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Luxembourg – diversifying
a small open economy

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LUXEMBOURG – DIVERSIFYING A SMALL OPEN ECONOMY

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By Jan Stráský and Eckhard Wurzel

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ABSTRACT/RÉSUMÉ

Luxembourg – Diversifying a Small Open Economy

Developing activities in areas other than finance would help to sustain growth and deal with the declining potential output and trend productivity growth that Luxembourg's economy is facing. Given the relatively high labour costs, Luxembourg's future comparative advantages are likely to lie in higher value added and skill intensive activities. Further development of Luxembourg's high living standards thus requires strengthening the economy's growth potential via further diversification of activity in high value added sectors.

Stepping up investment in knowledge based capital and enterprise innovation can help Luxembourg to maintain and further develop comparative advantages in high value added activities. The government is promoting the formation of enterprise clusters by providing networking, infrastructure investment and financial support for research and development. To enhance the efficiency of the government's policy, high priority should be given to outcome-oriented evaluation. This is required to ensure that costly infrastructure investment yields good results. Further efforts should be made to create synergies via cross-border initiatives, in particular with respect to research. Experience in other countries points to the importance of regulatory framework conditions in product and labour markets to spur enterprise dynamics. Regulation in professional services can be made more competition friendly, and impediments to labour force participation, notably for women, can be reduced. Productivity and innovation are also affected by the effectiveness of the secondary education system to produce skilled workers, which in Luxembourg is hampered by high repetition rates among students.

This Working Paper relates to the 2015 OECD Economic Survey of Luxembourg (www.oecd.org/eco/surveys/economic-survey-luxembourg.htm).

JEL classification: H52, H54, I25, L25, L52, L53, O31, O32, O38

Keywords: education, infrastructure, labour migration, competitive advantage, diversification, clusters, entrepreneurship, innovation, intangible assets, research and development, government policy

Luxembourg – diversifier une petite économie ouverte

Développer l'activité dans des domaines autres que la finance permettrait de soutenir la croissance et de faire face à la baisse de la production potentielle et de la croissance tendancielle de la productivité que connaît l'économie luxembourgeoise. Étant donné les coûts de main-d'œuvre relativement élevés, les avantages comparatifs futurs du Luxembourg vont vraisemblablement reposer sur des activités à plus haute valeur ajoutée et à plus forte intensité de main-d'œuvre qualifiée. Par conséquent, la progression du niveau de vie du Luxembourg, déjà élevé, exige le renforcement du potentiel de croissance de l'économie à travers une diversification plus poussée dans des secteurs d'activité à forte valeur ajoutée.

Investir plus massivement dans le capital intellectuel et dans la capacité d'innovation des entreprises peut aider le Luxembourg à maintenir et à renforcer des avantages comparatifs dans des activités à forte valeur ajoutée. Le gouvernement s'emploie à promouvoir la mise en place de pôles d'entreprises en favorisant la constitution de réseaux, en investissant dans les infrastructures et en aidant financièrement la recherche-développement. Pour améliorer l'efficacité de la politique publique, il faudrait accorder une priorité élevée à la réalisation d'évaluations axées sur les résultats, afin de s'assurer que les investissements dans les infrastructures, qui sont coûteux, produisent des résultats satisfaisants. Il faut aussi s'employer davantage à générer des synergies par le biais d'initiatives transfrontalières, en particulier en matière de recherche. L'expérience d'autres pays fait ressortir l'importance que peut jouer le cadre réglementaire des marchés des produits et de l'emploi pour insuffler un nouveau dynamisme aux entreprises. Il est possible de rendre la réglementation des services professionnels plus favorable à la concurrence et de réduire les facteurs pesant sur le taux d'activité, notamment des femmes. L'efficacité du système d'enseignement secondaire au Luxembourg, qui se caractérise par un taux de redoublement élevé et a du mal à produire des travailleurs qualifiés, affecte également la production et l'innovation.

Ce Document de travail se rapporte à l'Étude économique de l'OCDE de Luxembourg, 2015 (www.oecd.org/fr/eco/etudes/etude-economique-luxembourg.htm).

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Mots clefs: l'éducation, l'infrastructure, la migration de travail, avantage concurrentiel, la diversification, l'entrepreneuriat, les clusters, l'innovation, la recherche et le développement, la politique du gouvernement

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LUXEMBOURG: DIVERSIFYING A SMALL OPEN ECONOMY

By Jan Stráský and Eckhard Wurzel¹

Diversifying growth

In the two decades prior to the crisis, Luxembourg grew twice as fast as the European average, and per capita incomes climbed to one of the highest in the OECD area. Even if aggregate income per capita is measured by GNI rather than GDP, excluding factor income from domestic production that accrues to Luxembourg's high share of non-residents, Luxembourg still ranks at the top of the OECD, surpassed only by Norway.

However, the economy depends heavily on its financial sector, creating potential vulnerabilities, and the sector's contribution to the economy's growth might diminish. This highlights the need to develop activities in other areas to sustain growth. Given the relatively high labour costs, Luxembourg's future comparative advantages are likely to lie in higher value-added and skill-intensive activities. Securing high growth and employment will also require reinvigorating Luxembourg's declining productivity growth. This paper considers key policy issues related to diversifying the economy towards higher value-added activities and raising productivity more broadly.

Luxembourg has experienced a slowdown in potential per capita output growth that is driven by rising structural unemployment and declining trend labour productivity growth (Figure 1). Estimates of potential growth and its components are surrounded by a high degree of uncertainty though, which is larger for Luxembourg than for most other OECD countries, due to the large share of cross-border workers in the labour force, and difficulties in measuring the value-added of the financial sector with large in and outflows of capital. (Annex 1).

¹ Jan Stráský is an economist on the Luxembourg Desk in the Economics Department of the OECD; Eckhard Wurzel was head of the Luxembourg Desk. This paper is based on Chapter 2 of the 2015 OECD Economic Survey of Luxembourg, published in March 2015 under the authority of the Economic and Development Review Committee (EDRC). The authors thank Nataša Jemec, who contributed the part on estimating potential output in Annex 1, Damien Azzopardi, Guillaume Bousquet, Arnaud Daymard and Giuseppe Maggio for excellent research assistance. The authors would also like to thank Robert Ford, Álvaro Pereira, Piritta Sorsa and colleagues from the OECD's Centre for Tax Policy and Administration and the Directorate for Science, Technology and Innovation for valuable comments. The report also benefited from comments from the Luxembourg authorities. Special thanks go to Anthony Bolton for technical assistance.

Sectoral shift-share analysis, which distinguishes growth within a sector versus growth from shift in output between sectors, points to declining contribution to productivity of the traditional growth drivers of financial and other business services (Figure 2, Annex 2). Since the middle of the 1980s until the onset of the crisis, financial intermediation, manufacturing, transport, storage and communication and community and social services were the largest contributors to overall within-sector productivity growth (Figure 2, upper panel). Financial intermediation was the only sector that had a further increase in productivity growth in the decade prior to the crisis.

Figure 1. Trend unemployment and productivity

Source: OECD Economic Outlook 96 database and Analytical database annual (2014)

The shifting of resources towards sectors with high productivity - notably real estate, renting and business activities and financial intermediation - accounted for a significant part of overall productivity growth (Figure 2, lower panel). This positive reallocation effect slowed significantly after the crisis and turned negative in financial intermediation as its output fell. Securing and further developing Luxembourg's high living standards calls for fully exploiting the scope for structural reform to enhance reallocation of resources to new activities.

Figure 2. Shift-share analysis of labour productivity growth

Source: OECD STAN Database.

Future growth potential is likely to lie in high value-added activities

For high-income economies such as Luxembourg, activities that produce high value-added should be particularly important as they are relatively highly remunerated. High value-added activities also tend to be technology and knowledge intensive. Indeed, in the EU value-added per employee in the high-tech manufacturing and the knowledge intensive service sectors (according to the EU Commission classification) exceeds that in the rest of the economy by some 25% (Table 1).

Table 1. **High-tech manufacturing and knowledge-intensive services industries**

<i>NACE / area letter codes</i>	Industry type
High- and medium-high technology manufacturing	
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
Knowledge-intensive services	
50	Water transport
51	Air transport
58	Publishing activities
59-60	Motion picture, video, television programme production; programming and broadcasting activities
61	Telecommunications
62-63	Computer programming, consultancy, and information service activities
64	Financial service activities, except insurance and pension funding
65	Insurance, reinsurance and pension funding, except compulsory social security
66	Activities auxiliary to financial services and insurance activities
69-70	Legal and accounting activities; activities of head offices; management consultancy activities
71	Architectural and engineering activities; technical testing and analysis
72	Scientific research and development
73	Advertising and market research
74-75	Other professional, scientific and technical activities; veterinary activities
78	Employment activities
80	Security and investigation services
O	Public administration and defence; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment and recreation

Note: Classification by Eurostat, see the ISIC Rev. 3 Technology-intensity definition; <http://www.oecd.org/sti/ind/48350231.pdf>

Source: Eurostat indicators on High-tech industry and Knowledge-intensive services, Annex 3.
http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf

Thus, in developed economies that are close to the technological frontier, further increases in long-term growth need to come from improvements in multifactor productivity. Recent studies have shown that this is mainly driven by innovation and knowledge-based capital (KBC) - assets that lack physical embodiment, such as computerised information, intellectual property and economic competencies (OECD, 2013a). In the decade prior to the financial crisis, business investment in KBC was indeed an important driver of overall investment and accounted for 20% to 34% of the average labour productivity growth in the EU and the US (Corrado et al., 2012).

Investment in knowledge-based capital in Luxembourg is lower as a share of GDP than in other OECD countries (Figure 3). This points to unexploited growth and employment potential. Countries that invest more in KBC are also more effective at channelling capital and labour to young innovative firms. Thus the growth potential of KBC tends to also depend on the ability to reallocate labour and capital to their most productive uses, given that KBC is prone to misallocation (Andrews and Criscuolo, 2013).

Figure 3. Investment in knowledge-based capital, 2010

Source: OECD Science, Technology and Industry Scoreboard 2013.

Given the small size of the domestic economy, Luxembourg will also have to rely on high integration in global value-chains (GVCs) to broaden effective market size. With the rise of GVCs, some factors of production have become more mobile. At the same time, firms are sourcing more activities and resources across borders. In this context, it is increasingly important for further development of advanced economies with high labour cost, such as Luxembourg (Figure 4), to focus on factors that yield comparative advantage in the global value-added chain: human capital, education and skills, high-quality infrastructure, well-developed links between enterprises and research institutes or universities and sound institutions (Baldwin, 2012). High value-added activities are less contestable because required skills are more difficult to obtain. The deeper the integration into the global value chain, the more competitive advantages can be exploited to generate income at home. Moreover, high integration can generate beneficial spillovers of knowledge and best practices (OECD, 2013b).

Figure 4. Hourly labour costs by economic sector, 2012

Note: Total Labour Costs refer to the total expenditure borne by employers in order to employ staff. They cover wage and non-wage costs less subsidies. They do include vocational training costs or other expenditures such as recruitment costs, spending on working clothes, etc.

Source: Eurostat. Data refer to employees working in enterprises with at least 10 employees and NACE Rev. 2 Sections B to S excluding O.

Luxembourg is one of the most open countries in the OECD with respect to international trade in services and well integrated in some GVCs. More than 60% of final demand in Luxembourg stems from abroad (OECD, 2013b). The share of services value-added in total exports exceeds 80%, which is the largest in the OECD. The participation of the economy in GVCs through exports is mainly driven by the use of foreign intermediates (i.e. a high degree of “backward participation”), as is typical for small economies that source a large share of their intermediate inputs from abroad. In terms of the geographical origin of inputs, Luxembourg has a relatively small sourcing from other euro area countries compared to EU countries outside the euro area, particularly the United Kingdom, Denmark, Sweden, and also the United States. This distribution is mainly explained by a relatively large presence of multinational companies in Luxembourg stemming from non-euro area countries (Amador et al, 2013).

Financial services trade is more integrated into the global value-added chain than in all other countries (Figure 5). Integration is considerably lower in other sectors, leaving potential to raise productivity by further integration into international value chains in higher value-added non-financial activities. For example, the value-chain analysis seems to suggest that Luxembourg would benefit from better exploiting opportunities offered by deeper participation in business and transport services. Luxembourg’s exporters of computer services tend to be located at the upstream end of the value chain, as measured by distance to final demand. This position is associated with high value-added research and development (R&D) or with design (Figure 6).

Figure 5. **International comparison of GVC participation index for selected industries (2009)**

Sum of the share of foreign inputs in overall exports and the share of gross exports that are used as inputs in other countries' exports

Source: OECD Global Value Chains indicators.

Figure 6. Participation and position in computer services global value chains, 2008

1. How to read this figure: The participation index is calculated as the sum of foreign inputs and domestically-produced inputs used in third countries' exports, as a share of gross exports. The distance to final demand is a measure of upstreamness" in a global value chain. Longer distances indicate a specialization in producing inputs closer to the beginning of the value chain."

Source: OECD (2012), Policy Dialogue on Aid for Trade, Mapping Global Value Chains.

Stepping up investment in KBC and enterprise innovation can help Luxembourg to maintain and further develop its position in the global value chains and develop comparative advantages in high value-added activities. Important policies for innovation and KBC are those related to R&D, the business environment, access to finance, competition, labour markets, and education. Indeed, several of these factors are cited by entrepreneurs as important barrier for doing business (Figure 7). Cluster policies have also gained in importance among policy makers. The role of these various factors in Luxembourg is discussed in more detail below.

Figure 7. The most problematic factors for doing business

Note: From the list of factors above, respondents were asked to select the five most problematic for doing business in their country and to rank them from the most problematic to the least problematic one. The bars in the figure show the responses weighted according to the rankings.

Source: World Economic Forum, The Global Competitiveness Report 2014 - 2015, <http://www.weforum.org/reports/global-competitiveness-report-2014-2015>

Fostering entrepreneurship

Investing in research and development

Innovative ability includes R&D spending that leads to development of new products and services, copyrights and licences, as well as novel designs that translate into quality improvements and enhanced processes. Luxembourg's position among OECD countries in patents and trademarks is relatively strong in per capita terms, largely owing to the strong position in trademarks abroad (Figure 8). Per capita registration of triadic patents (patents registered at the European, Japanese and US patent offices), which may require more innovative and higher value-added research, is about average in the EU. The latest EU Community Innovation Survey (EU Commission, 2010) also suggests that a large majority of firms introduced product, process, organisational or marketing innovations (either new-to-market or new-to-firm). However, the share of SMEs in turnover derived from sales of product innovations is relatively low (EU Commission, 2014).

Luxembourg is lagging the OECD average in terms of both total and business R&D expenditure, which is an important determinant of the ability to innovate (Figure 9). R&D expenditure by the public sector increased over the last years, largely owing to larger outlays for the University of Luxembourg and for public sector research institutes, which are also relevant for the government's cluster initiative (see below). At the same time, business spending on R&D, in terms of gross domestic product (GDP), trended down already prior to the crisis and dropped further by 0.3 percentage points when the crisis set in, undercutting the EU average by a quarter of a percentage point. While measuring private sector R&D spending might be subject to a considerable degree of uncertainty in an economy with a large sector of financial market and related services, other factors, relating to the business environment and access to venture capital, are likely to be at play in hampering R&D spending.

Figure 8. **Patents and trademarks per capita, 2009-11**

Average number per million population, OECD and G20 countries

Source: OECD Science, Technology and Industry Scoreboard 2013.

Figure 9. Research and development expenditure

Source: OECD(2014), "Main Science and Technology Indicators"

The government financially supports private sector R&D by various direct programmes (mainly based on the 2009 law for the Promotion of Research, Development and Innovation). Support is geared towards SMEs, with rates of support declining with the size of the enterprise, although various maximum intensities and thresholds apply, depending on the type of the recipient (Table 2). In particular, one of the measures, *Aid for Young Innovative Enterprises*, exclusively targets small private firms or research units. Programme participation of SMEs has significantly increased since the introduction of the new system (Box 1). Also, royalties and capital gains derived from most types of intellectual property are tax deductible to some extent. OECD research suggests that R&D tax incentives benefit incumbents at the expense of entrants, suggesting that direct support is better suited for small and young firms facing constraints to access finance (Westmore, 2013; Jaumotte and Pain, 2005).

Table 2. **Maximum aid intensities and amounts of the aid schemes established by the Law of 5 June 2009**

Per cent					
Type of scheme	Type of R&D project or programme	Large enterprise or large private research organisation	Medium-sized enterprise or medium sized private research organisation (including 10 bonus)	Small enterprise or small research organisation (including 20 bonus)	Public research organisation
R&D project or programme	Experimental development	25	35	45	n/a
	Experimental development + collaboration (incl. 15 bonus)	40	50	60	n/a
	Industrial research	50	60	70	n/a
	Industrial research + collaboration (incl. 15 bonus)	65	75	80	n/a
	Fundamental research	100	100	100	n/a
Technical feasibility studies	Prior to experimental development	40	50	50	n/a
	Prior to industrial research	65	75	75	n/a
Protection of technical industrial property	Following experimental development	n/a*	25	25	n/a
	Following experimental development + collaboration (incl. 15 bonus)	n/a*	40	40	n/a
	Following industrial research	n/a*	50	50	n/a
	Following industrial research + collaboration (incl. 15 bonus)	n/a*	65	65	n/a
	Following fundamental research	n/a*	100	100	n/a
Aid for young innovative enterprises		n/a	n/a	EUR 1,000,000	n/a
Innovation advisory services and innovation support services		n/a*	EUR 200,000 maximum aid per 3-year period	EUR 200,000 maximum aid per 3-year period	n/a
Temporary secondment of highly qualified personnel		n/a*	50	50	n/a
Process and organisational innovation in services		15	25	35	n/a
Investment in innovation clusters		15	25	35	50
Animation of innovation clusters		50 on average, over a maximum period of 5 years	50 on average, over a maximum period of 5 years	50 on average, over a maximum period of 5 years	75 over a maximum period of 10 years
"De minimis" measures		EUR 200,000 maximum per period of 3 fiscal years	EUR 200,000 maximum per period of 3 fiscal years	EUR 200,000 maximum per period of 3 fiscal years	n/a

* "De minimis" measures may apply.

Source: Luxinnovation, "State Aid for research, development and innovation for the benefit of Luxembourg's economy".

Box 1. R&D aid schemes in 2013

In 2013, the government spent almost EUR 87 million in R&D aid under the Law of 5 June 2009, more than in the two years before (see Table 3). In these three years, at least 80% of the R&D aid in Luxembourg has been channelled through R&D projects and programmes, followed by aid for “young innovative enterprises”. Other schemes, including those targeted at investment in clusters, are relatively small.

Table 3. Amounts of R&D aid under the Law of 5 June 2009

EUR million

	2011 total amount of state aid	2012 total amount of state aid	2013 total amount of state aid	2013 total expenditure by recipients
R&D projects and programmes	27.21	33.56	74.90	199.50
Technical feasibility studies	0.62	0.73	1.32	2.69
Protection of technical industrial property	0.00	0.00	0.09	0.38
Aid for young innovation enterprises	2.49	4.64	6.23	15.25
Innovation advisory services and innovation support	0.08	0.04	0.02	0.04
Temporary secondment of highly qualified personnel				
Process and organisational innovation in services	0.18	0.21	3.32	11.6
Investment in innovation clusters		1.40	0.35	1
Animation of innovation clusters		1.11		
"De minimis" measures	0.53	0.26	0.53	
Total	31.11	41.95	86.76	230.46

Source: Ministry of Economy, Annual Report 2013

The number of projects supported by the “R&D projects and programmes” tool has been steadily increasing from 31 in 2009 to 87 in 2013 (Ministry of the Economy, 2014). The number of SMEs supported by this measure also increased, from 7 in 2009 to 28 in 2013. By field, 53% of the programmes were allocated to scientific and technical activities, 29% in manufacturing industries, 12% in ICT and 2% in finance and insurance.

In 2009, before the law for the Promotion of Research, Development and Innovation came into force, more than 90% of private R&D spending sponsored by the government was undertaken by large enterprises (Figure 10). At the same time, empirical cross-country evidence points to the important contribution of young enterprises in innovation processes (Lerner, 2010; OECD, 2013c). More profound, “radical” innovations are often pioneered by young enterprises, while older firms tend to produce more incremental innovation along established paths. It is thus important to monitor to what extent young enterprises benefit from support, and if necessary adjust support programmes to target a larger share of the support to younger enterprises.

There is also room to improve the structure of the programmes, as suggested by the non-utilisation of two of the measures (*support of temporary secondment of highly qualified personnel* and *animation of innovation clusters*). Low utilisation of some programmes could also reflect barriers in the economic environment that reduce the expected returns from engaging in R&D. Moreover, the low share of female researchers, and their high concentration in the public sector, could point to disincentives to female participation, and thus unexploited opportunities to step up research (Figure 11).

Figure 10. **Government financed R&D in the business sector, by the size of the firm, 2011**

Note: For some countries other years apply, as indicated in the parentheses.

Source: OECD, Entrepreneurship at a Glance 2014.

Figure 11. **Female researchers by sector of employment, 2011**

Source: OECD Science Technology and Industry Scoreboard, 2013.

Further improvements in the business environment to foster innovation

Entrepreneurship and productivity are heavily influenced by the business environment. There is a strong negative relationship between the strictness of product market regulation (PMR) and productivity, both in the aggregate (Bouis et al., 2011) and at the firm and sectoral levels (Aghion et al., 2004; Bourlès et al., 2010). In particular, lower entry barriers increase the supply of new ideas by raising firm entry rates, which in turn increases the pressure on incumbent firms to innovate. In addition, reforms that lead to less stringent PMR can also raise the incentives for firms to incorporate foreign technologies (Parente and Prescott, 2000; Holmes et al., 2008).

Overall, barriers to entrepreneurship in Luxembourg are close to the OECD average, but remain relatively high compared to best practice (Figure 12, panel A), despite some decline between 2003 and 2013. Administrative burden for sole proprietor firms and of barriers in network sectors declined, but in the services sector, business conditions became more restrictive due to tighter regulation of licencing in retail trade relating to retail surface (Figure 12, panel B).

Figure 12. **Product Market Regulation: Barriers to entrepreneurship¹**

1. All indices below the first line are sub-indices of the index "Barriers to entrepreneurship".

2. Simple average of OECD countries, 2013 data. USA: latest data from 2008.

Source: OECD Product Market Regulation database, 2013 edition.

There has been little progress in making regulation in professional services, such as architecture, engineering, accounting and legal services, more competition friendly. Barriers in these sectors appear to be relatively high by international comparison due to high entry barriers, such as compulsory qualifications and duration of compulsory practice. However, the Competition Authority was able to abolish recommended fee structures published by several professional associations, such as architects and safety and health coordinators.

Entrepreneurial barriers in the network sector remain relatively high. As the government retains full ownership in the major telecommunication network operators (*Luxconnect* and *Entreprise des Postes et Télécommunications*), in contrast to most other OECD countries, they are not open to investment by private firms. Opening the sector to foreign participation might lead to more investment, although the outcome is not certain and will depend on expected returns.

The entry to the rail sector is limited to a single firm (*Société Nationale des Chemins de Fer Luxembourgeois*, CFL). Passenger and freight transport are provided by a single operator and the separation between the operation of infrastructure and provision of railway services, although not as important in a small country as in other countries, is limited to accounting separation. Some 75% of the employees of the CFL group are civil servants while the rest is on private sector contracts. It should be considered whether a move towards universal private sector contracts would be efficiency enhancing.

Policies helping enterprises to form clusters could support innovation and productivity growth

The case for public policies to ease “clustering”, the tendency of firms in related lines of business to concentrate geographically, rests on the idea that clusters might help internalising spill-over effects that generate improvements in innovation and productivity (Fabiani et al., 2000; Beaudry and Breschi, 2000). Clusters might help ease the way for firms to attract a workforce with characteristics that match best the firms’ projects and can also support important knowledge spill-overs, such as knowledge of market opportunities and the transfer of technologies.

Studies on cluster policies also suggest that they need to build on existing strengths to be successful. Policies disregarding comparative advantages can entail high economic costs and risks (Warwick and Nolan, 2014). Support for clusters run the risk of “backing losers” rather than “picking winners” (Hospers et al., 2008). Several evaluations of cluster policies in OECD countries found no positive effect on employment, exports, sales, patents or R&D productivity (Martin et al., 2011; Bellego and Dortet-Bernadet, 2013; Nishimura and Okamuro, 2011). Other evaluations found modest positive effects of cluster policies such as a slightly higher share of knowledge-based firms in the locality, albeit stagnating over time (Viladecans-Marsal and Arauzo-Carod, 2012), and a somewhat higher probability that firms in a target industry would innovate (Falck et al., 2010). Also, valuation based on interviews and self-reports show that cluster policies can succeed in fostering inter-firm collaboration or business contacts (Engel et al., 2012; Uyarra and Ramlogan, 2012).

Experience from other countries with clusters suggests that favourable overall regulatory framework conditions for the economy are of high importance for successful cluster policies (see e.g. Uyarra and Ramlogan, 2012). In particular, this concerns competition-friendly product market regulation to foster the reallocation of resources; labour market regulation that activates the employment potential of the labour force and supports efficient matching of labour supply; and policies that secure the availability of a high-skilled workforce. Direct financial subsidy to firms’ location decisions, on the other hand, appears to have only modest effects on location decisions while giving rise to inefficiencies, such as wasteful competition and the lack of comparative advantage (Warwick and Nolan, 2014).

The government is supporting the formation of enterprise clusters within a special initiative in sectors that it considers promising for Luxembourg. At present, the initiative comprises the following clusters: eco-innovation technologies, healthcare and biotechnologies, information and communication technologies, materials technologies, space technologies, automotive components, logistics, and maritime transport (Box 2). These sectors fit with the usual classification of high value-added activities (Table 1 above). The initiative includes information networking between the private sector participants and the administration and R&D support via public sector research institutes or Luxembourg University.

Box 2 The government's cluster initiative

In 2002, the government launched a cluster initiative, which, in its present form, pursues the following objectives:

- Foster communication and the exchange of knowledge and know-how between cluster and innovation network members.
- Stimulate the development and implementation of collaborative projects on a national, European and an international level.
- Enhance the visibility of the technological excellence and the innovation potential of cluster and innovation network members.
- Encourage the uptake of new technologies and the identification of potential business opportunities.

The aim is to create 3 000 new jobs and contribute to the establishment of 300 new businesses by 2020.

Most of the clusters are led by a president coming from the private sector, who is supported by a vice-president from public research. Designated cluster managers are in charge of the daily organisational management.

Moreover, the government has undertaken substantial public infrastructure investment supporting cluster activities. In information and communication technologies this has been quite successful (Figure 13). The government's April 2010 National strategy for very high-speed networks aims to give access to optical fibre connections to all by 2020. Already, most of the country is covered by high-speed broadband and 68% of households were connected to some version of broadband in 2011 (OECD, 2013a). These investments position Luxembourg well to attract new technology activities such as cloud computing, trusted data management and the development of the internet economy. It has one of the most modern data centre parks in Europe with 19 data centres in operation that conform to high standards in security, availability and environmental benchmarks. Based on these strengths, many private and public sector institutions, including financial sector enterprises and the European Commission, established data centres in Luxembourg. The absence of taxation of servers also contribute to the comparative advantage, and energy prices, which account for a large part of data centres' operating costs, are competitive.

Figure 13. **Public telecommunications investment per capita**

Source: OECD Communications Outlook 2013.

Similarly, the government's decision to create a health care and bio-medicine cluster was followed by heavy investment to create the Luxembourg Centre for Systems Biomedicine (LCSB) and the Integrated BioBank of Luxembourg. So far, the success was mixed. The OECD Innovation Policy Review on

Luxembourg (OECD, 2015a) found that the quality of public sector research in biotechnology improved in recent years, largely owing to better international cooperation through the LCSB. Moreover, it seems that not enough attention was paid to the regulatory framework concerning health technologies, e.g. around genetic testing. The Review thus sees a need to reconsider the regulatory framework as a condition for reaping the full benefits from the biomedicine initiative, and points to a number of other issues that can hamper health-related innovation such as a relatively weak industrial base in the field and a lack of linkages between researchers, business and clinicians.

To enhance the efficiency of cluster policies the government should give high priority to outcome-oriented evaluation. The government is establishing a comprehensive data-base containing key characteristics of the enterprises participating in clusters. This is an important step towards effective policy evaluation. Project funding should rely increasingly on private resources as cluster participants obtain benefits from the policy stimulus. Also, evaluation should go hand in hand with an assessment whether regulatory policy needs to be adapted. Efforts should be made to create synergies via cross-border initiatives. To enhance innovation, clusters should also be kept inclusive through impartial public co-ordination and adaptable by effective interaction of firms and research institutions.

Other types of collaboration arrangements to enhance innovation

Collaboration with other companies, universities and research institutes can help innovation by small and medium enterprises (SMEs) that may otherwise have more limited resources for R&D. Innovative SMEs in Luxembourg are actively engaging in international collaboration on trademarks and patent submissions, as well as on joint marketing and distribution schemes (Figure 14, panel A). Collaboration of enterprises with public research institutions has been relatively weak (Figure 14, panel B), but has made progress in recent years as the governance of public research institutions improved (OECD, 2015a). Scope remains for further improving the performance of public research centres (CRP), as argued in the OECD Innovation Policy Review on Luxembourg, in particular by exploring closer cooperation of the research centres with the University of Luxembourg and with research institutes based abroad. Moreover, the possibility of further mergers of CRPs should be considered. Mergers can be a welcome opportunity to strengthen cross-border cooperation among institutions (OECD, 2015a).

Figure 14. **SMEs collaboration on innovation**

Per cent of product and/or process innovative firms, 2008-10¹

1. 2011 for Australia, 2006-08 for Ireland, 2009-10 for New Zealand and 2009-11 for Switzerland. SME: Small and medium-sized enterprises. The OECD aggregate covers 28 countries in panel A and 30 in panel B.

Source: OECD (2013), OECD Science, Technology and Industry Scoreboard 2013.

The government has prepared legislation designed to include non-profit organisations and private foundations in the funding of research cooperation between enterprises and research institutions. This initiative is welcome, because it can widen the supply of ideas and increase competition in the R&D sector. A network for promoting spin-offs and intellectual property from public research is being developed in the “City of Sciences” in Belval, which houses or will house many relevant infrastructures for promoting spin-offs from public research, such as Technoport and the House of Biohealth. The co-location of activities in the new City of Sciences is expected to result in synergies and facilitate public-private partnerships. Other structures promoting technology transfer, such as an interdisciplinary centre focussing on intellectual property issues (Centre de Veille Technologique), are hosted by the University of Luxembourg and the public research centres. The legal office of the University provides assistance in matters related to intellectual property (OECD, 2015a).

Start-ups face difficulties in accessing early-stage financing

Venture capital and start-up investment in Luxembourg is low by international comparison (Figure 15, panel A), although funding appears volatile (Figure 15, panel B). Many start-ups with limited own capital may not be able to benefit from venture capital due to lack of tangible assets that could serve as collateral. Suitable projects might also be missing. Indeed, start-ups appear to be small in Luxembourg by international comparison (Figure 16).

Figure 15. Venture capital investment as a percentage of GDP

Source: OECD, Entrepreneurship at a glance 2014; European Private Equity and Venture Capital Association.

Figure 16. Average size of start-up and old firms across industries and countries

Source: C. Criscuolo et al. 2014.

The government is promoting the availability of venture capital via two public investment funds that were established in 2012. The funds are designed to invest in innovative small and medium sized enterprises in the development phase, in sectors supported by the government's cluster initiative (such as information and communications technology (ICT) and clean technologies). First, *The Life Sciences Fund*, supports the government's programme in bio-technology through a venture capital fund specialising in biomedicine. The fund envisages investing 80% of its funds in start-ups, with 70% of the capital to be invested in European countries. Second, *The Luxembourg Future Fund*, with capital of EUR 150 million, managed by the European Investment Fund, extends equity participations as a minority shareholder. Both funds are still young and more time is needed to assess how successful they are.

Financial support benefitting start-ups is also provided as loans by the National Credit and Investment Company (SNCI) (Table 4). The Equipment Loans are targeted at SMEs with business permits in certain areas, including craftsman, tradesman, industrialist, and certain liberal professions for the purpose of financing professional equipment and land. Equity financing for SMEs is also provided through equity loans and participating interests used to promote creation, development and rationalisation of businesses. This includes loans for SMEs with equity properties, to promote the creation, development and rationalisation of businesses. The SNCI's research, development and innovation financing has been displaced by the 2009 state-aid measures discussed above.

These initiatives have not yet lead to a significant boost in venture capital. The instruments should carefully be evaluated in terms of how effective they are in achieving their goals, and adjusted periodically as needed. This, together with structural reform in product and labour markets could help to increase the number of quality projects put forward for financing.

Table 4. **National Credit and Investment Company, Overview of operations 1978-2013**

EUR million							
	1978-2008	2009	2010	2011	2012	2013	Total
Investment loans	2371.5	50.8	24.2	20.5	19.6	10.6	2497.2
Equipment loans	734.4	32.1	22.7	17.9	9.8	4.6	821.5
Medium- and long-term loans	1395	18.7	1.5	2.3	9.8	6.0	1433.3
Foreign investment financing	5.7	0.0	0.0	0.3	0.0	0.0	6.0
Steel industry loans	194.9	0.0	0.0	0.0	0.0	0.0	194.9
Loans BEI/CECA	41.5	0.0	0.0	0.0	0.0	0.0	41.5
RDI financing	104	0.3	0.0	0.0	0.0	0.0	104.3
Innovation loans	103.7	0.3	0.0	0.0	0.0	0.0	104.0
UNI CRP facility	0.3	0.0	0.0	0.0	0.0	0.0	0.3
Export loans	110.4	0.0	0.0	0.0	0.0	0.0	110.4
Equity transactions	380.5	32.6	1.5	28.2	126.1	31.5	600.4
Start-up and business transfer loans	9.3	1.7	0.9	1.0	0.1	0.3	13.3
Equity loans	186.4	0.0	0.1	0.1	0.2	3.3	190.1
Participating interests	184.8	30.9	0.5	27.1	125.8	27.9	397.0

Source: SNCI Annual Report 2013.

Raising the quality of human capital

Diversification into high value activities is facilitated by availability of highly-skilled human capital. On the one hand, Luxembourg has a large pool of specialised and highly qualified labour in financial and professional services and in the ICT sector, constituting a base from which further sectoral development could spread. Luxembourg has also been able to attract highly qualified labour from abroad when needed, although congestion in transport and housing supply within the city are becoming constraints.

On the other hand, the constant sharp rise in structural unemployment points to potential skill shortages among the resident population. Ensuring that the educational and skill training systems continue to produce high-skilled workers is thus a key challenge for developing innovative industries and raising potential output.

Quality of education

Overall educational attainment is high, with tertiary education rates among the adult working-age population well above the OECD average (Figure 17). Type A tertiary attainment (university degree) is higher across all age cohorts than type B tertiary attainment (vocationally oriented degrees). The tertiary attainment of the youngest cohort in Luxembourg has increased from 37% in 2005 to 50% in 2012, opening the tertiary attainment gap between the youngest cohort (aged 25-34) and the second youngest cohort (aged 35-44) of about 5 percentage points (OECD, 2014a). The improvement has been similar to the OECD average.

Figure 17. Educational attainment of 25-64 year-olds, 2012

Source: OECD (2014), Education at a Glance.

Secondary schooling also has many strengths. Teachers receive the highest salary per student within the OECD (measured in purchasing power parities) and that together with other factors, such as status and initial teacher training, should be attracting high quality people into the profession (Figure 18). Indeed, the social status of teachers in Luxembourg is high; they are expected to study abroad and speak several languages. However, there is no well-defined career path for established teachers, which is likely to undermine the links between teacher appraisal, professional development and career development (Shewbridge et al., 2012). Also, the professional development provisions have been found to be not sufficiently linked to school development and needs.

Figure 18. Salary cost of teachers per student

By level of education, 2012

Countries are ranked in descending order of the salary cost of teachers per student in lower secondary education.

Source: Education at a Glance 2014. Table B7.1. See Annex 3 for notes.

State schools in Luxembourg require virtually all teaching staff to speak Luxembourgish, as well as French, German and English, which largely closes the sector to outsiders. Recently, the proficiency requirement in Luxembourgish has been applied less stringently in technical disciplines like physics and mathematics, but teachers with insufficient knowledge of Luxembourgish are still expected to learn it on the job. Wages in state schools, where teachers are civil servants, are higher and working hours shorter than in private international schools that are open to cross-border competition and whose teachers do not have the civil servant status.

However, PISA results for 15 year-old students show performance somewhat below the OECD average in all three components, mathematics, reading and science (OECD, 2014b). There is a positive trend in PISA results in Luxembourg and the 2012 results represent improvement from 2009 in both reading and science. The variation in mathematics scores is similar to the OECD average. Differences between genders in mathematics and science performance are among the largest in the OECD, and the performance gaps between top and bottom deciles in reading and science are also above-average. This suggests that the education system in Luxembourg is less successful in closing performance gaps and thus in unlocking students' full potential.

Similarly, skill training and educational outcomes of certain vulnerable groups can be improved. Students with immigration background have lower performance and socio-economic background has substantial impact on students' achievement. The sensitivity of the mean PISA score to a change in the PISA index of student socio-economic background - adjusted for cross country distributional differences - is the fourth highest in the OECD (Figure 19).

Figure 19. **The influence of parental background on student achievement in secondary education¹**

Note: Regression of students' PISA science performance scores on their PISA economic, social and cultural status (ESCS), a broad indicator of family's socio-economic background. Country-by-country least squares regressions weighted by students' sampling probability. Robust standard errors adjusted for clustering at the school level.

1. The socio-economic gradient represents the change in PISA science score due to an improvement of one international standard deviation in the PISA index of student socio-economic background. The socio-economic gradient taking cross-country distributional differences into account is the change in PISA science score due to an improvement of one country-specific, inter-quartile change in the PISA index of student socio-economic background. Note that science literacy was the focus of PISA 2006, upon which these results are based.

Source: Causa and Chapuis (2009).

Students in Luxembourg spend longer in school than their OECD peers – 914 compulsory hours in school per year compared to the OECD average of 835.5 (OECD, 2014b). At the same time, 30% of students fail to complete upper secondary education. The share of students needing another two years on top of the regular time for high school completion is the highest among the OECD countries (Figure 20). This is due to the widespread practice of repeating one or more years of school, even though grade repetition is costly and largely ineffective in raising educational outcomes (OECD, 2012a). Additional support in addressing of learning gaps, and more use of special education techniques can be employed to decrease grade repetition (OECD, 2012a).

Also, the completion rate of vocational programmes (which are part of upper secondary education) barely exceeds 60% (OECD, 2014a). Although it is possible that some non-completing school leavers eventually find their way back into education and gain their qualifications, the window of opportunity between ages of 15 and 20 has been lost (OECD, 2010a).

Figure 20. **Successful completion of upper secondary programmes, 2012**

(N: theoretical duration of the programmes)

Note: Please refer to Annex 3 for details concerning this indicator, including methods used, programmes included/excluded, year of entry, etc.

1. N+2 information missing.
2. Countries are ranked in descending order of the successful completion of upper secondary programmes.

Source: OECD (2014), Education at a Glance, Table A2.4. See Annex 3 for notes (www.oecd.org/edu/eag.htm).

The government has proposed measures to raise equality of opportunities and educational outcomes of vulnerable groups. A free childcare programme for children below 3 years will become effective in September 2016. This can improve language competences in the three official languages used in schools. OECD work indicates that early childhood education and care helps in improving learning outcomes and provides foundation for lifelong learning, but the magnitude of benefits is conditional on quality (OECD, 2012b). In mid-2014, the government also reformed the financial aid system for students (CEDIES) and lowered the annual sum paid to all students regardless of background. The revised system, with topped up funding subject to eligibility criteria and means testing, focusses more on students with disadvantaged background. These are steps in the right direction.

Moreover, the government plans to give secondary schools more autonomy in three important dimensions: teachers' development; curricula; and financial matters (OECD, 2015b). These plans are in line with reforms that have been proven to be effective in other OECD countries, such as providing schools with more autonomy in choosing teachers and in budgetary matters (Sutherland and Price, 2007). The reform of curricula is planned to include schools with education tracks in other languages than French and German (such as English) that currently exist in private schools (such as the public Aggregated European School), but are not available free of charge. Plans include further diversification of the curricula and the resulting qualifications (international baccalaureate, A-levels, etc.). In rolling out these reforms, the government should also consider whether teachers at public schools should keep the civil servant status. Both models exist in different OECD countries, and some, such as Austria, have moved to abolishing civil servant requirements to increase flexibility.

The education reform could be used as an opportunity to give economics-related education more prominence in school curricula. Perception of entrepreneurship as a desirable career choice appears to be weak in Luxembourg and media attention given to entrepreneurship relatively sparse (EU Commission, 2014). At the same time, surveys show that entrepreneurs in Luxembourg are mainly driven by opportunity and desire for independence (GEM, 2014).

Getting workers to move to new high value-added activities and raising labour force participation

Reducing the stringency of the employment protection legislation and raising working time flexibility

Labour market policies that allow reallocation of labour into new sectors will help diversification. This is especially the case as high wage premia in the financial sector relative to the rest of the economy can make it difficult for other sectors to attract qualified workers. Cross-country empirical evidence suggests that overall labour utilisation rates are not robustly correlated with the tightness of employment protection legislation (EPL), because tight EPL has offsetting effects on employers' hiring incentives while limiting employers' ability to shed labour (Bassanini and Duval, 2006). However, there is evidence that strict EPL increases the average duration of unemployment spells as well as employment rates of older workers at the expense of younger workers. Both effects inhibit the reallocation of labour across sectors and firms, thus reducing labour productivity (OECD, 2010b).

EPL in Luxembourg is above the OECD average. The protection of permanent workers, in terms of notice periods, from individual dismissal, is only slightly above the OECD average (Figure 21, panel A), but protection against collective dismissal is one amongst the highest in the OECD (Figure 21, panel B). Relaxation of these requirements could facilitate reallocation of labour to growing sectors' activities and increase aggregate productivity growth (Haltiwanger et al., 2006; Bassanini et al., 2009). Less stringent employment protection legislation may shift risk from entrepreneurs to workers, however, which should be balanced by effective job placement policies.

Severance payments, at 6 months' salary for 20 years of service, are not particularly high by OECD standards (OECD, 2013c). However, they are to be paid in full at the end of the prescribed notice period and may then drag down a firm's cash-flow. The government may consider introducing a fee-based insurance scheme or individual saving accounts, with employers' contributions payable as a percentage of payroll, which can be accessed by workers upon dismissal. Such schemes have the advantage of inducing no disincentives for dismissals or voluntary separations, while insuring workers against dismissal. The schemes are considered best practice in the OECD, and several countries have them. Providing for flexibility, reinstatement of employees cannot be enforced; employers can choose additional compensation to employees instead.

Figure 21. **Protection of permanent workers, 2013**

1. The figure presents the contribution of different subcomponents to the indicator for employment protection for regular workers against individual dismissal (EPR). The height of the bar represents the value of the EPR indicator.
2. The figure presents the contribution of different subcomponents to the indicator for additional provisions for collective dismissals (EPC). The height of the bar represents the value of the EPC indicator. Note that this indicator quantifies only additional restrictions, over and above those for individual dismissals. For the sole purpose of calculating the EPC indicator, missing values of specific subcomponents are set equal to the average of other non-missing subcomponents for the same country.

Source: OECD Employment Protection Database, 2013 update, <http://dx.doi.org/10.1787/lfs-epl-data-en>.

In order to reduce the negative effects of tight EPL, the 2010 Survey recommended additional reform, including a longer total duration of fixed-term contracts and a possibility of more renewals; lifting thresholds for collective dismissals; reducing additional notice periods and severance payments following the negotiation of social plans; and extending trial periods for regular contracts, so that protection for younger workers with lower productivity does not unduly reduce employers' incentive to hire them. These recommendations should be introduced.

Restrictions on working time make overtime costly. This can lower the competitiveness of firms that engage in global competition, especially in the higher value-added portion of the value chain, and need the flexibility to respond quickly to demand and offer just-in-time delivery (WTO, 2013; OECD, 2013b). The maximum working time in Luxembourg is 48 hours per week, in line with the EU Working Time Directive, and not more than 10 hours a day. However, in addition, the weekly average of 40 hours must not be exceeded over a consecutive 4-week period.

Working time accounts, extending over several weeks, months or even more than a year, can increase flexibility and cost efficiency, benefitting firms' competitiveness within global value chains (Flecker et al., 2009). Some evidence suggests that other flexible working-hours arrangements, such as home-office and flexi-time can also improve productivity. A recent study of five thousand German firms concluded that adoption of flexible working-hours arrangements leads to an increase in innovation over and above the impact of working time accounts (Godart et al., 2014). The minister of labour is preparing a framework allowing social partners to freely negotiate details of working time account schemes at the company or sectoral level, while securing employee claims against the risk of employer's insolvency. Indeed, as experience in Germany shows, insurance against insolvency is crucial for workers' protection and acceptance of working time accounts.

The mechanism of wage indexation has been restarted in 2015, after a temporary moderation between 2012 and 2014. The government has announced that the economic situation and the evolution of prices will be taken into consideration in the adjustment. Wage indexation can lead to increases in unit labour costs with negative implications for competitiveness. Thus the wage indexation system should be reviewed to ensure that wages reflect productivity developments and do not present risks to competitiveness (OECD, 2012c).

Active labour market policies

Empirical evidence indicates that employment rates are higher in countries that spend more per unemployed person on active labour market policies (ALMPs) such as training, job creation schemes and wage subsidies to firms (Bassanini and Duval, 2006). The design of the measures is important though.

The magnitude of government spending on ALMPs in Luxembourg (0.46% of GDP in 2011) is about the same as in the EU (0.47%). The policy mix is different though. ALMPs in Luxembourg are heavily geared towards temporary job creation schemes (*incitations à l'emploi*) that represent 75% of ALMP spending (2010 shares), as opposed to 24% in the EU (STATEC, 2012). These schemes have been found to be generous and long, and in many cases participants return to unemployment after their completion (OECD, 2010b). On the other hand, expenditures on training represent only 9% of ALMP measures in Luxembourg compared to 43% in the EU.

The government is moving from subsidising employment to spending on training and lifelong learning. In the "*aide au réemploi*" programme, entitlement periods are planned to be reduced from 4 to 3 years and the maximum replacement to be limited from 90% of the previous wage to the minimum social wage. At the same time, more use is made of training programmes that are being designed to better meet qualification needs of regional business, such as "Fit for Finance" and "Green Jobs" in construction. These steps go in the right direction. The authorities should review existing ALMP programmes with respect to their effectiveness in raising jobseekers' employment prospects, and continue to reallocate resources in favour of training. Experience in other OECD countries shows that the effectiveness of such policies depend on appropriate organisation of the public employment service (PES), which needs sufficient resources to profile and advise job seekers. The 2012 PES reform in Luxembourg increased the number of case workers and local offices of the employment service (ADEM) as well as investment in IT infrastructure. While both are appropriate, policy makers should make sure that ADEM is further adjusted

if necessary to facilitate efficient administration of the new policies. At the same time, disincentives for job search inherent in Luxembourg's unemployment insurance and social assistance systems should be reduced, as recommended in the 2012 *OECD Survey on Luxembourg*.

Luxembourg's adult participation rates in lifelong learning exceed the EU average (14% compared with 9% in 2013). Emphasising life-long-learning is needed to raise the responsiveness of the workforce to changing demands, raise the productivity of older workers and support the competitiveness of domestic workers with cross-border labour supply (EU, 2014). In 2013, the government has increased its financial contribution to enterprises' investment in lifelong learning of their employees. The effectiveness of this policy should be monitored.

Attracting highly qualified workers to Luxembourg

Luxembourg has been successful in the past in attracting highly qualified labour from abroad, and foreign workers are well integrated into the domestic labour market (Figure 22). Further progress in diversifying the economy in high value-added activities will require continued inflows of qualified foreign labour. For example, around 90% of the staff in Luxembourg's public research organisations consists of foreigners (Ministry of Education, 2013).

Figure 22. **Gaps in labour market performance between natives and foreign-born in OECD countries**

Source: OECD International Migration Policies Database, 2013.

The requirements to obtain residence permits for non-EU nationals have a preference for highly qualified workers, such as educational attainment, work experience and a minimum level for the annual salary to be earned in Luxembourg. In exceptional circumstances, highly-qualified workers who do not speak the three official administrative languages can also be hired in the public sector. These permits do not include Physical and Engineering Science technicians (ISCO classification 311) (University of Luxembourg, 2013), which might be relevant to strengthen economic development outside the financial sector and the clustering of enterprises. It is thus worth revisiting entitlements for special residence, possibly extending eligibility to more technical and IT qualifications, and to clarify the handling of applications for entrepreneurs (OECD, 2013d).²

In order to attract high-skilled foreign workers, employers often have to pay a significant portion of the workers' relocation, accommodation and travel expenses. The state alleviates the incurred cost to the employer, who is allowed to pay these expenses as benefit in kind, without them being considered a part of the highly-skilled worker's income. These expenses are declared as an operating expense of the company and not taxed. This is an explicit cost that the government should weigh against more spending on improving non-monetary factors affecting the perceived quality of life in Luxembourg, such as traffic congestion, housing quality and the schooling system that are also relevant for attracting a highly qualified workforce.

Cross-border workers from neighbouring Belgium, France and Germany account for some 30% of Luxembourg's workforce, with an increasing share among them high-qualified (Figure 23). A recent study put Luxembourg's delay due to congestion at 80 hours per year for a 30 minutes commute (TomTom, 2013). The government plans to build new hubs at the outskirts of Luxembourg City that will be linked by tram and tangential buses, so that commuters can avoid travelling through the city centre. The first commercial tram service is expected in 2017. This initiative should be implemented. It can also contribute to reducing CO₂ emissions. Further co-ordination with adjacent regions in neighbouring countries should be explored to promote public transport and develop cross-border mobility schemes similar to the scheme with the French region of Lorraine (SMOT). Improvements in high-speed links to, in particular, Germany and Belgium should also be considered.

Moreover, introduction of a system of congestion charges around Luxembourg City should be explored to provide incentives for a shift towards public transport or car sharing. In order to address the existing externalities effectively, congestion charges should be combined with higher taxes on fuel and higher parking charges (European Conference of Ministers of Transport, 2003). The effective tax rate on transport fuel, below EUR 150 per tonne of CO₂, is below the OECD average. Excise taxes on gasoline and diesel should be increased to gradually narrow price differentials with neighbouring countries. Increasing parking prices are likely to be more efficient than restricting parking spaces in new office developments, which is likely to bring only gradual changes (OECD, 2012c).

2. International students also have a possibility to stay in Luxembourg after graduating, in order to acquire a first working experience, for up to two years. The student has to find a job before graduation, however, as there is no possibility of granting supplementary stay period for the purpose of job search.

Figure 23. **Change in the proportion of highly educated men and women among recent immigrants and the native-born population between 2000-01 and 2009-10**

Note: Recent immigrants have arrived in the last five years.

Source: European Union Labour Force Survey (Eurostat) for Austria, Denmark, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Spain and Sweden; 2000 Census and 2010 New Zealand Labour Force Survey; Database on Immigrants in OECD Countries (DIOC) 2000 and 2005-06 for data on all other countries.

Luxembourg's supply of housing may be falling short of demand, as rising real house prices indicate. The Ministry of Housing projects that some 2 600 new housing units are needed every year to keep up with growing demand (OECD, 2010b). The total number of new housing units stayed above this threshold for some years, but decreased to below 2 200 units in 2011. The supply of land and housing is constrained by numerous regulations and low property taxation encourage land hoarding. Permissions to build are often delayed by administrative procedures involving complex coordination among different actors. Barriers in housing markets could also weigh on the optimal level of clustering, which is influenced by the balance of economic benefits (Aghion et al., 2013).

The government has taken steps to promote more flexible housing supply. Municipalities now have the possibility to surtax vacant land and buildings. The government plans to increase the VAT on building not intended for owner-occupation from the current preferential rate of 3% to the standard rate of 17%. Since projects completed before 2017 will not be affected by this measure, housing supply is likely to

increase prior to the tax hike as projects are brought forward to benefit from the still-low tax rate. However, this supply response would only be temporary. More fundamentally, cutting the preferential tax treatment of housing investment contributes to reducing tax distortions. However, rents may rise too, as owners attempt to pass on the higher tax rates on tenants. The government also plans to build 10 500 new housing units, mainly for renting, and plans to reform the Housing Pact law, using part of the subsidy therein to finance the construction of subsidised housing. More fundamental reform appears necessary, however, such as making the building permit system more efficient and raising property taxation by updating property values used as a tax base, as described in the last *Economic Survey of Luxembourg* (OECD, 2012c).

Enhance incentives to work for second earners and women

The pool of workers is smaller than it could be, due to low participation of second earners, mainly women (Figure 24, panel A). Female part-time employment also falls short of the average in the euro area (Figure 24, panel B). Low female labour market participation suggests reducing disincentives for second earners' participation to increase labour supply for new industries, which otherwise would have to come from the financial sector and abroad.

Figure 24. Female labour market participation rate, 2013

1. The labour force participation rate is defined as the ratio of the labour force to the working age population, expressed in percentages.

Source: OECD Labour Force Statistics.

Some provisions in the tax and transfer system discourage labour supply of second earners. In the universal health care insurance system, all family members are covered by contributing family members, effectively reducing the earnings of working spouses. Resident married couples, taxpayers living in registered partnerships, and non-resident married couples with earnings taxable in Luxembourg can file jointly for income tax and are taxed at lower average income rates. This reduces work incentives for the spouse with the lower income. Also, effective marginal taxation of additional hours worked seems to be particularly high for lone parents due to the interaction of benefits and income taxation (OECD, 2007). These issues should be addressed. The government's plan to move away from joint income tax assessment for couples is welcome.

Significant fixed costs of work, notably the monetary and non-monetary costs of child care can be important impediments for higher female or spouses' labour force participation. Means-tested childcare service vouchers for children aged below 12 address this issue. The government's plan to augment this system by free childcare combined with promotion of French, German and Luxembourgish language skills for all children aged 1 to 3, starting in 2016 will be financed via a tax of 0.5% on households' total revenues (with part of subsistence income exempted). This could increase labour force participation by families with small children. The government should reduce disincentives for labour force participation of spouses and lone parents by charging health care contributions for each spouse individually.

Recommendations on raising human capital and enhancing resource allocation

Key recommendations

- Better evaluate the effectiveness of public R&D spending and cluster policies.
- Strengthen the cooperation between enterprises, University of Luxembourg and research institutes in Luxembourg and abroad.
- In secondary education, reduce grade repetition, provide more school autonomy and better monitor education quality.
- Increase excise taxes on gasoline and diesel to gradually narrow price differentials with neighbouring countries.
- Continue substantial investment in public transport infrastructure, using the receipts from fuel taxation for this purpose. Explore the introduction of a system of congestion charges. Increase taxes on petrol and diesel that gradually eliminate price differentials with neighbouring countries,
- Reduce disincentives for labour force participation of women by charging health care contributions for each spouse individually and introducing separate income tax assessment of spouses.

Further recommendations

- Speed up procedures for granting construction permits. Raise property taxes by updating property values used as a tax base.
- Increase enrolment in early childhood education with emphasis on low-income and foreign-language families.
- Consider opening the telecommunications sector to private ownership and investment.

ANNEX 1

LUXEMBOURG: POTENTIAL OUTPUT

Luxembourg is a small open economy with a comparatively high share of foreign workers in total employment (some 40%) and of services - notably financial - in total output. These features imply that national account measures of output and productivity should be interpreted with care.

Gross domestic product versus gross national income in Luxembourg

Gross domestic product (GDP), the factor income measure that is most frequently used to characterise an economy's production, measures total factor income generated within the economy within a certain period (a year). Thus, GDP includes income that is generated at home even if it accrues to non-residents, while it does not include income accruing to residents that is generated abroad. By contrast, gross national income (GNI) denotes all income accruing to residents. Thus, GNI also includes factor income accruing to residents that is generated abroad, but it excludes factor income from domestic production that accrues to non-residents.

For most countries, the difference between GDP and GNP is quite modest. However, if - as in Luxembourg - non-residents contribute a large share of the economy's production factors (labour or capital) GDP and GNI can diverge significantly. For Luxembourg, GNI undercuts GDP by 32% (Figure A1). However, even if aggregate income per capita is measured by GNI rather than GDP Luxembourg is still ranked at the top of the OECD, surpassed only by Norway (Figure A2).

Figure A1. Ratio of GNI to GDP, 2012

Source: OECD National accounts, 2014.

Figure A2. GNI per capita, 2012, US \$, current prices, current PPPs

Source: OECD National accounts, 2014.

The OECD's method of estimating potential output and structural unemployment

Assessing potential output is inherently difficult because it is an unobservable quantity. Analysis for Luxembourg is further complicated by the economy's cross-border openness in terms of labour and capital flows. High factor mobility means that production can be very sensitive to small changes in circumstances (Krugman, 2009). Moreover, a large share of Luxembourg's economy is accounted for by the financial services sector, whose output might be over-estimated. Also, the prospects of the financial sector after the crisis might be particularly uncertain. Overall, potential output estimates for Luxembourg are associated with a higher degree of uncertainty than for most other OECD countries.

The OECD estimates potential output based on a Cobb-Douglas production function with constant returns to scale:

$$(1) \quad Y_{it} = K_{it}^{\alpha} (E_{it} H_{it} N_{it})^{1-\alpha}$$

where Y, K, E, H and N denote output, physical capital, labour-augmenting technological progress ("labour efficiency", defined as the residual of the production function), human capital per worker and employment. Subscripts t and i denote year and country, (α) is calibrated to 1/3.

A potential output series is calculated by substituting trend variables, denoted by an asterisk, in the production function, maintaining actual capital:

$$(2) \quad Y_{i,t}^* = K_{i,t}^{\alpha} (E_{i,t}^* H_{i,t}^* N_{i,t}^*)^{1-\alpha}$$

or in terms of growth accounting:

$$(3) \quad Y_{i,t}^* = \alpha k_{i,t} + (1 - \alpha)(n_{i,t}^* + e_{i,t}^* + h_{i,t}^*)$$

where lower letters denote logarithms.

Each component of this quantity is estimated separately. Given an initial (unsmoothed) estimate of labour efficiency, a Hodrick-Prescott filter is applied to provide an estimate of trend labour efficiency. To reduce end-point problems associated with the use of the HP-filter, data on GDP and factor-inputs are extended with short-term forecasts of these variables.

The physical capital stock is represented by the non-housing capital stock. This corresponds to the accumulation of past non-housing investment flows, taking into account that the efficiency of assets typically falls as its life expectancy diminishes (Schreyer, 2003):

$$(4) \quad K_{it} = K_{it-1}(1 - r_{it}) + I_{it},$$

where r is the implicit rate of loss of productive capacity, and I is the non-housing investment flow. The capital stock is not de-trended, because the maximum potential contribution of capital is given by the full utilisation of the existing capital in the economy.

Human capital is derived from empirical estimates of the return to average years of schooling with falling marginal returns at higher level of education, as in Morrison and Murtin (2010). The resulting series is smoothed using a Hodrick-Prescott filter.

Potential employment (N^*) is computed as the combination of equilibrium unemployment rate (U^*), the working age population (PWA), the trend participation rate ($LFPR^*$) and the trend ratio between the domestic concept of employment from national accounts to employment from the labour force survey ($CLFS$):

$$(5) \quad N_{it}^* = LFPR_{it}^* PWA_{it} (1 - U_{it}^*) CLFS_{it}$$

The equilibrium unemployment rate is estimated using a reduced form Philips-curve approach by means of a Kalman filter. In this new approach, inflation expectations are anchored to inflation targets (Rusticelli et al, 2015).

Potential employment is based on the domestic concept of employment from the national accounts to preserve consistency with the definitions and sources for output and capital (Beffy et al, 2006). The domestic concept takes into account employment in resident production units irrespective of the residence of the employed person. However, all the other data regarding the labour force (e.g. unemployment, participation rate etc.) are only available from the labour force survey (LFS), thus relating to the employment concept of the labour force survey. The LFS concept covers resident households only. In the estimation of N^* , the LFS data are therefore adjusted (with the factor $CLFS$) to align them with the national accounts concept of employment. The adjustment is relatively high for Luxembourg due to the high share of cross-border workers.

ANNEX 2

SHIFT-SHARE ANALYSIS OF LABOUR PRODUCTIVITY GROWTH

The productivity-decomposition analysis is based on the shift-share analysis described in EU Commission (2003), which decomposes aggregate changes in labour productivity into an intra-industry, a shift and an interaction effect. The “intra-industry effect” measures productivity growth within each sector. The “shift effect” measures the effect on total economy productivity of the displacements of resources between industries of varying productivity levels. Finally, the interaction effect accounts for labour re-allocation effects between industries with varying productivity growth rates.

For each individual industry i , labour productivity LP is defined as output (Y) divided by labour input (L):

$$LP_{it} = \frac{Y_{it}}{L_{it}}$$

$$LP_t = \frac{Y_t}{L_t} = \sum_i Y_{it} / \sum_i L_{it}$$

Labour productivity can be written as a weighted sum of the intra-industry productivity values:

$$LP_t = \sum_i LP_{it} \frac{L_{it}}{L_t}$$

This gives, in difference terms:

$$\Delta LP = \sum_i \Delta(LP_i) \frac{L_{it-1}}{L_{t-1}} + \sum_i LP_{it-1} \Delta\left(\frac{L_{it}}{L_t}\right) + \sum_i \Delta(LP_i) \Delta\left(\frac{L_{it}}{L_t}\right)$$

Dividing by LP_{t-1} to get the growth (percentage change) and rearranging the terms:

$$\frac{\Delta LP}{LP_{t-1}} = \sum_i \frac{\Delta LP_i}{LP_{it-1}} \frac{Y_{it-1}}{Y_{t-1}} + \sum_i \frac{LP_{it-1}}{LP_{t-1}} \left(\frac{L_{it}}{L_t} - \frac{L_{it-1}}{L_{t-1}} \right) + \sum_i \frac{1}{LP_{t-1}} (\Delta LP_i) \Delta\left(\frac{L_{it}}{L_t}\right)$$

- The first component is the intra-industry effect, *i.e.* the sum of industry productivity growth rates, weighted by the initial output shares.
- The second component is the shift effect, *i.e.* the sum of changes in input shares, weighted by the relative productivity level (*i.e.*, the ratio of industry productivity to average productivity).
- The third component is the interaction effect.

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