Chapter 4.

Innovation actors in Lithuania

This chapter describes the main actors in the Lithuanian innovation system – business enterprises, higher education institutions and public research organisations – and highlights their respective roles in the development of innovation activities in recent years. It reviews competences for innovation, and related strengths and weaknesses.

4.1. Business sector

The moderate innovation performance found at the macro level (see Chapter 3) is largely caused by the limited innovation activities in Lithuania's business sector. Although investments in innovation are increasing, innovation activity by small and medium-sized enterprises (SMEs) remains weak and collaborative links between the business and public research sector are lagging in the area of research and development (R&D). This situation results from a combination of factors including: a weak demand for knowledge and innovation (both technological and non-technological) that somewhat mirrors the structure of the economy, prevailing productivity gaps, and little awareness of firms about the role of innovation in driving firm economic performance and competitiveness.

Innovation efforts by Lithuanian firms mostly focus on incremental innovation and adoption of technology reflecting firms' dependence on external technology in the process of catching up with the technological frontier. The preponderance of low and medium-high-tech industries explains to some extent firms' preference for embodied technology acquisition (machinery and equipment) and non-R&D-based innovation outcomes such as organisational and marketing innovation. Yet propensity rates to adopt international managerial practices and engage in more disembodied forms of technology acquisition are lower than peer economies and other central and eastern European (CEE) countries. This means that even in basic forms of innovation (e.g. non-technological innovation such as new management methods), Lithuanian firms are lagging behind on average compared to firms from peer economies and advanced countries. This situation makes the case for addressing the need for such forms of technology diffusion, which are particularly relevant to catching up with innovation and productivity in the services sectors.

Although the interest of firms in R&D is improving – following the introduction of new funding mechanisms – the Lithuanian business sector still invests insufficiently in R&D compared to the average in EU countries and peer countries. Important constraints exist in the innovation system inhibiting firms' demand for knowledge and their investment in innovation activities (particularly in R&D) on a more formal and continuous basis. Lithuanian firms perceive competition (in prices and quality) as a very important factor in dissuading innovation activities, as in other CEE countries. Lack of finance and scarcity of skills are the second and third most important factors hindering business innovation activity (as shown in Chapter 3). The latter is exacerbated by brain drain, particularly of highly- skilled people looking for higher living standards abroad. This situation explains in large part the difficulties in making R&D a relevant option for firms.

The growing levels of global economic integration raise opportunities for value chain integration and knowledge acquisition – which are key to domestic firms' productivity. Firm innovation would benefit from greater international spillovers from foreign direct investment (FDI) and improvements in firm's absorption capacity (including strengthening internal R&D). Improving absorption capacity would help firms better identify and absorb knowledge (and technology) opportunities, and boost participation of Lithuanian firms in global value chains (GVCs) (OECD, 2014). There is a high potential for technological learning and knowledge transfer through enhanced productive interactions with multinational enterprises (MNEs).

The industrial tissue – types of firms and sectors

The (non-financial) business sector of Lithuania is mostly composed of SMEs – 99.8% of the total firm population: a figure in line with the EU28 average (Table 4.1).

SMEs play a fundamental role in the Lithuanian economy. They are the main producer of value-added and the main source of employment in the non-financial business sector: they account for 69% of value-added versus the EU average of 58% (European Commission, 2015). Micro companies play a relatively minor role. In terms of employment, SMEs account for 76.7% of people employed in the non-financial sector, with large firms accounting for the reminder (33%). As discussed in the 2015 Small Business Act Fact Sheet (European Commission, 2015), SMEs have largely recovered from the crisis. Their value-added increased by 8% between 2008 and 2014, and has increased by almost two-thirds since 2009. The wholesale and retail trade and transportation and storage sectors are the industries with the greatest SME contribution to value-added, at 31% and 13% of value-added, respectively (the corresponding figures for the EU28 are 22% and 6%).

Medium-sized firms in Lithuania generate a higher share of industrial value-added than their peers in Slovenia, the Slovak Republic or Finland where less than 23% of industrial value-added comes from this type of company. As in many European countries, these trends highlight the need to address innovation needs for future competitiveness in the SME sector, particularly in those firms with potential to grow. Overall, SMEs account for more than three-quarters of all employment in Lithuania, compared with the EU average of just over two-thirds (European Commission, 2015).

Table 4.1. **SMEs – basic figures, Lithuania and EU28**

	Number of enterprises			Number of persons employed			Value-added		
	Lithuania		EU28	Lithuania		EU28	Lithuania		EU28
	Number	Share	Share	Number	Share	Share	EUR billion	Share	Share
Micro	132 276	91%	92.7%	231 678	26.6%	29.2%	2	15.3%	21.1%
Small	10 752	7.4%	6.1%	223 531	25.7%	20.4%	3	24.1%	18.2%
Medium-sized	2 057	1.4%	1%	211 326	24.3%	17.3%	4	29.2%	18.5%
SMEs	**145 085**	**99.8%**	**99.8%**	**666 544**	**76.7%**	**66.9%**	**9**	**68.5%**	**57.8%**
Large	280	0.2%	0.2%	202 851	23.3%	33.1%	4	31.5%	42.2%
Total	**145 365**	**100%**	**100%**	**869 395**	**100%**	**100%**	**13**	**100%**	**100%**

Note: These are estimates for 2014 produced by DIW Econ, based on 2008-12 figures from the *Structural Business Statistics Database* (Eurostat). The data cover the non-financial business economy, which includes industry, construction, trade and services (NACE Rev. 2 sections B to J, L, M and N), but not enterprises in agriculture, forestry and fisheries and the largely non-market service sectors such as education and health. The advantage of using Eurostat data is that the statistics are harmonised and comparable across countries. The disadvantage is that for some countries the data may be different from those published by national authorities.

Source: European Commission (2015), "2015 SBA Fact Sheet - Lithuania", http://ec.europa.eu/growth/smes/business-friendly-environment/performance-review/index_en.htm.

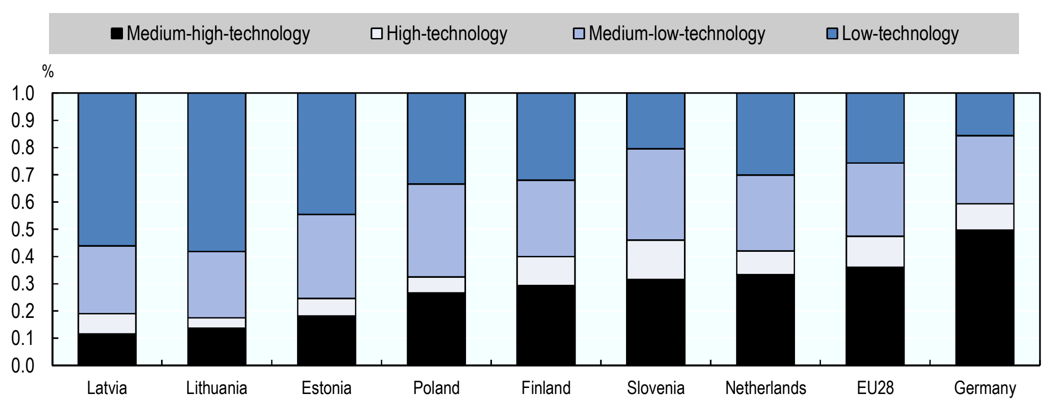
Lithuanian manufacturing is mostly dominated by low and medium-low technology industries. These industries represented 58% and 24% of total manufacturing value-added in 2013 (Figure 4.1). These sectors combined account for 95% of the total population of firms in manufacturing. In comparison, the average in the EU28 is 86% (Eurostat, 2016a).

The high-technology sector remains small, contributing just 4% of manufacturing value-added, compared to the European average of 11.4% (EU28). There are few medium-high and high-technology firms in Lithuania: only 4.6% and 0.99% of all manufacturing firms fall under these categories. High-technology industries suffered most from the economic downturn between 2010 and 2014 but are now on an upward growth trend. Chemicals, refined petroleum products, apparel, textiles and furniture are the most important sectors within manufacturing. The manufacture of refined petroleum products and food products represented 35% and 16% of manufacturing turnover, respectively, in 2012.

Knowledge-based activities are expanding but are mostly confined to a few industries within manufacturing and services. These include: biotechnology industries (industrial and diagnostics), laser manufacturing, mechatronics and information technology (IT). Together these industries are considered strategic for the future development of Lithuania's economy. R&D-intensive manufacturing industries absorb 33% of total employment (similar to the Czech Republic and Slovak Republic), which falls short of the EU28 average of 40% (Figure 4.2). Knowledge-intensive services, although growing, still account for a minor part of total employment: just 1.9% compared to the average in Europe which is approximately three times this figure (5.7%).

Figure 4.1. **Technology intensity of the Lithuanian manufacturing sector, 2013**

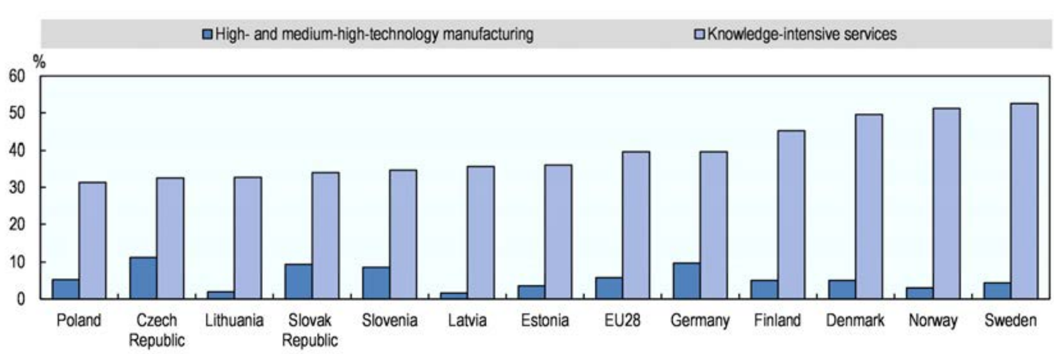
Share in total value-added at factor cost



Source: Eurostat (2016a), *Annual enterprise statistics for special aggregates of activities* (database), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=sbs_sc_sca_r2&lang=en.

Figure 4.2. **The importance of knowledge-intensive sectors, 2014**

Percentage in total employment



Source: Eurostat (2016b), *Science and Technology* (database), http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database.

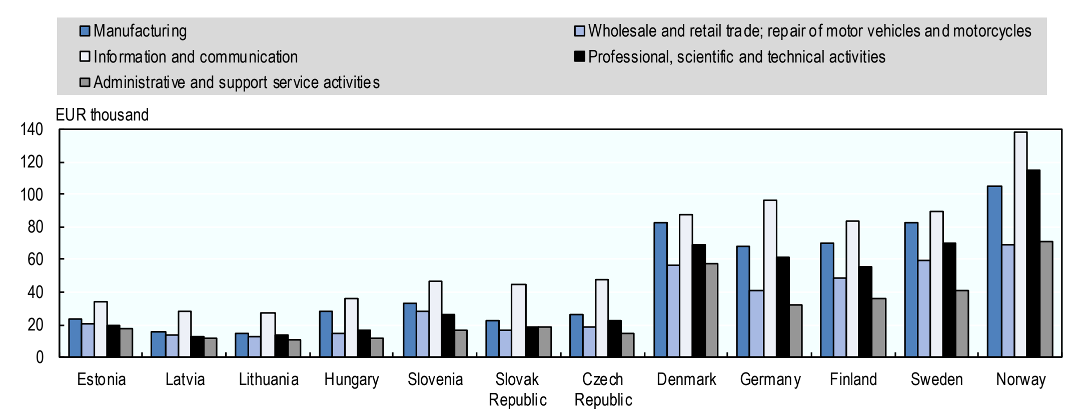
Productivity trends and uneven growth across industries

In spite of consistent productivity growth in recent years, productivity in Lithuanian industry, and all other sectors of the economy, lags substantially behind EU averages (Figure 4.3). For instance, in manufacturing, labour productivity is approximately one-sixth and one-seventh the productivity of Sweden and Finland, respectively.

An important challenge remains the high level of heterogeneity in productivity across Lithuanian industries. Information and communication (IC) industries are the leading sector in terms of labour productivity (and productivity growth rates), followed by manufacturing. Services show the weakest performance both in levels of labour productivity and growth rates, in spite of their growing importance in the economy in employment terms. Over the period 2006-13, there was negligible productivity growth in a number of professional and business services (especially in the wholesale and retail trade sectors). An efficient services sector is especially important given that services are intermediate inputs for other firms and can be integral to successful participation in GVCs (Adalet McGowan and Andrews, 2015).

The high dispersion in productivity levels across industries raises the possibility of more-targeted policy interventions and strengthened industry-level approaches in innovation policy. Examples of targeted approaches (vertical innovation policies) include: sectoral funds for innovation, (industry-focused) innovation networks, technology/industry clusters, industry-focused innovation or technology transfer centres, among others (OECD, 2015b). An efficient services sector is especially important given that services are intermediate inputs for other firms in all sectors of the economy.

Figure 4.3. **Apparent labour productivity in economic sectors, 2013**



Note: Apparent labour productivity is defined as value-added at factor costs divided by the number of persons employed.

Source: Eurostat (2016c), *Structural Business Statistics* (database), http://ec.europa.eu/eurostat/en/web/products-datasets/-/TIN00152.

Innovation activity

Business sector investments in innovation have considerably increased in the recent past (see Chapter 3 for R&D trends and Deloitte, 2016), but they remain low compared to international standards. Innovation investment, collaborative linkages and international integration – which are key to strengthening innovation capacity in small countries – are particularly underdeveloped and need to be strengthened.

As discussed in the previous chapter, R&D investment by the business sector has been growing but remains low compared to EU standards. Less than one-third of gross expenditure for R&D (GERD) is financed by the business sector (compared with some 60% in innovation-intensive countries within the OECD area). In 2014, business expenditure on R&D (BERD) was 0.24% of gross domestic product (GDP) – far below the EU28 average of 1.29%. This is also far from the national target for BERD, which is hoped to be met by 2020, of 0.9% of GDP.

In 2012, the share of researchers working in the business enterprise sector in Lithuania was 12%. This was lower than in the other Baltic countries and markedly lower than in some OECD countries such as France (60%) and the Netherlands (68%). Overall business R&D has been well below the EU average but some improvements in R&D capabilities have been made. In terms of R&D personnel, their number has increased considerably over the last decade, from 0.04% of the total labour force in 2003 to 0.19% in 2014. More generally, the number of employees involved in R&D activities has increased steadily over the last few years (Deloitte, 2016). However, the presence of R&D personnel in the labour force remains low compared to the EU average of 0.62% (Table 4.2).

According to the Community Innovation Survey (CIS) 2012, Lithuanian companies invest 0.79% of their sales in innovation activities (Figure 4.4). This figure is significantly lower than leading innovative European countries such as Sweden (3.6%), Denmark (3.2%), Finland (2.3%) and Estonia (1.4%) or Latvia (0.63%), and exceeds the investment ratio seen in other small CEE economies. However, the innovation investments of Lithuanian companies have increased considerably in the recent past. According to recent data from Statistics Lithuania, expenditure on innovation accounted for 3.5% of turnover in the group of technologically innovating enterprises in 2014.

Table 4.2. **R&D personnel in the business sector**

Full-time equivalent as a percentage of total labour force

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
EU28	0.48	0.48	0.48	0.5	0.52	0.54	0.53	0.55	0.57	0.59	0.6	0.62
Lithuania	0.04	0.06	0.08	0.08	0.14	0.13	0.1	0.14	0.14	0.12	0.16	0.19

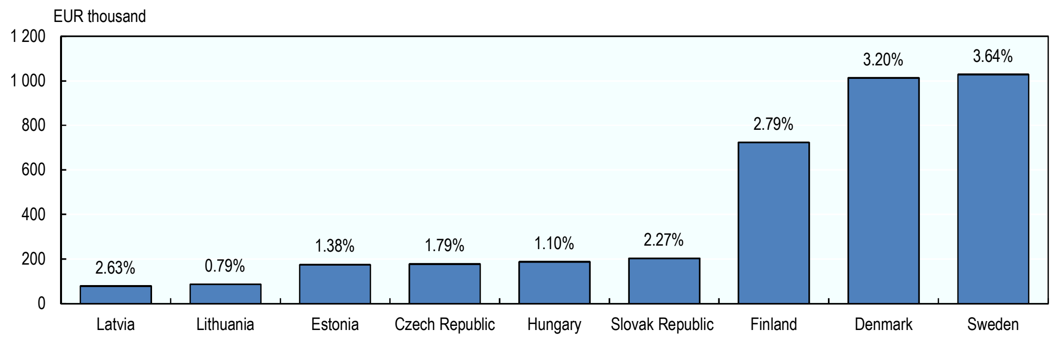
Source: Eurostat (2016b), *Science and Technology* (database), http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database.

The innovations of Lithuanian firms are not primarily driven by R&D. As is typical for economies in a catch-up phase of development, a large part of Lithuania's innovation expenditure (around 70%) is used for the acquisition of machinery and equipment (Figure 4.5), followed by extramural R&D (19%). Intramural R&D only represents 3.31% of total innovation expenditures. This indicates that the majority of innovative companies are catching up by transferring ("embodied") technology from abroad. More advanced economies typically invest less in machinery and equipment for innovation. Instead, the majority of their innovation expenditure is related to R&D and other intangible assets (as in the case for instance of Sweden, Finland or Denmark). As the innovation system matures and evolves, Lithuania may follow a similar trajectory.

There are indications that firm managerial and organisational competencies – which are fundamental to productivity growth and complementary to technological change (e.g. adoption of information and communications technologies [ICT]), might be underdeveloped in Lithuanian firms. Data from the World Bank Enterprise Survey suggest that Lithuanian companies in the manufacturing sector are lagging behind peers in other Baltic countries (Figure 4.6) in terms of their propensity to invest in international quality certifications (ISO 9000, 9002 or 14000). These and other types of international certification are often essential to exporting and integration in GVCs. Other requirements for firm upgrading and exporting include the adoption of product quality and safety standards, and/or the adoption of new production models (e.g. just-in-time, lean manufacturing, etc.).

Figure 4.4. **Average innovation expenditure per innovating firm, 2012**

In EUR thousand and percentage of turnover

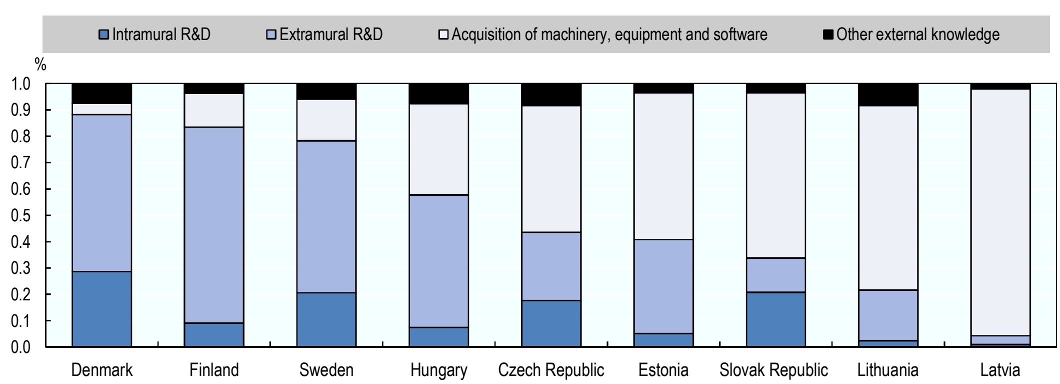


Note: Innovative firms are firms that introduced product and/or process innovation, regardless of organisational or marketing innovation (including enterprises with abandoned/suspended or ongoing innovation activities).

Source: Eurostat (2016b), *Science and Technology* (database), http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database.

Figure 4.5. **Innovation expenditure by type (by innovative firms), 2012**

Share in total expenditure



Note: Innovative firms are firms that introduced product and/or process innovation, regardless of organisational or marketing innovation (including enterprises with abandoned/suspended or ongoing innovation activities).

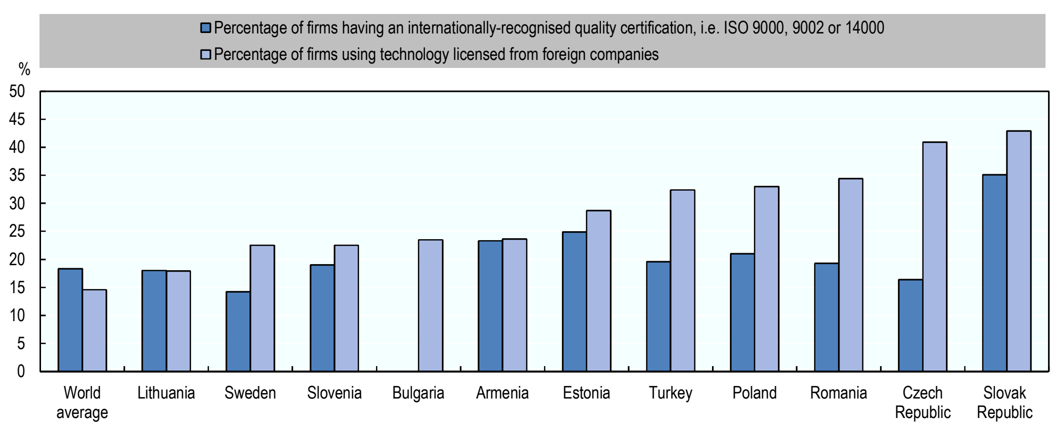
Source: Eurostat (2016b), *Science and Technology* (database), http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database.

Information from the same survey also indicates that while the importance of technology acquisition through machinery and equipment is high, few firms in Lithuania are engaged in "disembodied" technology acquisition, for instance through technology licensing agreements with foreign firms (Figure 4.6). In this indicator, Lithuania ranks well below its peers. In 2013, for example, 18% of manufacturing companies were involved in technology licensing from overseas firms while in Poland this figure was 33% and in the Czech Republic and Slovak Republic the rate was above 40%.

Foreign technology licensing can bring important benefits to firms through learning and know-how acquisition. These benefits are also larger when firms have an internal R&D capacity. Technology purchasing is not neutral with regard to its impact on firm innovation and the type of innovation that firms produce. The evidence shows that technology licensing is closely related to process innovation (Goedhuys and Veugelers (2012) and Arvanitis et al. [2013]).[1] But maximising the benefits of external technology depends greatly on internal absorption capacity, that is, in-house R&D activity and investment (Griffith et al., 2004). Innovation policies in Lithuania should aim to support both forms of innovation capacity (and their financing) and ensure that they interact in complementary ways (by supporting the building up of in-house R&D in parallel to technology acquisition to achieve more efficient productivity gains).

In terms of percentage of innovating firms, in 2013 Lithuania performed below the EU28 average (Figure 4.7): 32.9% of Lithuanian enterprises introduced some type of innovation (technological or non-technological) in the 2010-12 period, compared with 48.9% on average across the EU28 (Eurostat, 2016b). Firms' innovative activities mostly concern process and marketing innovations. According to more recent surveys by Statistics Lithuania, the share of innovating firms increased by almost 11% between 2010-12 and 2012-14, reaching 40% of total enterprises.

Figure 4.6. **Disembodied forms of technology acquisition in manufacturing firms, 2013**



Note: Data refer only to manufacturing.

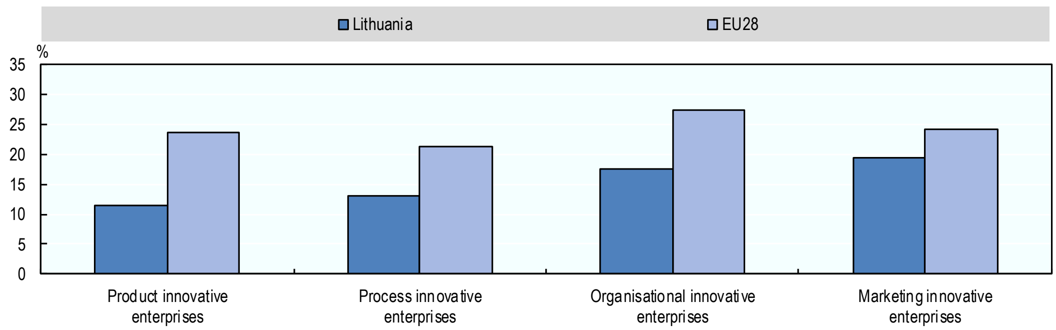
Source: World Bank Enterprise Survey (2013), available at: www.enterprisesurveys.org.

Part of the reason for low levels of firm innovation is firms' weak capacity to absorb foreign ideas and technologies (Angelis, Antanavicius and Martinaitis, 2014), as reflected in the limited importance of R&D in innovation strategies. A recent survey suggests that over 80% of Lithuanian SMEs can be classified as having "low absorptive capacity": that is, they underperform in knowledge and technology transfer activities (Leichteris et al., 2015). This is in line with the previously cited figures reporting limited international technology transfer activity.

Only 16.1% of SMEs introduced product or process innovations, which is half the EU28 average (32%). Some 25.2% of Lithuanian SMEs introduced marketing or organisational innovations, a figure near to the EU28 average (34%) (Figure 4.8). Only

14% of SMEs innovate in-house while the EU28 average is twice as high (29%). Lithuanian SMEs rely mostly on external sources of knowledge to innovate.

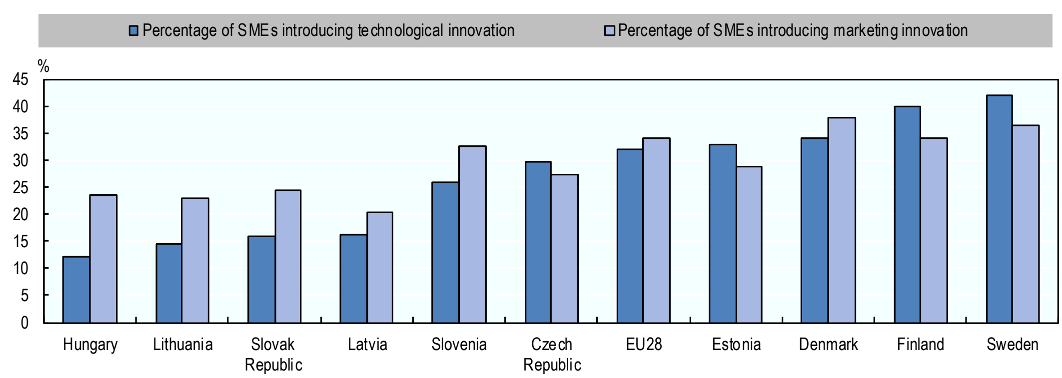
Figure 4.7. **Share of innovators in total firms, 2010-12**



Note: A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. An organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

Source: Eurostat (2016b), *Science and Technology* (database), http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database.

Figure 4.8. **Percentage of SMEs introducing innovation (from 10 to 49 employees), 2012**



Source: European Commission (2014), *Innovation Union Scoreboard 2014* (database), http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards/index_en.htm.

The weak innovation capacity of the Lithuanian business sector is also reflected in other performance indicators, such as intellectual property rights (IPRs). Over the last decade, Lithuania registered a small number of industrial designs (with the exception of furniture and household goods) (Table 4.3).[2] Industrial designs have IPRs protecting the ornamental or aesthetic aspects of an article or its parts against copyright or the independent development of similar designs.

Unlike the general trend in OECD countries, there is no striking difference in innovation rates between the manufacturing and services sector in Lithuania. Around 36% of firms in manufacturing undertake innovation activities while the figure for services is 31%. Yet both values are considerably below the European averages of 58% (in manufacturing, EU15) and 47% (in services, EU28).

Table 4.3. **Lithuania's OHIM[1] registered community designs (RCD) by economic class**

Based on the Locarno classification

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Health, pharma and cosmetics	0	0	0	0	0	0	0	1	3	2	6
Agricultural products and food preparation	1	0	0	2	1	0	4	0	0	0	8
Transport	0	0	0	0	2	0	4	6	1	2	15
Advertising	0	0	0	3	2	1	7	2	5	1	21
Tools and machines	1	0	0	0	0	10	2	2	8	0	23
Electricity and lighting	0	4	0	4	0	9	2	4	0	4	27
Construction	0	0	0	0	5	2	8	1	9	5	30
ICT and audio-visual	0	0	0	0	6	3	7	6	8	5	35
Leisure and education	0	4	2	0	0	11	0	3	17	6	43
Clothes, textiles and accessories	0	0	5	9	6	0	2	14	13	1	50
Packaging	1	1	26	2	4	9	3	6	6	17	75
Furniture and household goods	22	0	14	0	3	1	12	7	24	15	98

1. Office for Harmonisation of the Internal Market.

Source: Eurostat (2016b), *Science and Technology* (database), http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database.

Constraints to business innovation

According to the innovation survey, the four most important factors discouraging innovation in Lithuanian firms are (Figure 4.9): (strong) price competition (53% of innovative companies consider these obstacles as highly important), product quality (37% of innovative companies consider this factor as highly important); a lack of adequate finance and dominant market share (28% consider this highly important). These are closely followed by "high costs of accessing new markets" (23.9%) and lack of qualified personnel (22.4%).

Data from the CIS suggest that these perceived difficulties are somewhat similar to those in peer economies (for instance price competition often ranks uppermost among the reported difficulties). More striking differences appear when comparing to Sweden, where percentages of firms reporting barriers to innovation are approximately half or one-third of the Lithuanian figures.

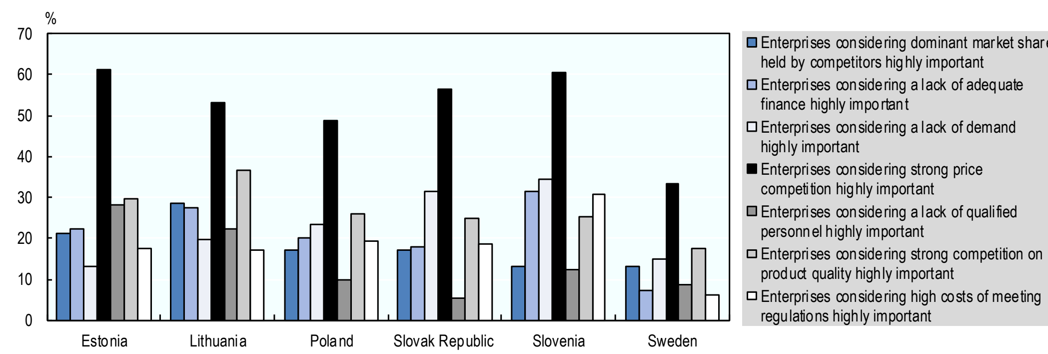
Obstacles such as lack of finance and qualified human capital (probably in terms of science and engineering graduates) are also much more important in Lithuania than in Sweden: while only 7.3% of innovative firms in Sweden consider access to finance a problem (highly important), in Lithuania 27.5% of innovative firms consider access to finance a serious handicap to innovation. The difficulties in accessing finance overall is a major issue for competitiveness, as discussed in Chapter 2. In terms of lack of qualified personnel, only 9% of innovative Swedish firms suffer from this issue whereas in Lithuania this handicap affects more than one firm in five (22.4% of innovative firms). Increasing business R&D in Lithuanian firms is challenging given that firms already report a shortage of researchers (Angelis, Antanavicius and Martinaitis, 2014), due in part to Lithuania's elevated rate of emigration of highly-skilled people and the significant administrative burden associated with hiring foreign specialists.

Co-operation in innovation activities

According to CIS statistics, Lithuanian firms co-operate with each other more often than the average firm in the EU28. For instance, 32% of innovative Lithuanian companies co-operate with suppliers (of materials, equipment, etc.) while the average in European countries is 18.3% (Figure 4.10). The most important form of co-operation is collaboration with suppliers, followed by co-operation with universities and higher education institutes. The least developed form of co-operation is co-operation with competitors and other firms from the same sector.

Figure 4.9. **Obstacles to innovation and their importance, 2012**

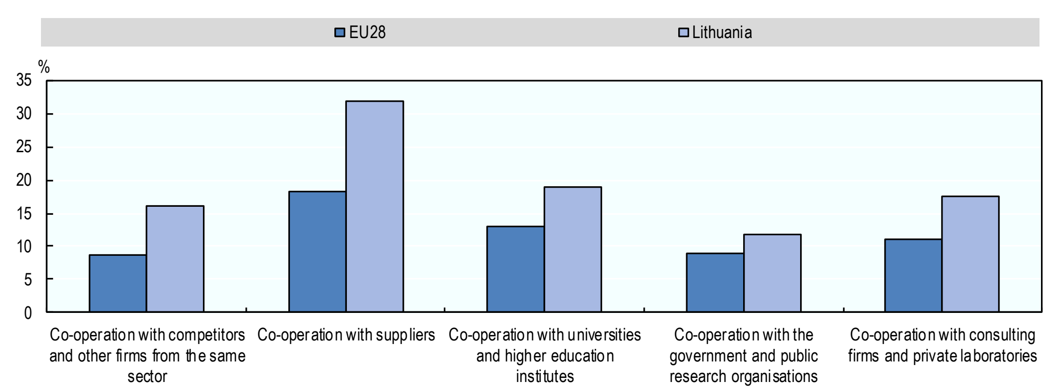
As a percentage of innovative firms, including firms with abandoned/suspended or ongoing innovation activities



Source: Eurostat (2016b), *Science and Technology* (database), http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database.

Figure 4.10. **Co-operation in innovation and its importance, 2012**

As a percentage of innovative firms, including firms with abandoned/suspended or ongoing innovation activities



Source: Eurostat (2016b), *Science and Technology* (database), http://ec.europa.eu/eurostat/web/science-technology-innovation/data/database/.

However, indicators of collaborative activity by SMEs are less encouraging. Compared to the European SME average, Lithuanian SMEs are involved less frequently in collaboration for innovation: 7.5% of innovative Lithuanian SMEs co-operate with other organisations, whereas the average for innovative SMEs in Europe (EU28) is

10.5%. This lack of co-operation hinders Lithuanian SMEs' ability to increase innovation capacity and learning. This situation puts SMEs at a further disadvantage when compared with large firms (and average European SMEs) in approaching the knowledge frontier. Public policy for innovation could pay further attention to ways to approach and involve SMEs in collaborative activities, starting by understanding what their priority needs are (in terms of technology and markets) and facilitating their links with national knowledge and technology institutions, and inter-firm collaboration.

Enhancing innovation and technological change for SMEs also requires supporting co-ordination and associative activity to address common (or industry-level) innovation or technology bottlenecks and jointly accelerate SMEs' technological learning and innovation capacity. Examples of such mechanisms include technology extension centres and innovation centres involving public-private collaboration (for example the Manufacturing Extension Partnership Program of the United States, and the Catapult Programme of the United Kingdom). These approaches can be adapted to innovation agendas addressing SMEs' integration in value chains and broader SME upgrading on the basis of partnerships with large and multinational firms.

Trade performance

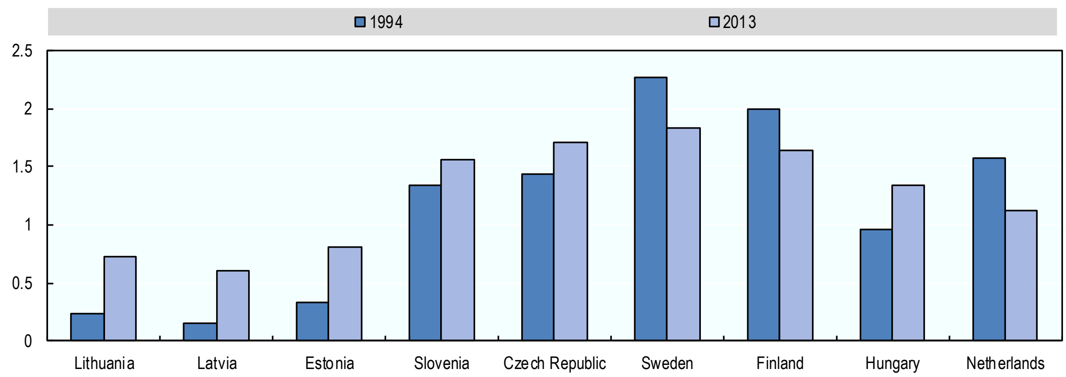
Trade is a major channel of global economic integration. Exporting is an important way to maximise economies of scale and specialisation, and is also a source of technological learning through interaction with global customers ("learning by exporting", Crespi, Criscuolo and Haskel, 2008). In addition, export-oriented firms are often required to undertake further efforts to innovate because of the competition effect from trade. Imports also facilitate learning by domestic firms and help firms to access frontier technologies.

In terms of trade performance, Lithuania has significant achievements. Lithuania is the 65th largest export economy in the world and the 33rd most complex economy according to the economic complexity index (ECI).[3] However, most of its export activity concerns traditional industries, with the exception of a few high-technology products. Statistics on exports show the predominance of low- and medium-high-technology industries in Lithuanian exports. The country's top exports are refined petroleum (USD 4.81 billion; 16% of exports), furniture (USD 1.21 billion; 4% of exports), polyacetals (USD 700 million; 2.3% of exports), wheat (USD 686 million; 2.3% of exports) and nitrogenous fertilisers (USD 647 million; 1.4%). Lithuania's main imports are crude petroleum (USD 5.14 billion), refined petroleum (USD 1.68 billion), petroleum gas (USD 1.14 billion), cars (USD 1.12 billion) and packaged medicaments (USD 877 million).[4]

The level of economic complexity of Lithuanian exports has increased over time (Figure 4.11) but remains very low. The ECI in Lithuanian exports is approximately half of that in Slovenia, Finland, the Czech Republic and Sweden. The complexity of an economy, which is closely related to national innovation performance, reflects the multiplicity of knowledge pieces embedded in the export basket (number of goods/pieces that combined can lead to different products, see Box 4.1) (Hidalgo and Hausmann, 2009).

Trade integration with the European Union has expanded opportunities for knowledge and technology acquisition. After Lithuania became a member, the structure of trade flows started to shift and volumes to expand. The export specialisation index[5] (Table 4.4) indicates that over the period 2007-13 Lithuania achieved comparative advantages in trade with the European Union in the following industries: food, drink and tobacco products, raw materials, mineral fuels and related materials, and other manufactured goods. The leading sector is food, drink and tobacco. This configuration has been influenced by different factors, the most important of which is the abolition of tariffs and customs taxes for food and alcoholic drinks from EU countries, which resulted in lower prices and increased imports.

Figure 4.11. **Evolution of the ECI**



Source: The Observatory of Economic Complexity (2016), *Economic Index Atlas* (database), http://atlas.media.mit.edu.

Industries in which Lithuania shows competitive disadvantages are: chemicals and related products, and machinery and transport equipment. The index of these two industries has improved in recent years but still remains below one. The comparison of export specialisation patterns indicates that the trade structure of Lithuania is rather similar to the EU average trade.[6] In this context, opportunities for technology learning via exports can be enhanced through quality upgrading and innovation resulting from closer relationships with customers abroad.

Box 4.1. **The Economic Complexity Index (ECI)**

The complexity of an economy is related to the amount of useful knowledge embedded in it. Because individuals are limited in what they know, the only way societies can expand their knowledge base is by facilitating the interaction of individuals in increasingly complex networks in order to make products. According to Hidalgo and Hausmann (2009), the economic complexity of a country can be measured by the mix of these products that countries are able to make.

Some products, like medical imaging devices or jet engines, embed large amounts of knowledge and are the result of very large networks of people and organisations. These products cannot be made in simpler economies that are missing parts of the network's capability set. Economic complexity, therefore, is expressed in the composition of a country's productive output and reflects the structures that emerge to hold and combine knowledge. To generate a more accurate measure of the number of capabilities available in a country, or required by a product, it is necessary to correct the information that diversity and ubiquity carry by using each one to correct the other. For a country, this requires calculation of the average ubiquity of the products that it exports, the average diversity of the countries that make those products and so forth. For products, this requires calculation of the average diversity of the countries that make them and the average ubiquity of the other products that the country makes.

Source: Hidalgo and Hausmann (2009), Methodology and index calculation, available at: http://atlas.media.mit.edu.

Table 4.4. **Export specialisation indexes (RCA) of Lithuanian trade with the European Union, 2008-13**

	2008	2009	2010	2011	2012	2013
Food, drink and tobacco	3.31	3.23	3.43	3.41	3.42	3.44
Raw materials	2.02	1.99	2.01	2.02	2.14	2.16
Mineral fuels, lubricants and related materials	2.64	2.6	2.62	2.67	2.69	2.7
Chemicals and related products	0.83	0.85	0.86	0.88	0.89	0.89
Machinery and transport equipment	0.55	0.54	0.55	0.65	0.67	0.69
Other manufactured goods	1.16	1.16	1.18	1.19	1.23	1.26

Note: The revealed comparative advantage (RCA) measures the intensity of trade specialisation of a country within a region or the world. It is the export share of an industry of the total exports (of goods) of a country divided by the export share of this industry of the region (European Union) or the world. If the RCA takes a value less than one this implies that the country is not specialised in exports of this industry. Similarly, if the index exceeds one this implies that the country is specialised in this domain.

Source: Bernatonyte (2015), "Estimation of export specialization: Lithuanian case equilibrium", http://dx.doi.org/10.12775, based on Eurostat (2016d), *International Trade* (database), http://ec.europa.eu/eurostat/web/euro-indicators/international-trade.

Foreign direct investment (FDI) and global value chain (GVC) integration

Innovation in domestic firms can potentially benefit from international knowledge spillovers through global interactions such as international trade and FDI. The extent of spillovers and the capacity to learn from trade and multinational activity, however, are determined by domestic absorption capacity and the existence (and quality) of productive linkages with global firms (Cohen and Levinthal, 1990; Griffith, Redding and Van Reenen*,* 2004).

Foreign firms have an important weight in the Lithuanian economy and as such they can have an important role in the process of innovation and technology learning by domestic firms. The participation of MNEs in generating value added is important in Lithuania, reaching 30%[7] in 2013 (three times the EU27 average). Furthermore, the amount of FDI has been increasing, reaching EUR 13.2 billion in 2015 (Central Bank of the Republic of Lithuania, 2016).

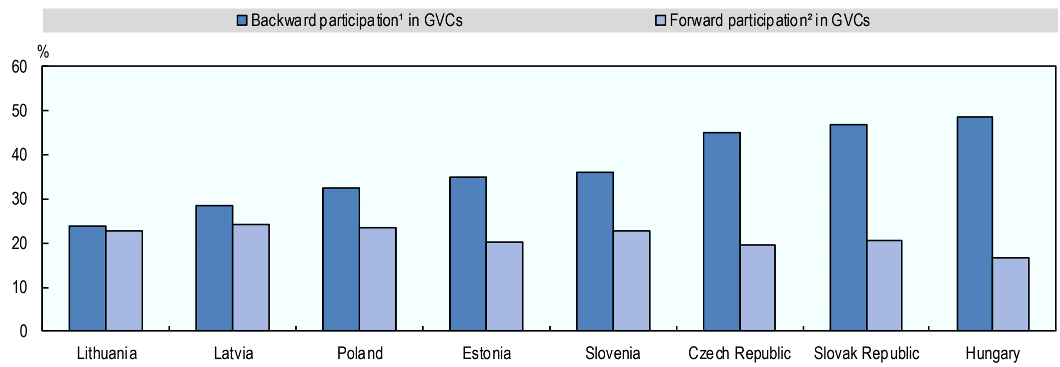
Inward FDI stocks represented 25% GDP on average over the period 2009-12, and reached 38% I 2014. In 2013 and 2014 FDI stocks were lower than in Estonia but higher than in Latvia and exceeded the EU28 average by a considerable margin. This multinational activity could be a potential source of knowledge transfer to domestic firms and a key mechanism for integrating GVCs through supply linkages.

Yet, in spite of strong MNE activity in the economy, Lithuania has not yet fully benefited from FDI, as reflected in the low levels of value chain integration (Figure 4.12). This situation (as of 2011) limits opportunities for global exposure by domestic firms, and limiting technology learning through GVCs. Lithuania shows a low "backward participation" in GVCs as at 2011 (i.e. it has a relatively low share of foreign value-added embodied in Lithuanian exports). The level of domestic value-added embodied in exports (as of total gross exports) is also low but similar to levels in peer economies.

Innovation would benefit from greater international spillovers from FDI and improvements in firms' absorption capacity, as both can reinforce each other. Reinforcing domestic firms' absorption capacity through R&D and upgrading would help boost the participation of Lithuanian firms in GVCs and make Lithuania more attractive to FDI (OECD, 2016). Furthermore, FDI in Lithuania is characterised by a relatively large share of green-field investment, which may be more beneficial than other types of FDI for job creation and knowledge transfer to domestic business. While Lithuania's inward FDI stock in 2012 was below that of other Baltic countries, there are signs of relatively strong growth since then (Invest Lithuania, 2014).

Figure 4.12. **Participation in global value chains (GVCs), 2011**

Percentage of gross exports



1. Foreign value-added embodied in exports, as % of total gross exports.

2. Domestic value-added embodied in foreign exports, as % of total gross exports.

Source: OECD-WTO (2016) *Statistics on Trade in Value Added* (*TiVA*) (database), https://stats.oecd.org/index.aspx?queryid=66237.

The country has become increasingly attractive to technology companies and international services companies. Google has recently established a sales office in the Lithuanian capital Vilnius, while Nasdaq has opened a centre of excellence in the same city. International companies in services have recently set up regional support centres. In 2011, Western Union officially opened their new European Regional Operating Centre in Vilnius. In 2009, Barclays established its Technology Centre Lithuania, one of four strategic engineering centres supporting Barclays' retail banking businesses across the globe.

4.2. Higher education institutions (HEIs) and public research institutes

Types of research systems: a characterisation

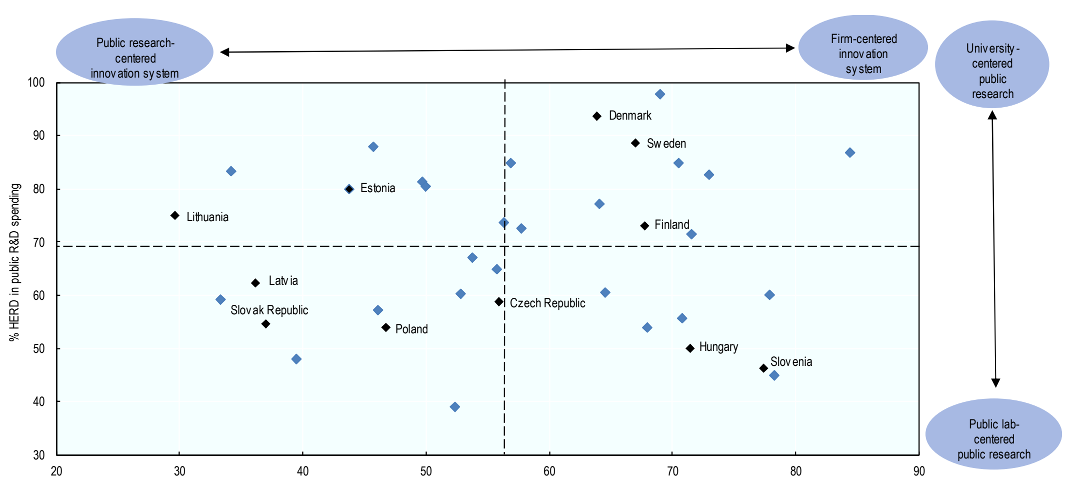
The share of BERD in GERD varies widely across OECD countries (Figure 4.13). The most advanced countries tend to have high shares of BERD in GERD while developing countries and emerging economies with low business innovation capability are placed at the other end of the spectrum, where R&D expenditure is typically low and concentrated in the public research sector (universities or government research institutes). This is where another important difference can be observed: national innovation systems show large variations with respect to the relative weight of universities (as measured by the share of higher education expenditure for research and development [HERD] in total publicly performed R&D) on the one hand and the public research institutes (measured by the share of governmental intramural expenditure for research and development [GOVERD] in total publicly performed R&D) on the other. Some countries rely on a large public research institute (PRI) sector, as is the case in a number of former transition economies, such as the Czech Republic, Hungary and Slovenia, which have retained important parts of their historical public research institutes (following reforms). But other countries with a history like France and, to a lesser extent, Italy and Spain also have a strong PRI sector. In contrast, other national research and innovation systems are clearly university-based, characterised by a high share of HERD in total publicly performed research. These countries include, for instance, Austria, Ireland, Sweden, Switzerland, and – reinforced by the merger of PRIs with universities – Denmark as a prominent case.

A number of arguably the best performing small OECD countries are located in the upper right quadrant (which means that they are at the same time firm-centred and university-centred systems) of Figure 4.13. Among the Baltic countries, Estonia, which undertook a radical reform of its public research system after gaining independence, performs R&D mainly in the higher education sector. While Lithuania, which, with a share of public sector R&D performed by universities is above the OECD median, is among the more university-centred public research systems, albeit to a lesser extent than the three countries mentioned above, it has a long way to go to become a firm-centred innovation system. The share of R&D performed by the business sector in GERD is at the bottom end of OECD economies.

Some emerging economies, especially those whose catching up has not been driven by raw materials, have increased the BERD share in GERD rapidly. In the case of former planned economies which have drawn on the Soviet model of organising their research system, this shift towards BERD has often gone hand in hand with sometimes radical, in other cases more gradual restructuring of the research system and privatisation. The People’s Republic of China is a prominent example for this type of trajectory but there are also examples among small CEE economies (such as Slovenia and Hungary).

Figure 4.13. **Share of R&D expenditure in firms, HEIs and PRIs**

Lithuania and comparator countries



Note: Data for Australia and Mexico refer to 2011; data for Ireland and Switzerland refer to 2012. The dashed lines correspond to the OECD mean values.

Sources: Eurostat (2016b), *Science and Technology* (database), http://ec.europa.eu/eurostat/web/science-technology-innovation/statistics-illustrated; OECD (2016c), *Main Science and Technology Indicators* (database), http://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB.

HEIs

The current Lithuanian higher education sector is a binary system consisting of two types of institutions:

- universities (i.e. universities, academies and seminaries) representing the university sector of higher education
- colleges.[8]

The current higher education system is the result of a sequence of recent institutional reforms. Until 2000, the Lithuanian higher education system was a unitary one. The binary system of higher education seen today was introduced in 2000, in compliance with European higher education standards. This reform was aimed at phasing out what was known as advanced vocational education (provided by advanced vocational education and training schools) and developing a non-university segment of the higher education system in its place. Institutions which were sufficiently qualified to provide non-university higher education were transformed into higher education colleges or departments of such colleges (SKVC, 2015).

The study programmes in the Lithuanian tertiary education system are designed in accordance with the Lithuanian National Qualification Framework which was approved in 2010 and is aligned with the European Qualification Framework.

The 2009 reform

Another major reform of the higher education system took place in 2009. In April 2009, after a long period of political consultation, the parliament of Lithuania passed the Law on Higher Education and Research. This law has strengthened the autonomy of universities and, at the same time, introduced new competitive mechanisms for funding education activities. Moreover, it has strengthened the role of colleges in the country, enabled competitive research funding (Table 4.5). To strengthen competitive funding mechanisms, the Lithuanian Science Council has been transformed into the Lithuanian Research Council and is responsible for distributing competitive research funding. The 2009 law also introduced the requirement of external evaluations of HEIs on the basis of their higher education and research activities. The external evaluation takes place every six years and is managed by an institution authorised by the Ministry of Higher Education and Science (the Centre for Quality Assessment in Higher Education). The results of this external evaluation are used for accreditation of HEI. In case of a negative evaluation, a second evaluation has to be arranged within two years. After a second negative evaluation the Ministry of Education and Science takes a decision to withdraw the licence to provide education studies.

The law has also redefined the regime for sharing the commercial revenues arising from IPRs. Researchers involved in the activity resulting in the intellectual property (IP) now benefit from at least one-third of the commercial exploitation of the IPRs. As a consequence of this change, technology transfer offices have been established in most universities.

An important change in the system since the reform of 2009 has been the funding of universities through student vouchers (tuition fees) which the students bring with them to the institution of their choice. The value of their vouchers depend on their secondary education results. Each year two quotas for vouchers are established: one for colleges and one for universities. In addition to the establishment of student vouchers, the 2009 reform has also increased the budget for loans to students in tertiary education (from

EUR 5.7 million to EUR 43 million in 2010) to cover additional expenses, such as living costs, part-time studies abroad and tuition fees for private universities.

The 2009 reform also introduced a new governance model for the universities which previously had solely senates composed of academic staff members and dealing with academic and management decisions. By the end of 2011 the management of all state universities had professional boards, composed of university staff and individuals from non-academic public or private organisations, to consider and approve strategic decisions and appoint rectors. Now councils and rectors decide on strategic and management issues while the senate deals with issues related to academic standards and education matters.

Table 4.5. **Main changes after the 2009 higher education reform**

Before the reform	After the reform
Higher education and students	
– Funding distributed to institutions according to the number of new students	– Funding tied to each student through a voucher allocated to the HEI of the student's choice
– State financing restricted to state universities and colleges only	– State funding targeting the institution chosen by the student, whether private or public
– State funding limited to full-time students	– State funding available to full-time and part-time students
Governance of HEIs	
– Senates composed of members of a university's academic community, in charge of the management of HEIs	– HEIs managed by boards that include, in addition to the university staff, individuals from other institutions outside of the academia. The board approve strategic decisions and appoints rectors
– HEIs had the legal status of budgetary entities receiving block funding from the state each year	– All HEIs, including colleges, have become public entities with more freedom in decision making and have the right to own and manage assets
Funding of HEIs	
– Funding based on a year-to-year allocation, only 20% based on performance	– The share of competitive funding increased to 30% in 2009, 40% in 2010 and has been 50% since 2011
IPRs	
– It was not possible to transfer IP developed through research to other persons or to businesses (but it was possible to license intellectual property)	– IPRs arising from intellectual activities belong to the HEIs. No less than one-third of the profit gained by the exploitation of the IPRs must be allocated to the author of the IP, employed by the HEIs

Source: Ministry of Higher Education (2011), *Higher Education and Research Reform in Lithuania, Resetting the System Towards Competitive Future*.

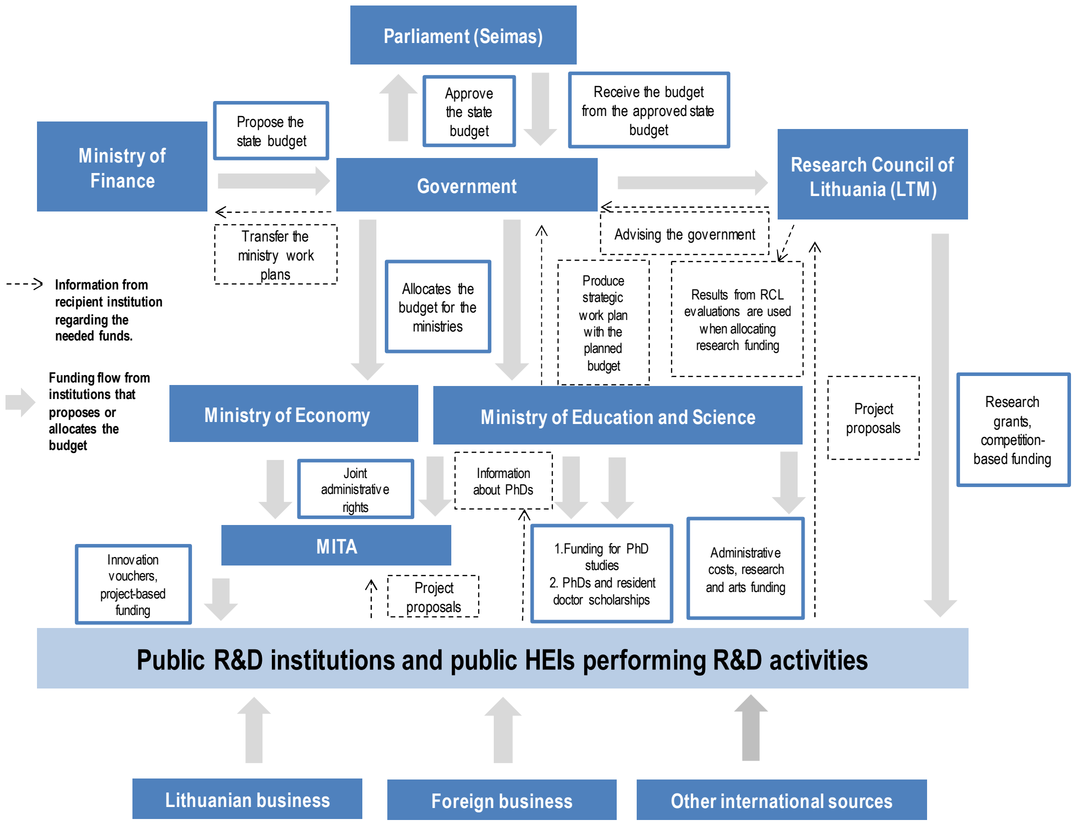
Institutional and third-party funding for research

Since the 2009 reform, the Lithuanian government has increased the share of performance-based funding for research (from 30% in 2009 to 50% since 2011). The remaining 50% of research funding is allocated on the basis of previous overall research funding, expressed in terms of "the standard number of research staff". The latter is approved by decree of the Minister of Education and Science for each organisation every three years.

The performance-based half of institutional funding is reallocated every three years on the basis of an assessment of R&D activities. According to a ministerial decree adopted in February 2015 the assessment of R&D activities is based on the following criteria:

- participation in international research programmes
- amount of contractual and collaborative research commissioned by the business sector
- publication and patent indicators according to an evaluation carried out annually by the Lithuanian Research Council.

Figure 4.14. **Overview of mechanisms of research funding**



Source: Arnold, E., J. Angelis and R. Nausėdaitė (2016), *A Review of the R&D and Higher Education Funding in Lithuania and Recommendations for Further Actions*.

The three criteria are weighted differently according to different fields of science. In 2016, institutional (including performance-based) funding for research in HEIs and PRIs amounted to approximately EUR 75.4 million, of which 62% were allocated to R&D activities and 38% to cover maintenance and administrative costs.

Additional sources of funding for public research institutions are grants awarded by the Lithuanian Research Council (LMT). The Lithuanian Agency for Science, Innovation and Technology (MITA), provides funding for innovation vouchers and other types of project-based funding to support industrial and social applied research. Some concerns have been raised about the practice of relying excessively on national experts for the evaluation of research project proposals (Paliokaitė, 2015; Arnold and Angelis, 2015). These studies suggest that a more systematic involvement of international experts would reduce the risk of potential conflicts of interest, which tends to be higher in small countries with a relatively small research and academic community.

This shift towards performance-based and competitive funding reflects a trend observed in OECD countries over recent decades (Arnold, Angelis and Nausėdaitė, 2016). There is no “ideal” balance between institutional and competitive/performance-based funding (see OECD, 2016b). It has to be noted, however, that institutional funding provides a basis for strategic planning of long-term and possibly risky research activities and for the development of large-scale research infrastructure that typically cannot be financed through short-term grants. Instead, too much performance-based funding may in practice steer researchers towards short-term research output and less risky research activities in order to maximise those research output indicators taken into account in the performance evaluation mechanism. On the other hand, too little or no performance-based funding may discourage HEIs from supporting excellence in research and innovation.

Assessment of Lithuania's research output

External assessments of the Lithuanian research system have been performed twice in the past (Arnold and Angelis, 2014). The first of these assessments was performed by the Research Council of Norway, from 1995 to 1996, with the second done by the World Bank in 2007. These evaluations made recommendations to improve the system and placed particular emphasis on international co-operation, doctoral training and research co-operation within Lithuania. Numerous observations and recommendations were also given in relation to the size and overall structure of the research system. Since the mid-1990s many changes have been introduced. Universities are now more involved in research. Increasingly research articles are published in English; grants to support researchers in doctoral programmes and the participation of researchers in international conferences have been created; workshops and seminars take place regularly; universities have more freedom to increase the salaries of their staff; and knowledge transfer and the creation of spin-offs have been supported with the creation of technology transfer offices and science and technology parks (STP) around the main universities and research institutes. However some of the problems highlighted in these past evaluations still remain: institutional fragmentation is still high, the co-operation within and between universities is still problematic, and linkages with the business sector are still weak. In addition, regular evaluation cycles of the public research system still need to be fully implemented.

Partly to address this issue, during 2014 to 2015, a Research Assessment Exercise concentrating on Lithuanian research was conducted by the Research and Higher Education Monitoring and Analysis Centre (MOSTA) in consultation with the Research Council of Lithuania And the Ministry of Education and Science. Nine panels of international experts assessed Lithuanian research covering the following thematic areas: agriculture, biomedicine, biological sciences, social sciences and technological sciences. The panel assessed the groups based on five dimensions:

- scientific/research quality and impact
- economic and social impact in Lithuania
- infrastructure
- research management
- development potential.

Research in Lithuania was assessed from average to good (Arnold and Angelis, 2015) according to international standards on a scale ranging from 1 (lowest score) to 5 (highest score). Biological and physical sciences obtained the highest score (Table 4.6). However, the social sciences show lower quality if compared to international counterparts. These results appear to be related to the fact that these disciplines were neglected before independence and they over-focus on nationally specific topics and publications. The research infrastructure has received relatively good ratings. This is not surprising, as during the 2007-14 EU Structural Funds programming period Lithuania invested considerably in order to improve the research infrastructure of universities and research centres. However, the assessment highlighted how the issue of the maintenance and renewal of this infrastructure has not been addressed yet. Additional concerns are related to the need for training researchers and students to use the newly developed research infrastructure in the most effective way.

Table 4.6. **Mean score of the Research Assessment Exercise by discipline (scale from 1 to 5)**

	Agriculture	Biological sciences	Medical sciences	Humanities	Physical sciences	Social sciences	Technological sciences
Overall score	2.6	3.2	2.9	2.9	3.0	2.2	2.6
Quality	2.6	3.0	3.3	3.0	3.0	2.2	2.5
Economic and social impact	3.1	3.5	3.0	3.1	3.1	2.7	2.9
Infrastructure	3.3	3.5	2.9	3.2	3.2	2.7	2.8
Research management	2.6	2.7	2.9	2.7	2.8	2.2	2.6
Development potential	3.0	3.2	3.3	2.9	3.3	2.4	2.7

Source: Arnold, E. and J. Angelis (2015), *Research Assessment in Lithuania: Lessons for the National Research System*.

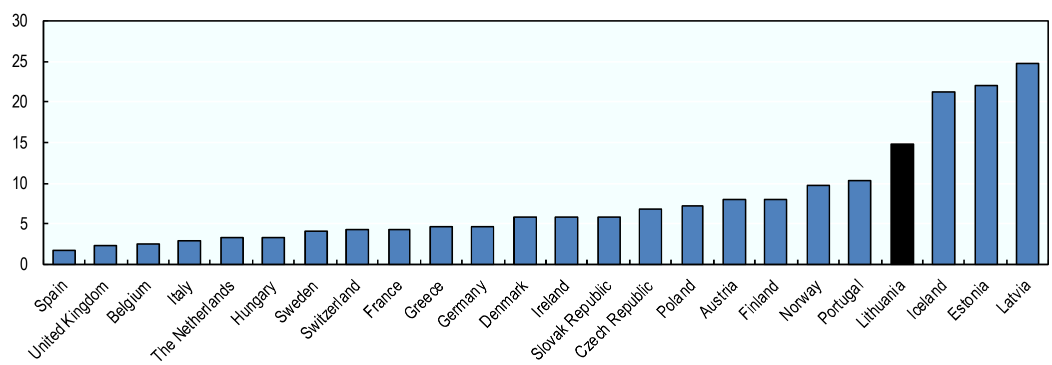
In addition to scoring individual research fields, the Research Assessment Exercise made a number of overarching conclusions on the Lithuanian research system. The experts noted that there is a general lack of strategic approach to set research priorities in research institutions: researchers do not appear to be bound to national research strategies and often are not able to identify their comparative strengths. The lack of a strategic approach in research institutions has repercussions on the ability of Lithuanian researchers to establish collaboration with companies as the latter are often unable to identify areas of strength in research institutions and as a consequence do not establish collaboration (Arnold, Angelis and Nausėdaitė, 2016).

The international experts highlighted the insufficient resources allocated to research activities: Lithuania relies too much on European funding that will inevitably decrease over the years, as opposed to national resources. Another weakness is related to the insufficient degree of international openness of Lithuanian research. Connecting domestic researchers to global science and research networks is crucial to increasing the quality of research, even more so for countries lacking critical mass, like Lithuania. Encouraging internationalisation and research periods abroad, promoting publications in international high-quality journals and in English are all means to strengthen international linkages in science and research. Another crucial aspect highlighted by the assessment is the need to attract more foreign researchers (and students) to Lithuania. The 2015 annual review of the science system (MOSTA, 2015) arrived at similar conclusions and recommended the Lithuanian government to:

- improve and increase the system of competitive research funding moving towards EU standards
- improve the training and careers of researchers
- create stronger science and technology (S&T) links with foreign institutions
- improve management and strategic planning skills in universities and research centres.

The experts also highlighted the high degree of fragmentation of the Lithuanian research system: they reported a too large number of research institutions relative to the small size of the country. In fact, Lithuania has a higher number of HEIs than larger research-intensive countries, such as Sweden, Switzerland or Denmark and a higher number of HEIs per million inhabitants than in most European countries, with the exception of the two other Baltic countries, Latvia and Estonia, and the geographically exceptional Iceland (Figure 4.15). As a consequence of this fragmentation of actors, the experts reported relatively small investments in research, resulting in small research units, duplication of research themes and little co-operation among research institutions as a result of increasing competition for funding at national level. They suggested to merge or to promote closer co-operation between some of the research units. The complexity of the HEI system is not a new issue and has been previously highlighted by an evaluation committee of the European Science Foundation in its 2014 institutional evaluation of the Research Council Lithuania (LMT), not only in terms of number of actors but also of complexity of funding streams (European Science Foundation [ESF], 2014). In addition, Arnold and Angelis (2016) point out that the current funding system for education (through vouchers) and research, by promoting competition, does not provide sufficient incentives for the consolidation of, or even collaboration between, institutions or research teams.

Figure 4.15. **Number of HEIs per million inhabitants in selected European countries**



Universities

In 2015 there were a total of 22 universities operating in Lithuania: 14 public universities and eight private universities (Table 4.7). As highlighted in the previous section, for a country of 2.9 million inhabitants that is a very large number of universities, compared to other small EU countries with a similar or larger number of inhabitants. In 2009 a total of 1 200 degree programmes were offered by Lithuanian colleges and universities for a total of 200 000 students.[9] In 2014-15 the number of students dropped to 140 000 while the number of study programmes increased to 1 800. Both numbers illustrate the fragmentation of the HEI sector.

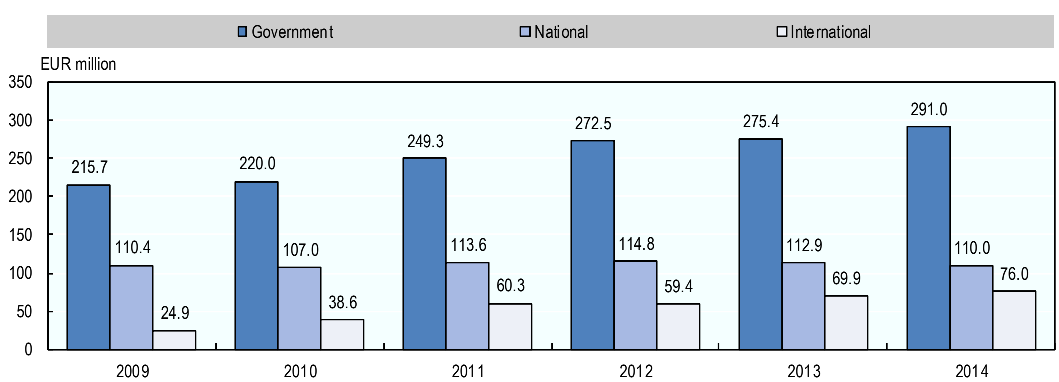
Universities are primarily funded by the Ministry of Education and Science, which receives funds from the government as part of the annual budget allocation. The funding of universities has been growing over time (see Figure 4.16 and Table 4.8 for the evolution of budgets and other key figures for the main universities in the country). In 2013, approximately 60% of the university funding came from the government, 25% from other domestic sources (such as private non-profit organisations and the business sector) and 15% from international sources (such as European programmes, foreign companies or non-profit organisations). The funding from international sources almost tripled between 2009 and 2013, thanks, primarily, to the increasing reliance on European funding.

Table 4.7. **Lithuanian universities**

Name	Type	Location
Aleksandras Stulginskis University	Public	Kaunas
European Humanities University	Private	Vilnius
ISM University of Management and Economics	Private	Vilnius
Kaunas University of Technology	Public	Kaunas
Kazimieras Simonavicius University	Private	Vilnius
Klaipeda University	Public	Klaipeda
LCC International University	Private	Klaipeda
Lithuanian Music and Theatre Academy	Public	Vilnius
Lithuanian Sports University	Public	Kaunas
Lithuanian University of Educational Sciences	Public	Vilnius
Lithuanian University of Health Sciences	Public	Kaunas
Mykolas Romeris University	Public	Vilnius
Šiauliai University	Public	Šiauliai
Telšiai Bishop Vincentas Borisevicius Priest Seminary	Private	Telšiai
The Faculty of Economics-Informatics of the University of Bialystok in Vilnius	Private	Vilnius
The General Jonas Zemaitis Military Academy of Lithuania	Public	Vilnius
Vilnius Academy of Arts	Public	Vilnius
Vilnius Gediminas Technical University	Public	Vilnius
Vilnius St. Joseph Seminary	Private	Vilnius
Vilnius University	Public	Vilnius
Vilnius University International Business School	Private	Vilnius
Vytautas Magnus University	Public	Kaunas

Source: Ministry of Education and Science.

Figure 4.16. **Funding allocated to universities, trends over time**



Source: MOSTA (2014), *Lietuvos švietimas skaičiais 2014. Studijos*, www.mosta.lt/images/leidiniai/Lietuvos_svietimas_skaiciais_2014_Studijos.pdf.

Many universities, including the largest university in the country, Vilnius University (Box 4.2), provide study programmes in several different study areas. Other universities are more specialised, such as Kaunas University of Technology (KTU) (Box 4.3) and the Vilnius Gediminas Technical University, in the field of physical and technological sciences, or the Lithuanian University of Health Sciences in the biomedical field.

Box 4.2. **Vilnius University**

Vilnius University is the oldest and currently the largest Lithuanian higher education institution. The university's importance to the Lithuanian higher education system is highlighted by the fact that it attracts the largest number of students (18 900, 23% of them at postgraduate level) and receives the highest amount of government funding for its activities (EUR 243 million). During the academic year 2015-16 Vilnius University had approximately 3 670 staff.

Vilnius University has 12 faculties, seven institutes, two university hospitals and four interfaculty centres of study and research. Each of the faculties focuses on different fields of education: sciences, medicine, humanities and social sciences. Its faculties and other academic units offer more than 70 bachelor and 115 master study programmes. While the faculties fulfil their role of education, research institutes and research centres focus on the university's research activities. The total budget for research is growing continuously: between 2009 and 2014 it increased from EUR 29.2 to EUR 78.5 million.

The university's Technology Transfer Office was created in 2013 and as of 2015 had a budget of EUR 160 000, 70% of which were financed by the ESF. Since its creation it has concluded 24 licensing agreements and as of 2015 had three permanent staff members.

Vilnius University has signed more than 130 bilateral co-operation agreements with universities in 41 countries, a third of which are with European universities. In addition, over 800 agreements have been signed with 430 universities in Europe and 55 agreements with universities in partner countries concerning academic mobility within the framework of the Erasmus+ programme (approximately 900 foreign students from more than 70 countries come to study at Vilnius University every year). In 2015 over 500 courses were taught in a foreign language.

Vilnius University participates in numerous national and international research projects and organisations such as the EU Seventh Framework Programme, Horizon 2020, COST, EUREKA and CERN. To enhance the interrelations between science and business, Vilnius University has established four open access centres aimed at providing access to research and laboratory equipment not only to students and researchers but also to representatives of business or to personnel of other institutions of science and research.

Institutes of Vilnius University

- The Institute of Applied Research is responsible for fundamental and applied research works in the fields of semiconductor materials and optoelectronics. The institute also focuses on training highly qualified specialists in the field of physics.
- The Institute of Biochemistry focuses on research of the biochemical and genetic principles of cell functioning (biocatalysis and cell regulation), designing and developing biosensors and synthesis of biologically active compounds.
- The Institute of Biotechnology focuses on the field of molecular biotechnology that includes nucleic acid and protein technologies, bioinformatics, molecular diagnostics, drug design, and next generation epigenomic and gene editing technologies.
- The Institute of Mathematics and Informatics is pursuing long-term research related to the economy of Lithuania and international co-operation.
- The Institute of Theoretical Physics and Astronomy investigates atoms, subatomic particles, molecules and their structures and plasma spectroscopy in their application in nanophysics and astrophysics. The institute also carries out research on the structure and evolution of the galaxy, stars and interstellar matter.

Box 4.2. **Vilnius University** (*continued*)

Study and research centres of Vilnius University

- The Centre of Oriental Studies focuses on providing knowledge about Asia and the Middle East within Vilnius University and at national level.
- The Religious Studies and Research Centre focuses on research about the situation of religion both in the national and international context.
- The Centre for Gender Studies conducts interdisciplinary academic research on women and gender.

Sources: www.vu.lt/en (accessed in June 2016); data provided to the OECD Secretariat by the Ministry of Education and Science of Lithuania.

Of the state universities three institutions emerge as the recipients of the highest amount of public funding. Vilnius University – the largest and oldest university in Lithuania – ranks first in terms of R&D funding, receiving nearly the same amount as the second and third recipient universities combined (Table 4.8). These two universities are the Lithuanian University of Health Sciences and Kaunas University of Technology. The Lithuanian University of Health Sciences is one of the few institutions which train doctors in Lithuania. KTU is an important university in terms of its R&D activities. The same holds true for the university ranked 4th on the list, Vilnius Gediminas Technical University. The government of Lithuania has placed great emphasis on the Lithuanian Valleys initiative and the funding for the universities reflects this. All the HEIs which are ranked among the top recipients of government funding are involved in the Lithuanian Valleys initiative and are either among the main academic partners or host the centre for the initiative's activities.

The main universities are also the main recipients of the competitive project-based funding for research allocated by the Research Council of Lithuania: in 2015 the University of Vilnius received approximately EUR 5.8 million, followed by the Kaunas University of Technology (EUR 2.1 million), the Lithuanian University of Health Sciences (EUR 1.2 million), and Vytautas Magnus University (EUR 1.24 million) (data provided by the Research Council, Lithuania). Vilnius University is also the institution attracting the highest amount of European Framework grants, followed by Kaunas University of Technology, Vilnius Gediminas Technical University and the Lithuanian University of Health Sciences (Leichteris et al., 2015).

In general, universities in Lithuania require higher entering scores than colleges. Also, the average entering scores for state-funded and non-state-funded study programmes vary significantly depending on the type of HEI. In 2014, biomedical sciences, arts and physical sciences in universities attracted students with the highest entering scores (Technopolis, 2015).

Box 4.3. Kaunas University of Technology (KTU)

KTU is one the largest universities of its kind in the Baltic region, with a total budget of more than EUR 62 million in 2015. KTU engages in all three cycles of higher education studies and awards bachelor's, master's, and doctoral degrees. In the academic year 2015-16 approximately 10 000 students were enrolled at KTU, 27% of whom were master's and PhD students. The primary domains at KTU are technological sciences, physical sciences, social sciences, humanities, biomedical sciences and arts.

R&D is an important part of KTU's activities. The total budget for research was almost EUR 46 million in 2014 and was largely financed by the government. Approximately 44% of funding was received on a competitive basis. In 2013 KTU's senate approved a resolution that outlined the five priority research areas of the university. These research areas seek to contribute to the solution of important challenges for the business sector, the R&D sector and the state. The research priorities of KTU are:

- diagnostic and measurement technologies
- new materials for high-technology
- smart environments and IT
- sustainable growth and socio-cultural development
- technologies for sustainable development and energy.

KTU is known for its increasing co-operation with business. In recent years it has adopted a flexible interdisciplinary approach to developing and adapting its study programmes to better meet the needs of its business partners and the university's increasing focus on R&D activities, which are strongly promoted among students.

In 2015 the Technology Transfer Office, created in 2012, consisted of 16 people and had a total budget of approximately EUR 640 000 (at least 50% of which is financed by European funding). Since 2012 it has concluded 19 licensing agreements (four in 2015) and had 422 contracts between business and researches in 2015.

KTU is involved in important national and international projects. A major part of current R&D activities are related to Santaka Valley, which was established on KTU campus in 2014. Santaka Valley was founded by Kaunas University of Technology in collaboration with academic partners (the Lithuanian University of Health Science and the Lithuanian Energy Institute), business partners (Achema Group, UAB MG Baltic Investment and AB Kauno tiltai) and other S&T institutions (KTU Regional Science Park, Technopolis and Kaunas High-Tech and Information Technology Park).

Sources: http://ktu.edu/en; data provided to the OECD Secretariat by the Ministry of Education and Science of Lithuania.

There is no long-standing tradition of benchmarking universities in Lithuania in terms of research and innovation outputs. For this reason it is difficult to assess individual universities' output performance over time. University rankings offer one possibility for international comparison. These rankings differ according to the specific indicators and weights they apply, in most cases for measuring education and research activities, and they vary accordingly. In many cases they tend to look at average indicators for the whole university and are therefore ill-suited to identify high-performing research teams or laboratories within a single institution. Nevertheless, they can provide some indications on the relative performance of universities. Comparing several published international university rankings it clearly emerges that Vilnius University is the strongest performing university in the country, which may also be due to its larger size (Table 4.8). However, it is at best a moderate performer in the overall European context.

Table 4.8. **Leading universities in Lithuania – key data**

	2010	2011	2012	2013	2014	2015
Vilnius University						
Total budget (EUR million)	107.10	131.22	163.03	168.91	199.14	242. 92
Budget for research (EUR million)	37.10	55.10	70.30	60.20	78.50	..
Total number of students	20 211	19 561	19 368	18 974	18 937	18 903
Total number of researchers	2 070.56	2 084.76	2 030.38	2 113.82	2 094.53	..
Number of national patents	1	2	12	3	7	11
Number of publications	1 230	1 308	1 104	1 110	1 176	..
Number of publications with foreign co-author	230	249	288	272	317	..
Kaunas University of Technology						
Total budget (EUR million)	53.60	57.10	78.30	60.00	65.60	62.30
Budget for research (EUR million)	35.38	37.74	43.82	56.85	45.89	..
Total number of students	13 843	13 204	12 006	10 916	10 848	10 490
Total number of researchers	1 169	1 202	1 197	1 176	1 117	..
Number of national patents	5	7	5	8	9	12
Number of publications	569	634	346	457	433	..
Number of publications with foreign co-author	31	58	65	69	79	..
Lithuanian University of Health Sciences						
Total budget (EUR million)	40.37	48.49	52.95	57.35	67.42	65.75
Budget for research (EUR million)	25.89	29.80	33.63	37.00	42.45	..
Total number of students	6 936	7 290	7 628	7 753	7 856	7 983
Total number of researchers	925	879	1 342	1 306	1 348	..
Number of national patents	0	0	0	0	0	0
Number of publications	99	123	174	193	268	..
Number of publications with foreign co-author	59	71	66	93	121	..
Vilnius Gediminas Technical University						
Total budget (EUR million)	Approx. 40	Approx. 40	Approx. 40	Approx. 40	Approx. 40	Approx. 40
Budget for research (EUR million)	11.23	17.73	18.41	17.64	17.05	..
Total number of students	13 758	12 603	11 628	10 577	10 440	10 209
Total number of researchers	827	826	787	748	699	..
Number of national patents	11	13	9	7	9	11
Number of publications	446	444	177	299	274	..
Number of publications with foreign co-author	7	15	26	64	54	..
Klaipeda University						
Total budget (EUR million)	14.52	20.83	22.62	23.91	27.19	26.98
Budget for research (EUR million)	4.48	10.48	11.97	13.65	17.16	..
Total number of students	7 412	6 894	6 294	5 417	4 897	4 370
Total number of researchers	546	555	548	441	470	..
Number of national patents	0	0	0	0	1	0
Number of publications	499	578	331	319	368	..
Number of publications with foreign co-author	13	25	29	20	39	..

Note: .. = data not available.

Source: Data provided to the OECD Secretariat by the Ministry of Education and Science of Lithuania.

In the Webometrics Ranking of World Universities[10] Vilnius University emerges as the first Lithuanian university, ranking 305th out of a total of 6 050 European HEIs. The second Lithuanian university in this ranking is Vilnius Gediminas Technical University, ranking 490th in Europe, followed by Vytautas Magnus University in Kaunas (704th), Mykolas Romeris University in Vilnius (790th), Kaunas University of Technology (823rd), the Lithuanian University of Health Sciences, also located in Kaunas (830th), Klaipeda University (858th) and finally Šiauliai University (992nd). The other universities do not appear among the top 1 000 European universities. Vilnius University is the only Lithuanian university on the list of 995 European top universities of the Centre for World University Rankings,[11] and it is also the only Lithuanian university appearing in the Times Higher Education World University Ranking (in the 600-800 bracket) receiving its best scores for international outlook and income from industry rather than research.[12] The CWTS Leiden Ranking 2015, which looks at scientific performance of major universities, does not include any Lithuanian universities.[13] In the European U-multirank platform Vilnius University is positioned considerably below the median of universities included in the ranking in terms of citation rates or top-cited articles.[14]

The picture emerging from these ranking is consistent with a recent benchmark of HEIs (Technopolis 2015) which notes the moderate research activity of Lithuanian universities. This study identify Vilnius University, Vytautas Magnus University and Kaunas University of Technology as the only universities in the country performing extensive research activities in many different fields. Vilnius Gediminas Technical University, the Lithuanian University of Health Sciences and Mykolas Romeris University, instead, perform research activities in specific areas: technological sciences, biomedical sciences and social science respectively.

Colleges

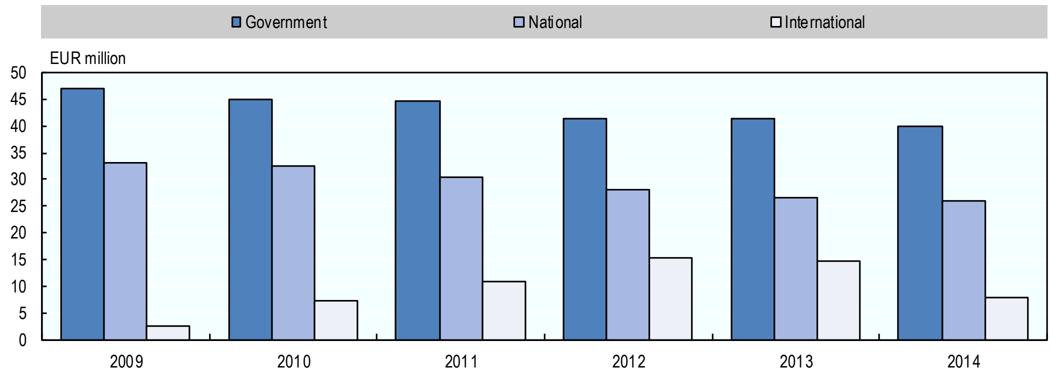
The other channel for tertiary education in Lithuania is colleges, which were established by a reform in 2000. Colleges offer more practical and professional education and are mainly oriented to teaching based on professional practice. Colleges specialise in applied tertiary education and knowledge transfer activities and in most cases do not perform research activities (see Box 4.4 for an example). Lectures remain a major part of the tertiary education programmes of colleges. However, as Lithuanian colleges often have closer ties with businesses than universities, college students generally have many options for internships. As of 2015 Lithuania had 24 colleges of which 13 were public HEIs and 11 were private.

The main source of funding for colleges is institutional funding by the government (Figure 4.17). National funding for colleges has slowly but steadily decreased since 2009, while international (largely European) funding has grown steadily. The evolution of the structure of funding is similar to that for universities. This highlights the importance of European funding for the Lithuanian higher education and research system.

PRIs

After the adoption of the 2009 Law on Higher Education and Research, the research institute landscape was restructured. Until 2010, Lithuania had 18 university research institutes, 17 state research institutes, and 11 other research institutions. As a result of the restructuring, 13 state research institutes were created. In addition there are nine non-state research institutes.[15] The research institutes cover a broad range of research fields and play a role in various national research strategies and policies. Table 4.9 presents an overview of the main PRIs in Lithuania.

Figure 4.17. **Funding sources of colleges in Lithuania**



Source: MOSTA (2014), *Lietuvos švietimas skaičiais 2014. Studijos*, www.mosta.lt/images/leidiniai/Lietuvos_svietimas_skaiciais_2014_Studijos.pdf.

Box 4.4. **Klaipeda State College (KSU)**

KSU is the third largest university of applied sciences in Lithuania, with a strong academic reputation. KSU is mainly focused on study programmes leading to a professional bachelor degree. The studies are practice-oriented which means that students are trained to successfully apply their knowledge in a real working environment.

KSU consists of three faculties: the Faculty of Social Sciences, the Faculty of Technologies and the Faculty of Health Sciences with approximately 4 000 students and 270 teachers and lecturers.

KSU has four "business practical learning enterprises" (BPLE) where students can simulate the activities of real business companies. This helps students to gain valuable experience for solving problems and applying their knowledge in real working condition by using "real" financial documents, agreements, tax tariffs, applying legal acts and foreign currency exchange rates. BPLE departments include human resources, purchase, sales and marketing, and finance and accounting.

KSU also collaborates with a number of educational institutions in different countries. It has an Erasmus University Charter (EUC) and is an active participant in the Erasmus+ programme.

Sources: www.studyinlithuania.lt/en/institutions/klaipedastatecollege (accessed in June 2016); data provided to the OECD Secretariat by the Ministry of Education and Science of Lithuania.

Another source of funding is funds awarded through calls for tender by the Research Council of Lithuania (LMT) for research programmes administered by LMT and by MITA. According to data from LMT the research institutes which attracted the largest amount of funding from LMT in 2015 were the Centre for Physical Sciences and Technology (EUR 1.2 million) and the Nature Research Centre (EUR 0.7 million). The Centre for Physical Sciences and Technology and the Lithuanian Energy Institute were the largest recipients of European grants during the 7th Framework Programme.

The number of PhDs awarded by Lithuanian PRIs has been fluctuating over time. The field of science in which they have awarded most PhDs are physical sciences, agrarian sciences, biomedical sciences and humanities (Figure 4.18).

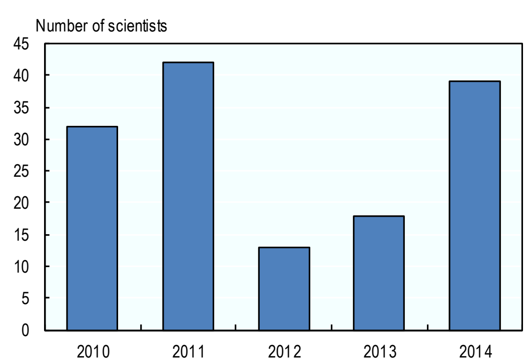
Table 4.9. **Leading PRIs in Lithuania – key data**

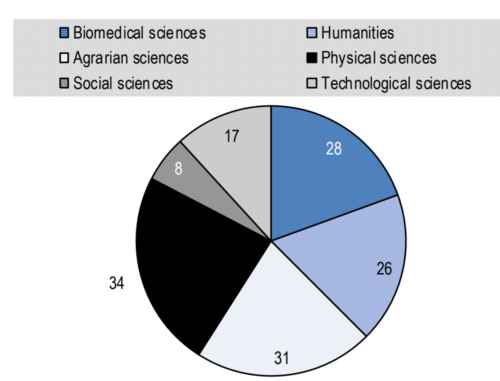
	2010	2011	2012	2013	2014	2015
Centre for Physical Sciences and Technology						
Total budget (EUR million)	8.04	9.72	14.03	18.06	18.60	17.40
Budget for research (EUR million)	6.38	15.5	13.7	17.8	12.1	..
Total number of students	44	53	51	58	65	70
Total number of researchers	323	389	431	471	475	..
Number of national patents	5	7	5	8	10	2
Number of publications	112	108	152	157	147	..
Number of publications with foreign co-author	64	51	67	62	59	..
Lithuanian Energy Institute						
Total budget (EUR million)	6.59	7.38	6.75	6.48	4.88	5.30
Budget for research (EUR million)	5.13	6.66	5.21	5.61	3.71	..
Total number of students	27	28	23	20	25	30
Total number of researchers	214	215	207	204	197	..
Number of national patents	0	1	0	0	2	1
Number of publications	36	45	48	45	63	..
Number of publications with foreign co-author	5	2	6	3	10	..
Lithuanian Research Centre for Agriculture and Forestry						
Total budget (EUR million)	6.97	9.60	10.10	10.00	9.70	10.50
Budget for research (EUR million)	4.16	6.16	6.24	5.45	5.81	..
Total number of students	35	39	48	56	56	52
Total number of researchers	362	354	326	347.61	334	..
Number of national patents	0	0	0	0	0	..
Number of publications	12	34	56	60	59	..
Number of publications with foreign co-author	4	11	38	21	13	..

Note: .. = data not available.

Source: Data provided to the OECD Secretariat by the Ministry of Education and Science of Lithuania.

Figure 4.18. **Number of scientists that gained their PhD degrees in Lithuanian PRIs by year and by field**





Source: Statistics Lithuania (2015), *The database for statistics indicators: number of doctoral awards in research institutes* (database), www.stat.gov.lt/en.

In many OECD countries, applied PRIs – especially research and technology organisations (RTOs) which play an important role as "connectors" in value chains and innovation eco systems (EARTO, 2014) – have a clear mission to work for industry or societal actors. They are typically obliged to generate a considerable share of their research income from business sector partners. Lithuanian research centres largely rely on public funding. The Centre for Physical Sciences and Technology (Box 4.5), one of the country's leading research institutes, together with the Lithuanian Energy Institute (Box 4.6), has established strong international links and works with business partners. Yet only 16% of its 2015 income comes from private sector contracts. The Lithuanian Energy Institute shows a similar pattern, with 16% of its 2014 income coming from Lithuanian industry and 3% from foreign companies. Both institutes are very dependent on contributions from Structural Funds and need to prepare for a reduction of that source of income in the medium term. Lithuania is taking the appropriate steps.

Box 4.5. **The Centre for Physical Sciences and Technology (FTMC)**

The FTMC in Lithuanian is one of the largest scientific research institutes in Lithuania. The centre operates in the fields of laser technology, optoelectronics, nuclear physics, organic chemistry, bio and nanotechnologies, electrochemical material science, functional materials and electronics. It is equally focused on science innovation and high technologies and also responds to the needs of businesses and society through research.

The FTMC was established in 2010 through the merging of the institutes of chemistry, physics and semiconductor physics in Vilnius. In 2012, following a government resolution the Lithuanian Textile Institute in Kaunas was affiliated with FTMC. In recent years through the combination of different strands of science the FTMC has become one of the leading scientific institutions in the country and carries out fundamental, applied and experimental research. According to its 2015 annual report, in 2015 FTMC had a total budget of EUR 23.5 million, of which 34% were from Structural Funds, 26% from the Lithuanian government, 17% from international projects which include FP7 projects and projects funded through bilateral S&T programmes (particularly with the Swiss government), and 16% from contracts with companies.

FTMC unites leading Lithuanian researchers and is equipped with modern laboratory facilities. The results of FTMC's scientific research and the technologies that are developed at the FTMC are shared at international level. The centre hosts PhD studies and post-doctoral fellowships and trains researchers to carry out independent research. In 2015, 38 habilitated doctors of science, 246 doctors of science, more than 500 researchers and 60 PhD students were working at FTMC. The total budget for research in 2014 was EUR 12.1 million, including 90% in government institutional funding. The total number of publications produced at FTMC exceeded 200 in 2015 and approximately 50% of these were published in top-quartile journals.

In the development of new technologies and innovative devices FTMC has co-operates with scientists from many countries, among which are France, Germany, Great Britain, Scotland, Poland, Chinese Taipei, the United Kingdom and the United States on joint research projects. FTMC and its researchers are members of various international organisations: the European Photonics Industry Association (EPIC), the Optical Society of America (OSA) and e Laser Institute of America (LIA).

The FTMC has a number of open access centres and S&T parks which actively contribute to the commercialisation of research results: the open access centre of electronic microscopy, X-ray diffractometry and spectrometry; the open access centre of processing technologies (BALTFAB); the S&T park of the Institute of Physics and the Park of S&T. The Technology Transfer Office was established in March 2015, has nine permanent staff members and is 100% financed by FTMC.

Sources: FTMC (2015), *Centre for Physical Sciences and Technology, Annual Report 2015*, www.ftmc.lt/en/science/FTMC_Annual_Report_2015.pdf; data provided to the OECD Secretariat by the Ministry of Education and Science of Lithuania.

The commercialisation of public research is high on Lithuania's science, technology and innovation (STI) agenda. Where there is a need (mainly in the areas of physics and technology), most higher education and research institutes have recently established technology transfer offices. In addition, public research laboratories and infrastructure are "open access" centres available to companies and citizens on demand. However, to promote collaboration with the business sector and society more broadly, there is a need for a customised approach. This is because opportunities to work with business and particular societal stakeholders differ depending on the scientific domain and the sector concerned. As with business innovation support programmes, a more demand-driven approach requires thorough analysis of the demand side and of the propensity of specific stakeholders to engage with PRIs at various stages, including in co-development.

A change in direction would require a clear restatement of the mission of these institutes with a strategy and an incentive system that gradually moves them towards achieving greater socio-economic impact. The experience from other countries also shows that this process takes many years to establish and cannot be expected to happen quickly.

Box 4.6. **The Lithuanian Energy Institute (LEI)**

The LEI is one of the oldest scientific institutes operating in Lithuania. In 1948 the Lithuanian Academy of Sciences established the Institute of Technical Sciences, which analysed issues of rational water energy and fuel consumption, metal industry rationalisation and automation of production processes. After a number of reorganisations, the institute was established as the LEI in 1992. The mission of the LEI is the leading institute in Lithuania in the areas of engineering, hydrology, metrology, nuclear safety, environmental protection and economy related to Lithuanian energy.

The LEI has three strategic objectives:

- to perform fundamental and applied research in the fields of thermal physics, hydrodynamics, metrology, safety and reliability of energy objects, materials engineering, hydrology, and processes management
- to develop energy sector planning on a conceptual and methodological basis
- to train specialists for energy and energy-related scientific research.

The number of staff employed in the 11 laboratories of the Institute was 283 in 2014, a slight decline since 2010 when the centre employed 305 staff. The 2014 budget was EUR 4.9 million of which 48% were accounted for by state funding, 8% by structural funds, 13% by competitive government resources, 12% by international projects, 16% by Lithuanian companies and 3% by foreign companies. The budget devoted to research in 2014 was EUR 3.7 million, mainly consisting of government funding.

The Technology Transfer Office was established in 2012 and is fully financed by the government. In 2015, the office signed approximately 70 contracts for services and works of various sizes and three general agreements for co-operation. The LEI participates in various international research projects including those financed through FP7, Horizon 2020, Intelligent Energy Europe and COST.

Sources: www.lei.lt; LEI (2014), *Lithuanian Energy Institute Annual Report 2014*, www.lei.lt/_img/_up/File/atvir/2015/leidiniai/LEI_Annual_Report-2014.pdf; data provided to the OECD Secretariat by the Ministry of Education and Science of Lithuania.

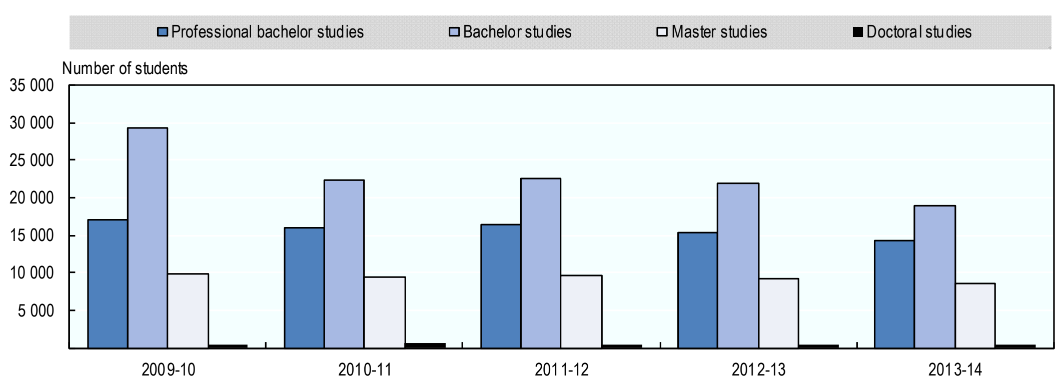
Human resources for STI

Lithuania has an above OECD average number of tertiary education graduates and high levels of students in science, technology, engineering and mathematics (STEM) disciplines. While the number of researchers is on the rise, Lithuania still has to catch up to reach the European average and narrow the gap with innovation-intensive countries. However, Lithuania is performing well on gender parity in tertiary education attainment and in R&D personnel.

Overall, the availability of skilled human capital for innovation remains an important concern. The number of students in Lithuanian HEIs has dropped considerably since 2009 at all levels of study programmes, and in all fields of study (Figure 4.19 and 4.20). The largest decrease in enrolled students has been recorded for the bachelor degree level at universities. Between 2009 and 2014 the number of students entering bachelor courses dropped by one-third. Professional bachelor studies and master's degree studies show a smaller decrease. The (low) number of PhD students has remained more or less stable over time. In 2013, the share of PhD students per thousand population aged 25 to 34 in Lithuania was approximately 1.2%, which is almost two times less than the EU average.

Both at universities and colleges the number of students in the humanities, arts, social sciences and physical sciences has declined, with the social sciences suffering the sharpest drop. The only exception is the biomedical sciences, which has recorded some growth in student numbers. Despite the decline in the number of students, the social sciences are leading in terms of student enrolments. Their popularity among young Lithuanians has encouraged HEIs to focus on programmes in social sciences to attract a larger number of students and, as a consequence, higher levels of funding.

Figure 4.19. **The evolution of students enrolling for higher education**

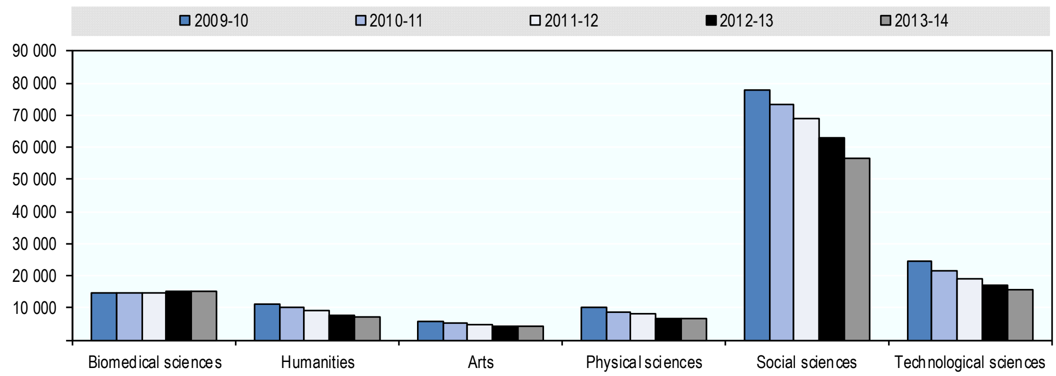


Source: MOSTA (2014), *Lietuvos švietimas skaičiais 2014. Studijos*, www.mosta.lt/images/leidiniai/Lietuvos_svietimas_skaiciais_2014_Studijos.pdf.

The declining number of students reflects demographic trends, exacerbated by the decision of many young and skilled Lithuanians to study and work abroad. On the other hand, only few skilled foreigners decide to come to Lithuania for their studies or work. According to the European Migration Network (2015), Lithuania's emigration rate is one of the highest in the European Union. Around 788 000 people (one-quarter of the population) have left the country since independence in 1990. The share of high-skilled emigrants from Lithuania is higher than from comparable eastern European countries (Figure 4.21). According to MOSTA (2015), the number of Lithuanian students in

European countries more than doubled between 2004 and 2011. The ratio of Lithuanians completing a PhD abroad to foreign PhD students in Lithuania is 10 to 1 (MOSTA, 2014).

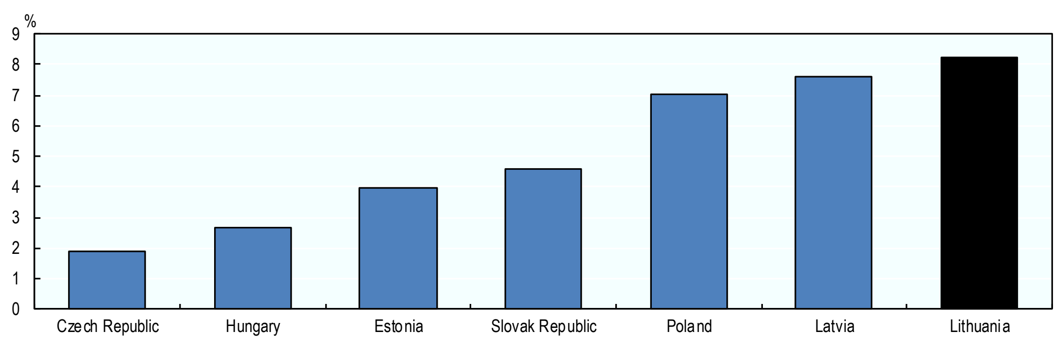
Figure 4.20. **The number of students per study field in Lithuania**



Source: MOSTA (2014), *Lietuvos švietimas skaičiais 2014. Studijos*, www.mosta.lt/images/leidiniai/Lietuvos_svietimas_skaiciais_2014_Studijos.pdf.

Figure 4.21. **Highly-skilled emigrants to OECD countries that have moved in the past ten years (2010-11)**

Percentage of domestic highly-skilled 15+ population



Note: Highly-skilled workers are defined as those with tertiary education.

Source: OECD (2016a), *OECD Economic Surveys: Lithuania 2016. Economic Assessment*, http://dx.doi.org/10.1787/eco_surveys-ltu-2016-en.

Most immigrants to Lithuania are returning Lithuanians. In 2013, Lithuanian nationals accounted for 86% of all arrivals. The increase in returns was due to the improved economic situation in Lithuania. At the same time, the immigration of foreigners to Lithuania remains very low, on average 2 000 to 2 500 people per year (European Migration Network, 2015).

Salaries of early-career researchers are low by international standards, which make Lithuanian public research institutions less attractive for both foreigners and Lithuanians (Technopolis, 2015, Paliokaitė, 2015). According to a survey by Idea Consult et al. (2013), only 30% of researchers are satisfied with their salaries. In addition, low early career salaries have increased the length of time PhD students take to complete their programmes (on average approximately six years): they often teach to augment their income and devote less time to research activities. The 2009 reform of the higher education system gave public research organisations more flexibility in allocating salaries to researchers. This may have a positive effect on the domestic labour market for researchers in the future.

Given the current trends in human resources for science, technology and innovation (STI), it is not surprising that businesses increasingly report skill mismatches in specific technology fields. For instance, a survey of manufacturing companies (Visionary Analytics, 2014) reported that one-third of the survey respondents lacked engineers, technology designers and project managers needed to carry out innovation activities. Furthermore, cross-country surveys suggest that skill shortages are a more serious constraint to businesses in Lithuania than in other comparable countries (OECD, 2016a). To address this problem, in 2014, the Ministry of Education and Science increased funding for higher education in technology fields, with the aim of encouraging students to choose this path of studies (Paliokaitė, 2015).

Recent studies (e.g. Arnold and Angelis, 2015) highlight the need to increase both domestic and international mobility of Lithuanian researchers, particularly younger researchers. International post-doctoral studies are not very common among Lithuanian researchers, who instead tend to stay in the same institution where they complete their PhD. In this way they miss the opportunity to acquire new skills that mobility programmes provide. Another way to support researchers to develop skills and build international networks would be to encourage sabbatical leave abroad, which is currently uncommon for Lithuanian researchers. Sabbatical leave abroad could be a way of connecting senior researchers with their international peers and strengthening collaboration with research institutions abroad.

Notes

1. Technology purchasing, especially of new machinery and equipment, tends to be mostly related to process innovation, the most frequent type of innovation in firms in developing countries (see Goedhuys and Veugelers (2012) and Arvanitis et al. (2013).
2. Registered industrial design data can be used to proxy firms' creative activities. In Europe, the European Office for Harmonisation in the Internal Market (OHIM) registers industrial designs that are protected in all the EU market. Such records, therefore, may capture the export ambition of creative firms: firms competing only in the domestic market are more likely to register design rights in national offices only.
3. In 2014, Lithuania exported USD 30.3 billion and imported USD 34.5 billion, resulting in a negative trade balance of USD 4.22 billion.
4. The top export destinations of Lithuania are Russia (USD 4.58 billion), Belarus (USD 3.02 billion), Latvia (USD 2.69 billion), Germany (USD 2.07 billion) and Poland (USD 1.61 billion). The top import origins are Russia (USD 7.16 billion), Germany (USD 3.56 billion), Poland (USD 3.09 billion), Latvia (USD 2.31 billion) and the Netherlands (USD 1.64 billion).

5. The revealed comparative advantage (RCA) measures the intensity of trade specialisation of a country within a region or the world. It is the export share of a particular type of industry of the total exports (of goods) of a country divided by the export share of this industry of the region (European Union) or the world. If the RCA takes a value less than 1 this implies that the country is not specialised in exports of this industry. Similarly if the index exceeds 1 this implies that the country is specialised in this industry's exports.

6. According to Bernatonyte (2015) the Lithuanian export basket shows a low level of trade dissimilarity index compared to the EU average. Her study examined trade data from 2007 to 2013.

7. However, structural business statistics (SBS) do not capture the whole economy. SBS cover all activities of the business economy with the exception of agricultural activities and personal services. Taking the whole economy into equation, MNEs would most likely represent lower shares both for Lithuania and for other EU member countries.

8. In some countries referred to as universities of applied sciences.

9. See Ministry of Education and Science (2011).

10. www.webometrics.info/en/Europe, January 2016 edition.

11. cwur.org/2014/europe.html.

12. https://www.timeshighereducation.com/world-university-rankings, 2016.

13. www.leidenranking.com/.

14. www.umultirank.org/#!/home?trackType=home&sightMode=undefined&section=entrance, 2016 update.

15. These PRIs are the following: Lithuanian Research Centre for Agriculture and Forestry; Lithuanian Energy Institute; Nature Research Centre; Institute of the Lithuanian Language; Institute of Lithuanian Literature and Folklore; Lithuanian Institute of Agrarian Economics; Lithuanian Institute of History; Institute of Lithuanian Culture Research; Lithuanian Social Research Centre; Centre for Physical Sciences and Technology; Centre of Innovative Medicine; Institute of Lithuanian Textile; Law Institute of Lithuania; Public Policy and Management Institute; Space Science and Technology Institute.

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