

Figure 12

Final energy consumption in Luxembourg (2005 = base 100) (2019)

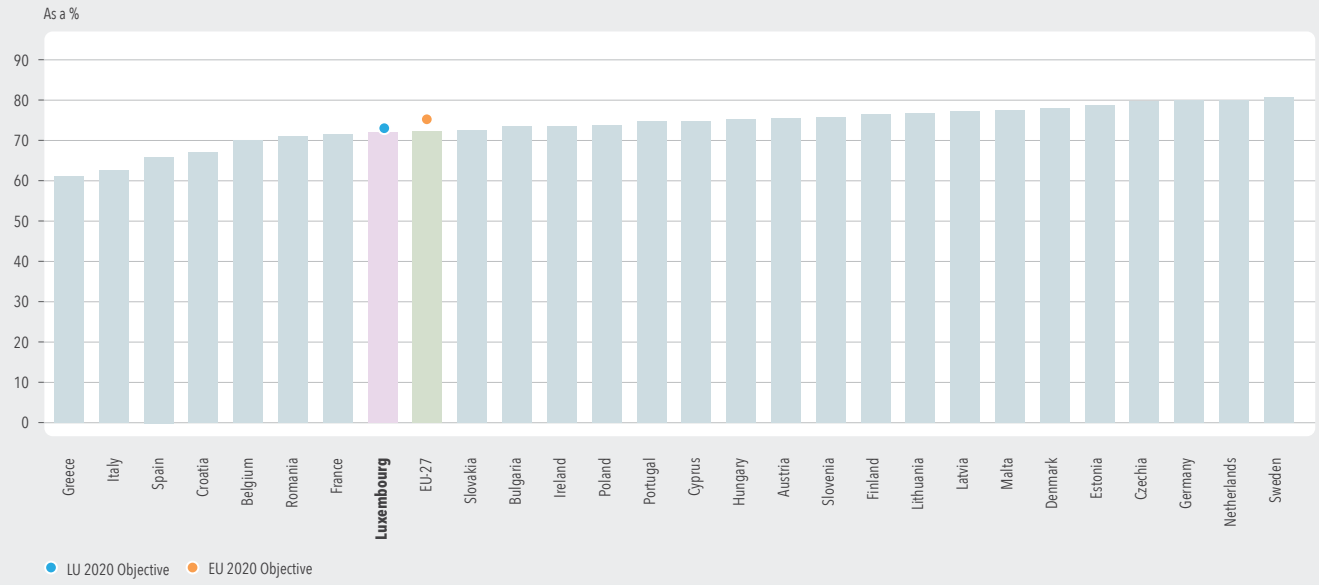


Source: Eurostat

23 As data for the UK and EU-28 are not available for 2020, reference is made to EU-27 data only.

Figure 13

Employment rate of population aged 20-64 (2020)



Source: Eurostat

In 2020, the EU27 had an employment rate of 72, 4%. With a rate of 72,1%, Luxembourg performed slightly below the EU average.

The employment rate, which is an average for the resident active population, nonetheless masks important differences in the employment rate depending on the socio-economic category observed. A more selective apportionment of the employment rate, for example by gender or age of the worker, shows that the employment rate fluctuates significantly. For example, in 2020:

- The employment rate for men was 75.6% in Luxembourg, compared to 68.5% for women;
- The employment rate for those aged 55 up to 59 was 63.3%, while the employment rate for those aged between 60 and 64 was 20.2%;
- The employment rate of national residents was 69.8%, while that of foreign residents was 73.8%(76.9% for people from the EU-27 and 64.6% for those from third countries)[24];
- The employment rate of students aged 20-34 who graduated in the three previous years was 83.7% for the EU as a whole. Luxembourg (84.7%) was slightly above the EU-27 average.

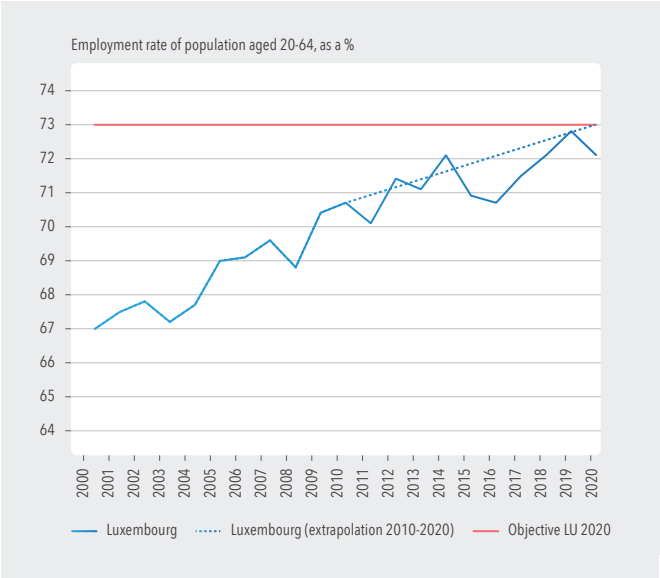
The employment rate in Luxembourg increased from 70.7% (2010) to 72.1% (2020), notably as a result of an increase in the employment rate of women and older people. Although the employment rate, calculated on the basis of the Labour Force Survey (LFS) data, fell slightly in 2020 compared to the previous year, it still showed an upward trend in Luxembourg in the longer term.

Nevertheless, this trend should be interpreted with caution. STATEC has carried out technical analyses on this subject[25]. The employment rate can be calculated from two different sources: the LFS or administrative data. The employment rate calculated on the basis of administrative data is based on the national employment of the national accounts in relation to the population, an official figure from the population census. National employment data is mainly based on IGSS data and is calculated according to harmonised rules at European level. Over the last few years, the employment rate trends diverge strongly between these two sources, the first indicating an increase in the employment rate and the second a decrease. The analysis shows that the increase in the employment rate (LFS) is mainly due to methodological changes aimed at improving the survey (better response rate, better coverage of people in work, etc.). The decrease in the employment rate (administrative sources) is explained by longer academic studies periods, the introduction of parental leave and the ageing of the population.

24 For more details see: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsa_ergacob&lang=en
25 For more details see https://statistiques.public.lu/catalogue-publications/cahiers-economiques/2018/PDF-Analyses-01-2018.pdf and https://statistiques.public.lu/catalogue-publications/note-conjoncture/2018/PDF-NDC-02-18.pdf

Figure 14

FTE Employment rate of people aged 20-64[27]



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

Finally, while an increase in the employment rate generally makes it possible to stimulate growth and reduce social and public expenditure, these observations must be put into perspective in the case of Luxembourg. In Luxembourg, there are three components to the labour supply: domestic, cross-border and immigrant workers. However, as the employment rate is a purely national concept and therefore linked to the worker's place of residence, frontier workers are not included in this definition. Domestic employment in Luxembourg incorporates cross-border workers amounting to more than 46%. As the Economic and Social Council (ESC) has noted[26], this indicator *"is not representative of the macroeconomic reality in Luxembourg and is even less suitable as a macroeconomic employment target against which employment policy should be defined."* On the other hand, the employment rate of young people, women and older people is useful for understanding the use of human resources in the economy.[27]

C.2 Reducing poverty

The EU target for social inclusion initially proposed by the European Commission was to reduce poverty by 20 million people at risk of poverty. However, in order to meet the Europe 2020 objective of inclusive growth, the European Council of March 2010 asked the Commission to work further on social inclusion indicators, including non-monetary indicators. The European Council then agreed in June 2010 to ensure that at least 20 million people are no longer at risk of poverty or exclusion. This population has been defined as the number of people who are at risk according to three indicators, with Member States being free to set their national targets on the basis of the indicators they consider most appropriate among these:

- At-risk-of-poverty rate after social transfers: people living on less than 60% of national median income. The at-risk-of-poverty rate is the flagship indicator for measuring and monitoring poverty in the EU. It is a relative measure of poverty, linked to income distribution, which takes into account all sources of monetary income, including market income and social transfers. It reflects the role of work and social protection in preventing and reducing poverty. It should also be noted that the national at-risk-of-poverty thresholds are relatively widely dispersed, ranging from EUR 4,634 (PPA) in Romania to EUR 17,205 in Luxembourg.[28,29]

- Material deprivation rate: people whose living conditions are severely limited by a lack of resource[30]. The material deprivation rate is a non-monetary measure of poverty that also reflects the different levels of prosperity and quality of life in the EU.

- People living in jobless households: this population is defined in relation to zero or very low work intensity over a whole year, in order to properly reflect situations of long-term exclusion from the labour market. These are people living in families facing long-term exclusion from the labour market. Long-term exclusion from the labour market is one of the main factors of poverty and increases the risk of transmission of detriment from one generation to the next.

26 CES, Deuxième avis sur les Grandes Orientations des Politiques Économiques des États membres et de la Communauté (GOPE), Luxembourg, 2003. For more information see: https://ces.public.lu/dam-assets/fr/avis/themes-europeens/2003-gope-2.pdf
27 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.
28 For more details: see Box 3 "Analysing the risk of poverty after social transfers", p. 109 of the Competitiveness Report 2020.
29 For more details: https://ec.europa.eu/eurostat/databrowser/view/tessi014/default/table
30 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.

Elements that may affect changes to poverty indicators are related to macroeconomic developments, as well as to the capacity of employment policies to promote an inclusive labour market and employment opportunities for all, as well as the capacity of social protection systems to become more efficient and effective due to the constraints on public finances.

It should be noted that monetary indicators of poverty, such as the at-risk-of-poverty rate, have one important limitation. They do not take into account the many non-monetary public services and benefits in kind that are available to citizens. In Luxembourg, the childcare service vouchers which are not taken into account form one of these factors. Other factors such as demography, consumption, wealth and the fact that an income below 60 % of the national median income does not necessarily imply a high risk of poverty, should be taken into account when analysing the at-risk-of-poverty rate.[31]

In order to obtain a more complete picture of those at risk of poverty or social exclusion, Eurostat has developed an indicator that allows better quantification of the percentage of the total population at risk of poverty or exclusion by combining the three individual indicators mentioned above. In addition, this indicator is also a major indicator for monitoring the poverty or social exclusion target of the European Social Rights Framework for 2030.

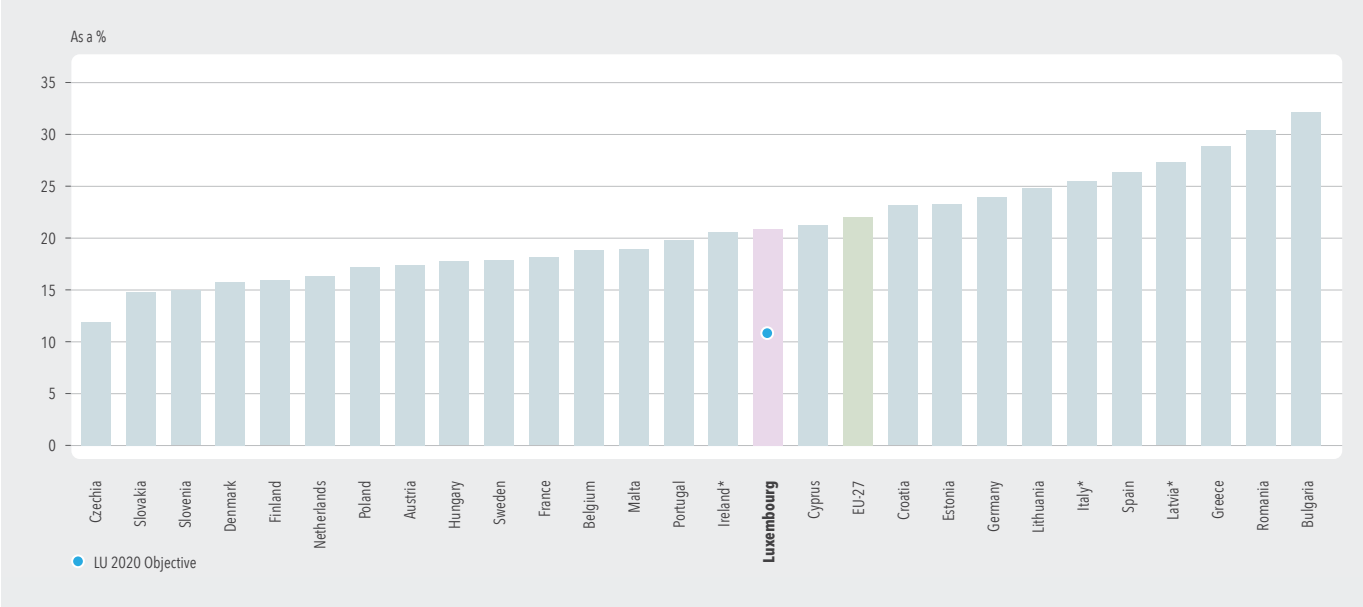
Luxembourg had set a national target for 2020 in its NRP to *"reduce the number of people at risk of poverty or social exclusion by 6,000"*.

In 2020, an average of 22% of the total EU-27 population was considered to be at risk of poverty or social exclusion. In Luxembourg, this rate was 20.9% and concerned about 125,000 people.

When analysing this indicator, fewer people were at risk of poverty or social exclusion among national residents (15.4%) than among foreign residents (25.7%). Among the latter group, people from the EU-27 (23.3%) were less affected than those from non-EU countries (36.5%)[32]. People at risk of poverty or social exclusion in Luxembourg were mainly those at risk of poverty after social transfers (17.4%). To a much lesser extent, they were people living in a very low work intensity household (7.9%) or people in a situation of severe material deprivation (1.7%).

Figure 15

People at risk of poverty or social exclusion (2020)

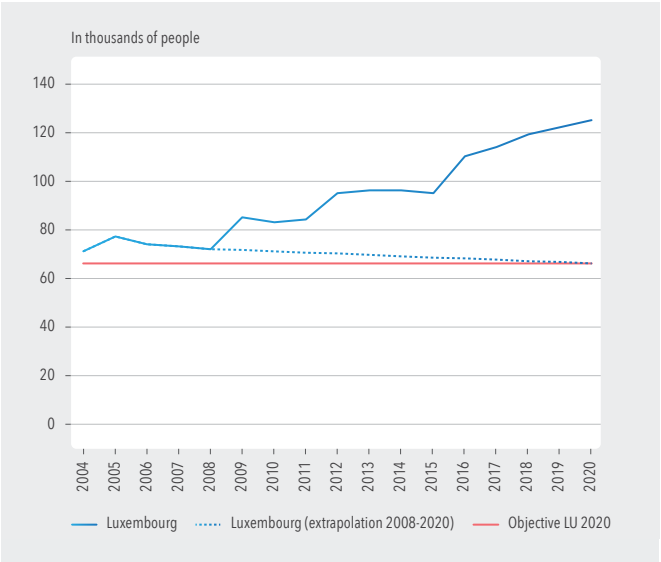


Source: Eurostat, ODC calculations
Note: *Ireland, Italy, Latvia (2019)
The LU 2020 target is calculated on the basis of information provided by Eurostat. This rate is the ratio between the target (expressed in number of people) and the population in 2020 (obtained from a sorting rule: the percentage of people at risk of poverty or social exclusion and the value expressed in number of people being known). Several countries, namely Germany, France, Belgium, Denmark and Luxembourg reported breaks in the series in 2020.[33]

31 For more details: see Box4 "Reflections on the at-risk-of-poverty rate or social exclusion", p. 111 of the Competitiveness Report 2020.
32 For more details: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Migrant_integration_statistics_-_at_risk_of_poverty_and_social_exclusion
33 For more details: see Chapter 3 on the national indicator system pp. 63-64.

Figure 16

Change in the number of people at risk of poverty or social exclusion (2004-2020)



Source: Eurostat
Note: The dotted line connecting the years 2008-2020 is an example to illustrate the linear trend that Luxembourg's performance should have shown afterwards in order to achieve the national target set by Luxembourg for 2020. The 2020 target is therefore the 2008 figure minus the 6,000 people that Luxembourg wanted to lift out of poverty or social exclusion.

Like the majority of EU Member States, Luxembourg did not reach its 2020 European target in terms of people at risk of poverty or social exclusion. Indeed, since the global economic crisis of 2008, the number of people concerned has continuously increased in Luxembourg. With approximately 125,000 people in 2020, and according to the methodology used by the European Commission (2008 = basis for comparison), Luxembourg is far from its national target for 2020.

The national target would require Luxembourg to count 6,000 fewer people in 2020 than in 2008 (72,000 people). This would mean that only 66,000 people would be at risk of poverty or social exclusion in Luxembourg in 2020.

4.1.3 Final points

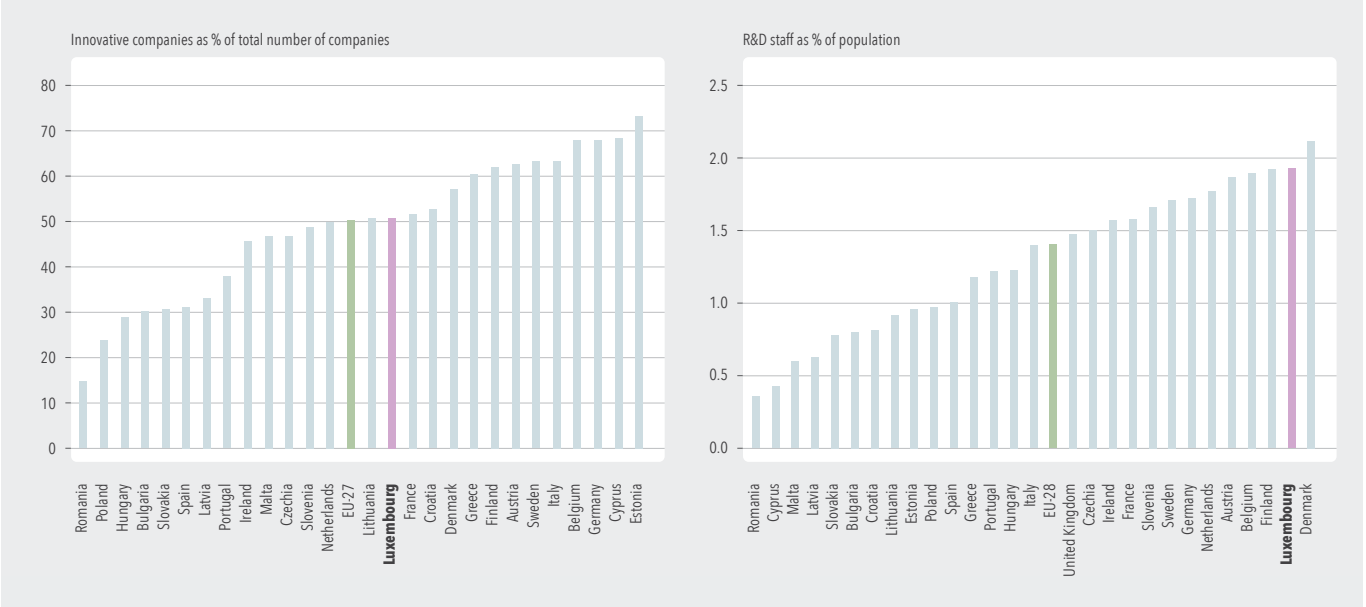
A. Other possible perspectives

The Europe 2020 Strategy indicators, which were selected following negotiations at EU level and taking into account the considerations of stakeholders, are not the only ones that provide valuable information on the progress of the different EU priorities. Accordingly, it is useful to present other indicators that refine the analysis made in this chapter.

This is the case, for example, in the top priority area of smart growth, which takes into account R&D expenditure, the early school leaving rate and the share of people with a university education. However, these indicators could be complemented by the use of other indicators to give a more comprehensive picture.

Figures 17 et 18

Number of innovative companies as a % of the number of companies (2018) and R&D personnel as % of labour force (2019)



Source: Eurostat

For **R&D**, in addition to R&D expenditure, personnel working in R&D could also be taken into account. With regard to R&D output, it may also be interesting to look at the number of innovative companies.

As for **innovative enterprises**, Luxembourg scores slightly higher (50.6%) than the EU-28 (50.3%), while the country ranks very well (around 1.94%) in the share of R&D personnel in the active population.

However, it should not be overlooked that there are still many other indicators that could provide insights into the state of smart growth. The *European innovation scoreboard*, in which Luxembourg is ranked 7th as a "strong innovator", includes a wide selection of indicators in this field[34].

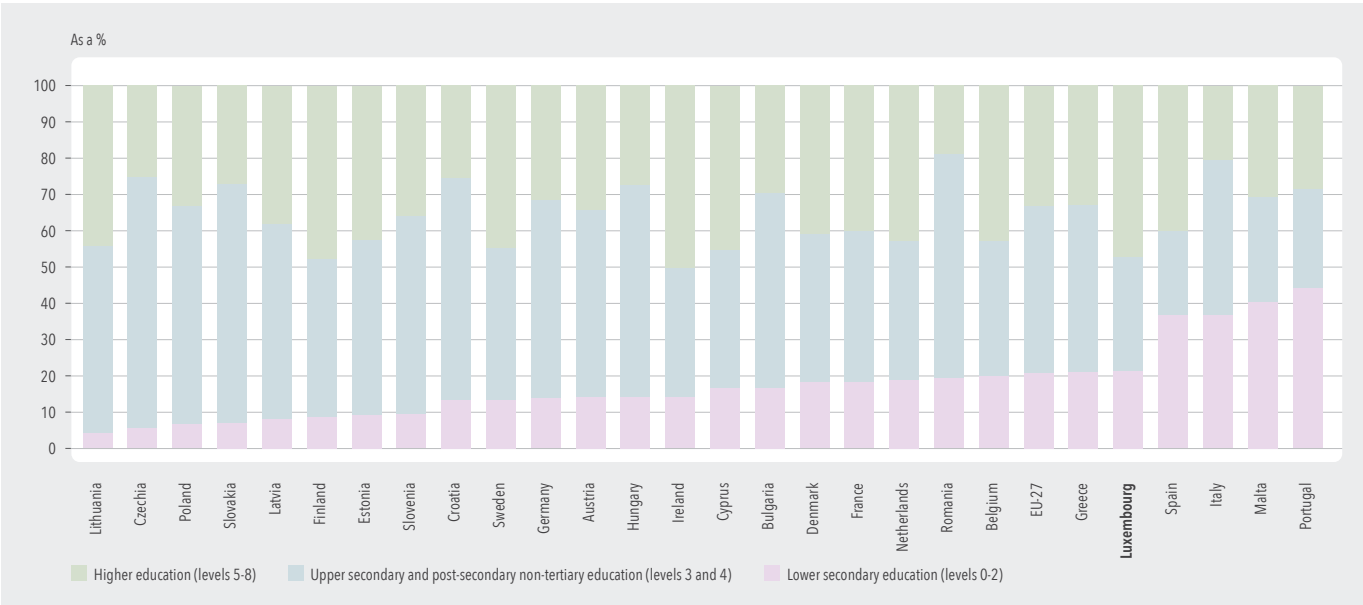
For the **education** and **training** target, only two indicators, namely the early school leaving rate and the share of people with university education, are included. However, other indicators could also provide valuable information in this area.

Figures 19 and 20 give an overview of the level of education in the European Union. The first shows, among other things, that compared to other Member States there are many highly qualified people, as well as a large number of poorly qualified people, while there are relatively few people with average qualifications. The second graph shows how the structure of educational attainment has changed in 2020 compared to 2010. While the number of people with few skills has decreased in the EU, it has remained almost constant in Luxembourg. In contrast, the number of workers with medium skill levels has only slightly decreased in the EU, while it has decreased more in Luxembourg. The number of highly skilled people increased in both the EU and Luxembourg, but slightly more in the EU.

With regard to the **poverty reduction** objective, it might be useful to include a more in-depth analysis of the risk of poverty in the assessment and considerations in order to obtain a more complete picture of the situation. Eurostat's risk of poverty or social exclusion indicator of 20.9% includes, alongside the risk of poverty itself (17.4%), two other sub-indicators: severe material deprivation (1.7%) and very low work intensity households (7.9%). However, an examination of the intersections, which was carried out by STATEC in the report *"Travail et cohésion sociale"* (Work and social cohesion) published in 2021, revealed that about 80% of people at risk of poverty or social exclusion in Luxembourg were excluded according to only one of these three dimensions. The remaining people were in a situation of multiple exclusion, with at least two of the three dimensions involved. Furthermore, the analysis showed that more than half of the people at risk of poverty or social exclusion in Luxembourg were excluded on the basis of the "at risk of poverty" dimension alone.

Figure 19

Population by level of education achieved and by country (2020)

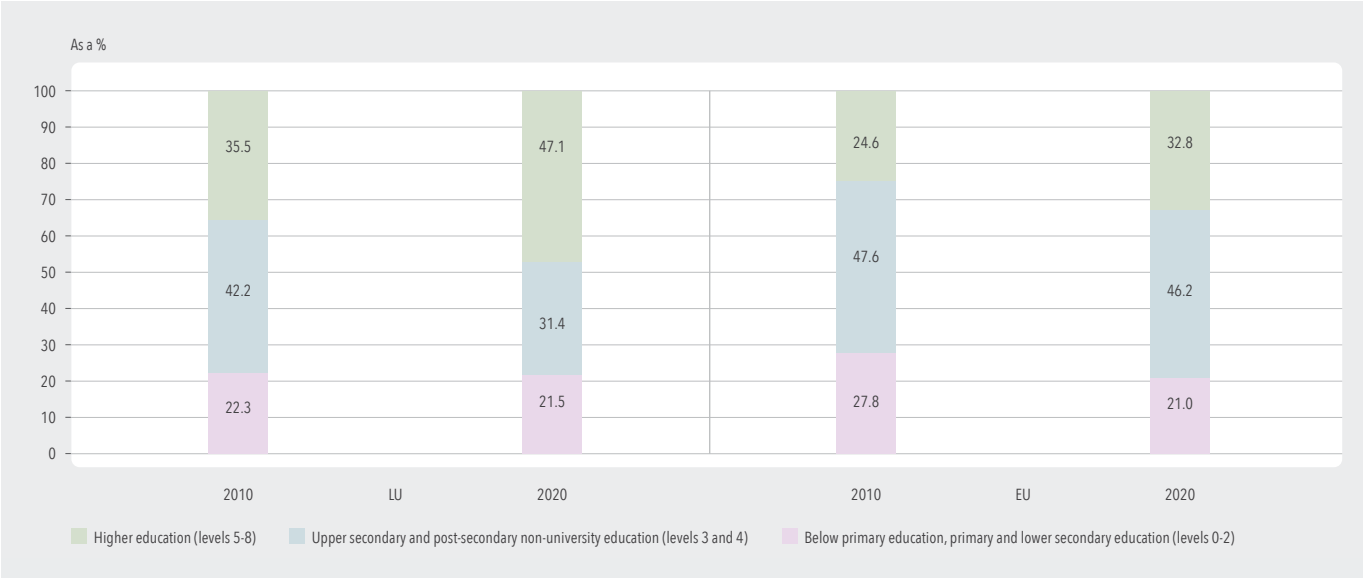


Source: Eurostat

34 For more details see: https://ec.europa.eu/docsroom/documents/46013

Figure 20

Population by level of educational achievement



Source: Eurostat

In the same report, STATEC noted that *"Current methods of calculating the poverty rate in Luxembourg and in Europe are mainly based on disposable household income adjusted by the number of consumption units in the household. However, income is not the only factor affecting a household's well-being"*. To address this, STATEC calculated the poverty rate combining three dimensions: household income, consumption and financial wealth. This calculation reveals that *"(...) among the 17.4% at risk of income poverty, 8.3% also have a low level of consumption and 10.8% have less than three months' resources in their bank accounts or financial assets. Moreover, 5.6% of the population are at risk of poverty in all three dimensions."* This calculation refines the approach to the at-risk-of-poverty rate and thus offers a more detailed insight into this dimension.

B. Impact of the COVID-19 pandemic

The last year of the Europe 2020 strategy was strongly marked by the COVID-19 pandemic which hit the world - including the EU and Luxembourg - hard both economically and socially. According to the latest estimates, the economic growth of the previous years was followed by a decline in GDP of 1.8% in 2020 in Luxembourg.

Although the impact of the pandemic on the achievement of the Europe 2020 objectives is difficult to define and even more difficult to demonstrate, it can be assumed that the pandemic has had an impact on each of the five priorities of the Europe 2020 strategy. In particular, the health crisis could have significant impacts on the first, third and fifth objectives of the Europe 2020 strategy.

With regard to the first objective, i.e. to increase R&D expenditure to 3% (EU) or 2.3% (LU), an impact induced by the health crisis is unavoidable, particularly because this rate is expressed as a percentage of GDP, which itself fell relatively sharply in 2020, mainly due to the measures and restrictions put in place to prevent the spread of the virus.

The third objective, which is in the environmental and energy field, is also likely to be influenced by the pandemic, insofar as countermeasures and regulations, aimed at limiting the negative repercussions of the pandemic, have reduced economic activities and, consequently, economic performance, which, together with logistics and mobility, are among the causes of energy consumption and greenhouse gas emissions.

With regard to the fifth objective, the fight against poverty and social exclusion, STATEC found in its report "Work and social cohesion"[35] that the effects of the COVID-19 pandemic were relatively limited.

The scars left by the COVID-19 pandemic will only be fully captured with some temporary hindsight, as data becomes available.

35 For more details see: https://statistiques.public.lu/catalogue-publications/analyses/2021/PDF-Analyses-05-2021.pdf

4.2 Macroeconomic surveillance

4.2.1 Setting up systems for monitoring macroeconomic imbalances

The years leading up to the 2008 economic and financial crisis were characterised by divergent macroeconomic developments that created imbalances between EU Member States. Before the onset of the global economic and financial crisis, however, little attention was paid to these imbalances within the EU, and particularly within the euro area. Public attention only began to focus on this unhealthy situation after the crisis began. As a result, new challenges arose in terms of monetary policy and economic and fiscal policy coordination because of the interdependence of the European economies and because the existing mechanisms proved insufficient. It has therefore proved important to further strengthen and coordinate this economic policy.

The European Commission has therefore recommended further strengthening economic policy coordination. In its May 2010 communication "Reinforcing economic policy coordination", the Commission noted a persistent accumulation of macroeconomic imbalances that could destabilise the euro area and the functioning of the European Monetary Union. On the basis of this communication, the European Council decided in June 2010 to set up a European stabilisation mechanism. The Commission subsequently developed its ideas in its publication "Enhancing economic policy coordination for stability, growth and jobs - Tools for stronger EU economic governance" on economic policy governance and proposed developing a new structured mechanism for the detection and correction of macroeconomic imbalances. In order to be able to better detect these imbalances, the Commission established an initial scoreboard of economic and financial indicators with the Member States. On 29 September 2010, the Commission finally proposed a legislative package ("Six-Pack") which includes the monitoring of internal and external macroeconomic imbalances at Member State level, such as housing and the growing divergence in cost competitiveness between Member States[36]. This legislative package on economic governance was finally approved on 28 September 2011 by the European Parliament and entered into force at the end of 2011.

4.2.2 The macroeconomic imbalances monitoring procedure (MIP)

The macroeconomic imbalances procedure has two components, the preventive and the corrective arms.

A. The preventive arm

A scoreboard was set up to address the preventive arm of the procedure and is published annually by the Commission. The first edition of this scoreboard was published as part of the Alert Mechanism Report (AMR)[37] in February 2012. This mechanism analyses various indicators for each Member State compared to alert thresholds and is supported by an economic reading of the indicators so as not to be limited to a 'mechanical' interpretation. The Commission uses this procedure to identify a possible risk. If this initial scoreboard indicates the existence of a possible macroeconomic imbalance in a Member State, then as a second step, the Commission requests an in-depth analysis of the imbalance. The in-depth analysis examines the origin, nature and severity of a potential imbalance.

During the analytical work carried out in the context of setting up this scoreboard, it proved very difficult to agree on "one size fits all" indicators for all the Member States, which could take into account both the specifics of each Member State and the potential methodological problems. It was therefore agreed not to limit ourselves to a "mechanical" interpretation of the results but to accompany this interpretation with an economic analysis. The choice of indicators was made mainly on the basis of four guidelines: the indicators should capture the main macro-economic imbalances and signs of loss of competitiveness; the indicators should allow for the analysis of both the level and the flows; the indicators should serve as an important communication tool; the statistical quality of the data should be high and the data should allow for international comparisons.

The main scoreboard initially used included eleven indicators divided into two categories: external and internal imbalances. The analysis of external imbalances includes indicators such as the current account balance (a country's trade with foreign countries) or factors that have a direct impact on this aggregate, such as cost competitiveness. With regard to internal imbalances, experience from past crises identified various key indicators, such as unusual developments in the financial sector or extreme credit developments accompanied by major house price increases. The statistics used in the Scoreboard are updated periodically by Eurostat[38]. For each of these indicators, the Commission had also defined, in consultation with the Member States, thresholds at which performance could be considered as potentially "at risk" based on the historical statistical distribution of each indicator[39].

36 Based on the two European regulations 1176/2011 and 1174/2011. For more details see: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32011R1176 et http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32011R1174

37 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.

38 For more details see: http://ec.europa.eu/eurostat/web/macroeconomic-imbalances-procedure/indicators

39 For more details on the methodology used to set up 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

This means that if a Member State exceeds a set threshold, it could have a macroeconomic imbalance. It is important to stress that the thresholds set are generally the same for the different Member States and only in some cases make a difference between Member States inside and outside the euro area.

Since the end of 2015, the European Commission has added three new employment-related indicators to the original Scoreboard: change in the activity rate of the total population (15-64 years), change in the long-term unemployment rate (active population 15-74 years), change in the youth unemployment rate (active population 15-24 years). The Scoreboard therefore now contains fourteen headline indicators[40] for the identification and monitoring of internal and external macroeconomic imbalances, as well as employment and social developments, in order to better understand the social implications of macroeconomic imbalances. The indicators and thresholds of the Scoreboard should not be considered as targets or policy instruments. Their interpretation should be complemented by a critical and country-specific economic analysis. The composition of the set of indicators is reviewed regularly and may change over time.

B. The corrective arm

If the in-depth review, which is carried out in a second step after the Scoreboard analysis, identifies the existence of an excessive macroeconomic imbalance in a Member State, the corrective arm of the procedure will be triggered. The Member State in question is then placed in a situation of excessive imbalances. In this case, the Member State must submit a corrective action plan to the Council specifying concrete measures and a detailed timetable for implementation. The Commission and the Council assess this corrective action plan, which is either deemed sufficient, in which case regular progress reports are to be submitted to the Council, or insufficient. In the latter case, the Member State is requested to amend its action plan. If the measures remain insufficient after modification, then the Council adopts sanctions on the basis of the Commission's recommendations, unless the Council supports arguments made based on exceptional economic circumstances by a reverse qualified majority.

4.2.3 The 2020 version of the procedure on macroeconomic imbalances

The tenth edition of the Scoreboard was published in the Alert Mechanism report released in November 2020 under the European Semester. In this edition, the European Commission concluded the following in its review of Luxembourg: *"Luxembourg entered the COVID-19 crisis with no identified macroeconomic imbalances although with some risks related to increasing housing prices and household debt. With the COVID-19 crises price and cost pressures reduce temporarily. Overall, the Commission does not see it necessary at this stage to carry out further in-depth analysis in the context of the MIP".*[41]

40 In addition to the main scoreboard, there is also an auxiliary scoreboard for more detailed analysis. This will not be analysed in this chapter. For more details see: https://ec.europa.eu/eurostat/web/macroeconomic-imbalances-procedure/indicators

41 For more details: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0745

Results of the MDP Scoreboard indicators (November 2020 edition)

	EXTERNAL IMBALANCES AND COMPETITIVENESS					INTERNAL IMBALANCES						EMPLOYMEMNT INDICATORS[1]		
2019	Current account balance– % of GDP (average over 3 years)	Net international investment position (in % of GDP)	Real effective exchange rate – 42 trading partners, HICP deflater (% change over 3 years)	Export market share - as % of world exports (% change over 5 years)	Nominal unit labour cost index (2010=100) (% change over 3 years)	Housing price index (2010=100), deflated (% change over 1 year)	Private sector credit flow, consolidated (% of GDP)	Private sector debt, consolidated (% of GDP)	General government gross debt (as % of GDP)	Unemployment rate (3-year average)	Total financial sector liabilities, non-consolidated (1 year %)	Activity rate - % of total population aged 15-64 (3-year change in pp)	Long-term unemployment rate - % of active population aged 15-74 (3-year change in pp)	Youth unemployment rate - % of active population aged 15-24 (3-year change in pp)
Thresholds	-4%/+6%	-35%	±5% (EA) ±11% (NON EA)	-6%	9% (EA) 12% (NON EA)	6%	14%	133%	60%	10%	16.5%	-0.2 pp	0.5 pp	2 pp
BE	0.1	50.6	2.6	-3.1	5.3	2.5	3.8	179.1	98.1	6.2b	4.6	1.4	-1.7	-5.9
BG	2.5	-31.2	4.5	15.4	19.5p	4.0p	5.6	91.8	20.2	5.2	5.8	4.5	-2.1	-8.3
CZ	0.6	-20.3	8.7	5.1	14.4	6.2	3.1	80.8	30.2	2.4	5.6	1.7	-1.1	-4.9
DK	8.0	76.9	-0.2	2.6	1.4	1.5	11.4	221.2	33.3	5.3b	13.1	1.6b	-0.4	-2.1
DE	7.4	71.7	2.1	-1.1	7.9	4.3	5.4	105.4	59.6	3.4	7.3	1.3	-0.5	-1.3
EE	1.7	-21.4	6.2	2.0	19.9	4.4	3.8	97.8	8.4	5.2	12.5	1.4	-1.2	-2.3
IE	-1.6	-174.0	-1.4	71.0	-4.4	0.0	-9.1	202.4	57.4	5.8	15.5	0.6	-2.6	-4.3
EL	-2.1	-155.9	0.3	3.7	1.7p	6.5e	0.8p	109.9p	180.5	19.4	11.5	0.2	-4.8	-12.1
ES	2.3	-73.9	1.7	2.6	4.0p	4.1	1.3p	129.4p	95.5	15.5	0.9	-0.4	-4.2	-11.9
FR	-0.7	-22.9	1.6	-0.5	1.3p	2.3	8.0p	153.3p	98.1	9.0	7.5	0.3	-1.2	-4.9
HR	2.6	-50.3	1.5	22.5	4.7p	8.1	1.7p	91.2p	72.8	8.8	6.8	0.9	-4.2	-14.7
IT	2.7	-1.5	0.2	-2.6	3.2	-0.6	0.2	106.6	134.7	10.6	3.8	0.8	-1.1	-8.6
CY	-5.2	-122.3	-0.1	13.7	5.2p	2.6	2.7p	259.1p	94.0	8.9	3.9	2.6	-3.7	-12.5
LV	0.1	-41.7	3.7	3.6	17.0	5.8	1.5	67.1	36.9	7.5	4.6	1.0	-1.6	-4.9
LT	1.4	-24.1	3.7	16.8	16.4	4.9	3.0	55.1	35.9	6.5	4.1	2.5	-1.1	-2.6
LU	**4.7**	**56.2**	**2.0**	**10.3**	**11.9**	**8.0**	**3.8**	**318.7**	**22.0**	**5.6**	**3.3**	**2.0**	**-0.9**	**-1.9**
HU	0.7	-43.7	0.3	5.9	10.0p	12.8p	3.2p	66.6p	65.4	3.8	17.8	2.5	-1.3	-1.5
MT	5.1	54.6	1.3	18.1	8.5	4.0p	8.5	123.7	42.6	3.8	4.4	5.3	-1.5	-1.4
NL	10.5	90.0	2.4	0.7	5.9p	4.8	0.0p	234.0p	48.7	4.0	6.1p	1.2	-1.5	-4.1
AT	1.8	12.1	2.1	1.4	5.5	3.9	4.5	120.1	70.5	5.0	4.3	0.9	-0.8	-2.7
PL	-0.4	-49.4	2.8	25.1	9.2p	6.7	3.3	74.0	45.7	4.0	4.2	1.8	-1.5	-7.8
PT	0.5	-100.3	-0.4	8.5	7.6p	8.7	2.2p	149.2p	117.2	7.5	0.0	1.8	-3.4	-9.7
RO	-4.0	-43.5	0.2	17.9	24.5p	-1.7	2.0p	46.7p	35.3	4.3	10.4	3.0	-1.3	-3.8
SI	5.9	-15.4	1.0	16.0	8.4	4.8	0.8	68.7	65.6	5.4	9.9	3.6	-2.4	-7.1
SK	-2.3	-66.3	2.6	1.9	14.5	6.2	5.0	91.6	48.5	6.8	4.9e	0.8	-2.4	-6.1
FI	-0.9	3.6	0.2	4.6	0.8	0.0	7.6	147.5	59.3	7.6	7.6	2.4	-1.1	-2.9
SE	3.3	18.2	-8.3	-5.1	8.2	0.5	9.8	203.9	35.1	6.6b	10.6	0.8	-0.4	1.2
UK	-3.9	-26.2	-2.9	-1.4	8.8	-0.3	2.8	154.7	85.4	4.0	3.3	0.8	-0.4	-1.8

Figures highlighted are the ones at or beyond the threshold.
Flags: b:Break in series. d:Definition differs. e:Estimated. p:Provisional.
1) For the employment indicators, see page 2 of the AMR 2016. 2) House price index e=estimate by NCB for EL. 3) Nominal unit labour cost HR, d: employment data use national concept instead of domestic concept. 4) Unemployment rate for BE: revision in the survey methodology.
5) In Total financial sector liabilities for SK, derivatives are estimated.
Sources: European Commission, Eurostat and Directorate General for Economic and Financial Affairs (for Real Effective Exchange Rate), and International Monetary Fund data, WEO (for world volume exports of goods and services).

4.2.4 Updating the alert mechanism scoreboard data

The data used in this chapter to illustrate Luxembourg's position under the alert mechanism comes from the Eurostat database. This is an update of the data published in the last AMR scoreboard (November 2020). This data[42] therefore provide the basis for a more in-depth national analysis of the main indicators of the procedure on macroeconomic imbalances. In order to evaluate Luxembourg's performance, the graphs contain the corresponding data for the Benelux countries and Luxembourg's two other neighbours (FR, DE). The next version of the Alert Mechanism report is likely to be published by the Commission in November 2021 as part of its autumn package launching the European Semester 2022.

In this year's edition, which is mainly based on data from 2020, the varying degrees of impact of the COVID-19 pandemic on a number of key indicators need to be taken into account. These include public and private debt, the labour market and unit labour costs, all of which have been heavily impacted by the COVID-19 crisis.

A. External and competitiveness imbalances

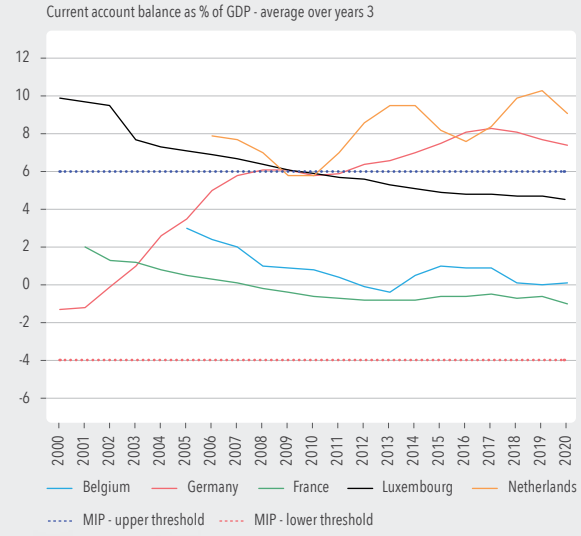
A.1 Current account balance[43]

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

Luxembourg exceeded the upper threshold limit between 2000 and 2009 but, over the past few years, its current account surplus has fallen and, since 2010, has been below the upper threshold limit and is thus included in the interval defined as not posing a macroeconomic imbalance risk.

Figure 21

Current account balance for transactions as % of GDP – average over 3 years)



Source: Eurostat; dotted lines = -4%/+6% thresholds set by the 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.

42 The data cut-off date, i.e. the date on which the data were extracted from the Eurostat database for the preparation of this document, was 19 October 2021.
43 The balance of payments is the statistical statement that systematically summarises, for a given period, the economic transactions of an economy with the rest of the world. It consists of three main sub-balances: the current account, the capital account and the financial account. The current account is the main determinant of an economy's net lending/borrowing and provides important information on a country's economic relations with the rest of the world. It records all transactions (other than those recorded in financial items) in economic assets between resident and non-resident units.

A.2 Net international investment positions[44]

The net international investment position indicator provides information on the relationship between a country's international assets and debt[45]. A country is considered to be potentially at risk if it has a negative balance of more than -35% of GDP.

Luxembourg's performance is very volatile. Nevertheless, for the entire observation period for which Luxembourg data are available, Luxembourg is above the threshold. In line with a current account surplus, Luxembourg thus meets the criteria set for the net international investment position balance. Its foreign assets far exceed its foreign liabilities.

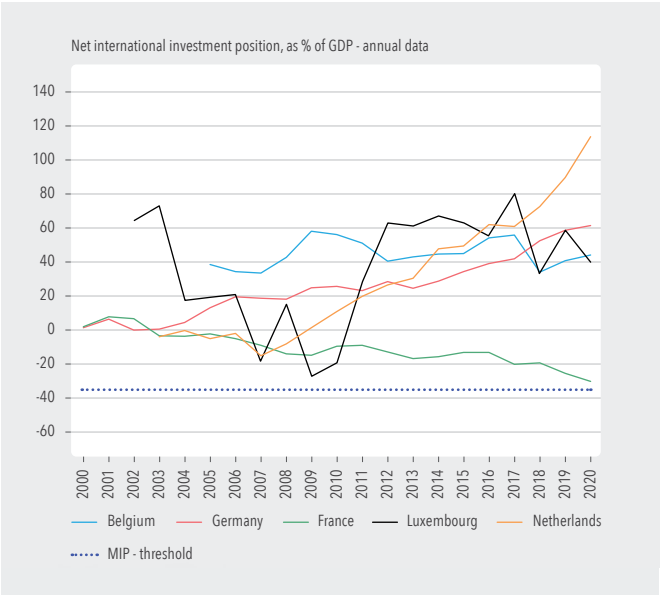
A.3 Real effective exchange rate (REER)[46]

The REER indicator tracks the evolution of a country's price competitiveness or cost competitiveness by analysing the relationship between domestic prices or costs and foreign prices or costs, expressed in euros. Thus, an increase in the REER is usually equivalent to a decline in 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 not to pose a risk of imbalance. According to the latest data available for 2020, Luxembourg's value is 1.5%.

Figure 22

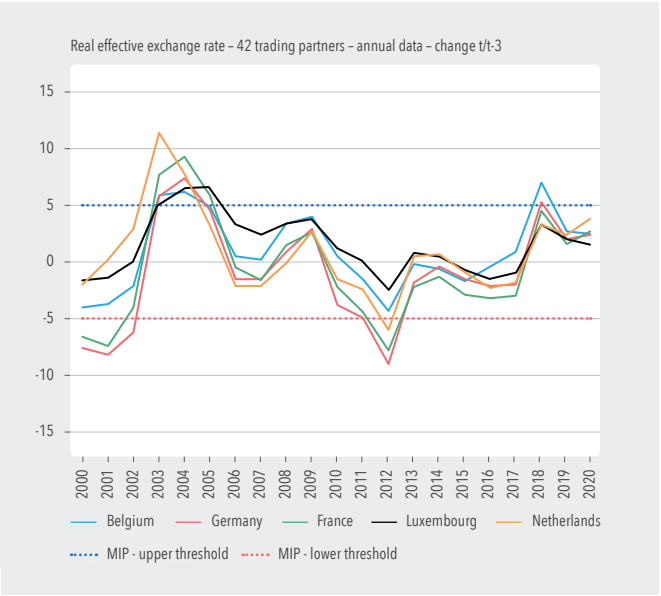
Net international investment positions, as a% of GDP



Source: Eurostat; dotted lines = thresholds of -35 % set by the 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.

Figure 23

Real effective exchange rate (% change over 3 years)



Source: Eurostat; dotted lines = thresholds of +/- 5% for euro area Member States.
Note: A 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.

44 International investment position (IIP) statistics record the position of a country's financial assets and liabilities vis-à-vis the rest of the world. They are an important measure of the net position of the domestic sectors of an economy in relation to the rest of the world. The net international investment position (NIIP) is calculated as the difference between the assets and liabilities of the GIP. It allows for a stock-flow analysis of external positions.
45 For more details see: http://ec.europa.eu/eurostat/statistics-explained/index.php/International_investment_position_statistics
46 The REER 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 the Macroeconomic Imbalance Procedure is deflated with the price indices 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 means real appreciation. Data is expressed as a three-year percentage change and a one-year percentage change. The scoreboard indicator corresponds to the three-year percentage change of the real effective exchange rate based on the consumer price index.

A.4 Export market shares[47]

The scoreboard includes an indicator on changes in a country's market share 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 increased demand. It has been agreed that a country is at risk if this indicator is lower than -6%.

According to the latest available data, Luxembourg has observed the threshold limit every year with the exception of 2012.

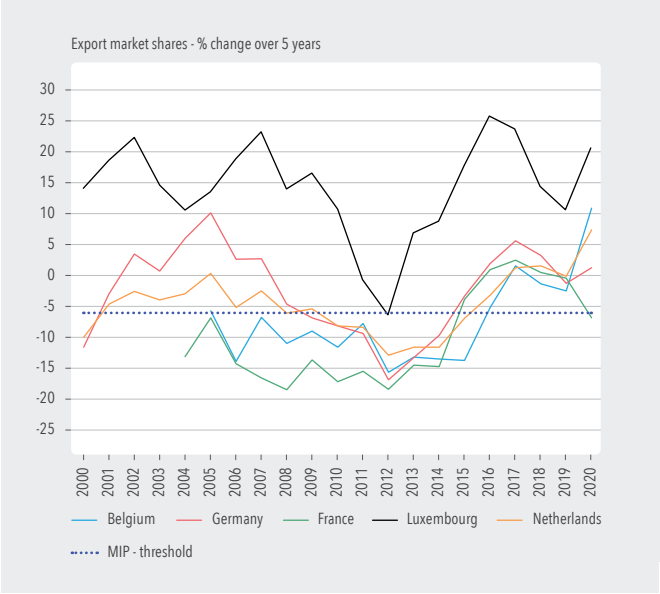
A.5 Nominal unit labour costs[48]

Nominal unit labour costs (nominal ULC) are the indicator traditionally used to measure the cost competitiveness of an economy. The change in a country's domestic nominal unit labour costs, i.e. the cost of labour per unit of value added produced, is compared to those of its main trading partners. This indicator includes two factors: firstly, the average labour cost in an economy; and secondly, the level of productivity. It has been agreed that a country is at risk if this indicator is higher than +9%.

Luxembourg's performance for this indicator is quite volatile Luxembourg scored under the threshold limit in the period 2014-2018 and therefore did not face a macroeconomic imbalance risk under this indicator, but in 2019 and 2020 Luxembourg again exceeded the threshold, however, during these two years, the rate fell from 12.4% to 11.1%.

Figure 24

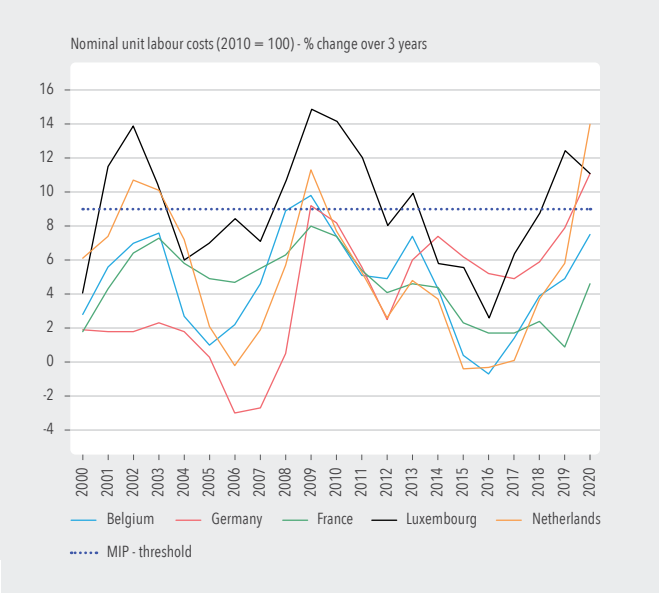
Export market shares (% change over 5 years)



Source: Eurostat; dotted lines = thresholds of 6 % set by the MIP
Note: A Member State is considered to be at risk of imbalance if the change in export market shares is lower than -6 %. If the indicator is above this threshold, a Member State is not considered to be at risk.

Figure 25

Nominal unit labour costs – % change over 3 years



Source: Eurostat; dotted lines = thresholds of +9 % for euro area Member States
Note: A Member State is considered to be at risk of imbalance if the change in its nominal unit labour costs rises above+9 %. If the indicator is above this threshold, a Member State is not considered to be at risk.

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

48 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 is obtained through official data transmissions from countries' national accounts in the ESA 2010 transmission programme. Data is expressed as a percentage change in indices between the year Y and the year 3.

B. Internal imbalances

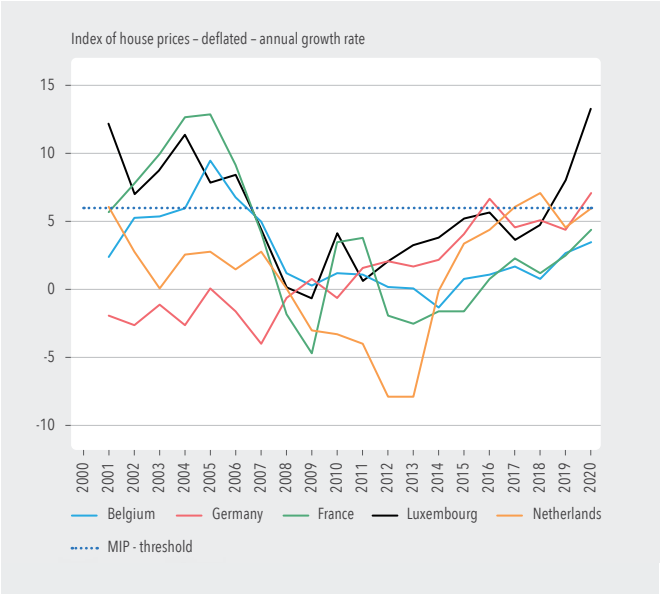
B.1 House prices[49]

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 that a country is at risk if this indicator is higher than +6%.

Real-estate (housing) prices in Luxembourg have risen, in real terms, almost continuously since 2001, with the exception of 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, 2016. In 2019, the index crossed the threshold with a growth rate of 8%. This trend increased further and the rate reached 13.3% in 2020, which is well above the 6% limit.

Figure 26

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



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

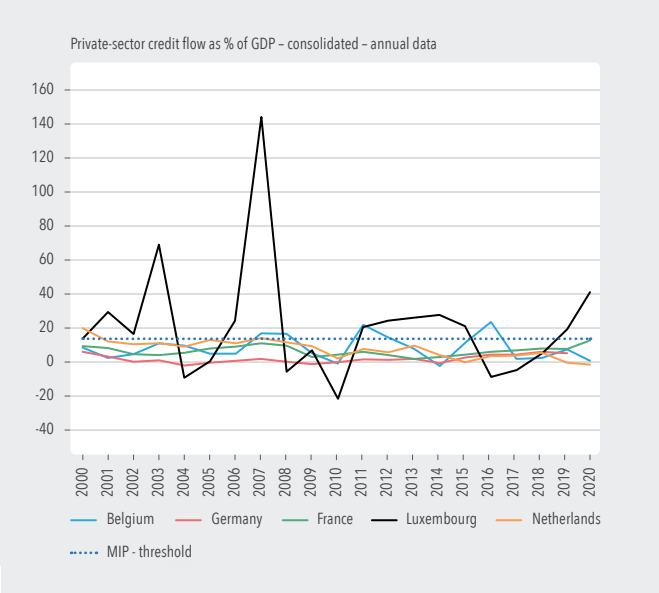
B.2 Private sector credit flow[50]

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 the indicator is above +14%.

Luxembourg's performance for this indicator varies to a far greater extent than its neighbouring countries. The structure of the Luxembourg economy, which is very small but open and home to several large non-financial companies whose financial decisions can have a major impact on the national economy, could explain this situation. In 2019 and 2020, the private-sector credit flow was 19.6% and 44.5% of GDP respectively, and was thus well above the threshold limit (14%).

Figure 27

Private sector credit flow (% of GDP)



Source: Eurostat; dotted line = +6% threshold set by the MIP
Note: A Member State is considered to be at risk of imbalance if the change in the private sector credit flow is above +14%. If the indicator is above this threshold, a Member State is not considered to be at risk.

49 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 (NPIs)). Therefore, this indicator measures inflation in the housing market compared to that in the final consumption of households and NPIs. Eurostat's 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 housing built on own account is excluded. The land is included. The data shows percentage changes from year Y compared to year Y-1.

50 The private-sector credit flow corresponds to the net changes in liabilities of 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 "Securities other than shares" (F.3) and "Credits" (F.4), with all other instruments excluded. The concepts used in the definition of sectors and instruments are consistent with ESA 2010. Data is expressed as a percentage and calculated on a nonconsolidated basis, i.e., by including transactions among units of the same sector.

B.3 Private sector debt[51]

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

Since 2001 in Luxembourg, this indicator has significantly exceeded the threshold set by the MIP. However, 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 needs 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 outside Luxembourg, because 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 out for housing acquisition.

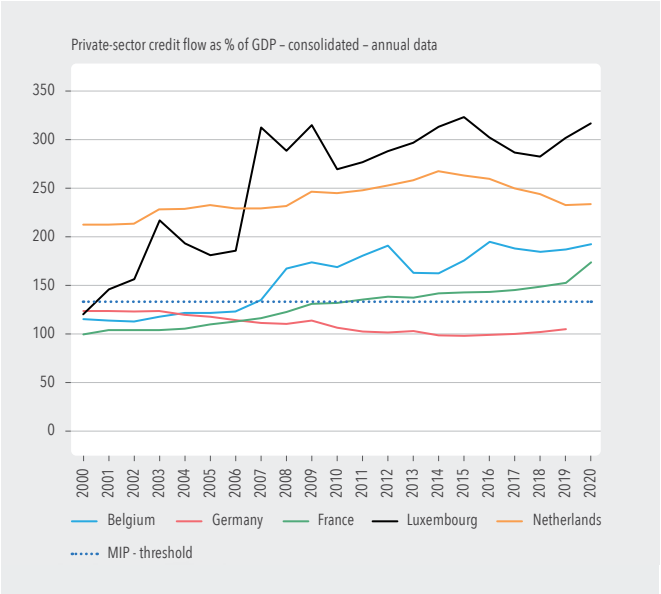
B.4 General government sector debt[52]

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 complementary to the indicator for 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 the indicator is above +60% of GDP.

The rate of gross government sector debt in Luxembourg is well below the Maastricht threshold (60% of GDP). However,

Figure 28

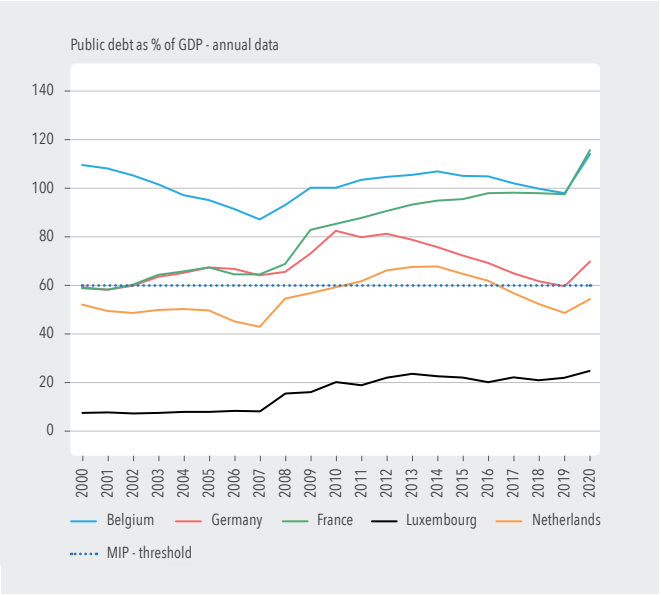
Consolidated private-sector debt, as a % of GDP



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

Figure 29

Gross general government sector debt, as a % of GDP



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

51 Private-sector debt corresponds to the outstanding amount of liabilities of nonfinancial corporate sectors (S.11), households, and non-profit institutions serving households (S.14_S.15). The instruments included in the calculation of private-sector debt are "Securities other than shares", excluding financial derivatives (F.33), and "Credits" (F.4), with all other instruments excluded. The concepts used in the definition of sectors and instruments are consistent with ESA 2010. Data is calculated on a consolidated basis, i.e. excluding transactions among units of the same sector. The indicator is calculated as a percentage of GDP.

52 General government sector 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 sub-sectors: central government, State government, local government and social security funds. Definitions are available in Council Regulation (EC) No 479/2009, as amended by Council Regulation (EU) No 679/2010. National data for the general government sector is consolidated among the subsectors. The series are available as a percentage of GDP. The GDP denominator comes from the ESA 2010 transmission programme, and not from the EDP notifications. As the revised GDP is transmitted with a delay, this may result in potential differences in debt as a % of GDP, depending on the source (EDP or the AMR scoreboard).

between 2007 and 2010, during the economic and financial crisis, Luxembourg's public debt increased. It then stabilised at around 21% over the period 2010-2019.

In 2020, the COVID-19 crisis clearly pushed Luxembourg's public debt rate up (22.3% in 2019 against 24.8% in 2020). However, the increase, due to many factors such as increased public spending, falling revenues and the deterioration of GDP, has been limited and the public debt remains well below the "Maastricht" threshold.

B.5 Unemployment rate (%)[53]

This indicator is intended to monitor high and persistent unemployment rates and highlights any potential misallocation of resources (incompatibility) and a 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 a 3-year average unemployment rate well below the threshold. Since 2000, however, this rate has shown a significant upward trend in Luxembourg. Between 2019 and 2020 the 3-year average unemployment rate has increased by 0.4 percentage points to reach 6%.

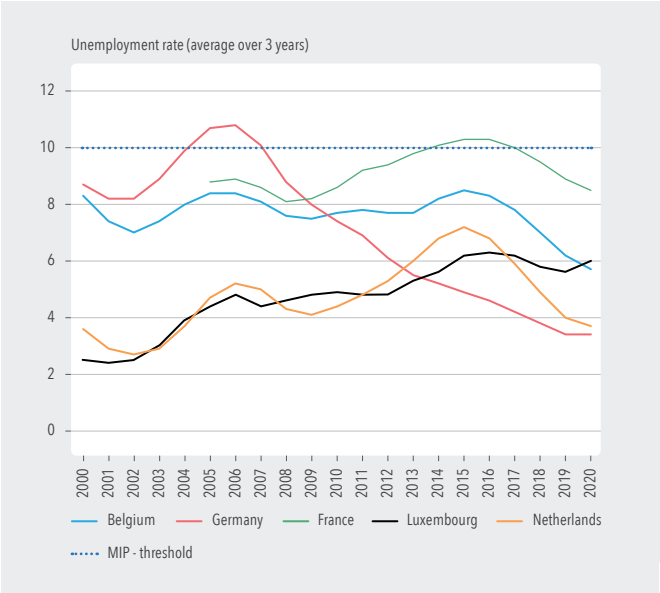
B.6 Total financial sector liabilities[54]

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 that a country is potentially at risk if the indicator is higher than +16.5%.

In most of the years under analysis, Luxembourg has been below the threshold limit, although it exceeded the threshold in 2005, 2006, 2014 and 2015. Based on the latest available data, Luxembourg is below the threshold limit in 2020.

Figure 30

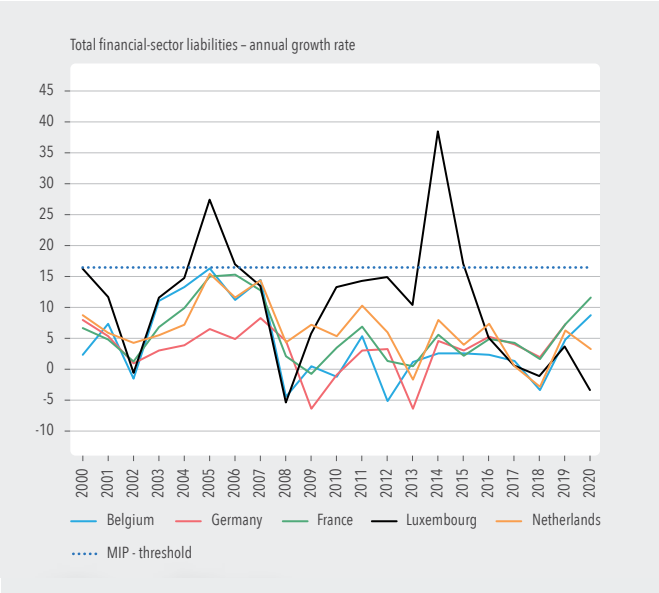
Unemployment rate (average over 3 years)



Source: Eurostat; dotted line = threshold of 10 % set by the 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.

Figure 31

Growth rate of total financial-sector liabilities



Source: Eurostat; dotted line = threshold of 16.5 % set by the MIP
Note: A Member State is considered to be at risk of imbalance if growth rate of the total financial-sector liabilities exceeds +16,5 %. If the indicator is above this threshold, a Member State is not considered to be at risk.

53 The unemployment rate represents the number of unemployed people as a percentage of the labour force as defined by the International Labour Organization (ILO). The labour force consists of employed and unemployed people. Unemployed people 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. The data is expressed as 3-year moving averages, i.e. year Y's data is the arithmetic mean of years Y, Y -1, and Y -2. In this context, it is not the national definition of unemployment used in Luxembourg, which is the one used by the National Employment Agency (ADEM): *"The unemployment rate is the ratio of the number of available resident jobseekers to the labour force. The latter consists of all persons living in the country who are working (employed or self-employed) or looking for a job (jobseeker)."* For additional details: https://adem.public.lu/en/publications/communiques/2015/note-technique.html

54 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.

C. Employment indicators

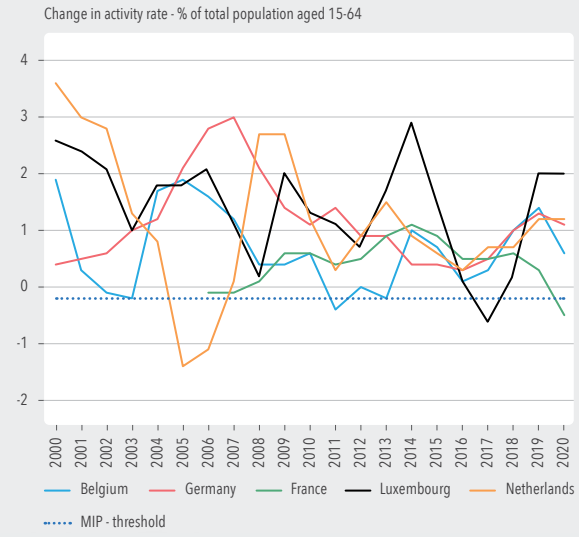
C.1 Activity rate[55]

This indicator measures variations in the activity rate amongst Member States' residents. The indicator is expressed in percentage points (pp) 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 pp over the period in question.

Between 2000 and 2016, the activity rate rose in Luxembourg, so the threshold was met. Conversely, in 2017, the activity rate in Luxembourg dropped (-0.6 pp) and the threshold was not adhered to, but the following year, Luxembourg exceeded it again (+0.2 pp). In 2020, the activity rate withstood the effects of the pandemic well, thanks in particular to job retention measures, including the extension of short-time working, and the variation is at the same level as the previous year (+2 pp).

Figure 32

Activity rate – % of total population aged 15-64 – change in percentage points (t, t-3)



Source: Eurostat; dotted line = threshold of -0.2pp set by the MIP
Note: A Member State is considered to be at risk of imbalance if the growth rate is below -0.2 pp If the indicator is above this threshold, a Member State is not considered to be at risk.

C.2 Long-term unemployment rate[56]

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 pp over the period in question.

For the whole period under review, Luxembourg shows a growth rate below or equal to this threshold. In 2020, the variation of the long-term unemployment rate was somewhat less favourable than in 2019, in the sense that the decline in long-term unemployment slowed down.

Figure 33

Long-term unemployment rate – % of active population aged 15-74 – change in percentage points (t, t-3)

Source: Eurostat; dotted line = threshold of +0,5pp set by the MIP
Note: A Member State is considered to be at risk of imbalance if the growth rate exceeds +0.5 pp. If the indicator is above this threshold, a Member State is not considered to be at risk.

55 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 Organization (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 nor unemployed. The scoreboard indicator reveals the change over three years expressed in percentage points. The indicative threshold is -0.2 pp. 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.

56 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 Organization (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 previous four weeks or have found a job that they will start within the following three months.
The scoreboard indicator reveals the change over three years expressed in percentage points. The indicative threshold is 0.5 pp. 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.

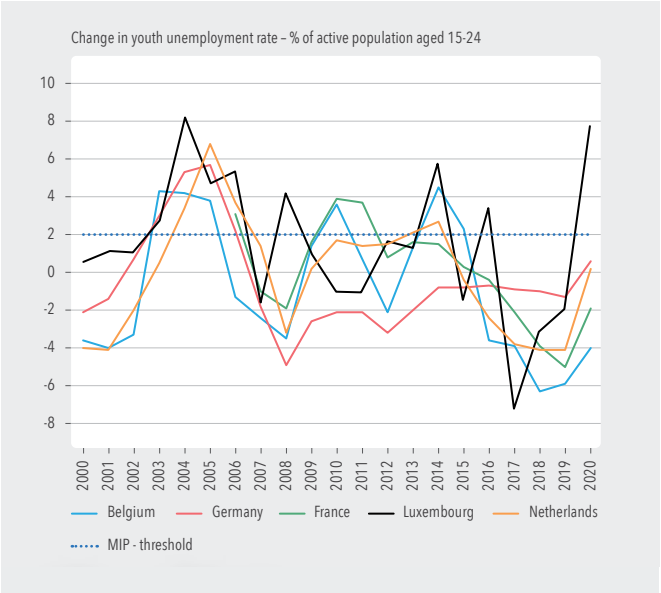
C.3 Youth unemployment rate[57]

This indicator measures the variation in the youth unemployment rate 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 2 pp 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. In 2020, the year of the COVID-19 pandemic, the change in the youth unemployment rate increased considerably compared to the previous year (7.8 pp in 2020 versus -1.9 pp in 2019).

Figure 34

Youth unemployment rate – % of active population aged 15-24 – change in percentage points (t, t-3)



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

D. Conclusions

Based on the updated data, we note that Luxembourg is currently exceeding five thresholds in the 14 MIP indicators:

- Nominal unit labour costs - % change over 3 years;
- The Index of house prices – deflated – annual growth rate (% change over 1 year);
- Private-sector credit flow as % of GDP;
- Consolidated private-sector debt;
- The change in youth unemployment (expressed in percentage points).

57 The youth unemployment rate is the percentage of unemployed individuals aged 15-24 and the active population in 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 Organization (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 previous four weeks or have found a job that they will start within the following three months.
The scoreboard indicator reveals the change over three years expressed in percentage points. The indicative threshold is 2 pp. 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.

Table 4

Summary table of the alert mechanism update (October 2021)

	EXTERNAL IMPBALANCES					INTERNAL IMPBALANCES						EMPLOYMENT INDICATORS[1]		
	Current account balance	Net inter-national 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	Unem-ployment rate	Total financial-sector liabilities	Activity rate	Long-term unemploy-ment rate	Youth unemploy-ment rate
LU *	4.5%	39.9%	39.9%	20.63%	11.1%	13.3%	13.3%	316.8%	24.9%	6%	-3.6%	2 pp	-0.4 pp	7.8 pp
Thresh-olds **	> -4% *< +6%*	> -35%	> -35%	> -6%	< +9%	< +6%	< +6%	< 133%	< 60%	< 10%	< +16.5%	> -0.2 pp	< +0.5 pp	< +2 pp

Sources: European Commission, Eurostat
Notes: * 2020 data
** Conditions for not being considered imbalanced (for some indicators these thresholds differ between euro area Member States and other Member States).
The colour codes of the Luxembourg values indicate whether they are in the range defined as posing no risk of macroeconomic imbalance or not. If they are, they are marked in green, otherwise in red.

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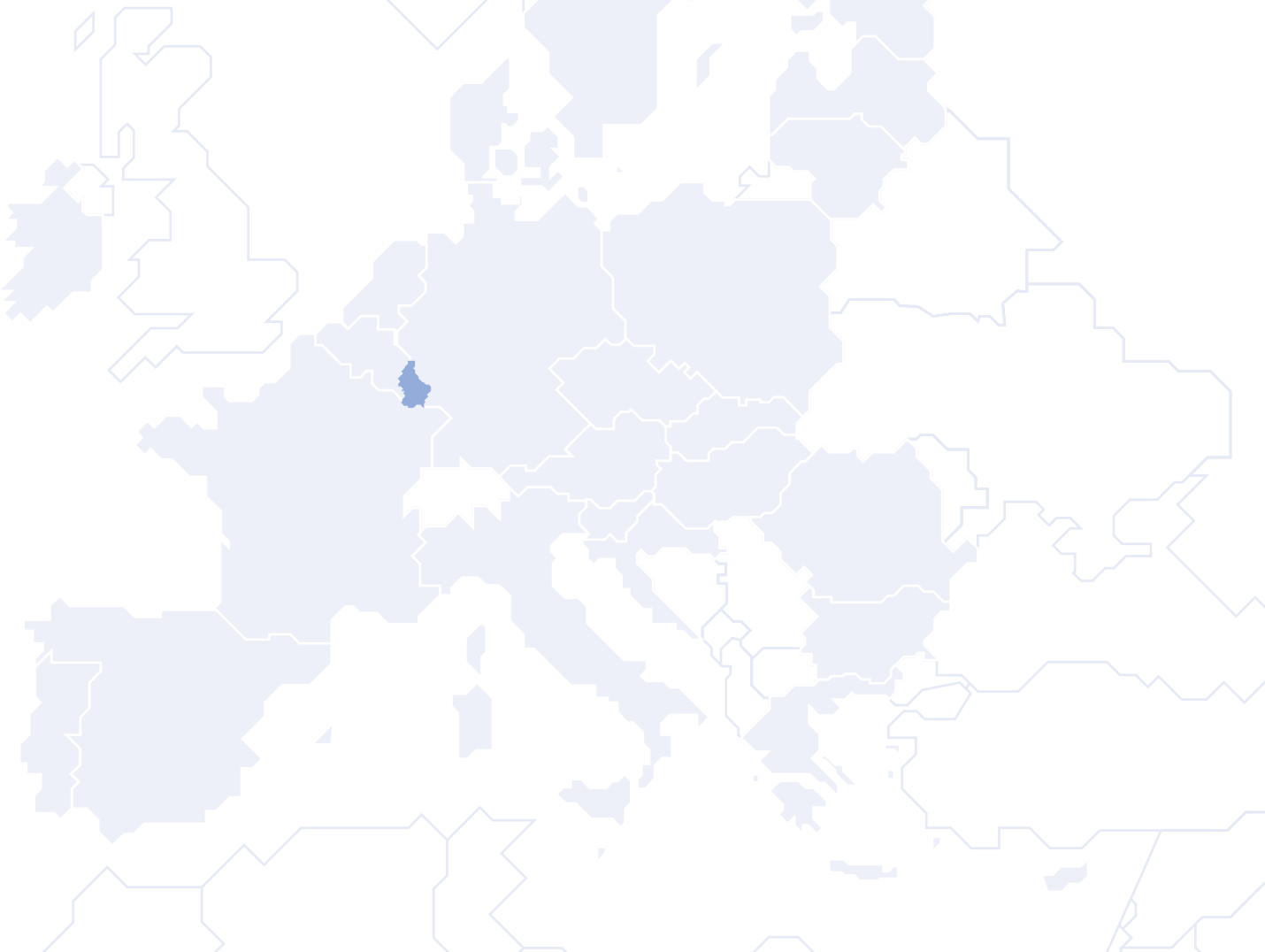
Chapter 5

Studies from STATEC Research: timely information on well-being and the economy



Studies from STATEC Research: timely information on well-being and the economy[1]

The events that have marked the last twelve months – the emergence of variants of SARS-COV-2, further pandemic waves and lockdowns, but also the deployment of vast vaccination campaigns - have confirmed, and possibly reinforced, what had emerged during the first pandemic wave. Namely, the relevance of issues such as the role of social cohesion and trust for compliance with policies, and the role of timely information about economic and social conditions in deploying successful containment strategies.

The pandemic has highlighted the relevance of social science research and data analysis in providing information, insights and feedback to decision-makers. This information is crucial for understanding people's behaviour, the social and economic impact of the pandemic, and, as a result, for designing effective interventions. What is more, in times of crisis, timely, rapid information is needed to quickly assess the effects of the pandemic on people's behaviour and the economy. This chapter summarises results from research that, with different data and methods, addresses those important issues.

Section 5.1 presents results from two projects that explore novel data and methods to study well-being, trust and compliance with health policies during the coronavirus crisis. The projects, supported by the FNR, are part of the Research Luxembourg's COVID task-force efforts to tackle the pandemic's challenges. The project **Appreciate** provides a framework for administering rapid online surveys on nationally representative and repeated samples of Luxembourg's residents. The project **Preferences through Twitter** uses sentiment analysis on social media data to document the evolution of well-being, trust, and economic fear, during the pandemic. It presents evidence of large variations in well-being during 2020, variations that would not be captured by traditional surveys. It also assesses the validity of these measures. Findings from both projects highlight the key role of trust in determining compliance to containment policies.

Section 5.2 summarises key results from a project aimed at **nowcasting economic activity** (e.g. GDP growth) in Luxembourg. Knowledge of the current economic situation is crucial for decision-making, but it is a complex task, because the information needed to assess it is available with delay. Moreover, it requires novel methods capable of dealing with large datasets containing irregular observations. This is even more so for small open economies, which feature highly volatile GDPs. This research contributes a large innovative dataset, consisting of standard and alternative indicators, used as inputs in several nowcasting methods, including various factor and machine learning models. Overall, results highlight that nowcasting models produce improved economic predictions of real GDP growth, with larger gains in accuracy during problematic times, such as the COVID pandemic period. To achieve a reasonable forecasting performance, it is sufficient to employ conventional series in conjunction with business and consumer survey series.

Finally, the third and last section presents the results from the latest release of **Luxembourg's Entrepreneurship Monitor**, which is part of the Global Entrepreneurship Monitor (GEM) research programme. The report examines the state of entrepreneurial activities in Luxembourg from a cross-country perspective, by comparing Luxembourg's entrepreneurial performance with all European countries for which GEM data are available. The report devotes special attention to entrepreneurial dynamics after the emergence of the coronavirus pandemic. The findings provide a mixed picture, consistent with the idea that crises also bring about opportunities for entrepreneurs. On the one hand, fewer residents engaged in entrepreneurial activities in 2020; they perceived worsened conditions and they encountered delays. On the other hand, some entrepreneurs envisioned opportunities to seize, and were satisfied with the government response to the pandemic. One feature emerging from the data is the surge in new business formation which occurred in the last months of 2020.

5.1 New sources of timely information: the role of trust for compliance with health policies

In 2020, STATEC Research was awarded two competitive grants by the FNR to investigate changes in well-being during the pandemic, and explore sources of timely information to analyse changes in socio-economic conditions. Both projects examine the role of trust in determining compliance with measures deployed by authorities to counter the spread of COVID-19.

The first project, **Appreciate**,[2] studies the acceptance of applications installed on mobile phones for the contact tracing of COVID-19 in Luxembourg. This is relevant to the issue of compliance to health measures, as apps' effectiveness largely depends on the public's uptake.

Appreciate analyses the determinants of the likelihood of adopting an app using data collected from a representative online survey of Luxembourg's residents. The survey was administered on a panel of respondents for whom the probability of being recruited is known, which greatly improves the representativeness of the sample and the quality of the data. An important additional feature of the panel is that it allows tracking respondents over time. The survey, conducted in two waves in the second half of 2020, reached participation rates of about 70%.

Results from the first survey showed widespread public support for the app in Luxembourg; 72% of respondents declared they would probably or definitely install the app. Respondents were in favour of apps that: operated across borders and in Europe, could be installed on a voluntary basis, and stored data on the users' mobile device rather than on a central server.

Results from the analysis of the longitudinal dataset, which combines both survey waves, show that support for contact-tracing apps is high and stable over time in Luxembourg, but privacy and data security concerns remain. If a tracing app were available, respondents would favour an app that is European, installed on a vol-

1 Kelsey J. O'Connor, Chiara Peroni, Cesare Riillo, Pietro Santoleri, Francesco Sarracino, and Vasja Sivec contributed to this chapter. They are affiliated with STATEC Research. Opinions and views expressed in this chapter are those of the authors and not those of STATEC or the Observatoire de la compétitivité.
2 Grant number COVID-19/2020-2/14844092.

untary basis, and respectful of privacy. Preferences on app design did not change considerably over time. Analysis of the determinants of the likelihood for adopting the app, using various regression techniques, consistently shows that trust is a key determinant of the app's adoption. It is plausible that privacy concerns explain at least part of the discrepancy between declared support and the low installation rates when apps have been implemented in other European countries. Our results further indicate that a strong motivating factor for installing the app is the sense of responsibility towards the community. Findings from the Appreciate project are documented in greater detail in two STATEC working papers.[3]

An additional contribution of Appreciate is the establishment of the first online representative access panel for Luxembourg. The project provides a framework for administering online surveys on nationally representative and repeated samples of Luxembourg's residents. This could allow STATEC to collect rapid data on urgent matters by administering short and relatively inexpensive surveys.

The second project, **Preferences through Twitter (PRET)**,[4] studies changes in people's well-being, preferences and attitudes during the pandemic, as those affect people's economic decisions, welfare and social cohesion. Changes in people's trust in others and confidence in institutions can reduce social cohesion and the ability of the society to cooperate to achieve common goals, including the containment of the pandemic.

PRET derives key indicators of well-being and public mood, including trust, economic fear, and loneliness, from the sentiment analysis of Twitter data. In doing so, it explores new sources of data to draw timely information of interest to decision-makers.

What follows provides an overview of the first results from the PRET project.

From tweets to well-being: Sentiment analysis reveals how people's feelings evolved during the COVID-19 pandemic[5]

The COVID-19 pandemic, and the fight to contain it, have had large widespread impacts on individuals' well-being. What is less clear is, by how much and through which channels? What was more impactful: the incidence and fear of infection, or the consequences of the containment policies? Perhaps the pandemic, in which everyone is at risk, engendered a positive sense of solidarity. How resilient were we – were the impacts lasting?

To address these questions, the research project Preferences through Twitter applied machine learning (sentiment analysis) to big data to generate a unique dataset and investigate how people fared during the pandemic. Here, we provide a summary of the projects' first results. We describe the changes in well-being that occurred throughout 2020 in seven European countries, and in Australia, South Africa and New Zealand. The dataset consists of daily observations on well-being, generalized trust, trust in national institutions, economic fear, and loneliness. Collectively, the observations help us to describe the changes in well-being, but they are also independently important.

Feelings of well-being, trust, fear, and loneliness are important for their socio-economic consequences. Happier people tend to live longer and healthier lives, have better employment outcomes, and are more productive and collaborative (De Neve et al., 2013). What's more, both happiness and trust predict compliance with COVID-19 containment policies (Krekel et al., 2020, Sarracino et al., 2021a). These feelings play an important role in determining the overall, compounded, impacts of COVID-19.

To monitor the changes in well-being during the pandemic, STATEC Research set up a collaborative project with researchers from the University of Johannesburg (UJ) and Auckland University of Technology (AUT) to extend the Gross National Happiness (GNH, Greyling et al., 2019), a real-time measure of well-being, to Luxembourg and six other European countries, and to derive measures of trust in institutions and economic fear. (GNH was initially developed for Australia, New Zealand, and South Africa.)

GNH is computed by retrieving tweets in real time as they are posted. Every day a large number of people around the world share their opinions, reactions, discoveries, worries, questions, and decisions via tweets. In Luxembourg, people share approximately 300 tweets per day, which is more than 2000 per week. This wealth of short texts provides a real-time source of information that is transformed into usable data using sentiment analysis.[6] The sentiment of each tweet is derived, and GNH is then calculated as the average sentiment expressed in a country during a particular day and rescaled to take values from 0 to 10, with greater values reflecting higher well-being.

GNH has distinct advantages for monitoring rapid changes in well-being during challenging periods such as pandemics. Well-being data are typically collected via large scale surveys. These occur infrequently and take time to administer and process, all of which limits their usefulness for decisions that need up-to-date information. Moreover, the infrequent measurement makes it difficult to interpret the findings. For instance, the Eurobarometer, one of the most frequent representative surveys, was only administered once in 2020 (in 2019, it had assessed people's well-being twice). The data indicated that life satisfaction, a reliable and valid measure of well-being, decreased by eight percentage points between Autumn 2019 and Summer 2020 in Luxembourg (Table 1). Was this decline lasting? Perhaps individuals recovered quickly? Indeed, eight percentage points might already reflect recovery from a worse period. Infrequent measures, especially those based on a relatively short period, risk missing important information and could lead decision-makers to the wrong conclusions.[7] As an example, the latest World Happiness Report indicates that live evaluations in 2020 were remarkably similar to those in previous years (Helliwell et al., 2021, p. 24), as if people had not suffered during the pandemic. In con-

3 The first paper has been released as a STATEC working paper and can be downloaded at the following link: https://statistiques.public.lu/catalogue-publications/economie-statistiques/2020/117-2020.pdf. The second paper is available at this link: https://statistiques.public.lu/en/publications/series/economie-statistiques/2021/11-2021/index.html.
4 Grant number COVID-19/2020-2/14878312.
5 The study is supported by the Luxembourg National Research Fund (grant number FNR-14878312), University of Johannesburg (South Africa), and Auckland University of Technology. The working paper is available on line here: https://ideas.repec.org/p/zbw/glodps/831.html
6 Sentiment analysis is an automated process that uses natural language processing to determine the feelings and attitudes of a written text's author (Hailong et al., 2014).
7 OECD (2013), among other sets of guidance, recommend fielding over a longer period to reduce these concerns.

trast, other researchers document the significant negative impacts that containment policies had on well-being. However, generally these studies do not take the duration of impacts into account. In stark contrast, GNH is computed daily, even hourly, in countries with large enough numbers of Twitter users, which provides policy-makers with invaluable, timely, information.

The evolution of GNH reveals how significantly well-being changed throughout 2020. Figure 1 presents average GNH across the seven European countries (Belgium, France, Germany, Italy, Luxembourg, Spain, and United Kingdom). Additional results for Australia, New Zealand, and South Africa are available in a working paper available online[8]. What is perhaps surprising is how quickly individuals seemed to recover. By the end of April 2020, GNH had fully recovered and was even higher than some pre-pandemic levels. Following that, the trend is negative, reaching a minimum at the end of October in correspondence with the second wave of infection. Although GNH ended the year at a similar level as at the beginning of the year, it exhibited dramatic changes, from 6.65 to 7.30 in approximately a month and a half, thus illustrating the importance of frequent measurement in volatile times. What then explains these changes? To provide an initial answer, we look at the number of confirmed new cases of COVID-19 and containment policies.

The observed changes in well-being are partially explained by the changes in confirmed COVID-19 cases and containment policies. Figures 2 and 3 replicate Figure 1, but add in new confirmed cases of COVID-19 per day per million of population (Roser et al., 2021) and containment policies (Hale et al., 2021).[9] At the onset of the first wave, when GNH declines rapidly, both new cases and the stringency of containment policies increase rapidly. Then, as cases begin to peak and containment policies stabilize, GNH recovers rapidly. Throughout midyear, GNH declines again, corresponding with increasing cases. When GNH reaches a minimum at the end of October, the second wave peaks. Containment policies were also increasing rapidly at this time. During the last two months, cases came down, but GNH did not increase notably, possibly because containment policies were becoming more stringent.

Table 1

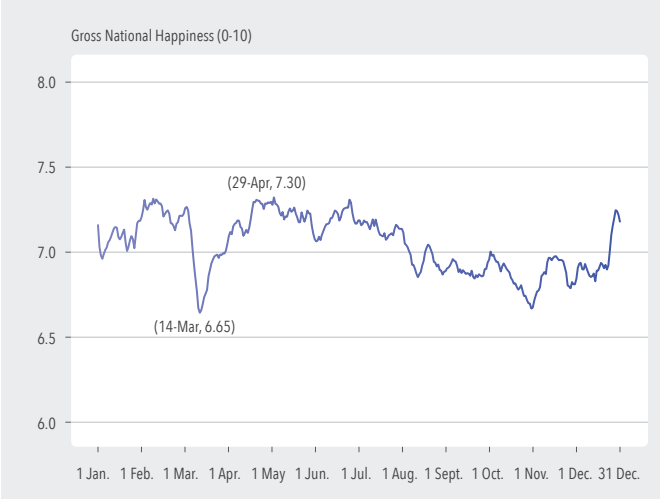
Life satisfaction in Luxembourg from Spring 2019 to Summer 2020

	SPRING 2019	AUTUMN 2019	SUMMER 2020
People not satisfied with their lives (%)	4	6	14
People satisfied with their lives (%)	96	94	86

Source: Eurobarometer data (European Commission 2019, 2020). The original variable is organized into four categories. For ease of interpretation, the bottom and top two categories have been merged.

Figure 1

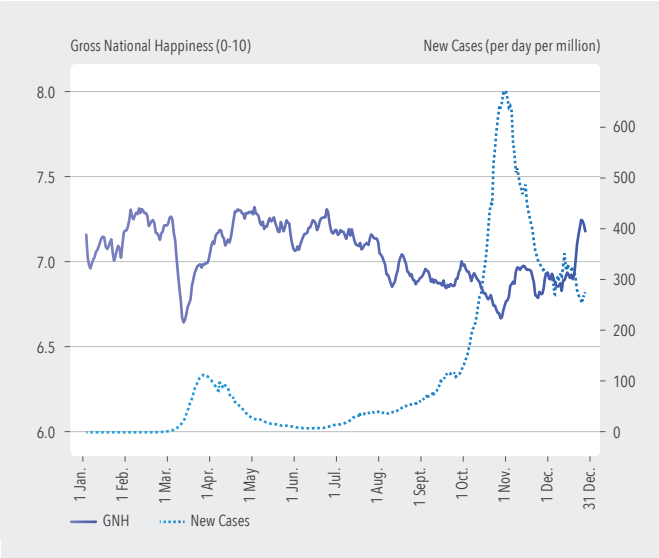
Average Gross National Happiness across seven European countries



Source: GNH data (Greyling et al., 2019) are sourced from the project "Preferences Through Twitter" with the support of FNR, UJ and AUT. GNH is smoothed using a centered, weekly moving average.

Figure 2

GNH and Confirmed COVID-19 Cases averaged across Seven European countries

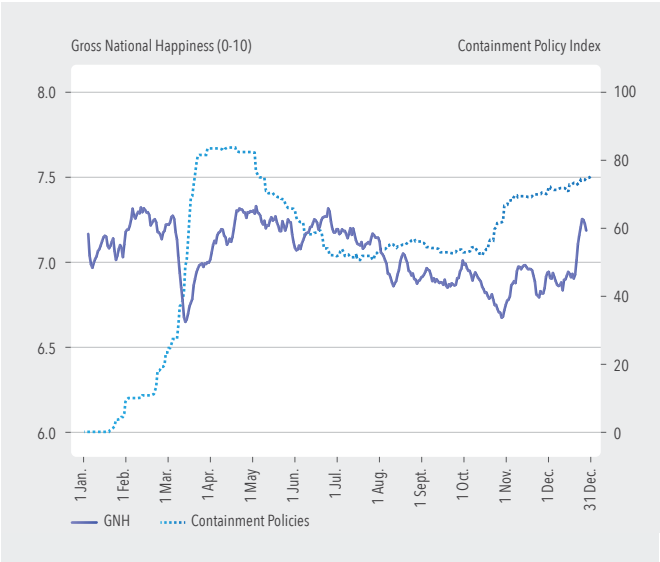


Source: GNH data (Greyling et al., 2019) are sourced from the project "Preferences Through Twitter" with the support of FNR, UJ and AUT. New confirmed cases per day per million of population are available from Roser et al., 2021. GNH and new cases are smoothed using a centered, weekly moving average.

8 The working paper can be downloaded for free here: https://ideas.repec.org/p/zbw/glodps/831.html
9 Containment policies are observed via the Stringency Index from the University of Oxford's COVID-19 Government Response Tracker. Higher values represent more stringent containment policies (Hale et al., 2021).

Figure 3

GNH and Containment Policies averaged across Seven European countries



Source: GNH data (Greyling et al., 2019) are sourced from the project "Preferences Through Twitter" with the support of FNR, UJ and AUT. Containment measures are sourced from the Oxford COVID-19 Government Response Tracker (stricter measures take greater values) (Hale et al., 2021). GNH and policies are smoothed using a centered, weekly moving average.

Additional factors may explain the evolution of GNH throughout the pandemic, in particular: country characteristics; the season of the year; staying at home, for work or other reasons; trust, generalized or in national institutions; economic concerns; and loneliness. We accounted for each variable, as well as new cases and containment policies, using regression analysis. Country characteristics are accounted for indirectly when accounting for persistence in GNH. As is often the case with time series, the best predictor of a variable is its value in the previous period. GNH is no exception. To account for this persistence, we included the previous value of GNH in the regressions, which also accounts for the factors that predict the previous level of GNH, such as country characteristics. Staying at home reflects the relative amount of time spent at home compared to pre-pandemic levels, and is obtained using Google Mobility Reports (Google, 2021a). We also assessed the role of seven emotions: anger, anticipation, disgust, fear, joy, sadness, and surprise, which were generated using sentiment analysis in the same way that trust was generated (for more details about data and methods, see Sarracino et al., 2021b).

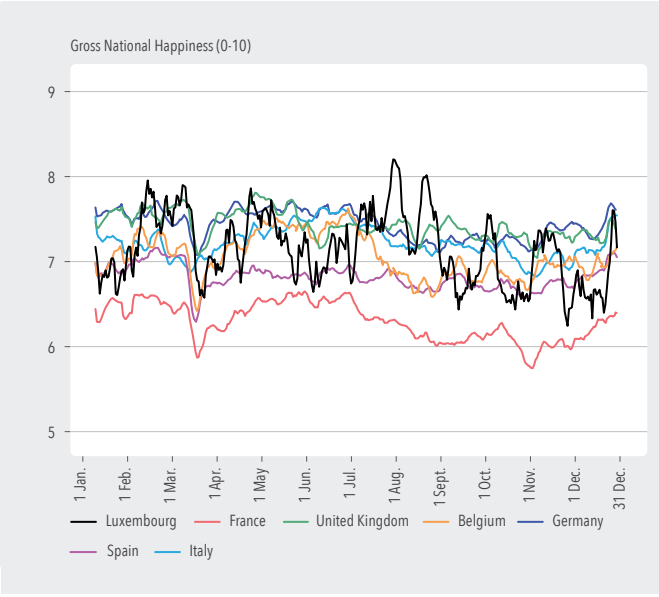
In short, the results reveal for all ten countries that GNH correlates negatively with both new positive cases and the expected increase in containment policy stringency. In contrast, an increase in time spent at home is associated with greater GNH; the feeling of personal protection and altruism or solidarity – doing one's part to fight the contagion through physical distancing – could explain this finding. Additionally, a study by O'Connor and Peroni (2021) revealed that the majority of people in Luxembourg also seemed to enjoy working from home. The results also indicate that economic fear, trust in national institutions, and loneliness are not significantly associated with GNH. This is puzzling, but could indicate that during the pandemic, health and containment policies dominated individuals' mood. Finally, we found that GNH correlates positively with surprise and generalized trust, and negatively with disgust. Fear was not significantly correlated with GNH after accounting for the other variables.

One of the advantages of applying sentiment analysis to Twitter data is that it allows researchers to compute GNH for almost any country in the world. This can be done remotely; it only requires a sufficient number of Twitter users. In this way, researchers can easily compare the well-being dynamics in their country with others.

Figure 4 presents the GNH for Luxembourg and the six other European countries in the sample: Italy, Spain, the United Kingdom, France, Belgium, and Germany. The comparison reveals the level of GNH in Luxembourg (black line) to be fairly similar to the others, except France (red line). France expresses lower sentiment than the other countries throughout the year. GNH is more volatile in Luxembourg than in the other countries, especially July to August, in which period GNH appears to be higher in Luxembourg. Part of this volatility is likely due to the smaller number of twitter users in Luxembourg.

Figure 4

Gross National Happiness in Luxembourg and a sample of European countries



Source: GNH data (Greyling et al., 2019) are sourced from the project "Preferences Through Twitter" with the support of FNR, UJ and AUT. GNH is smoothed using a centered, weekly moving average.

A question remains, is GNH a valid and reliable measure of national well-being? To answer this question we analysed whether our variable consistently provides a good representation of well-being, i.e. the concept we intend to measure. Reliability is traditionally assessed by looking at the consistency (correlation) between two closely timed measures for the same individual. GNH is estimated at the national level, not the individual level. Allowing for this difference, correlation in GNH from one week to the next is above

90%, which indicates a high degree of reliability. Validity can be tested in various ways. A first check consists in verifying whether GNH relates to factors we would expect it to. In this regard, we found that GNH correlates meaningfully with COVID-19 cases and containment policies. The regression results also reveal Twitter users express greater GNH in the spring and fall months compared to winter, which is consistent with findings from the well-being literature.

Another important test of validity is whether GNH correlates with other measures that reflect national sentiment. Assessing the validity of metrics based on unstructured data, such as Twitter data, is difficult because their features – timeliness, large (non-representative) samples, and high frequency – make them unique, thus limiting the availability of comparable measures. In other words, (objective or subjective) measures of well-being that are available with the same frequency and timeliness of GNH are scarce. The tests we were able to run provide encouraging results. First, country rankings of GNH correlate positively with measures of subjective well-being issued by two nationally-representative surveys, namely the Eurobarometer (European Commission, 2020) and Gallup World Poll (Helliwell et al., 2021). Correlations of measures within a country, over time, are mixed: in the expected directions for consumer confidence and searches for negative emotions on Google[10] (Google 2021b), while in the unexpected direction for life satisfaction, though this measure is from a convenience sample (Vogele et al., 2020). Details of this analysis are presented in Appendix A of Sarracino et al. (2021b).

In summary, we provided real-time information on well-being in Luxembourg and nine other countries (Australia, Belgium, France, Germany, Italy, New Zealand, South Africa, Spain, and United Kingdom), which can be used to inform decision-makers.

We observed that well-being declined dramatically across seven European countries at the onset of the COVID-19 pandemic in March 2020, but then quickly recovered. In mid-March, confirmed COVID-19 cases increased at exponential rates and severe containment policies were implemented. After the initial shock, shortly before the peak of the first wave, well-being began to recover. Then, as cases started to slowly climb again through mid-year, well-being slowly declined, reaching a minimum at the end October, corresponding with another peak in cases. Beyond these observations, regression analysis suggests well-being declined as result of COVID-19 cases and containment policies, and between the two, cases had a more robust impact throughout 2020.

A key insight from this real-time measurement of well-being is how quickly people apparently recovered. Real harm was caused to mental and physical health, but data also indicate significant resilience. Efforts should be made to prevent and cushion individuals from such shocks, but not necessarily at every expense, e.g., long-term health. Of course, there are limitations to what we can infer from the data. Most importantly, there may be significant heterogeneities, and/or long run impacts that are not yet observable.

5.2 Nowcasting GDP Growth in Luxembourg

Knowledge of the current economic situation is a key ingredient for economic policy decision-makers. Current conditions, however, are unobservable because the economic indicators needed to predict them take time to compile, and are typically released with a delay. This is especially problematic in turbulent periods such as the COVID-19 outbreak, or financial and sovereign crisis, when timely data are needed to guide policy.

Economic nowcasting exploits information from non-standard economic indicators, typically released more frequently than traditional ones, to deliver predictions on current real GDP growth, possibly the widest used indicator of current economic stance. In particular, nowcasting uses a wider range of data collected at a higher frequency (e.g. monthly survey data, weekly financial data). In contrast, traditional forecasting predicts real GDP one or few quarters ahead, by extracting information from a few predicting variables observed at the same frequency as the variable of interest (e.g. quarterly unemployment or industrial production).

We set up a collaborative research project to estimate timely growth rates of real GDP for Luxembourg. This research aims are twofold: 1) assessing the performance of nowcasting models in predicting Luxembourg's current economy's stance compared to traditional forecasting models; 2) enhancing our understanding of data needed for nowcasting.

We collected a rich dataset consisting of conventional quarterly and monthly variables (e.g. exports, industrial production), augmented by unconventional monthly variables (e.g. business and consumer surveys), and alternative series (Google keyword searches, vehicle registrations, petrol sales…). This is because conventional monthly and quarterly variables have a large publication lag, and tend to reflect past instead of current conditions. The resulting dataset included more than 500 variables and series observed at different frequency.

We explored eight different modelling techniques, designed to handle datasets with many series and observations at mixed frequency. We employed single-series models (autoregressive model with one explanatory series and univariate mixed data sampling model), models that extract information from multiple series simultaneously (dynamic factor model, mixed frequency dynamic factor model and three pass regression filter), and two machine learning approaches designed to accommodate a large number of series (neural networks and random forests). We compared their performance to a simple *benchmark* model, namely the autoregressive model.

We derived several recommendations for nowcasting Luxembourg's real GDP. Firstly, we found that a simple autoregressive model and the more complex models achieve similar performances in normal economic times. Secondly, and in contrast to the previous finding, in turbulent periods complex models outperform the autoregressive model in terms of forecast accuracy.

10 Such search results are available daily by country and have been used in numerous research projects ranging from the assessment of economic conditions to individuals' feelings (e.g., Brodeur et al., 2020).

Figure 5

Quarterly real GDP nowcasts: benchmark model and the best performing series in COVID-19 period

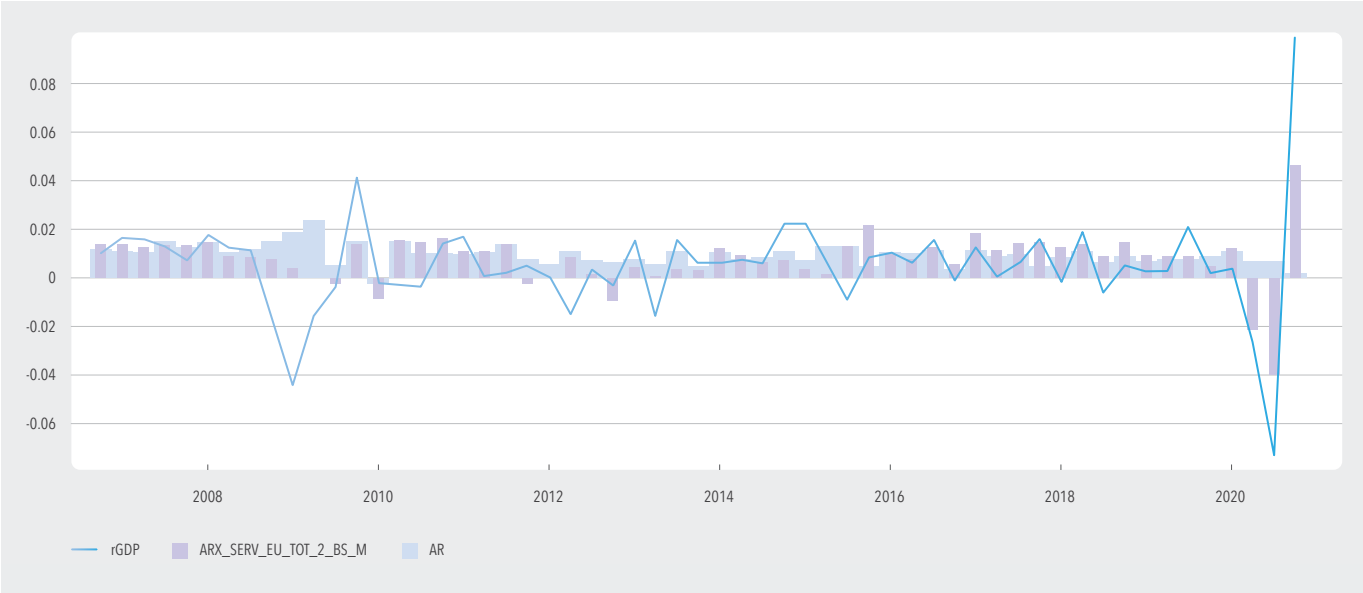


Figure depicts quarterly rGDP growth (rGDP, blue line), nowcasts produced by an autoregressive model (AR, blue bars), and best performing series in COVID-19 period (ARX_SERV_EU_TOT_2_BS_M, purple columns). Period is 2008-2020. Source: Statec, EC and own calculations

Among the complex models, the three-pass regression filter, neural networks and mixed frequency dynamic factor model perform best. The latter reduces the mean squared forecast error, which is a standard measure of forecast accuracy, by 11-24% compared to the autoregressive model. Thirdly, as far as data are concerned, business and consumer surveys are most useful for nowcasting purposes. This is likely because they are very timely, as their current observation is released about a week before the end of the month. Alternative data, such as Google searches, which are released in real time, do not seem to contribute much to nowcasting Luxembourg GDP. These series tend to be noisy and volatile. Among alternative series, an exception is vehicle registrations as it carries some forecasting power, albeit no higher than surveys.

Overall, nowcasting models produce considerably improved forecasts of current economic conditions in turbulent times. To achieve a reasonable forecasting performance, it is sufficient to employ conventional series in conjunction with business and consumer survey series.

Our large dataset will enable us further explorations. It is useful to identify series that could have improved GDP's predictions during COVID-19. What follows provides an example. The figure on the previous page illustrates the observed quarterly growth of real GDP (blue line) for the years 2008-2020. One can see that the simple benchmark model, the so-called "autoregressive model" (blue bars), performs poorly in tracking GDP growth, especially so during the COVID-19 crisis (the distance between the blue line and blue bars is large).

In contrast, using the "Business and Consumer survey" series (EC), which summarises the evolution of EU service demand in the previous 3 months, would have greatly improved the accuracy of nowcasts. This is shown by the purple bars, which display results for the "autoregressive model" augmented with this series. For 2020, this information captures the drop in economic activity which occurred at the pandemic's onset. Note that the same series would have performed poorly in the financial crisis (2008-2010). A possible explanation is that COVID-19 mostly affected the service sector, while services fared relatively well during the 2008 global financial crisis. This example highlights the need for exercising some discretion when forming nowcasts, a topic left for future work.

This project has been financially supported by STATEC, and represents a contribution to STATEC's programme "COVID19 - Lessons learned".

Results from this research are documented in the article authored by Marcellino and Sivec (2021).

5.3 Entrepreneurship in times of COVID-19: cross-country evidence from the GEM Report

The global spread of the coronavirus dramatically affected societies and economies worldwide. The sudden and deep economic contraction[11] that followed the emergence of COVID-19 had, inevitably, a negative impact on entrepreneurship (Peroni et al., 2020; OECD, 2020). Given the crucial role played by entrepreneurship in fostering technological change, job creation and, ultimately, economic growth,[12] monitoring how entrepreneurs are responding to the COVID-19 crisis is important to encourage the recovery, and represents a central policy concern.

In this context, the 8th edition of the **Global Entrepreneurship Monitor (GEM) for Luxembourg** (Peroni et al., 2021) devotes special attention to entrepreneurial dynamics in the country after the emergence of the coronavirus pandemic. The report examines the state of entrepreneurial activities in Luxembourg from a cross-country perspective. In particular, the report compares Luxembourg's entrepreneurial performance with all European countries for which GEM data are available, based on information from the surveys administered in 2019 and 2020.[13]

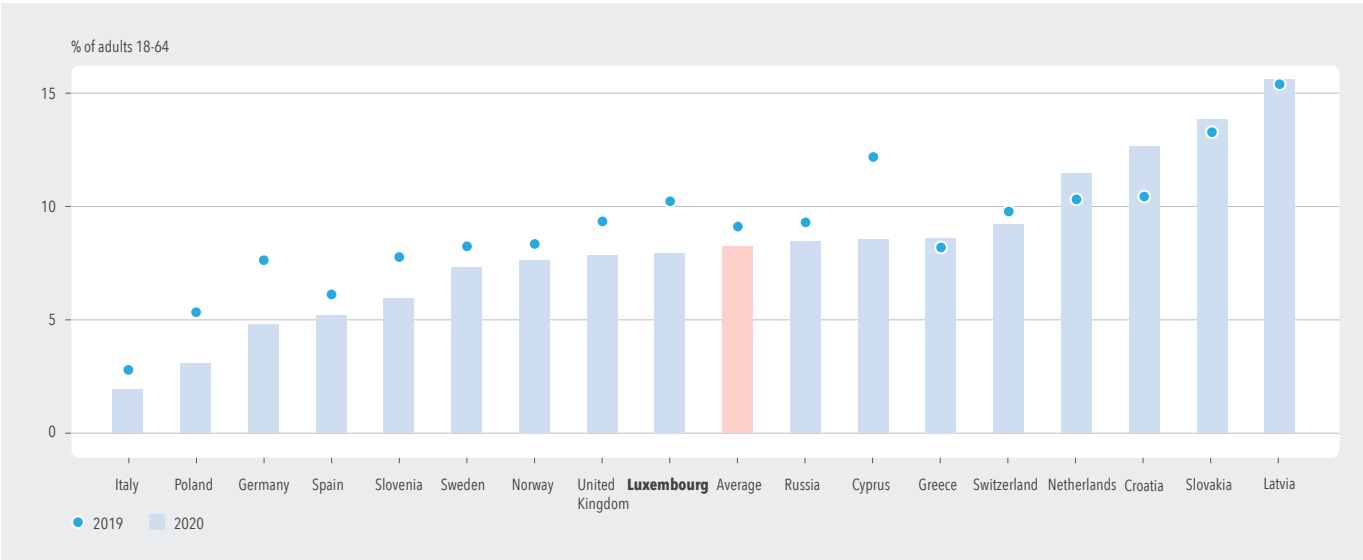
The report starts out by showing that the sudden economic downturn of the first half of 2020 led to a decline in the share of individuals' perceiving good opportunities to start a business. In Europe, this share dropped from 51% in 2019 to 40% in 2020. In Luxembourg, this decline was somewhat more pronounced, moving from 58% in 2019 to 42% in 2020. This deterioration in perceived business opportunities was accompanied by a decrease in new entrepreneurial efforts: the share of individuals trying to set up a business in the country went from 15% in 2019 to about 9% in 2020. This decline was stronger compared to the European average, which fell from 11% in 2019 to 9% in 2020. Among those individuals that decided to start a business, the majority declared that the pandemic delayed getting their businesses operational (68% in Luxembourg vs. 61% in Europe).

The decline in the share of individuals trying to set up a business contributed to a reduction in total early-stage entrepreneurship (TEA), that is, the share of individuals effectively involved in starting or running a new business. In Luxembourg the reduction in TEA (from 10.2% in 2019 to 8% in 2020) was somewhat larger than the European average (from 9% in 2019 to 8% in 2020), as shown in Figure 6. However, also considering the unprecedented challenges brought about by the pandemic, the magnitude of this variation does not appear to be severe if compared with historical GEM data for Luxembourg. In the period 2013-2020, TEA was on average 9.2%, ranging from 7.1% in 2014 to 10.7% in 2018.

While COVID-19 negatively affected entrepreneurial activities, some categories were hit harder than others by the pandemic. For instance, female-led businesses suffered more than male-led ones (Alon et al., 2020). The decline in TEA has been more severe for women than men, especially in Luxembourg. The average female TEA declined by 13%, while male TEA declined only by 7%. Figure 7 documents that in Luxembourg the drop in female TEA was substantial (-40%), while the decline in male TEA was similar to the European average (-9%). This has widened the already existing entrepreneurial gender gap.

Figure 6

Total early-stage Entrepreneurial Activity (TEA) (% of adults 18-64)

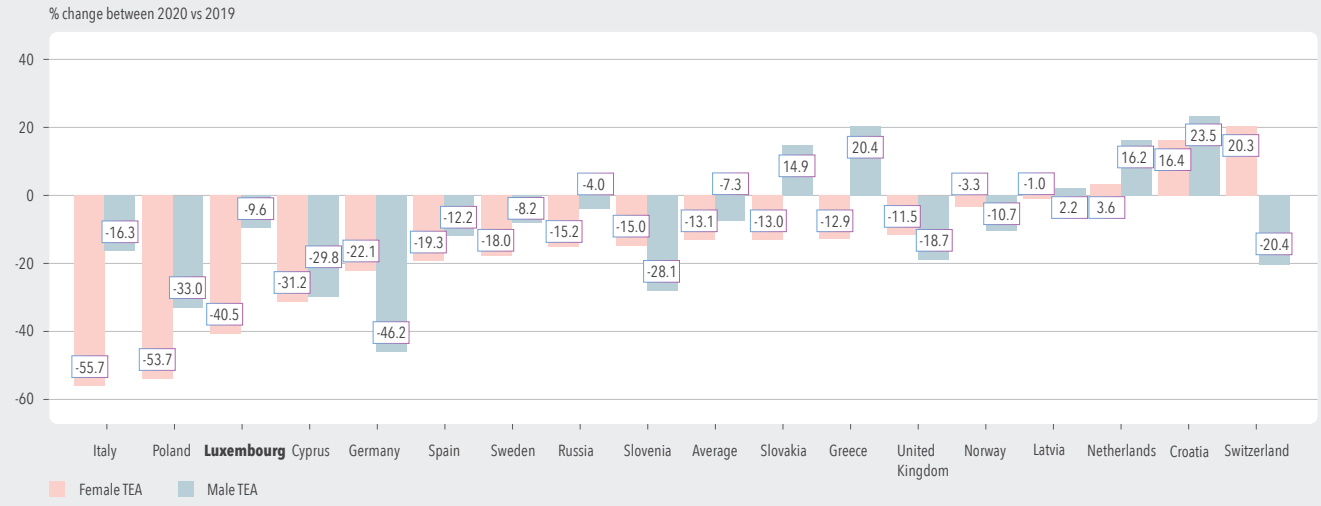


Source: Peroni et al., 2021

11 During the second quarter of 2020, economic output in EU-27 countries declined by 14% compared with the same quarter of the previous year.
12 New firms account for about 20% of employment but create almost half of new jobs on average across OECD countries (Criscuolo et al., 2014), and their innovation efforts contribute significantly to aggregate productivity growth (Klenow and Li 2021).
13 Data were collected during the summer of 2019 and 2020. While these data allow us to benchmark Luxembourg with respect to other countries, it is important to stress that they refer to mid-2020 and that results should not be extrapolated to more recent developments.

Figure 7

Percentage changes in female and male TEA over 2019-2020



Source: Peroni et al., 2021

As typically observed during economic downturns (Fairlie and Fossen, 2019), 2020 saw an increase in necessity-driven entrepreneurship. The term refers to individuals that are "forced" to choose entrepreneurship because of the inability to find paid employment. In Europe, the share of those individuals starting or running a new business "to earn a living because jobs are scarce" rose from 52% in 2019, to 60% in 2020. Similarly to Europe, Luxembourg experienced an increase (moving from 38% to 44%), but remained a country with one of the lowest share of necessity-driven entrepreneurship.

The breakout of the pandemic substantially increased uncertainty and negatively affected business expectations (Bloom et al., 2020). As a result, 43% of early-stage entrepreneurs reported lower growth expectations in 2020 when compared with 2019 (45% in Luxembourg). However, with uncertainty comes opportunity. Consistent with the idea that crises can also be regarded as times of "creative destruction" characterized by the emergence of successful entrepreneurs, a non-negligible share of early-stage entrepreneurs perceived that the pandemic brought about new opportunities to pursue (32% in Europe and 31% in Luxembourg). The increase in uncertainty affected both current and prospective entrepreneurs. The report shows that the share of individuals expecting to start a new business in the next three years has declined during 2020 in Luxembourg as well as in the majority of European economies.

Figure 8

Government response to the economic consequences of the pandemic was satisfactory (% of TEA)

Source: Peroni et al., 2021

Figure 9

Business registrations in Luxembourg during 2019, 2020 and 2021

Source: Luxembourg Business Register

While the emergence of COVID-19 represented an unprecedented challenge for entrepreneurs, it was met by rapid and strong government interventions (OECD, 2020; OECD, 2021). Among other things, these have allowed firms to access resources to stay afloat and avoid bankruptcy. As a result, the report shows that the share of individuals discontinuing a business was generally stable in most European countries, including Luxembourg. Relatedly, GEM data also reveal that the government response to the economic consequences of the pandemic during 2020 was met with favour by entrepreneurs. Luxembourg showed the highest appreciation with 76% of early-stage entrepreneurs at least somewhat agreeing that the government response was indeed satisfactory compared to a European average of 46%, as shown in Figure 8.

Finally, the report combines the rich characterization of the initial effects of the pandemic on entrepreneurship offered by GEM surveys with data from the Luxembourg Business Register to account for more recent developments. These confirm the decline in business registrations during the first half of 2020. However, they document a surge in new business formation over the last months of 2020 in Luxembourg (see Figure 9) as well as other European countries (Criscuolo, 2021). In Luxembourg this positive trend continued in the first eight months of 2021 with registrations up 28% on average, when compared with the same period in 2019.

This represents a positive development, suggesting that the drop in entrepreneurial entry during the first half of 2020 might have been partially reabsorbed. This sharp rebound is also at odds with what was observed in past recessions, when business entry declined for a long period of time after the onset of the downturn (Dinlersoz et al., 2021). It remains to be seen if this trend will persist in 2021, and whether this rise reflects an increase in necessity-driven vs. opportunity-driven entrepreneurship. Nonetheless, it will be important to closely track this timely indicator until new GEM data for 2021 will be released.

The Luxembourg GEM report is available for download at this link: https://statistiques.public.lu/catalogue-publications/LuxGEM/2021/GEM_Report_2021.pdf

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