

JASPERS-Lot 5-Knowledge
Economy-R&D/Innovation
**Analysis and Evidence Base of the
R&D&I Market in Romania**
Final Report

Issue 2 | 11th April 2013



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Job number 600778-10

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Document Verification

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Job title		Analysis and Evidence Base of the R&D&I Market in Romania		Job number		600778-10	
Document title		Final Report		File reference			
Document ref							
Revision	Date	Filename					
Issue 1	1 Mar 2013	Description	Issue 1				
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Issue 2	11 Apr 2013	Filename					
		Description	Issue 2				
			Prepared by	Checked by	Approved by		
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		Signature					
		Filename					
		Description					
			Prepared by	Checked by	Approved by		
		Name					
		Signature					
		Filename					
		Description					
			Prepared by	Checked by	Approved by		
		Name					
		Signature					
Issue Document Verification with Document							☒

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Glossary of Terms

Appendices (Separate Document)

Executive Summary

This assignment of which this document and its appendices represents the final report has analysed the evidence base of Romanian research and development expertise (supply side) and the competitiveness of the Romanian economy (demand side), to understand the linkage and correlation between research and development with business performance within the innovation system.. It is based on desk research undertaken in November 2012 and February 2013 and four stakeholder workshops delivered in Bucharest, Romania on the 12th and 13th February 2013.

In the European Commission's proposal for cohesion policy in 2014-2020 there will be a precondition for using the European Regional Development Fund (ERDF) in 2014-2020 to support investments. This precondition requires that a smart specialisation strategy supporting integrated, place-based economic transformation is established for the funding of research, development and innovation. Promoting "Smart Specialisation" strategies is a novel way national and regional governments are attempting to enhance the competitiveness of firms and clusters. This strategy development will be led by the Romanian organisation Autoritatea Nationala pentru Cercetare Stiintifica (ANCS) who currently have responsibility for the Research and Development thematic priority of the structural funds.

This assignment has analysed the evidence base of Romanian research and development expertise (supply side) and the competitiveness of the Romanian economy (demand side), to understand the linkage and correlation between research and development with business performance within the innovation system.. This report has been based on desk research utilising existing research publications and policy reports, existing data and new data analysed in relation to research publications and the reanalysis of economic and science and technology data. It should be noted that the availability and quality of data has been limited.

The methodology adopted for this report has directly addressed the principles and priorities of the smart specialisation approach and communication from the European Commission to Romania regarding the thematic priority for research, technological development and innovation through a multi-method approach with a specific focus on the competitiveness of sectors at a national level, the capability and competitiveness of clusters at a regional level and the investment in funding for research and development based on established national priorities, engagement in Framework 7, the profile of individual institutions and the outcomes of research based on publications and patents.

This report provides a national view and an analysis of the regional context and potential for innovation, which is the first of six stages in the overall process of establishing a Smart Specialisation Strategy. Such a strategy is not a static document but one that will continue to evolve as new stakeholders become engaged, as additional analysis is undertaken and as projects are developed and delivered. This report has identified the four areas of food and agriculture, ICT, energy and the environment and engineering and technology as the basis for potential smart specialisation focus.

Our analysis has specifically identified the importance of food and agriculture in the Romanian economy and its significance in terms of employment and GVA at both a national and regional level. It is also relatively significant in research in both agriculture overall and biotechnology. This report recognises that agriculture within European Commission documentation is reflected as low technology and low skill, however by considering this within the context of agro food and agricultural biotech as a potential smart specialisation this would reposition this activity as higher-skill and higher-tech.

The ICT sector overall is well reflected in economic activity in both telecommunications and software at a national and regional level which established clusters across Romania. In addition ICT has a strong research profile at a national and European level in terms of project profile and relatively significantly in terms of publications. Given the fundamental importance of this sector it should be a focus for smart specialisation and a number of research areas are identified in this report that could form the basis for this specialisation.

Energy and the Environment are reflected in the European Commission communication which highlights the transition to a low carbon economy and green growth. At an economic level the potential of this sector can be seen in investment in renewable energy however in research terms while this is a growing area it is one that needs a significant increase in research infrastructure capacity and capability based on the level of publications in this field to date. Environmental research is however a strong area in Romanian research particularly in areas of environmental engineering, pollution and environmental biology. The combination of these research themes is seen as a positive basis for potential specialisation.

The field of engineering and technology is the most diverse of all the sector areas incorporating motor vehicles, other transport, electronics, machinery and equipment and technical textiles. At a business level these are the areas in which the largest level of business expenditure in research and development can be seen and in which there are significant foreign owned businesses. It is in this area that the linkage between foreign owned firms and SMEs, increasing high-technology exports and cross-sectoral linkages identified by the European Commission in their briefing to Romania should be focussed.

From a research perspective this is also the most diverse area of activity incorporating electrical and electronic engineering, nanotechnology, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering, motor vehicle transport and other transport. There is a clear argument for smart specialisation in this field, however further investigation and discussion is needed with research and business stakeholders to highlight specific areas of activity. This may for example lead to a focus on motor vehicles and other transport which would bring in the specialists of electronic engineering, material, machinery and equipment.

In addition there are other sectors that are worthy of consideration for a potential focus on smart specialisation including:

- Textiles - ranked strongly in employment, wages and salaries, specialisation and comparative advantage

- Machinery and Equipment – ranked strongly in wages and salaries, value added and employment
- Wood and Furniture – ranked 1st in comparative advantage and high in number of businesses

These sectors of the economy are not as highly ranked as ICT, Agriculture and Food and Motor Vehicles and Other Transport. However Romania does have regional differentiation and it should be considered that such sectors are an appropriate focus at an individual regional rather than national level.

1 Introduction

1.1 This Report

OVE ARUP and Partners Ireland (Arup) has undertaken an assignment under the Framework agreement for technical assistance to JASPERS beneficiary countries to support the review and analysis of the Research, Technological Development and Innovation (RDTI) based activities within Romania referred to as the ‘Analysis & Evidence Base of R&D&I Market in Romania’. This assignment is within the context of establishing a Smart Specialisation Strategy (RIS3) (European Commission, 2012), which is a pre-condition for accessing funding under the thematic priority for research and development within the 2014 to 2020 European Structural Funds.

This strategy development will be led by the Romanian organisation Autoritatea Nationala pentru Cercetare Stiintifica (ANCS) who currently have responsibility for the Research and Development thematic priority of the structural funds. This document and its appendices serve as the final report on the analysis of the RDTI market in Romania based on desk research undertaken in November and December 2012 and February 2013 and four stakeholder workshops delivered in Bucharest, Romania on the 12th and 13th February 2013.

1.2 Assignment Background

In the European Commission’s proposal for cohesion policy in 2014-2020 (European Commission, 2011) it is a precondition for using the European Regional Development Fund (ERDF) that investment in research, development and innovation are made based on a smart specialisation strategy that supports integrated, place-based economic transformation. The adoption of a smart specialisation strategy will:

- Focus policy support and investments on key national/regional priorities, challenges and needs for knowledge-based development.
- Build on each country or region’s strengths, competitive advantage and potential for excellence.
- Support technological as well as practice-based innovation and stimulate private sector investment.
- Engage stakeholders and encourage innovation and experimentation.
- Be evidence-based and include sound monitoring and evaluation systems.

Promoting “Smart Specialisation” strategies is a novel way national and regional governments are attempting to enhance the competitiveness of firms and clusters. As highlighted in the European Commission Guide to Research and Innovation Strategies for Smart Specialisation (RIS3) (European Commission, 2012) “Priority setting in the context of RIS3 entails an effective match between a top-down process of identification of broad objectives aligned with EU policies and a bottom-up process of emergence of candidate niches for smart specialisation, areas of experimentation and future development stemming from the discovery activity of entrepreneurial actors. It is of crucial importance that RIS3 governance bodies focus on a limited number of innovation and research priorities in line with the potential for smart specialisation detected in the analysis phase.”

The European Commission Guide to Research and Innovation Strategies for Smart Specialisation (European Commission, 2012) outlines the development of a strategy as an economic transformation agenda based on four general principles:

1. *(Tough) Choices and Critical mass*: limited number of priorities on the basis of own strengths and international specialisation – avoid duplication and fragmentation in the European Research Area – concentrate funding sources ensuring more effective budgetary management.
2. *Competitive Advantage*: mobilise talent by matching RTD + I capacities and business needs through an entrepreneurial discovery process.
3. *Connectivity and Clusters*: develop world class clusters and provide arenas for related variety/cross-sector links internally in the region and externally, which drive specialised technological diversification – match what you have with what the rest of the world has.
4. *Collaborative Leadership*: efficient innovation systems as a collective endeavour based on public-private partnership (quadruple helix) – experimental platform to give voice to unusual suspects.

1.3 Assignment Methodology

The ARUP assignment of which this document represents the final report has analysed the evidence base of Romanian research and development expertise (supply side) and the competitiveness of the Romanian economy (demand side), to understand the linkage and correlation between research and development with business performance within the innovation system.

The methodology adopted for this report has directly addressed the principles and priorities of the smart specialisation approach and communication from the European Commission to Romania regarding the thematic priority for research, technological development and innovation through a multi-method approach with a specific focus on the competitiveness of sectors at a national level, the capability and competitiveness of clusters at a regional level and the investment in funding for research and development based on established national priorities, engagement in Framework 7, the profile of individual institutions and the outcomes of research based on publications and patents.

The assignment objectives have been delivered through the effective combination of both information collection and analysis. A series of tasks for data collection and analysis were identified in the project specification.. The delivery of the assignment objectives has been achieved through the following tasks:

Task 1: Analysis of Evidence Base.

The methodology adopted for this report has been multi-method with a specific focus on the competitiveness of sectors at a national level and the capability and competitiveness of clusters at a regional level. It evaluates the investment in funding for research and development based on established national priorities and the profile of individual institutions.

The aim of this report is not to set the priorities for Smart Specialisation in Romania but to highlight areas of interest that can be analysed and investigated further, supported by the involvement of stakeholders and the development of a vision for innovation at a regional and national level. The report was based on desk research utilising existing research publications and policy reports, existing data and new data analysed in relation to research publications and the reanalysis of economic and science and technology data. It should be noted that the availability and quality of data has been limited. An initial report was supported to the JASPERS project team in December 2012 and a revised report in February 2013.

To support the desk research analysis of the evidence base, stakeholder workshops were organised in Bucharest, Romania on the 12th and 13th of February 2013, with the following aims:

- to validate by means of a qualitative evaluation the results of the analysis to identify new approaches or smart sectors which might have been overseen or insufficiently highlighted by the initial analysis
- to ensure that the feedback of key stakeholders are incorporated within the final assignment report
- To ensure that stakeholders are engaged at a key early stage in the development of a smart specialisation strategy

The workshops included the following stakeholders:

- Public authorities on central level: ANCS, Ministry of Economy (newly renamed to the Ministry of Industry), Ministry of Regional Development, Executive Unit for the Financing of Research (UEFISCDI), Ministry of Agriculture, Ministry of Environment, Ministry of IT&C
- Public authorities on regional level: 8 RDAs, etc.
- R&D: Research Institutes and Universities\
- Business sector: clusters, professional associations, technology transfer centres, enterprises.

The workshop discussions were moderated providing a focused and objective oriented approach. The participants were asked to comment on a summary of the initial analysis and to express their opinion in terms of those sectors and subsectors and research themes which can be regarded as providing a basis for future smart specialisation in Romania.

Task 2: Bringing Forward Recommendations

A recommendations report has been issued from this assignment which is based on the comprehensive analysis performed in task 1 based both on the initial desk research analysis, stakeholder workshops and the conclusions of the final report (task 3).

Task 3: Reporting

This report provides a national view and an analysis of the regional context and potential for innovation, which is the first of six stages in the overall process of establishing a Smart Specialisation Strategy. Such a strategy is not a static document but one that will continue to evolve as new stakeholders become engaged, as additional analysis is undertaken and as projects are developed and delivered.

Chapter 2 of this report outlines the Romanian Research, Development and Innovation Environment.

Chapter 3 of the report provides an assessment of the business structure and business dynamics in Romania utilising available data. It provides an overall perspective on sector performance relating to value added, business expenditure on research and development, exporting and specialisation. It addresses sub sector performance for manufacturing and other services, examining the number of businesses, employment, wages and salaries, value added and a comparative analysis to the European Union. The chapter considers the structure of business at a regional level within Romania, examining employment, number of businesses and wages and salaries at sector and sub-sector level within each Romanian region.

Chapter 4 of this report of this report profiles each Romanian region in relation to business structure, its dominant manufacturing and service sectors and outlines its profile in relation to cluster development. A summary assessment of skills and technology is provided which will provide a basis for identifying potential focus areas for smart specialisation.

Chapter 5 of the report provides a high-level assessment of the current focus of Romanian research by area of science based on the number of researchers; expenditure; number of PhD's and number of publications. This highlights the current key areas of focus and provides a basis for a more detailed examination of each area of science. In addition this chapter profiles each Romanian region in relation to RTDI capacity in the form of researchers and expenditure and in the form of outputs based on patents. A summary assessment of research capacity is provided which will provide a basis for identifying potential areas of smart specialisation.

Chapter 6 highlights the increasing focus of academic-industry or university-business cooperation in the European Union context and how Romania could develop new approaches that strengthen cooperation.

Chapter 7 of this report in conclusion highlights areas of interest that can be analysed and investigated further, supported by the involvement of stakeholders and the development of a vision for innovation at a regional and national level.

This final report will provide the Autoritatea Nationala pentru Cercetare Stiintifica (ANCS) with the evidence base to make decisions, seek internal agreement and to support discussions with the European Commission with regards to the development of the Operational (and other funding) Programmes.

2 Main Trends and Challenges in Romanian Research, Technological Development and Innovation

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2.1 Recent Trends in Economic Performance

Romania is the ninth-largest country in the European Union in terms of geographical size and seventh largest in terms of population, but it is also one of the least economically developed members of the Union. The economic crisis at the end of 2008 impacted Romania significantly and it was forced to turn to the IMF, EU and World Bank for emergency support, obtaining a 20-billion-euro rescue package in May 2009, in exchange for drastic spending cuts. The crisis particularly impacted the country's automotive industry and inward direct investment. As a result, the economy contracted by more than 7% in 2009 and by 1.3% in 2010.

In 2011, Romania saw a slow recovery, with economic growth at 2%. GDP growth was mainly driven by increased demand for Romanian exports, causing industrial production to expand. In 2012 domestic demand, export growth and investments are projected to fall as a result of the continued recession in the European Union (Romania's main export market). Consequently, GDP growth is expected to fall to a low 0.5% in 2012. Currently, the Romanian economy is predominantly service driven accounting for 67% of GDP followed by manufacturing at 22% and agriculture and non-manufacturing at 7% and 4% respectively (World Economic Forum, 2012).

In the medium term, Romania's economic progress is challenged by a number of structural problems. These include an unproductive business climate (made worse by a high level of corruption), a rigid labour market, resulting in high wage levels, and an underperforming education system. One of the most important challenges is the reform of the public sector, including the privatisation of large state-owned enterprises and the restructuring of the transport and energy enterprises. As identified by the IMF (IMF Country Report No. 12/291, 2012) (International Monetary Fund, 2012) Romania has a relatively large State Owned Enterprise sector compared with many of its peers in Eastern Europe with nearly 1000 enterprises owned by both local and central government, accounting for 10% of employment and 9% of output. The impact of state-owned enterprises on the country is significant with issues including subsidies, low levels of profitability and higher wages all of which is seen to limit business growth and income to the state.

The Global Competitiveness index 2011-2012 (World Economic Forum, 2012) positions Romania as a 'stage 2 - efficiency driven economy' with a requirement to focus on higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness and market size within the 12 pillars of competitiveness.

In the context of this report analysing the Romanian RDTI capacity, capability, adoption and commercialisation is an important starting point. Romania is ranked 77th overall on the global competitiveness index and is ranked 95th out of 142 countries in the global competitiveness index for innovation. This accounted for its lowest score (2.9) out of all the 12 competitiveness pillars.

The positioning of Romania as an efficiency driven economy highlights the importance of having a well-educated and trained workforce that is adept at absorbing new technologies

where there is sufficient financing for research and development and with an environment where it is possible to commercialise innovation. In this context the major improvements should be targeted at goods market efficiency, labour market efficiency, financial market development where the country is lower ranked and technological readiness where although the country ranked higher in the index its score was low. In particular the country rankings for availability of technology and firm level technology absorption were low (115th and 117th respectively). The innovation performance was low across all the indicators but particularly important is the issue of university-industry collaboration (ranked 115th) and the procurement by government of advanced technology (ranked 111th). In comparison the availability of scientists and engineers ranked and scored well (59th).

Data from Eurostat (Eurostat, 2012) on High Tech Industry and Knowledge Intensive Services and from the community innovation survey provide for comparison between Romania and the EU27. Employment in Romanian high-tech and medium-high tech manufacturing was 5.6% in 2008 and 5.66% in 2007 which is comparable against an EU average of 6.69% for the EU 27 in 2007. However significant differences appear in the area of employment in Knowledge Intensive Sectors where employment in Romania was 14.84% in 2008 and 14.4% in 2007 against an EU 27 average of 32.96% for 2007. Regional differences should also be noted. Employment in high tech sector's within the NUTS 2 regions for 2008 varied significantly with Bucuresti Ilfov (6.55%) and Vest (4.16%) having the highest levels of employment in high tech sector's with the remaining regions varying from Sud Vest Oltenia (0.95%) to Nord Vest (2.03%).

The impact of this is reflected in both the turnover from innovation and high-tech exports. In 2008 Romania outperformed the EU27 average in Turnover from Innovation in both industry and services with 14.9% against 13.3% for the EU27. However a clear and significant gap is visible in export performance with Romania achieving 3.85% of exports from high tech in comparison to 16.65% for the EU27.

2.2 Recent Trends in Innovation Performance

The Innovation Union Competitiveness Report 2011: Country Profile – Romania (European Commission, 2011) recognises that R&D intensity has increased from 0.37% in 2000 to 0.48% in 2009. Despite this Romania remains one of the lowest ranked countries in Europe for R&D intensity. Investment in R&D has been significantly impacted by the economic downturn; however a target of 2.0% R&D intensity as a percentage of GDP is being targeted by 2020.

Funding for Research and Development in Romania in 2011 is mainly (49.1%) supported by Government with Business Enterprise funding increasing in 2011 to 37.4% (Eurostat, 2012). In comparison for 2010 the EU27 average was 34.6% for Government and 53.9% for Business Enterprise. Interestingly international R&D funding into Romania (12.1%), was larger than the EU27 average of 8.9% for 2010.

Overall research and development expenditure in Romania remains low at 0.48% of GDP in 2011 in comparison to the EU27 average of 2.03% (Eurostat, 2012). Given the dominance of Government support to research and development in Romania the overall funding level still remains low at 0.2% of GDP in comparison to 0.26% for the EU27. The largest difference however is in business enterprise expenditure which is 0.17% in comparison to 1.26% for the average of the EU27.

The low levels of funding for Romanian research and development is reflected in the data (Eurostat, 2012) for Human Resources in Science and Technology. For Romania in 2011 25.8% of the economically active population is employed in science and technology in comparison to an average of 42.3% for the EU27. Yet there are significant regional variances at the NUTS2 level with Bucuresti Ilfov exceeding the EU27 average with 46.7%, with the remaining regions varying between 17.7% in Nord Est to 25.1% in the Vest region.

The performance of the Research and Development system is reflected in multiple indicators. The Regional Innovation Scoreboard 2012 (European Commission, 2012) classifies European regions into four innovation performance groups, "innovation leaders", "innovation followers", "moderate innovators" and "modest innovators". The assessment of the regions in Romania is relatively homogeneous where most regions are considered modest innovators. Relative strengths are in finance and support and outputs. Relative weaknesses are in open, excellent and attractive research systems, linkages & entrepreneurship, intellectual assets and innovators. High growth is observed for Public R&D expenditure, community trademarks and community designs. A strong decline is observed for non-EU doctorate students. Growth performance in finance and support and intellectual assets is above average. In the other dimensions it is below average (Pro Inno Europe, 2011).

This modest innovation is also reflected in patent performance where in 2009 Romania produced 0.299 high tech patent applications per million inhabitants in comparison to the EU27 average of 9.536. Once again there are significant regional variations with Bucuresti Ilfov the highest of the regions submitting data at 1.518 with the remainder reporting between 0.1 and 0.4.

The Innovation Union competitiveness report 2011 (European Commission, 2011) highlights key challenges in the Romanian Research and Innovation System including:

- The large number of universities, research institutes and institutes of the Romanian academy, and
- The quality of research results resulting in publications and patent applications.

From the business perspective concern is raised both at:

- The level of business research and development expenditure, and
- The framework conditions for business investment in research and development.

In the context of international cooperation, the Innovation Union competitiveness report additionally identifies that collaboration between researchers in Romania within the European Union is low. Main partner countries for research are France, Germany, Italy, UK and Spain and for patenting Germany and Ireland.

2.3 Identified Challenges

Detailed research reports including the ERAWATCH Country Report for 2011 (European Commission, 2012), Inno Policy Trend chart (Pro Inno Europe, 2011) World Bank (World Bank, 2011) and the Mid-Term Evaluation of the National Strategy and of the National RD&I Plan 2007-2013 (Technopolis, 2012) have been delivered which consistently highlight the key issues for the Romanian RTDI system.

The ERAWATCH Country Report for 2011 (European Commission, 2012) specifically identifies the main structural challenges of the Romanian RDTI system as:

- Poor synergy between the RDTI system and the rest of the national socio-economic system, arising from flaws in the RDTI systems governance, institutional set-up, policy mix and coordination,
- Sharp cuts in R&D funding induced by the economic crisis, further reducing Romania's already low R&D Intensity,
- Low levels of innovation, especially in the private sector, and business investment in R&D,
- The supply and demand of human resources for Science and Technology (HRST)

The recent evaluation of the Romanian RDI system performed by the World Bank (World Bank, 2011) provides four main recommendations:

- Strengthen the governance of the RDI system
- Strengthen the performance of R&D activities within the public sector itself
- Accelerate the translation of R&D into innovation in the private sector
- Increase the level of private sector R&D

The findings of all these reports are consistent. The aim of this report is to provide an input into the development of a Smart Specialisation strategy by providing the background to the key infrastructure and capability of Romanian Research and Development and the performance of the key economic clusters and their linkage to the research base. Sections 3 and 4 of this report will highlight the key economic sectors and clusters at a national and regional level and section 5 will provide an assessment of Romanian research and development of its thematic priorities and key infrastructure.

3 Structural Business Assessment: National Level

3.1 Introduction

The European Commission DG Enterprise and Industry report from October 2012 on Competitiveness Performance (European Commission, 2012) identifies Romania in the catching up group of countries which is lagging behind in most indicators of competitiveness. This chapter of the report provides an assessment of the business structure and business dynamics in Romania utilising available data. It will provide an overall perspective on sector performance relating to value added, business expenditure on research and development, exporting and specialisation. It will address sub sector performance for manufacturing and other services, examining the number of businesses, employment, wages and salaries, value added and a comparative analysis to the European Union. The chapter will consider the structure of business at a regional level within Romania, examining employment, number of businesses and wages and salaries at sector and sub-sector level within each Romanian region.

3.2 Background

Recent studies have sought to assess the level of competitiveness of the Romanian national economy or at a sector level. One of the most recent has been undertaken by the Romanian National Commission of Prognosis and a comparison of our findings in relation to this study is provided in this chapter.

In a recent study “New directions of industrial policy and needed structural change” (Cojanu, 2012), the competitiveness of Romanian sectors is analysed based on a composite index which analysed: production, technology, structure and exports. This study based on 2009 data concluded that AgroFood and Transport Equipment have the greatest development potential.

The study included a forecast based on a linear regression. This regression analysis based on turnover growth for the period 2010-2015 identified the following sectors as having strong growth potential:

- Tobacco
- Machinery and equipment
- Manufacturing of leather products
- Manufacturing of textile products
- Manufacturing of electrical equipment

Based on gross investments the following sectors are identified as having strong growth potential:

- Tobacco
- Manufacturing of motor vehicles
- Manufacturing of leather products
- Manufacturing of electrical equipment
- Decontamination services

Based on the growth rate of industrial output the following sectors are identified as having strong growth potential:

- Manufacturing of electrical equipment
- Decontamination services
- Manufacturing of leather products
- Tobacco

- Food and beverages

Of these sectors the majority have been included within the national and regional assessment undertaken in this report. Only tobacco and decontamination services have not been previously identified. Tobacco cannot form the basis for a smart specialisation strategy, however decontamination services is worthy of further analysis.

A further study, “SME Contribution to economic growth – status quo and perspectives” (Pislaru, 2012), considered the concept of fast growing firms and their contribution to economic development. Fast growing enterprises are those which over a period of 3 years have increased their turnover or number of employees by more than 20%. Based on a reference period of 2003-2010 such enterprises represented 8% of all enterprises in 2010, 47% of the total number of employees and 54% of turnover of which 58% were SMEs. Within the scope of the study no dominant sector could be identified.

In addition, two further studies have identified two sectors of particular interest. Firstly, agriculture, as a traditional sector of the Romanian economy and secondly, energy as one of the new, high growing and innovative sectors in the EU and worldwide. It is estimated that agriculture could contribute to an increase in gross added value by between 2.9% and 8.6%, against the background of concentration of agricultural land, its current dispersion being considered as the most important development hindering factor. (Luca, 2012).

Within the energy sector an investment of 4.6 bn EUR is estimated by 2020 (out of which 2/3 in hydropower and 1/3 in biomass), from an overall investment of 8837 bn EUR. The new investment will increase the gross added value of the energy sector by 43% by 2020. (Musatescu, 2012)

In addition to these studies research on exports, employment and research and development have also been reviewed. A study on “Increase of foreign trade contribution to real convergence” (Albu. L-L, 2012), identified the following sectors as important contributors to Romanian exports:

• Agriculture	• Construction	• Other transport equipment
• Textiles	• Electronics	• Furniture
• Apparel and shoes	• Electrical engineering	• Telecommunication
• Wood	• Machinery	• Information Technology
• Coke and refined petroleum products	• Automotive	• Rubber and plastic products
• Chemical products		

3.3 Sector Performance

At a high-level, sector performance in Romania has been assessed by considering value added, business expenditure on research and development, exporting and specialisation. The assessment of the competitiveness of Romanian Industrial Sectors and Clusters for this report is based on an analysis concluded by the Romanian Cluster Association (Guth, 2010). In undertaking the analysis the following considerations were addressed:

- The need for consistency of assessment between the national, sectoral and cluster level. This required a flexible set of indicators based on available data;
- The need for both a quantitative and qualitative analysis, particularly given the qualitative dimension of clusters;
- The need to analyse information in accordance with relevant European practice (European Cluster Observatory, European Trend chart of Innovation)

The assessment builds upon a qualitative analysis of the existing clusters based on a peer review methodology 2009-2010 and an Analysis of Existing and Potential Clusters and Poles of Competitiveness in Romania. The analysis has been concluded in line with the processes and practice of the European Cluster Observatory. The analysis considers both the qualitative and quantitative aspects of the Romanian Industrial Clusters and Sectors:

Quantitative: Importance, Size, Focus, Specialisation, Innovation and Exporting.

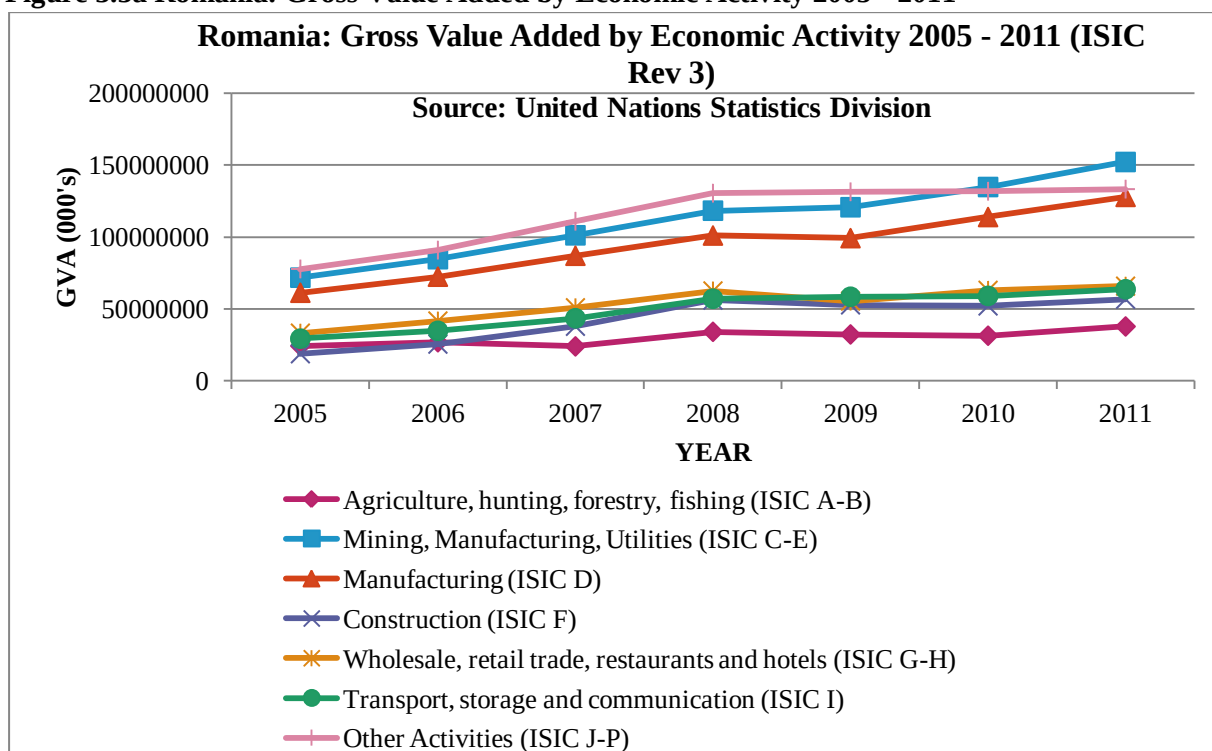
The quantitative data has been assessed at both a national and cluster level. In this context, importance is considered at the national level in terms of contribution to Gross Domestic Product and at a cluster level on the basis of turnover. The indicators for size, focus and specialisation are based on examining the share of employment at either a sector or cluster level. Innovation has been assessed by adopting the innovation scoreboard methodology. The indicator for exporting is based on the share of sector exports at a national level and the share of cluster exports within the sector at a cluster level.

Qualitative: Geographical Focus, Research and Development, Labour Force, Cooperation, Internationalisation and Catalyst Institutions.

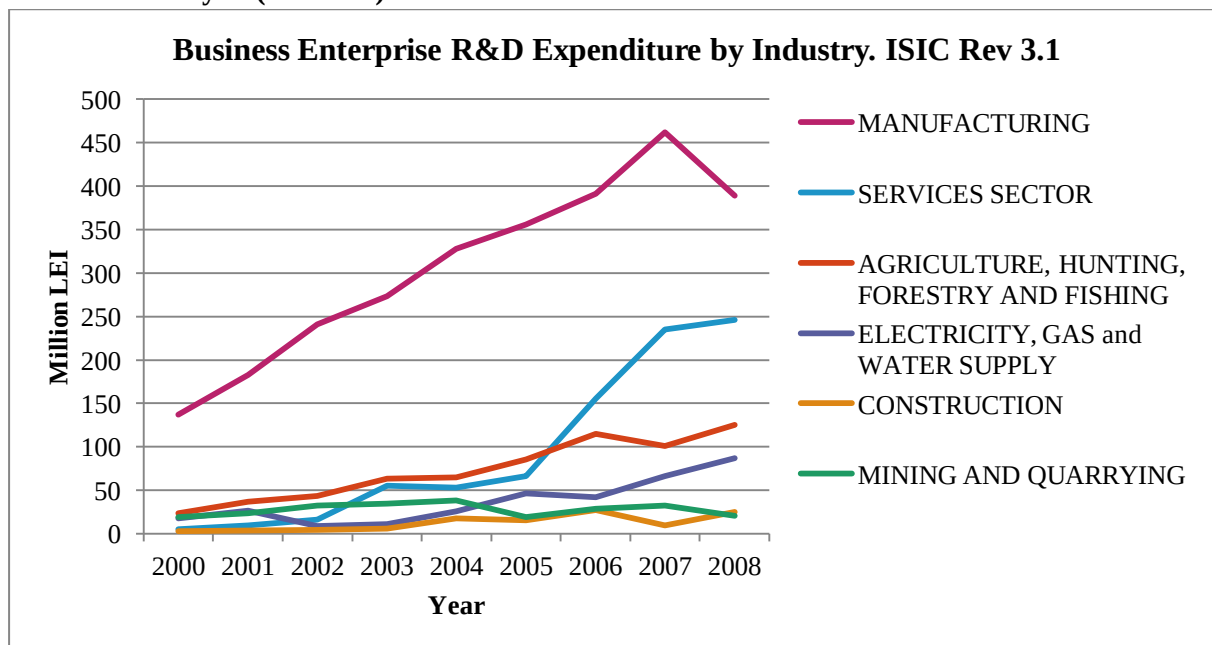
The qualitative approach has also been undertaken at both a national and cluster level. Geographical focus is assessed through the concentration of industries within a defined geographical area. Research and Development is based existence of universities and research institutes in a cluster. Labour Force is based on the availability (quantity), quality and availability of qualification services in the cluster. Cooperation is based on partnership relations between members of the cluster. It is a critical factor that differentiates a cluster from an industrial sector well represented at regional level. Internationalisation is based on the orientation of the cluster towards international markets. And finally the evaluation of Catalyst institutions – is based on the existence of support organisations within the cluster (e.g. technology transfer centres, chambers of commerce, consultants).

One of the most recent studies of sector competitiveness has been undertaken by the Romanian National Commission of Prognosis. A correlation between the assessments of competitiveness from both studies can be seen has been undertaken and this is detailed within this report.

This high level assessment will provide the evidence for a further more detailed assessment at sub-sector and regional level. The business structure of Romania is dominated by manufacturing and this is supported by 2011 data from UNIDO where manufacturing and ‘other services’ dominate the ‘value added’ assessment of the Romanian Economy (see Figure 3.3a). In addition the 2012 European Commission report on industrial competitiveness (European Commission, 2012) highlights that manufacturing accounts for 22% of total value added in comparison to the EU average of 14.5%.

Figure 3.3a Romania: Gross Value Added by Economic Activity 2005 - 2011

The European Union Innovation Scoreboard (European Commission, 2012) classifies Romania as a modest innovator, reflecting the low level of innovation and R&D expenditure from both the public and private sector. OECD structural analysis data (Figure 3.3b) available in time series to 2008 profiles Business Expenditure in Research and Development by sector. This data when compared (figure 3.3b) with our high level value added assessment of sectors once again highlights the importance of manufacturing, services and additionally agriculture.

Figure 3.3b Romania: Industry Expenditure on R&D by Sector (2000 – 2008); Source: OECD, Structural Analysis (Ed. 2010)

The third assessment at this macro level is based on export data available from the 2011 annual yearbook of the Romanian National Institute of Statistics (figure 3.3c). An assessment of exports in 2010 has provided the details of the top ten product classifications for international trade. Export performance is predominantly driven by manufacturing in particular through motor vehicles, electrical equipment, machinery and equipment and basic metals. The potential of ICT is reflected in the ranking (2nd overall) of Computer, Electronic and Optical products. Also worthy of note in this assessment is the inclusion of agriculture and textiles within the top ten sectors regarding exports.

Romanian exports reached 46 billion EUR in 2012. Concerning the exports of goods, 71% went to the European markets. The top 5 export destinations are Germany, Italy, France, Hungary and Turkey. Transport equipment, Electronics and electrical engineering, Textiles and Metallurgy have been identified as the biggest exporting sectors of the Romanian economy (over 10% of total exports). Concerning transport equipment, 82.3% of exports are represented by the automotive industry, specifically cars and spare parts for cars. The first 5 destination export countries are Germany, France, Italy, Russia and Turkey. The manufacture of electrical equipment is represented mainly by wires and wiring devices (35.8%) and telephone devices (14.2%). The top 5 export countries are Germany, Italy, Hungary, France and the United Kingdom.

The Romanian Business Review published in August 2012 (Posirca, 2012) identified that “Romania’s exports had risen by 6 percent to RON 97.7 billion (EUR 22 billion) in the first semester of 2012 from the same period of 2011, while imports increased 5.8 percent to RON 117.8 billion (EUR 27 billion), based on data from the National Statistics Institute”. They identified that the “largest traded products include, machinery and transport equipment that accounted for 40.9 percent of exports and 33 percent of imports, while other manufactured products accounted for 34.5 percent of exports and 29.6 percent of imports”.

This concentration of exports was also reported by Romania insider (Romania Insider, 2012) which highlighted in April 2012 that “Cars and transport equipment accounted for almost 42 percent of the country’s exports and 34 percent of its imports. Romania also exported food products, beverages and tobacco, 6.4 percent of its exports, as well as chemical products, some 5.8 percent. Other manufactured products accounted for 35 percent of the country’s exports. In turn, Romania imported more chemical products, 14.5 percent of its imports, food, beverages and tobacco, some 6.5 percent of its imports, and other manufactured products, accounting for some 30 percent”.

With regard to metallurgy, 41.5% of exports were represented by iron and steel material and products of iron and steel (27.2%). The second category is mainly represented by tubes, pipes, hollow profiles and related fittings of steel. The top 5 export destination countries are Germany, Italy, USA, France and the Netherlands. Textile exports are mainly represented by the classical wearing apparel component. The top five destinations are Italy, France, Germany, United Kingdom and Austria.

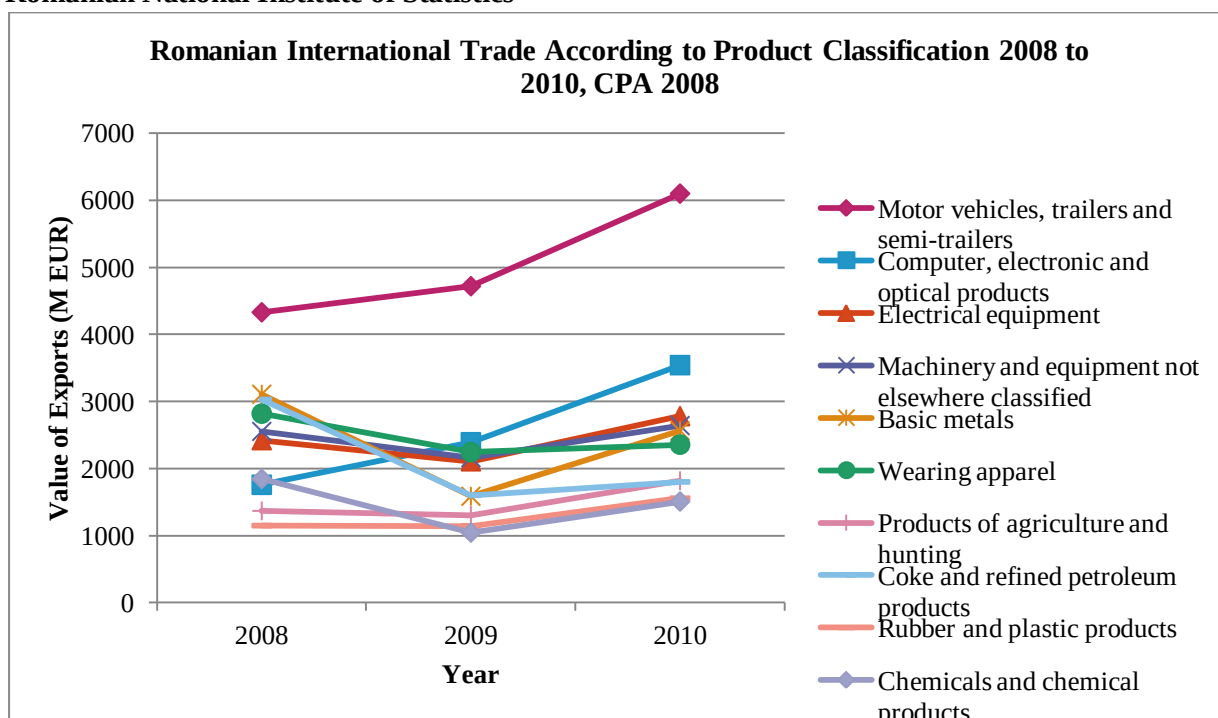
Foreign Direct Investment (FDI) is also an important consideration for Romania. Business Review reported in June 2012 (Business Review, 2012) that “Romania is the 6th most attractive country for investments in Europe in the next three years, according to 840 executives surveyed by Ernst & Young in the 2012 *European Attractiveness* report. Business leaders across the world find Romania more attractive than the Czech Republic, Switzerland, Netherlands, Italy, Spain or Sweden.”

In the Business Review article, Bogdan Ion, Country Managing Partner for Ernst & Young Romania highlighted that “Romania boosts a confident GDP growth, compared to the European average, and a valuable human capital. We are seeing more and more investors attracted by renewable. Further

privatizations are lined-up, encouraging investors all over the world to look towards our country. It is crucial that we foster this positive trend through appropriate economic strategies,”

The article also identified that Central and Eastern European economies lead in process industries, highlighting that “Romania, Serbia, Slovakia and the Czech Republic attracted 53 percent of new automotive jobs. These countries have attracted big projects because they are cost-competitive and close to Germany, home to many key industrial customers.” In addition “Business services and software sectors remain the biggest recipients of FDI projects in Europe with an increase of 19 percent to 666 and 15 percent to 436 respectively. Altogether the two sectors accounted for 28 percent of total projects in 2011, providing more than 16,000 jobs. The automotive sector also saw an increase in the number of FDI projects to 270 from 258 last year and it was also the sector that created the highest number of jobs, at 37,790. The sectors that saw the biggest declines were financial intermediation which fell by 16 percent and electronics by 8 percent.”

Figure 3.3c Romania: International Trade by product Classification (2008 to 2010), Source: Romanian National Institute of Statistics



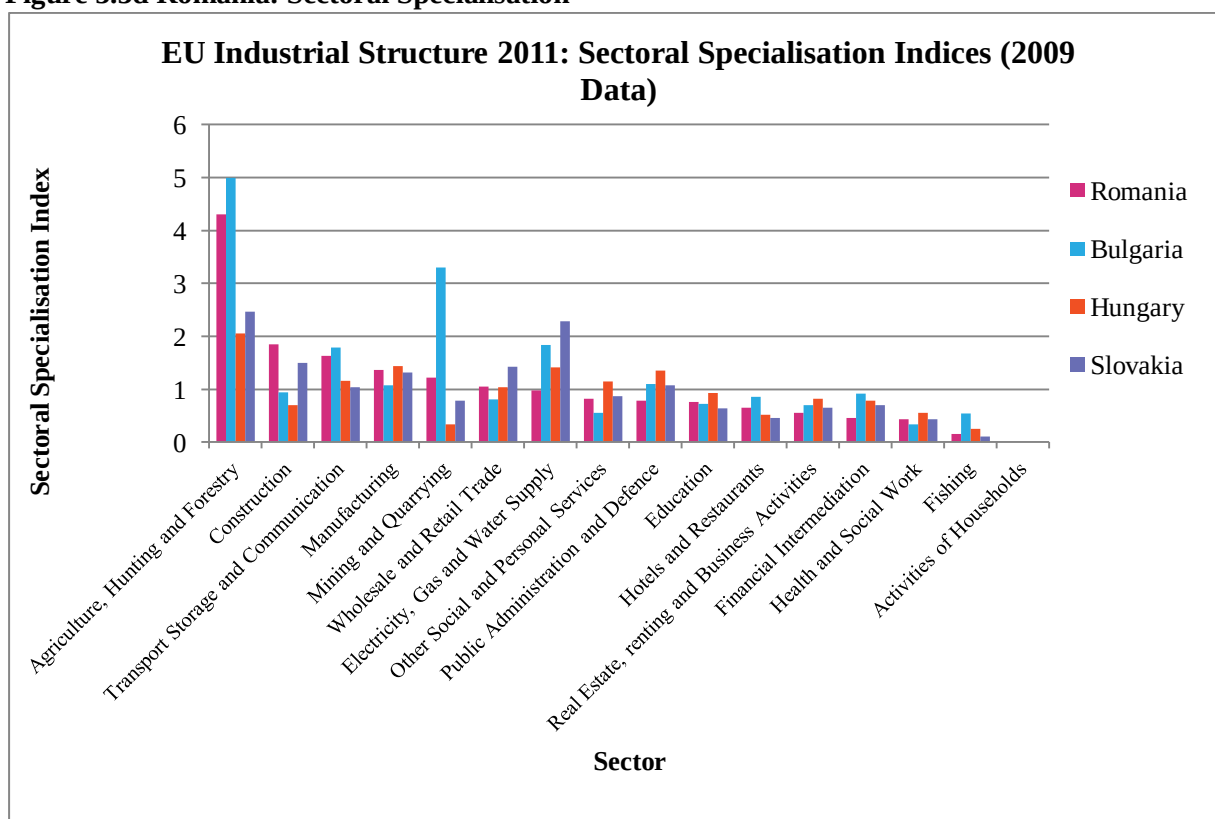
Our final high level assessment of the business structure is based on specialisation (figure 3.3d) The European Commission DG Enterprise and Industry report from October 2012 on Competitiveness (European Commission, 2012) specifically notes that “at the detailed manufacturing industry level, Romania is highly specialised in labour-intensive industries (preparation and spinning of textile fibres, sawmilling, wearing apparel and accessories), as well as in capital-intensive industries (cement), and marketing-driven ones (value-added only; footwear). At the more aggregated sector level, Romania features specialisation in low innovation and education sectors (wearing apparel, leather), but also in medium-high innovation sectors (textiles, basic metals)”.

The European Commission Industrial Structure Report of 2011 (European Commission, 2011) provides an overview of the changes in; EU industrial structure, exploring sectoral specialisation and skills and technology specialisation; and an assessment of the drivers of growth and competitiveness, exploring

output, labour, production and demand side factors. The report references the small market service sector in Romania and its relatively large manufacturing sector.

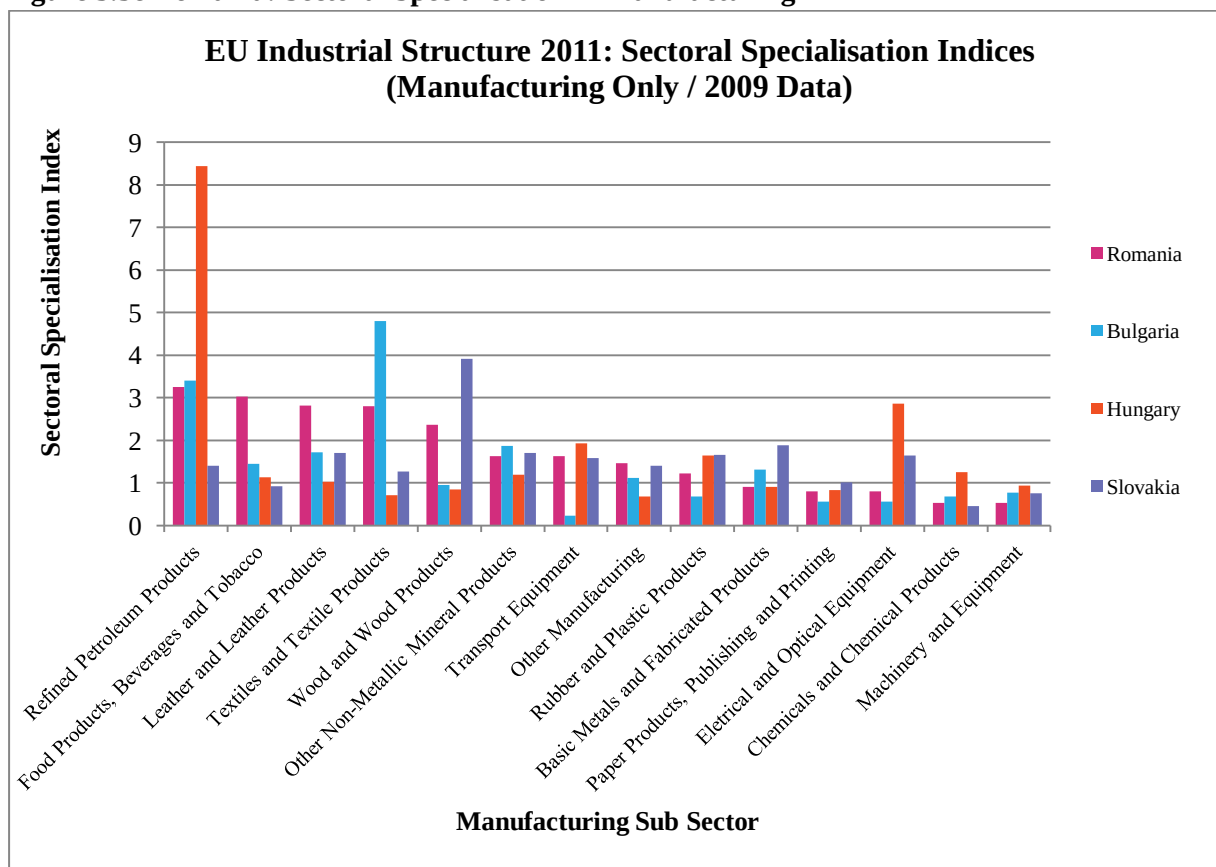
This highlights the decline overall in the EU of manufacturing and agricultural services and it is in agriculture where Romania has suffered most significantly with the second largest percentage decrease in GDP between 1997 and 2009, while manufacturing although declining has reduced less than the EU27 average.

Figure 3.3d Romania: Sectoral Specialisation



The industrial structure report (European Commission, 2011) provides a valuable assessment of sectoral specialisation based on the relative share of industry in each country correlated with the share of the same sector in the European Union. The indicator of a country's sectoral specialisation compares the share of a given sector in one country with the share of the same sector in the EU as a whole. A value of 1 for a sector indicates the same share for that sector and in the European Union. The higher the value of the indicator the higher the country's specialisation compared to the EU average. Romania is ranked 6th overall in its degree of specialisation, in particular for its high degree of agricultural activity. Figure 3.3d presents for Romania the highest ranking sectors based on the index of specialisation and figure 3.3e the data for manufacturing sectors highlighting the dominance of low-technology and low-intermediate technology classified sectors.

The report further details skill and technology specialisation by country and sector. Unfortunately as highlighted in the report information on Romania is not available due to lack of data, however the labour skills taxonomy and technology taxonomy will be used in analysing sector and sub sector data and in drawing conclusions on areas of focus for the Romanian economy within the remit of Smart Specialisation.

Figure 3.3e Romania: Sectoral Specialisation in Manufacturing

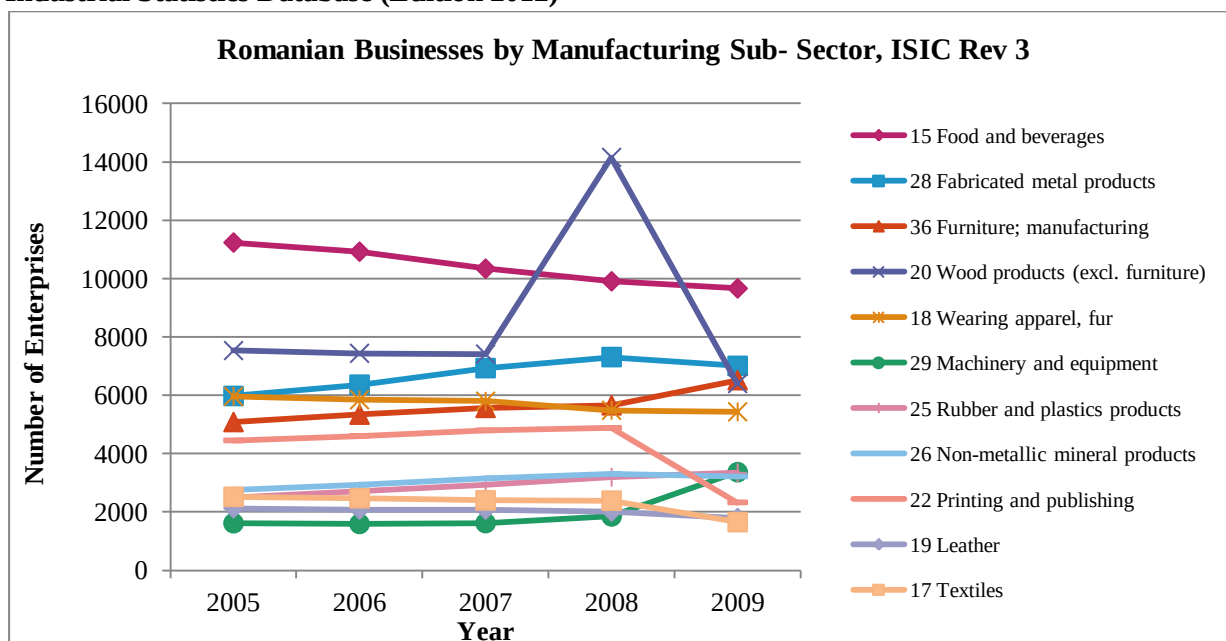
From this high-level review of sector performance we can see the dominance of; manufacturing in terms of GVA, Business Expenditure on R&D and in international trade; the service sector through GVA and Business Expenditure on R&D; and agriculture and food through the analysis of sectoral specialisation and its consistent referencing in the data relating to GVA, R&D expenditure and international trade. These areas will form the basis of a more detailed analysis at sub-sector level which is detailed in the following sections of this report.

3.4 Manufacturing Sector Performance

As has been highlighted previously the manufacturing sector is significantly important for the Romanian economy in GVA and in comparison to the wider economy of the EU27. This section will determine the most important areas of the manufacturing sector economy and assess which areas have potential to be considered within a smart specialisation strategy approach based on a review of the number of businesses, value added, employment and wages and salaries.

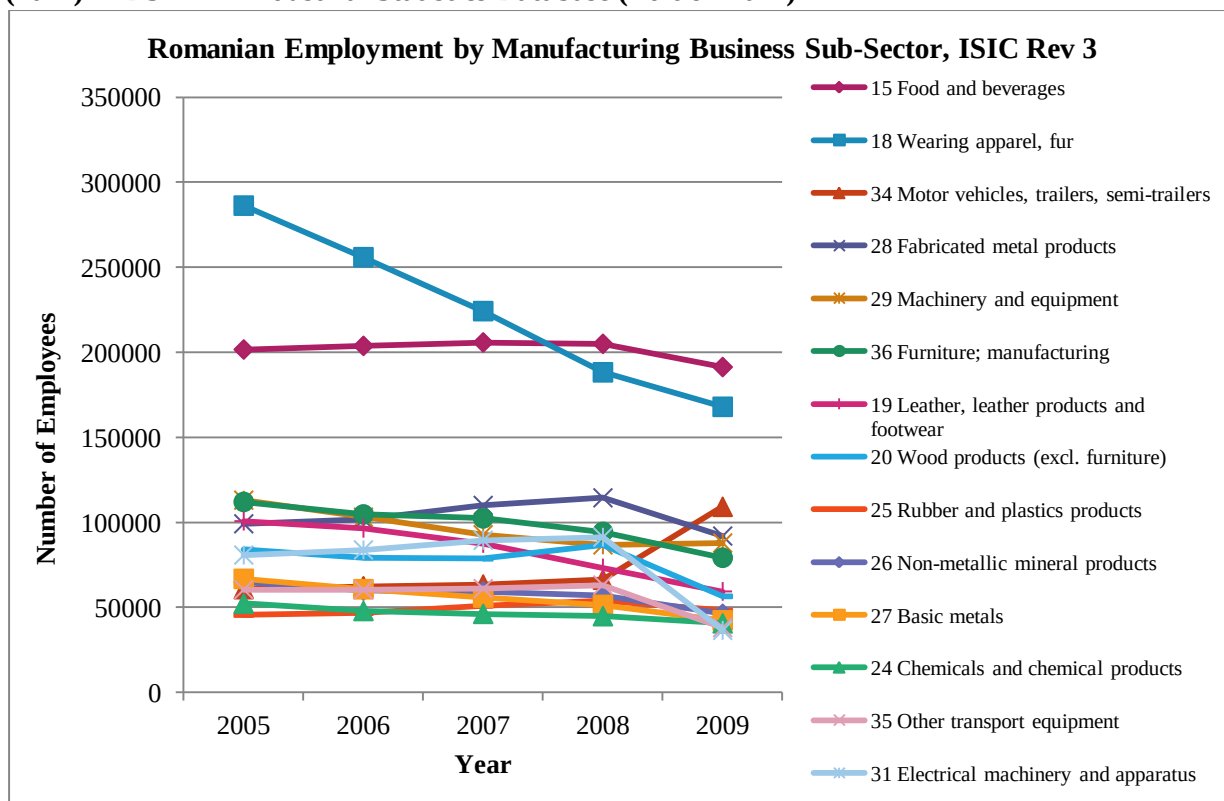
The manufacturing sector (figure 3.4a) has a high-level of business stock in food and beverages, fabricated metal products, furniture, wood clothing and machinery and equipment. All of these sub sectors which are the highest ranked in relation to the number of businesses in Romania fall into the category of low skill or low intermediate skill in the labour skills taxonomy and in the low tech and intermediate low-tech category of the technology taxonomy presented within the European Commission Industrial Structure Report of 2011 (European Commission, 2011).

Figure 3.4a Romania: Businesses by Sub-Sector 2005 – 2009, Source: UNIDO (2012) INDSTAT2 Industrial Statistics Database (Edition 2012)



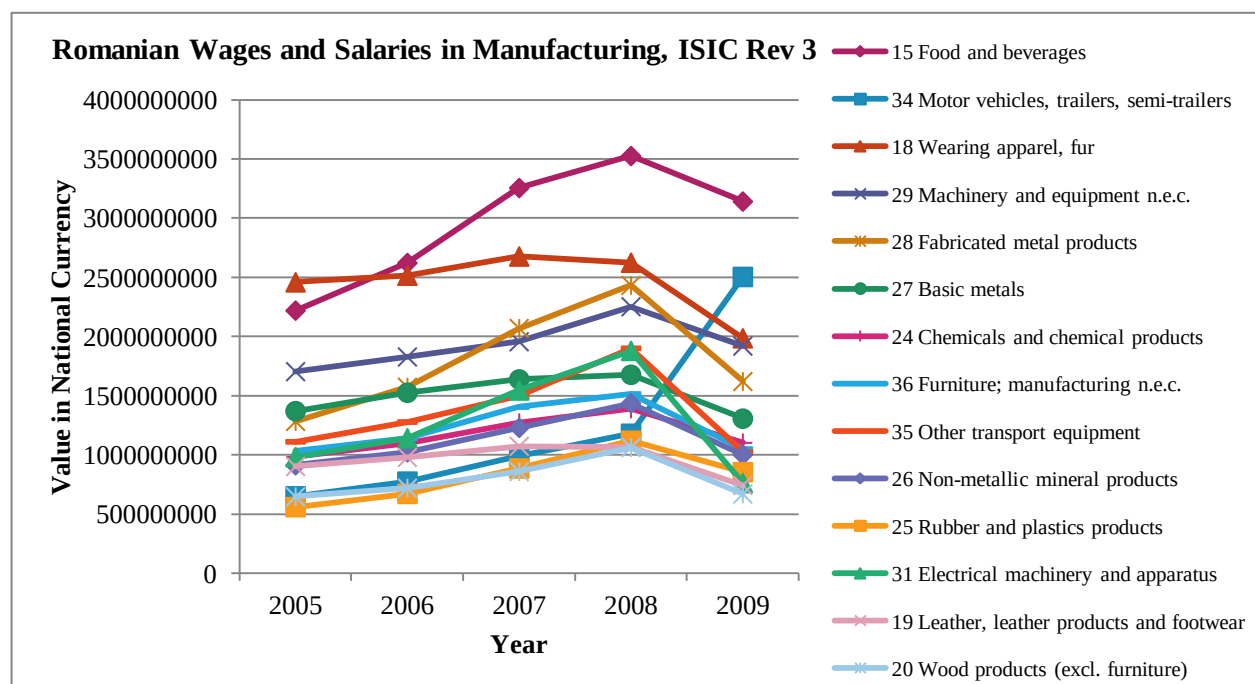
Considering employment statistics (figure 3.4b) the sub-sectors of manufacturing relating to motor vehicles, trailers and semi-trailers; other transport equipment and chemicals and chemical products rank as high intermediate on the technology taxonomy with high intermediate skill and high skill seen in the sub sectors relating to other transport equipment and chemicals, chemical products respectively. All remaining sectors are classified as either low or low intermediate in both skills and technology.

Figure 3.4b Romania: Employment in Manufacturing Sub-Sectors 2005 – 2009, Source: UNIDO (2012) INDSTAT2 Industrial Statistics Database (Edition 2012)



Considering value added in the sub-sectors of manufacturing (Figure 3.4c) a similar sub-sector breakdown is observed with the sub-sectors of motor vehicles, trailers and semi-trailers; other transport equipment and chemicals and chemical products being among the highest value adding areas of the Romanian manufacturing economy. This assessment is once again replicated in the assessment of wages and salaries (Figure 3.4d).

Figure 3.4c: Romania Wages and Salaries in Manufacturing Sub-Sectors, Source: UNIDO (2012) INDSTAT2 Industrial Statistics Database (Edition 2012)

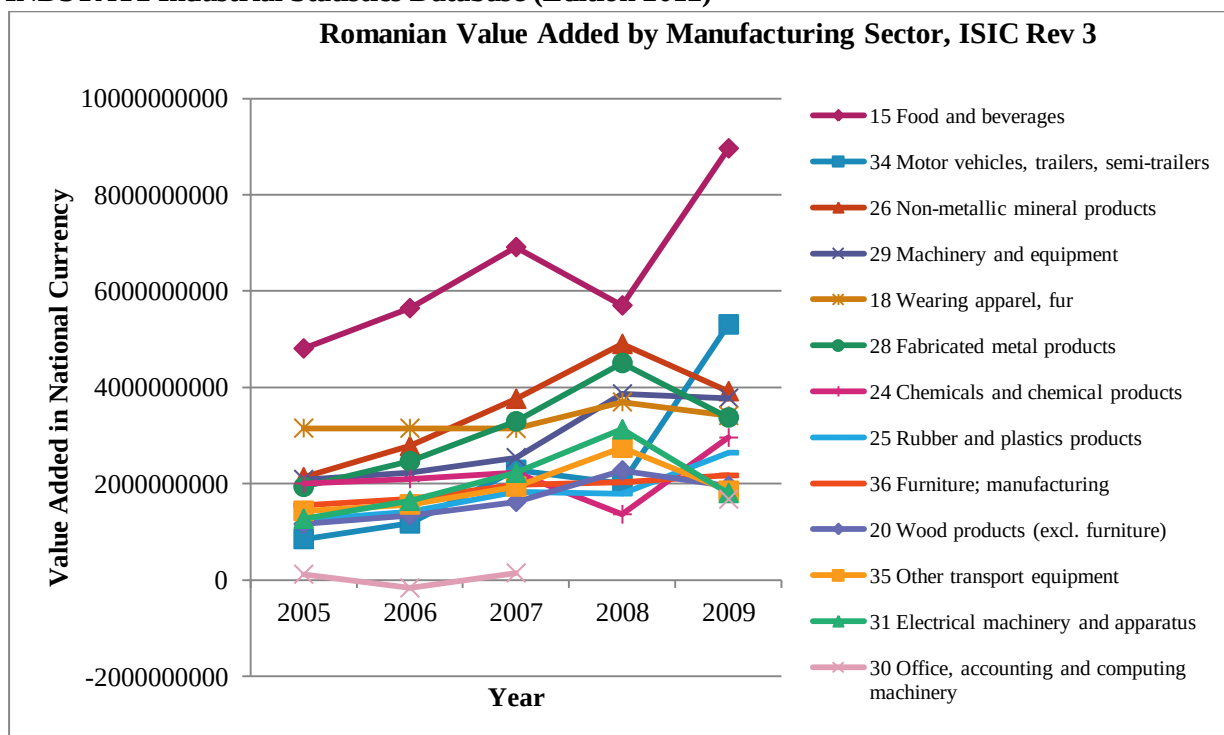


Industry expenditure on research and development has been profiled by sub-sector of manufacturing (figure 3.4e). The emphasis on motor vehicles, trailers and semi-trailers; other transport equipment and chemicals and chemical products has been maintained within this analysis. Additionally new sub-sectors of electrical machinery (high intermediate technology) and medical precision and optical instruments (high intermediate skill and technology) have been identified.

Overall this assessment of the manufacturing sub-sector has identified the potential for focusing on; motor vehicles, trailers and semi-trailers, other transport equipment, chemicals and chemical products and medical precision and optical instruments which are based either on technology and skills which are considered at high intermediate levels.

Machinery and equipment while outside of this classification has a strong representation in sector performance and in R&D investment by industry. However it must be recognised that the Romanian economy which is dominated by manufacturing is made up of manufacturing sub-sectors which are low skill / low technology or low intermediate skill / low intermediate technology based. Such sectors including food and drink, textiles and wood play an important role in the Romanian Economy.

Figure 3.4d: Romania: Value Added in Manufacturing Sub-Sectors, Source: UNIDO (2012) INDSTAT2 Industrial Statistics Database (Edition 2012)



The European Union Competitiveness Report for 2012 (European Commission, 2012) explores the comparative advantage of sectors industries in both manufacturing and service industries. This Revealed Comparative Advantage is based on export competitiveness considering the European Union in global export markets. Only those sectors where Romania is ranked above the European Union have been profiled in the chart (Figure 3.4g). Of these sectors Romania ranks 3rd in clothing, leather and footwear and furniture; 4th in motor vehicles and 5th in wood and wood products and electrical equipment.

Figure 3.4e Romania: Expenditure on R&D by Manufacturing Sub-Sector, Source: OECD Structural Analysis (Ed 2010)

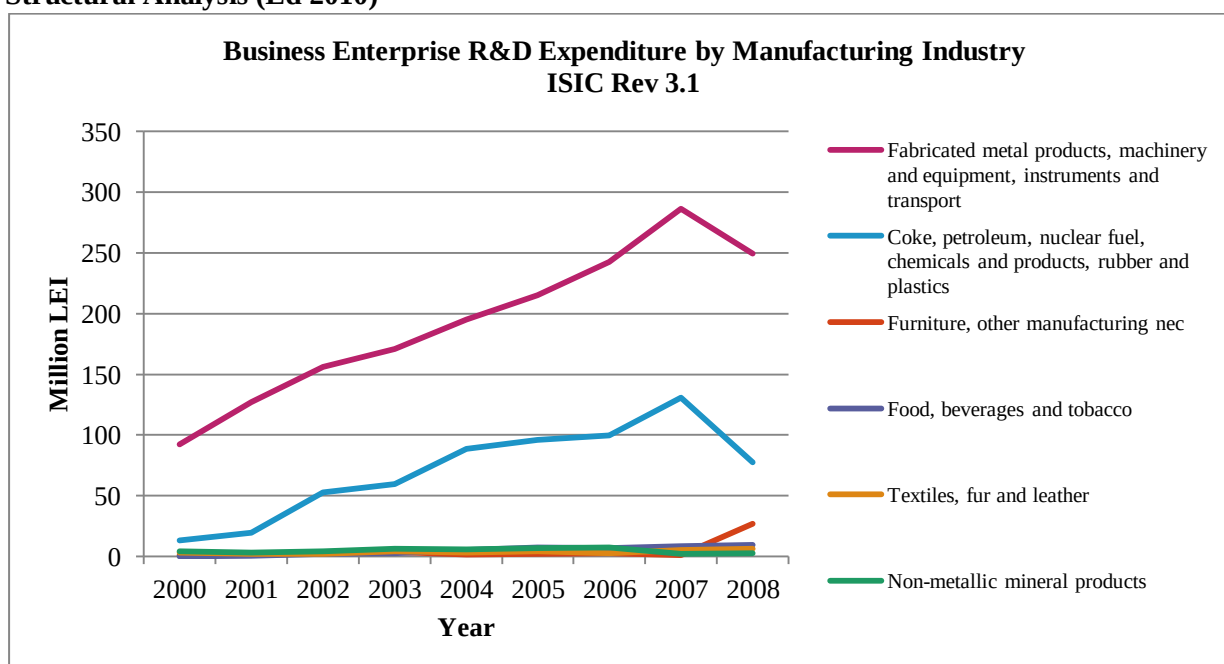


Figure 3.4f: Romania: Expenditure on R&D in Fabricated Metal Products, Source: OECD Structural Analysis (Ed. 2010)

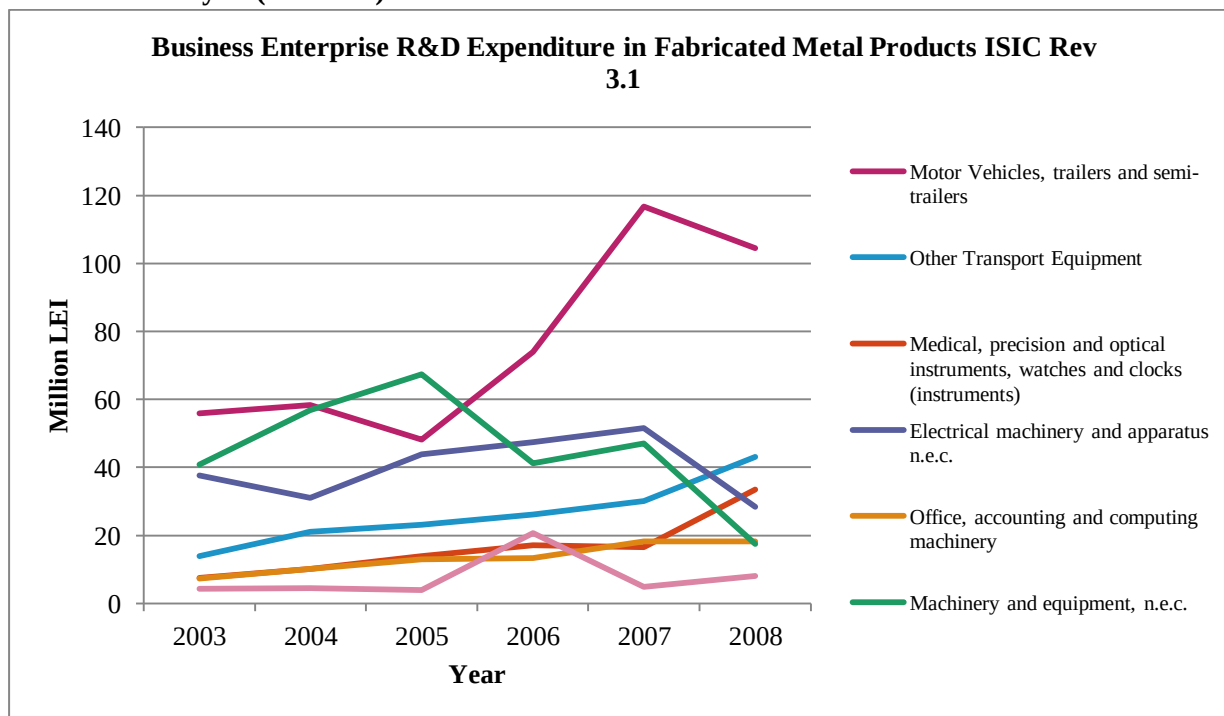
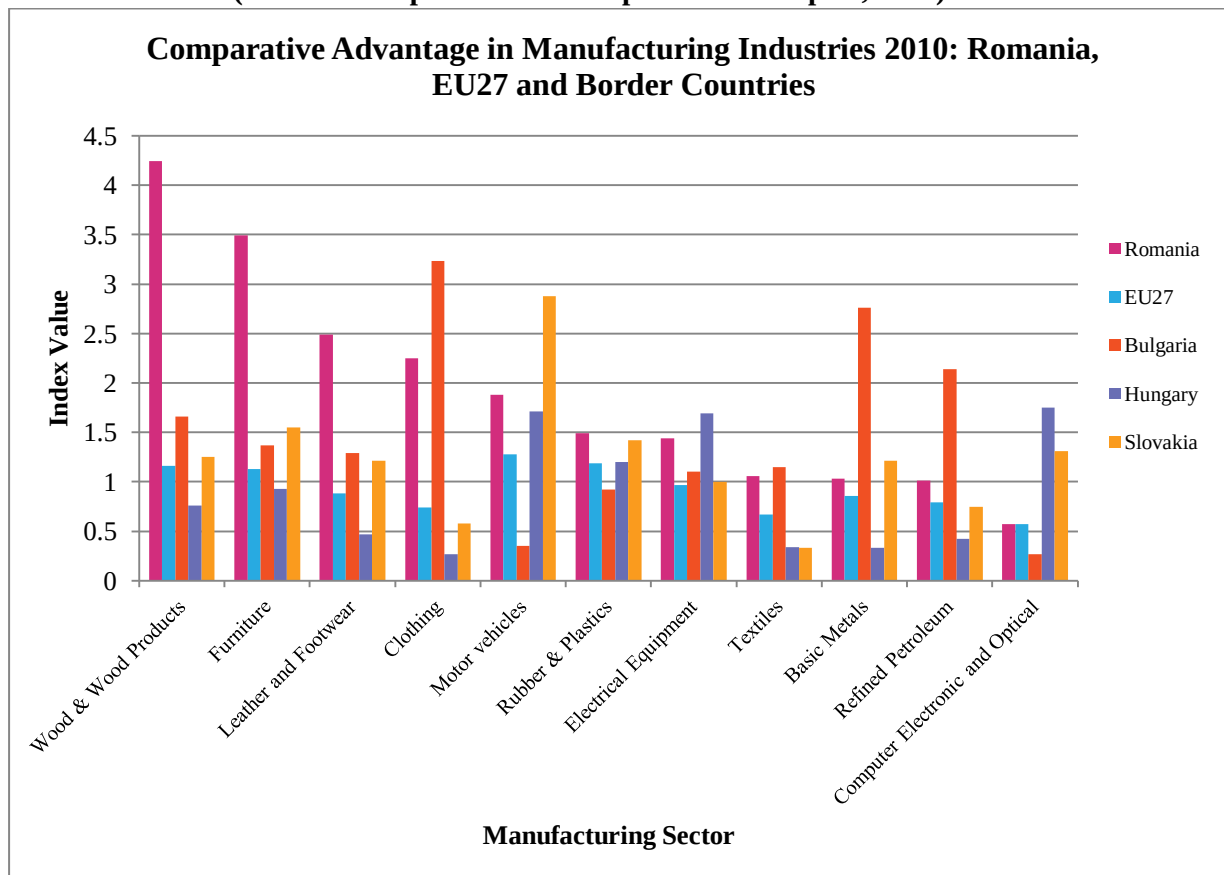


Figure 3.4g: Comparative Advantage in Manufacturing Industries 2010: Romania, EU27 and Border Countries (Source: European Union Competitiveness Report, 2012)



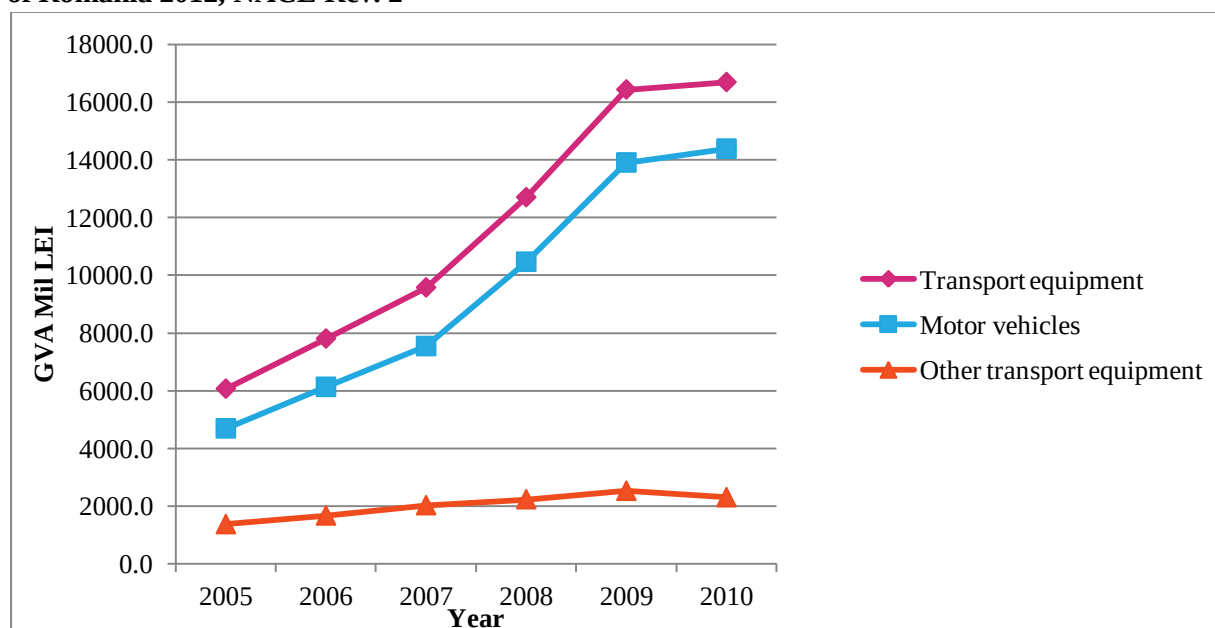
3.5 Overview of Manufacturing Sectors

Automotive (Motor Vehicles and Other Transport)

Two of the leading sub-sectors identified are motor vehicles and other transport equipment. The automotive sector is identified (Romanian Centre for Trade and Investment Promotion, 2012) as one of the key economic areas for the Country. The sector includes two global car producers (Ford and Renault) with over 500 automotive industry suppliers and has seen production growth of 4.5% between 2010 and 2011; forecast growth for 2012 of 8.0% and 9.1% for 2013. The sector is well supported by research with 11 technical universities and the largest Renault R&D facility outside France employing over 2300 engineers alongside private research being undertaken by Continental, Siemens and Ina Schaeffler. Alongside Renault and Ford the sector includes major automotive component suppliers in Electric and Electronic Systems, HVAC systems, exhaust systems, seating, plastic and rubber components, gearboxes, tyres and steering wheels.

The sector has the highest level of competitiveness identified in both the Romanian Cluster Association and the Romanian National Commission of Prognosis studies reflecting its economic importance, exporting and innovation. The sector is also showing promising potential. It has more than doubled its contribution to the gross added value between 2001 and 2009, while at the same time reducing its unit costs by 50% and a five-fold increase in productivity. Exports for the sector have also seen an increase of 80% in 2008 compared to the previous year (Cojanu, 2012)

Figure 3.5a Gross Value Added in the Automotive Sector 2005 -2010: Source: Statistical Annear of Romania 2012, NACE Rev. 2



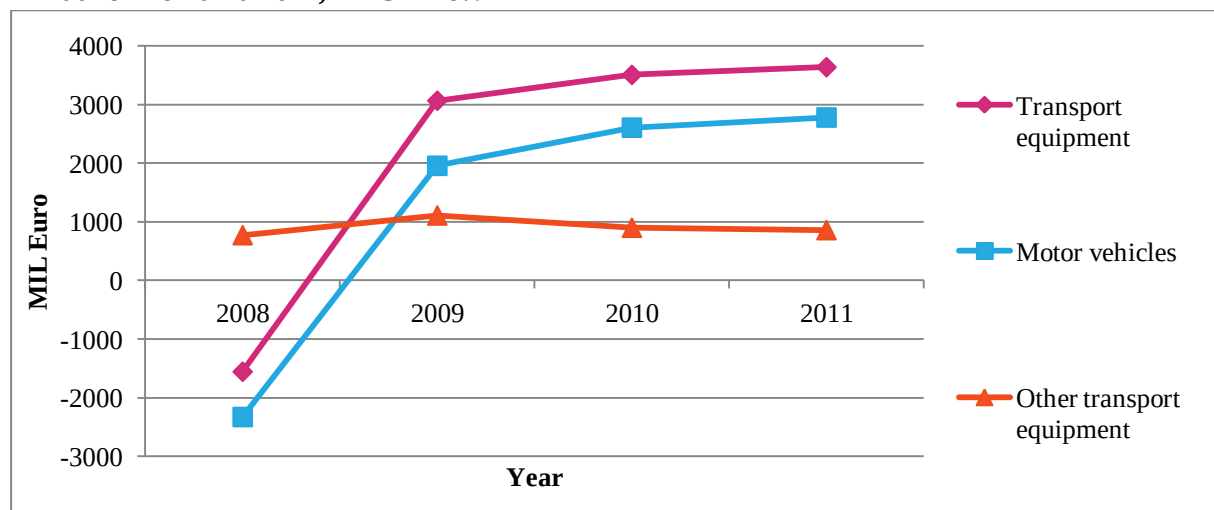
This is an industrial sector dominated by large enterprises (Dacia and Ford in the automotive sector). SMEs contributed only 2% to the overall gross value added in the transport equipment sector in 2012. In addition, the SMEs in the subsector of other transport equipment showed a decrease in turnover of 18.3 billion lei from 2008 to 2010 (Pislaru., 2012). The transport equipment sector is ranked first in terms of overall turnover produced by innovative companies (Pislaru., 2012) and R&D expenditure (over 170 billion lei in 2009). Over 80% of exports are represented by the automotive industry. The main export countries are Germany, France, Italy, Russia and Turkey. Dacia is ranked as the leading export company in Romania. Expenditure in research and development in the sector in 2010 was dominated by motor vehicles and to a lesser extent by other transport equipment.

The Romanian Business Review provides a current perspective on the Romanian motor vehicle industry (Sebesi, 2012). They identify that “despite the unfavorable international and local contexts, representatives of Ford Romania say the company is signing contracts on a daily basis for the B-Max model manufactured in Craiova and estimate they will supply about 400-500 units on the local market by the end of the first quarter of 2013”. Quoting Zoltan Brassai, general manager of Ford Romania, it was identified that “the company will produce 60,000 units in 2012 with this number due to increase in 2013. Company representatives estimated at the beginning of this year that production would increase to over 100,000 units in 2013. In May Ford Romania started production of the 1 liter EcoBoost engine in Craiova. Brassai said that Ford intended to produce between 800,000 and 1.3 million engines at plants in Romania and Germany during 2012-2015. The American carmaker announced at the end of June that it would make a 1.5 liter engine in Craiova, with mass production starting at the beginning of next year”.

In addition the article (Sebesi, 2012) identified that Renault Group, the owner of Dacia, “will invest over EUR 250 million in Romania this year. A robotized line of high tonnage presses, measures to double the capacity of the aluminum cast house and others to increase the gearshift production capacity by 30 percent are among the projects that will be carried out through this investment. Renault’s strategy is to promote its “budget” brand Dacia in Africa, trying to compensate for the strong contraction of the European market. Meanwhile Asian companies that manufacture low-cost cars are aggressively attacking Europe while premium carmakers like BMW and Mercedes-Benz are introducing smaller models. According to the ACEA, the European car market has contracted for the fifth consecutive year and will fall to its lowest volume since 1995 in 2012.”

The Romanian Business Review article (Sebesi, 2012) also identified that, “the international car market continues to struggle. The effects of the crisis on the Euro zone’s auto industry could generate over 500,000 layoffs as carmakers and car parts manufacturers seek to cut their costs and adapt their production capacity to the difficult economic conditions in an attempt to reduce their losses, says a Bloomberg analysis. Moreover, the car industry has cut about 800,000 jobs in the last five years. “It has become more obvious that production and the number of employees of some carmakers exceed the necessary capacity considering the drop in car sales in the Euro zone. The excess of production capacity is the main problem. The low level of sales is killing these companies,” says Ian Fletcher, analyst at IHS Automotive in London. At present about 30 percent of the car production capacity in Europe is unused.

3.5b Romania: Trade Balance in the Automotive Industry (2008 to 2011) Source: Statistical Annual of Romania 2012, NACE Rev. 2



In the same article (Sebesi, 2012) “APIA reports that production and assembly activity in Romania dropped by 7.2 percent in the first eight months of this year on the same period of last year to 202,474 units; imports decreased by 15.9 percent to 43,015 units; exports increased by 3.6 percent to 197,734 units while total sales on the local market dropped by 19 percent to 56,853 units (sales include passenger cars, commercial vehicles and buses)”.

Doing business in Romania (Doing Business in Romania, 2012) identified that “eexports of new vehicles during the nine months of 2012 (233,728 units) were higher by 3.9% compared to the same period in 2011. The increase is being driven by the higher export of passenger cars by 8% (223,619 units in 2012 compared with 207,108 units in 2011), while the exports of Load Carrying Vehicles (LCVs) were lower by 43.1% (10,109 units in 2012 compared with 17,774 units in 2011). The decrease recorded by LCVs has the same main cause, the discontinuance of production of model Ford Transit Connect. However, it is expected that the new Ford B-MAX will contribute to an increase in the volumes of exports during the last quarter of the year. As the domestic demand continues to be extremely low, the share of the exports in total production increased during 2012, representing 97.7% at the end of September 2012 (89.6% in 2011).

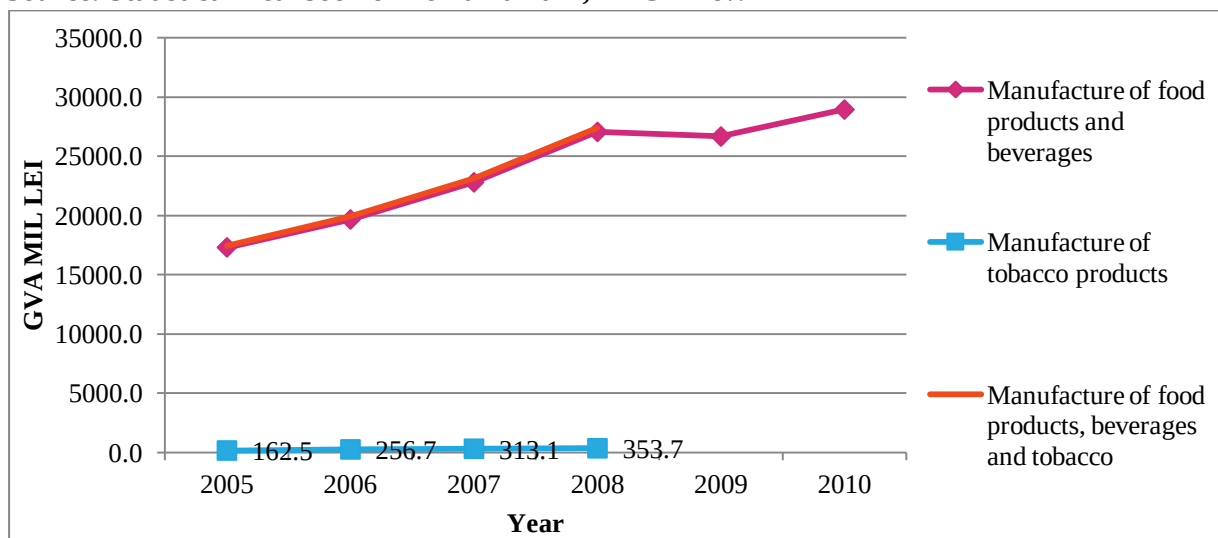
In the same article (Doing Business in Romania, 2012) it is highlighted that “industry data suggests that Romania boasts a strong integrated supply base with the presence of nearly 500 suppliers, employing around 100,000 staff. Traditionally, the segment has been dominated by electric systems manufacturers, but this is rapidly changing as a host of foreign players such as Michelin to Autoliv have gradually set up production in Romania. However, BMI research shows that much of this investment has been fairly unbalanced, as suppliers are mostly concentrated in the western part of Romania, where numerous industrial parks host vehicle manufacturers. More recently, however, the southern part of the country has emerged as an alternative region on the back of various investments. Another major concern for the parts segment is the low level of orders from carmakers due to slow recovery in auto production, which may delay new investments in the country. Business Monitor International (BMI) believes that Romania offers huge potential for the parts segment. It is strategically placed to serve demand in Western and Eastern Europe and an improved regulatory structure following EU accession has made it an attractive destination for investment”. Over 80% of the sector contribution to gross added value, R&D expenditures and exports is represented by the manufacturing of motor vehicles, trailers and semi-trailers. The main challenge of the sector is the horizontal integration of the car manufacturing industry in Romania.

Food and Beverages

The food and beverages sector contributes 26% to the GVA of manufacturing industry and 12% of its employment. As a result it is ranked as the first sector in the study of the National Commission of Prognosis for Competitiveness. The sector has improved its competitiveness overall by a factor of three between 2000 and 2009. The sub sector of tobacco is also highlighted in the same study as one of the major growing subsectors in the period 2010-2015, concerning investment, turnover and industrial output.

The food and beverage sector is SME dominated with around 7000 active enterprises in 2010. SMEs in the food sector contributing 13% of overall GVA of SMEs in industry. However, the sector is import oriented, with a trade deficit of 1 billion EUR in 2010. Exports consist mainly of cereals, meat products tobacco to countries including Spain, Italy, Hungary, South Korea and Saudi Arabia. Spend on Research and Development within the sector is dominated by food and beverage sector accounting in 2008 to 7,481,000 LEI in comparison to tobacco products which had 1,746,000 LEI of R&D expenditure.

Figure 3.5c Romania: Gross Value Added for the Food and Beverage Sector (2005 to 2010)
Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



Euro Monitor International in their market research report “Packaged Food in Romania” published in March 2012 (Euro Monitor International, 2012) identified that, “the economic recession was the main factor responsible for the performance of packaged food in 2011. The decline of available incomes came naturally as result of the austerity measures taken by the government in order to reduce the deficit, which impacted the incomes of employees in the public sector as well as in private companies; both categories having to cope with higher taxes and a changing attitude towards consumption under the impact of saving and caution regarding the future. As a consequence, the main trend in consumption consisted of the reduction of volume sales and the orientation of consumption to products of immediate need”.

The market research report (Euro Monitor International, 2012) also identified that “traditional and independent small grocers continued to be the dominant channels in 2011 and supremacy cannot be discussed yet due to their strong penetration in the majority of the cities and in rural area where large chains are absent but also where proximity is important to consumers. The expansion of large multinational retailers was one of the most important factors behind the dynamic performance of packaged food during the review period. Despite a reduction in the expansion rate of large retailers due to the adverse economic conditions, they continued to attract consumers in large and medium-sized cities and can be considered as the main channel to support modest but positive growth”.

The same research (Euro Monitor International, 2012) also concluded that “artisanal products continued to retain an indisputable leadership; a result of the domination of bakery products and huge sales of artisanal bread. On the other hand, the Romanian packaged food industry continued to be highly fragmented, with none of the present manufacturers being capable of exceeding a 4% share in 2011. Multinationals retained the top leading positions in packaged food, with Royal Friesland Campina ranking first in 2011 although far behind the artisanal producers. The low company shares reflected the industry as a whole, with a large number of small manufacturers competing successfully at regional level”.

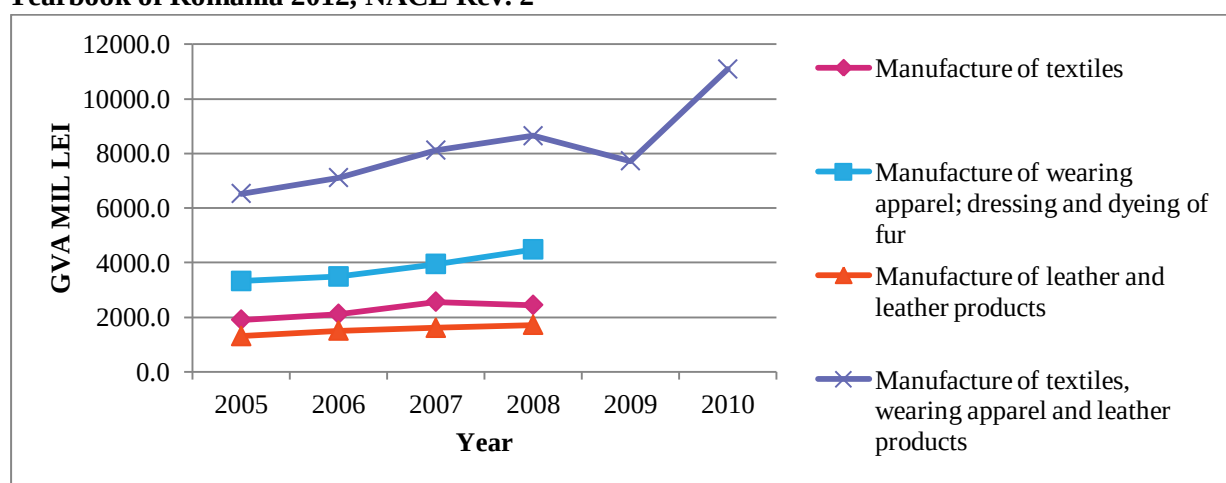
Textiles and Leather

The textiles and leather sector contributes 12% to Romanian exports and is the largest employer in manufacturing industry (25%). Its contribution to the GVA has increased by 30% between 2005 and 2008. R&D expenditure in the sectors recovered in 2010 after a significant decline in 2009 due mainly

to the contribution of the leather sector which accounted for 70% of R&D expenditures in the sector in 2010. While the overall trade balance is positive it should be noted that this is as a result of the positive trade balance of wearing apparel (clothing). Overall the sector ranks 4th in number of SMEs (3904 enterprises in 2009) and contributes approximately 10% to the overall GVA produced by SME businesses.

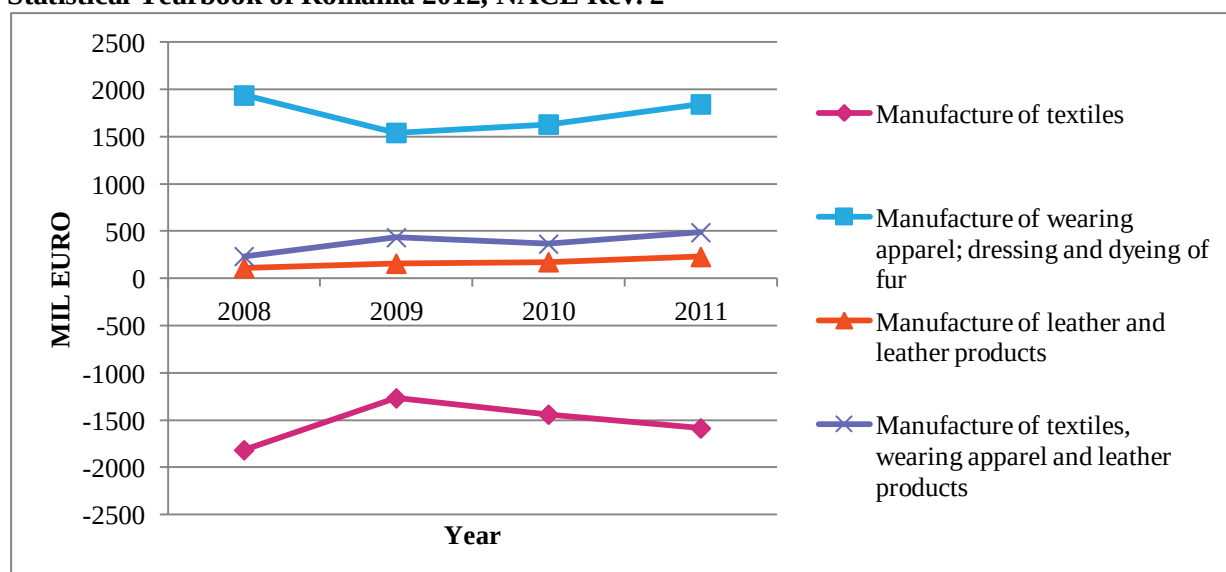
In 2010, Romania accounted for 1.59% of European Union turnover, represented 9.6% of the labour force, 4.7% of the number of enterprises, 0.71% of clothing exports and 0.61% textile exports. (Bucur., 2012). Technical textiles, intelligent textiles and personalised apparel are seen to be the most important development trends of the Romanian textile industry. Textile exports are mainly represented by the classical wearing apparel (clothing) component.

Figure 3.5d Romania: Gross Value Added in the Textile and Leather Sectors Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



It is however considered a modest innovator assessed by means of turnover produced by innovative SMEs (Pislaru., 2012). Research and development in leather and textiles in 2010 is dominated by leather and leather products (69%) with textiles and clothing representing 25% and 6% respectively of R&D expenditure.

Figure 3.4e Romania: Trade balance in Textiles and Manufacturing 2008 to 2011 Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



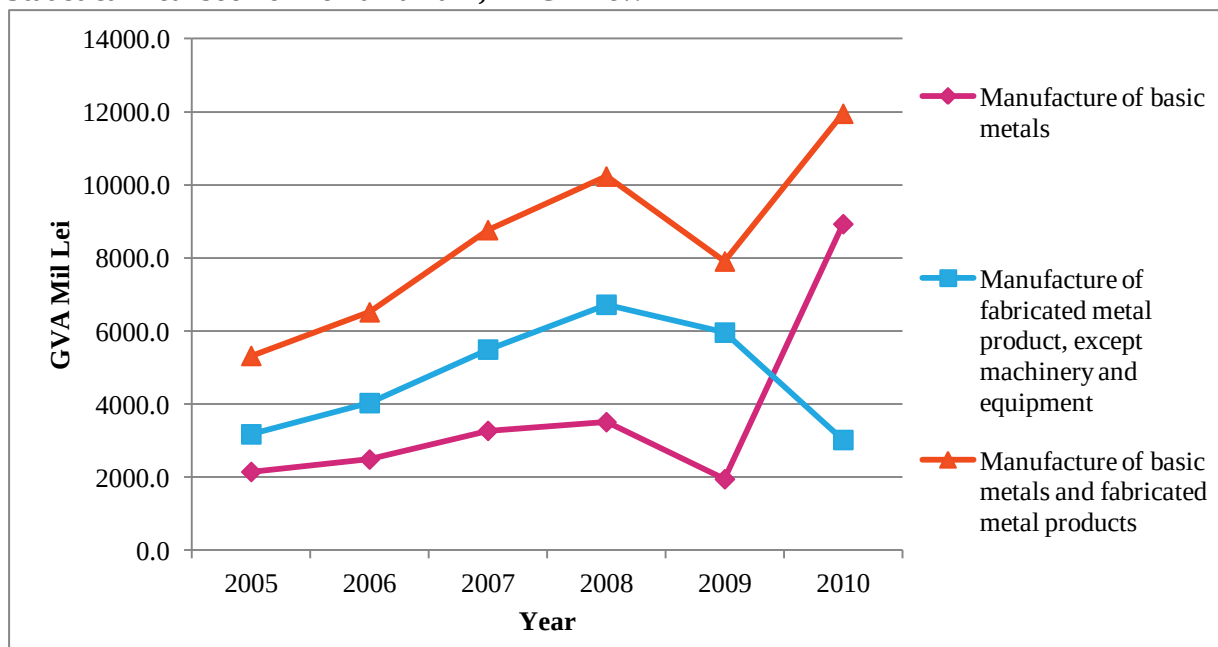
Euro Monitor International in their market research report “Apparel in Romania” published in August 2012 (EuroMonitor International, 2012) identified that “the apparel market experienced one of the best-case scenarios in 2011, almost managing to maintain the sales recorded in 2010, and it managed to maintain consumers’ attention through frequent discounts and special marketing strategies.”

Euro Monitor (EuroMonitor International, 2012) also identified that, “the apparel market is expected to see gradual, mild recovery throughout the five year forecast period. One of the key factors influencing this trend will be Romanians’ shift in purchasing behaviour, from extensive to cautious. Discounts and promotions generate most of the sales in the market, by providing consumers with the perception of saving money. Thanks to the strong interest of international fashion retailers in the market and the increasing economic upsurge, consumers will be offered an even wider array of apparel options; thus both value and volume sales are expected to increase. The presence of online retailers and the possibility to order items from home will be other drivers of sales in terms of both demands, as consumers have to invest less effort in shopping, and supply, as e-stores are cheaper to launch, manage and promote.”

Metallurgy

Metallurgy accounts for 12% of employment in the manufacturing industry and for 10% of exports. Iron and steel represent 41.5% of exports in metallurgy and products of iron and steel (27.2%). The second category is mainly represented by tubes, pipes, hollow profiles and steel fittings. The top five export destination countries are Germany, Italy, USA, France and the Netherlands. The top five destinations are Italy, France, Germany, United Kingdom and Austria. Arcelor Mittal ranks 4th in the top 20 of Romanian exporters (steel products).

Figure 3.5f Romania: Gross Value Added in the Metallurgy Sector 2005 to 2010 Source: Statistical Yearbook of Romania 2012, NACE Rev. 2

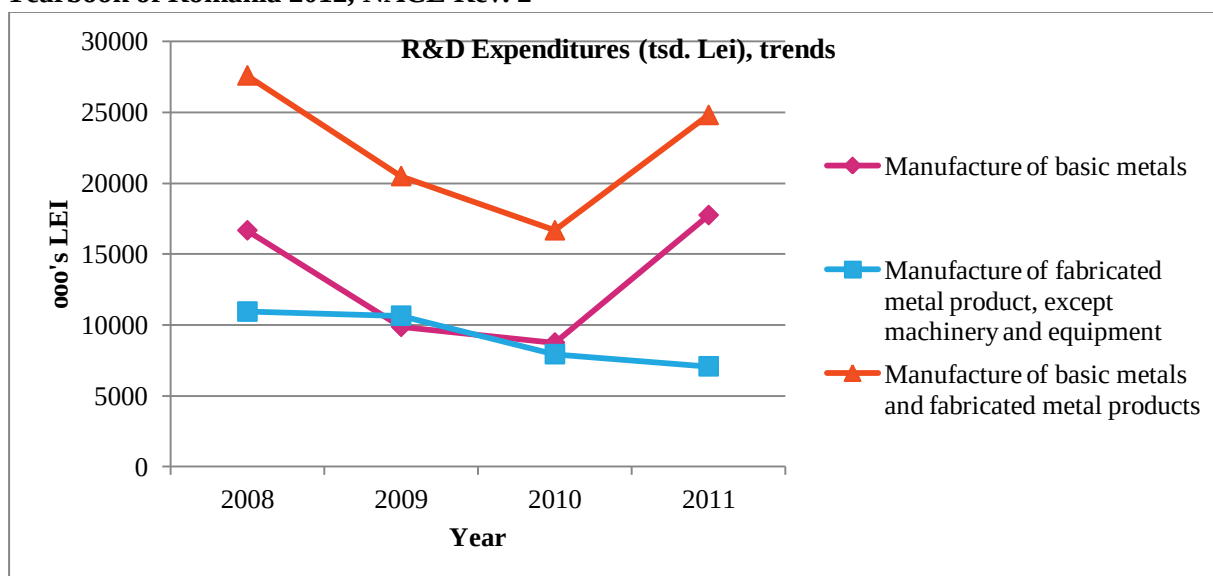


The Romanian Business Digest in their November 2012 article (Munteanu, 2012) “Metal industry faces bleak perspectives” identified that “After the sharp 45% year on-year decline in 2009, the industry had a 35% comeback in 2010, based on the gradual recovery of the Euro zone, where Romania exports most of its metal products. However, the growth lost steam in 2011 and slowed down to only 2.9%, up to 3.8mn tons. The slight increase of Romania’s medium export prices for steel products, up to USD 1,054 per ton in 2011, contributed to the positive evolution of the industry”. “The situation worsened in 2012,

when prices and demand for steel, which represent a barometer for the economy evolution, reached their minimum levels within the last three years.”

In addition the article highlighted that “in Romania, crude steel production decreased by 7.51% year-on-year in the first nine months of 2012, down to 2.62mn tons, according to World Steel Association (WSA) data. “The metal industry is still deep in crisis and I expect it will not get out of it in 2013 either,” said Mircea Budur, executive director of UniRomSider. The WSA forecasted in October that the global apparent steel use will increase by 2.1% in 2012, which is considerably lower than the 6.2% growth achieved in 2011 and the 3.6% forecasted in April. The association lowered its growth expectations for 2013 as well, from 5.6% in April to 3.2% in October. The moderate growth expectations for 2013 can be achieved only if the euro zone controls the crisis, the US manages to deal with its fiscal tightening due next year and if the economic stimuli measures show their effects in China”.

Figure 3.5g Romania: R&D Expenditure in the Metallurgy Sector 2008 to 2011 Source: Statistical Yearbook of Romania 2012, NACE Rev. 2

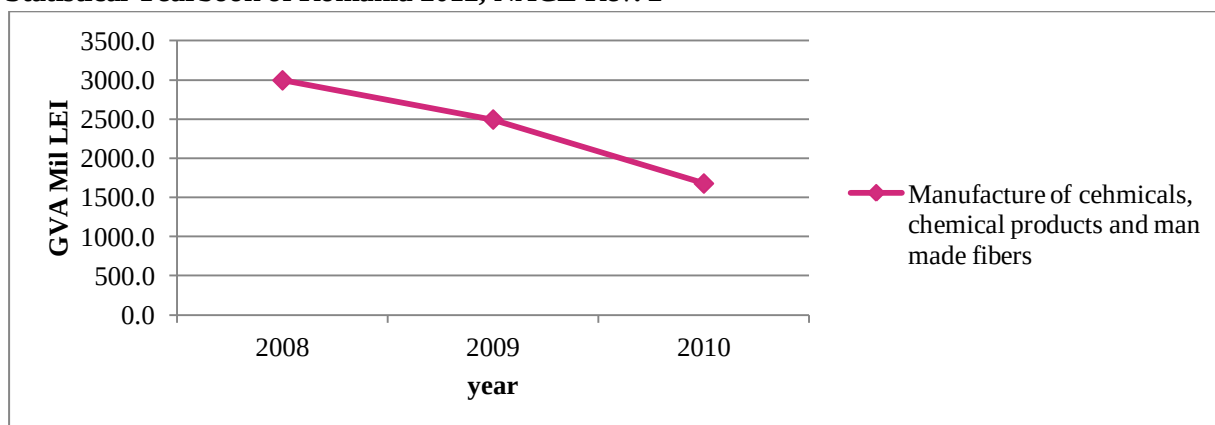


Chemicals

The chemical sector is high-skilled with 17% of employees having a tertiary education; it also represents 20% of R&D expenditure in manufacturing industry. However R&D expenditure has slowly decreased over the last 3 years and the trade balance of the sector is negative. Exports from Romania represented 0.59% of the world market in 2009. Over 90% of Romanian sector exports are represented by fertilisers. Leading export markets include Turkey, USA, Hungary, Kenya and Bulgaria.

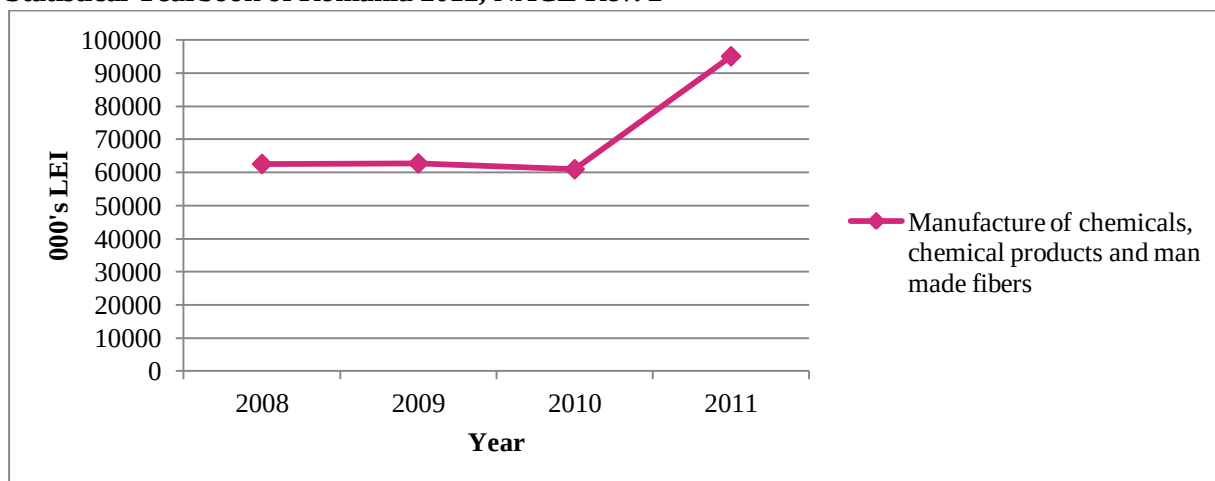
Press Release Newswire reporting in January 2013 (New Market Research Report: Romania Petrochemicals Report Q1 2013, 2013) on the release of a market research report “Romania Petrochemicals Report Q1 2013” by Business Monitor International highlighted that, “by 2012, Romania had modest olefins capacities of 200,000 tonnes per annum (tpa) ethylene and 100,000tpa propylene. Polyolefins capacities in 2011 were: 160,000tpa high density polyethylene (HDPE); 160,000tpa low density polyethylene (LDPE); 80,000tpa polypropylene (PP); 60,000tpa polystyrene (PS); and 170,000tpa polyvinyl chloride (PVC). The structure of the industry, poor infrastructure and low capacities has long been barriers to growth and investment.”

Figure 3.5h Romania: Gross Value Added for the Chemicals Sector 2008 to 2010 Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



In addition the market research report identified that “the monthly production index for chemicals and chemicals products fell 9.0% year-on-year in the first seven months of 2012, while the rubber and plastic production index fell 12% year-on-year. This indicates that there has been a reversal in the gains that the Romanian petrochemicals industry made in 2011, when chemicals output grew 9% and rubber and plastics output grew 6%. The indications are that 2012 may be as bad as 2009, when the industry was hit by the effects of the international financial crisis of 2008. The restructuring and integration of the Romanian petrochemicals industry with local refinery capacity is seen as key to any revival. Until the situation is resolved, the country's petrochemicals industry will operate below its full potential.”

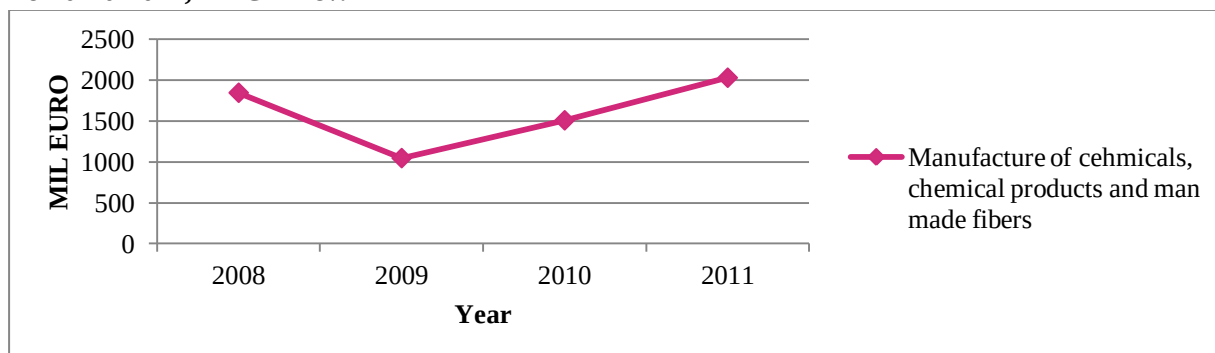
Figure 3.5i Romania: Expenditure on R&D in the Chemical Sector (2008 to 2011) Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



Regarding the pharmaceutical sector, an article in the Romanian Business Review published in February 2013 (Posirca, Romania's pharma sector faces weak growth prospects, 2013) identified that “while this expanded by 5 percent to EUR 2.7 billion in 2012, industry players are warning that this year's growth will be hindered by Romanians' impeded access to healthcare services, combined with delayed payment terms and a controversial claw-back tax. In an industry dominated by innovative medicines, the generics are trying to gain ground on the backdrop of a hostile legal environment. The innovative sector represented 75 percent of the market and around 25 percent of the volume in 2012. The rest belonged to generics, which are medicines whose patents have expired, allowing other firms to make and market their own versions. In spite of the tough market, the innovative industry has invested heavily in clinical testing. ARPIM estimates that companies have invested between EUR 100 and 200 million locally in 2012.”

The article also identified that “Romania has some of the lowest regulated medicine prices in the EU, in an effort to give more Romanians access to treatment. This has led to constant growth in the parallel trade of pharmaceuticals. These exports soared by 40 percent to EUR 700 million in 2012.”

Figure 3.5j: Romania: Chemical Sector Exports 2008 to 2011 Sources: Statistical Yearbook of Romania 2012, NACE Rev. 2



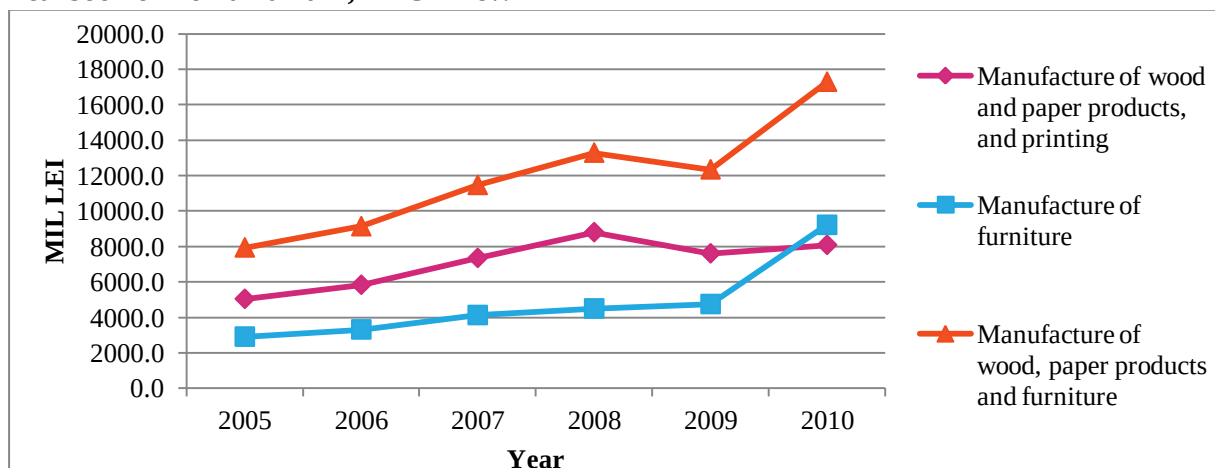
Wood and Paper

Representing 12% of employment in manufacturing industry the wood and paper sector has seen a decrease of 66% in R&D expenditure between 2008 and 2010. Despite this the trade balance of the sector is positive and increasing (due mainly to the paper component) as a result of an increase in productivity between 2005 and 2009, a reduction in unit costs and an increase in exports.

The sector is dominated by SMEs who contribute more than 12% to the overall SME GVA. The sector is ranked third for the number of SME businesses (over 5000 only in the wood sector in 2010). However the sector is a modest innovator with 46% of the wood exports represented by “raw” wood and 20% by wooden boards.

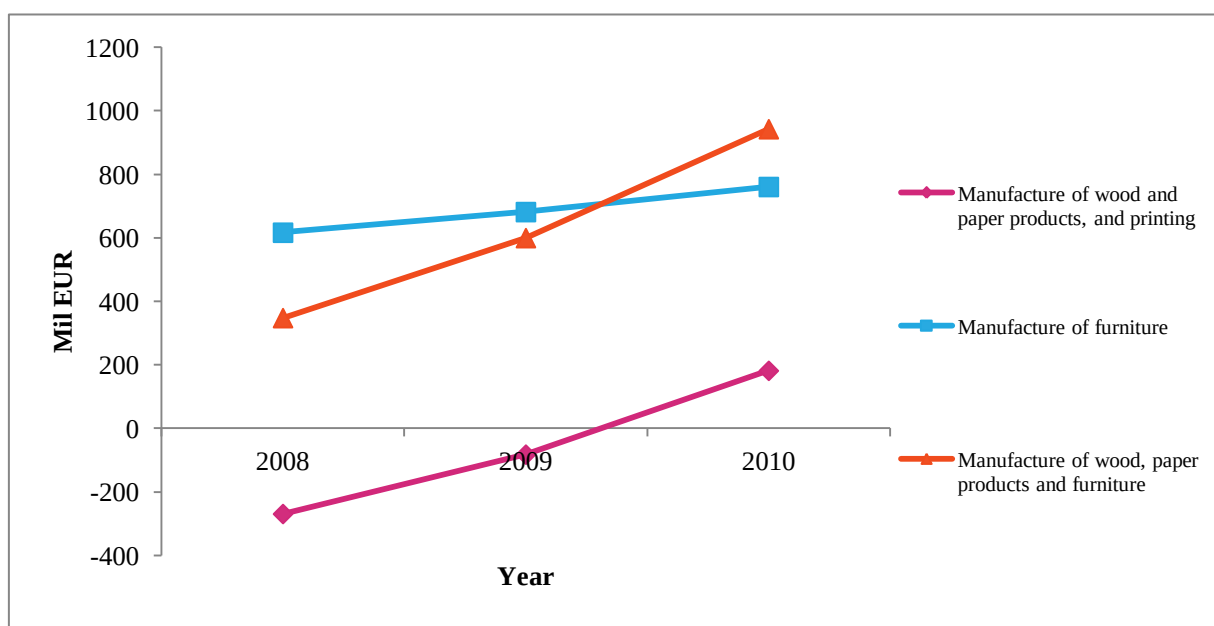
Top export destinations for the wood sector are Italy, Japan, Turkey, Egypt and Austria. With regard to the furniture sub-sector 50% of the exports are represented by chairs, top export countries including Germany, France, Italy, United Kingdom and the Netherlands. Research and Development expenditure in the sector is limited with 317,000 Lei sent on furniture manufacture in 2010 and 149,000 Lei spent in 2010 on wood, paper products and printing.

Figure 3.5k Romania: Gross Value added in the Wood Sector (2005 to 2010) Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



The Romanian Business Review in an article from November 2012 (Bazavan, 2012) highlighted that “Romanian furniture manufacturers have exported furniture worth approximately RON 822 million (approximately EUR 183 million) in the first 7 months of 2012, up 10.2 percent year-on-year, according to data from the National Institute of Statistics. Furniture imports amounted to RON 185 million (approximately EUR million) for the same time period, up 0.6 percent year-on-year. Highly dependent also on the construction and real estate field, the internal furniture market is not showing signs of recovery, leaving many manufacturers and retailers with the only option of doing business outside the country. Exports to EU countries, and even more so, to markets outside the EU, are expected to further increase in 2013.”

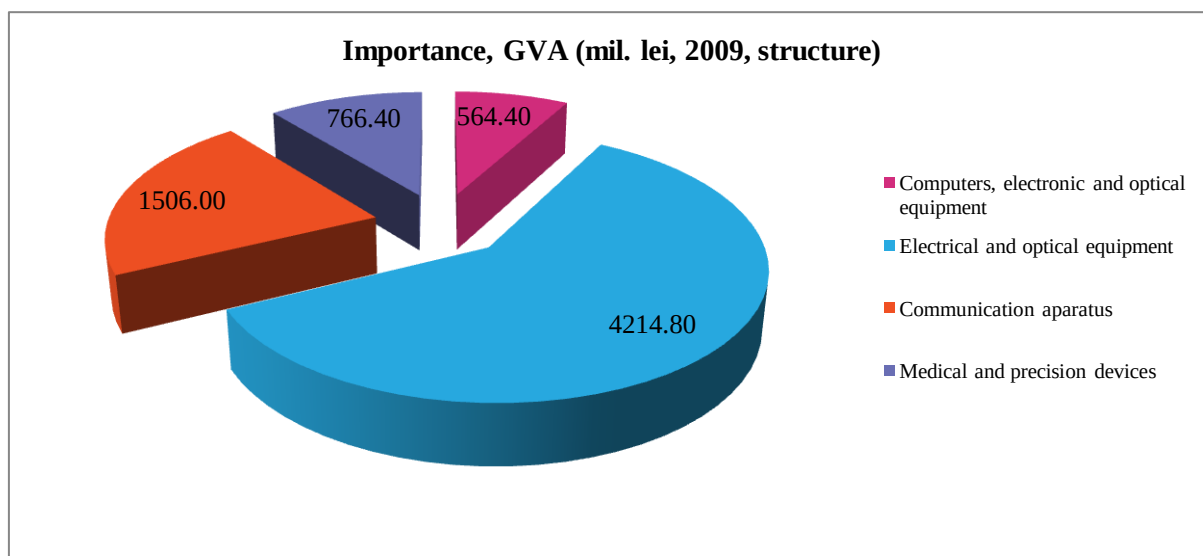
Figure 3.5I Romania Trade Balance in the wood sector 2008 to 2010 Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



Electronics

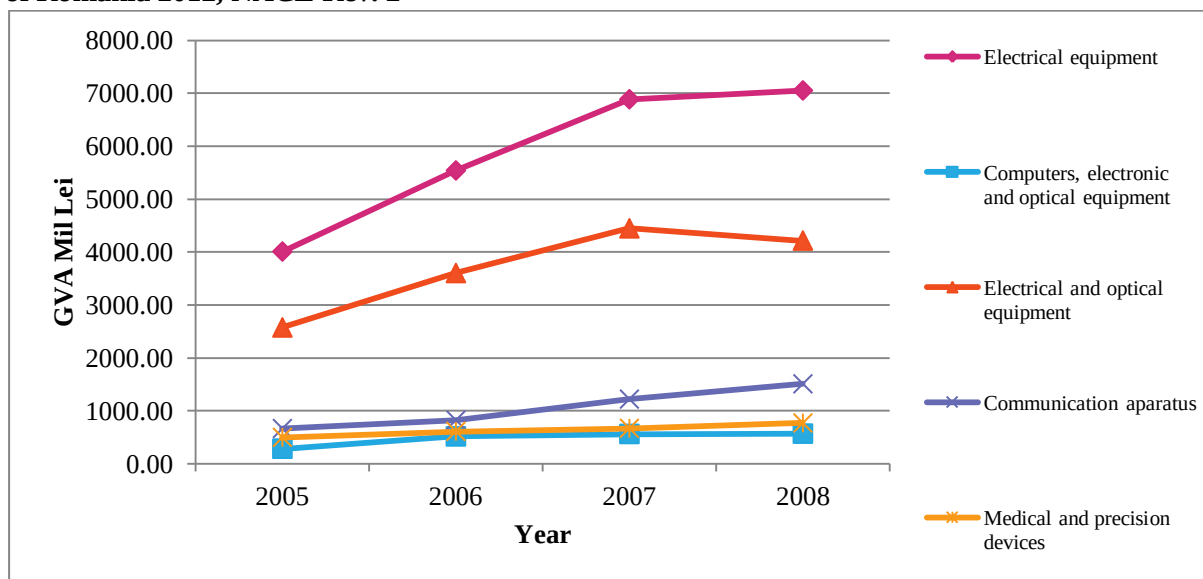
The electronic sector is high-tech and high-skills based with 17% of people employed having a tertiary education and accounting for 12% of R&D in manufacturing overall. Accounting for 18% of exports at a national level, the manufacturing of electrical equipment represents one of the most important sectors of the Romanian economy. It is also one of the most important innovating industries according to the Study of the National Commission of Prognosis (Pislaru, 2012). One particular subsector, the manufacturing of medical and precision devices has doubled its contribution to GVA between 2005 and 2008.

Figure 3.5m Romania: Gross value Added in the Electronics Sector, 2009 Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



The sector is a strong exporter with 5 of the top 20 Romanian export companies trading in the sector (Flextronics, Takata, Samsung, Celestica, Delphi). The leading export markets for the sector are Germany, Italy, Hungary, France and the UK.

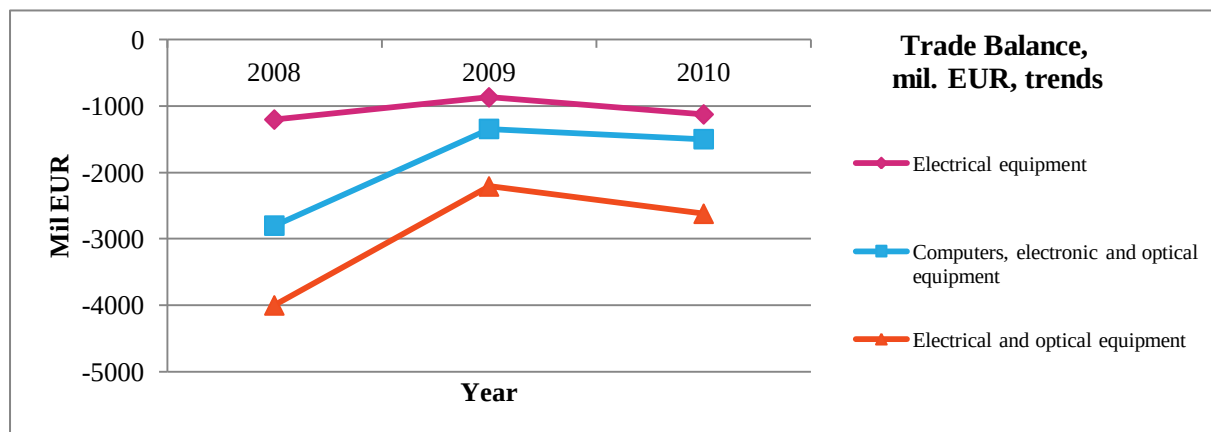
Figure 3.5n Romania: GVA in the Electronics Sector (2005 to 2008) Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



The inclusion of medical, precision and optical instruments in research and development expenditure is interesting as this is not reflected in importance based on turnover, employment or value added, however its inclusion in the profile of R&D expenditure may highlight a potential new embryonic sector. Interestingly this market is being actively targeted by importers as is evidenced by the US Commercial Service in its Romania 2012 commercial guide (US Commercial Service, 2012). They identify that “the Romanian market for medical equipment and supplies is estimated at US\$373 million, and is expected to grow by an average 8.9% in the 2011-16 periods. This will bring the total to around US\$571 million (US\$27 per capita) by 2016. Around 90% of the medical device market is supplied by imports. These have risen sharply in recent years, as the general level of health spending increases and new diagnostic equipment has been purchased for hospital refurbishments. The growth of the private

hospital market over the next five years is also likely to boost spending, as demand for private healthcare grows with improvements in economic growth and income. Demand for medical equipment in Romania is almost entirely met by imports, with a number of smaller domestic manufacturers holding a market share of less than 10%. GE Healthcare, Siemens and Philips hold the majority market share in the country”.

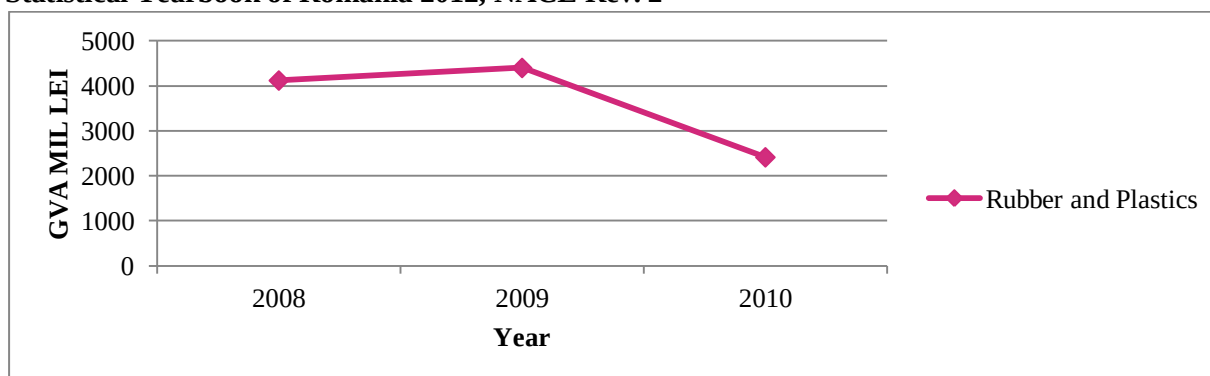
Figure 3.5O Romania: Trade Balance in the Electronics Sector (2008 to 2009) Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



Rubber and plastics

The rubber and plastics sector is considered in the study by the National Commission of Prognosis as one of the sectors with the highest growth potential. It has doubled its contribution to the GVA between 2001 and 2009. It has constantly registered high value of the competitiveness index (ICCS). This positive improvement is largely due to an increase in productivity, cost reduction and high investment rates (Cojanu, 2012). Leading export markets for sector of which 60% is represented by tyres, are Germany, Hungary, France, Italy and Poland. Plastics are exported mainly to Italy, Germany, Bulgaria, Hungary and France.

Figure 3.5p Romania: Gross Value Added in Rubber and Plastics (2008 to 2010) Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



Other non metallic products

With competitiveness values similar to the industrial average, the other non-metallic products sector is considered by (Cojanu, 2012) as showing important potential. It has increased its world market share five times between 2000 and 2009.

Figure 3.5q Romania: Gross Value Added in Other Non-Metallic Products (2008 to 2010) Source: Statistical Yearbook of Romania 2012, NACE Rev. 2

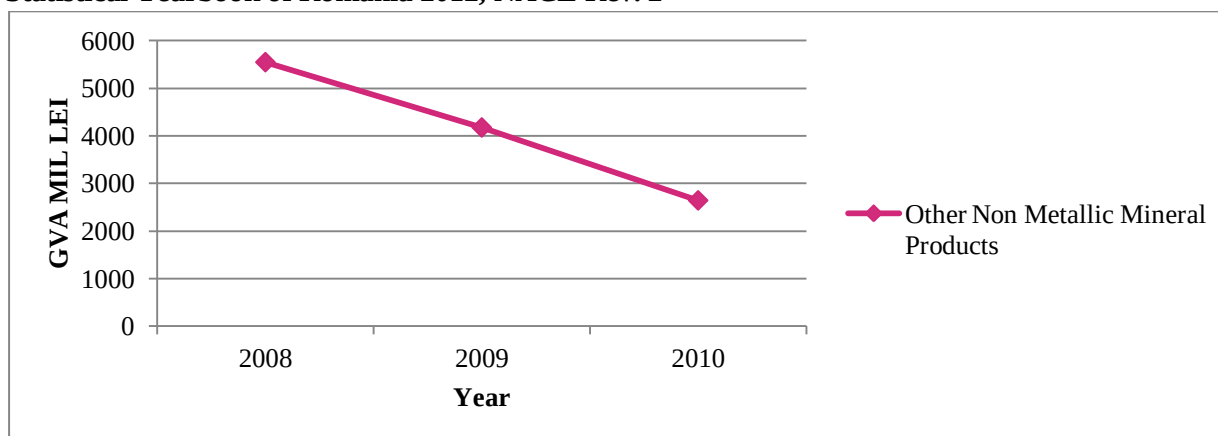
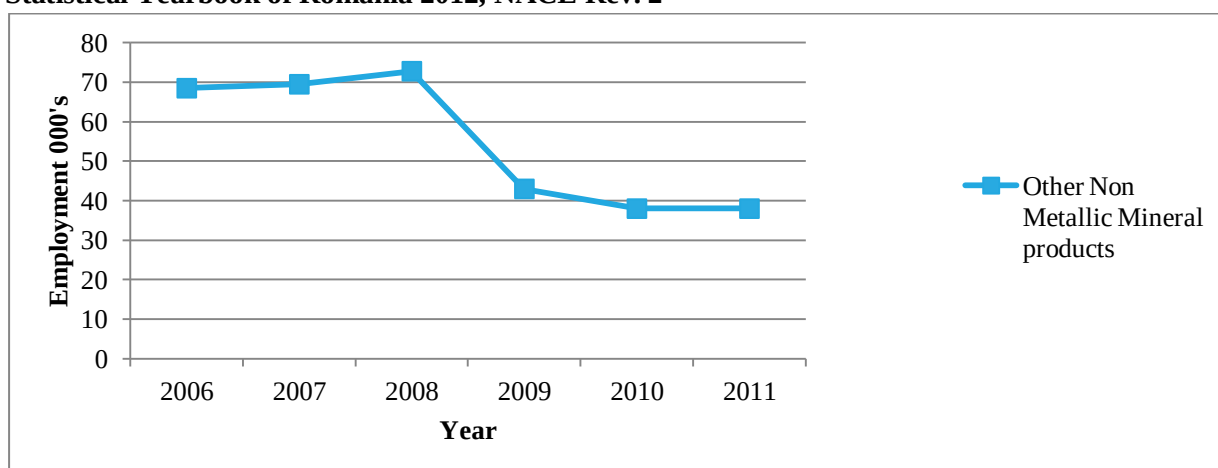


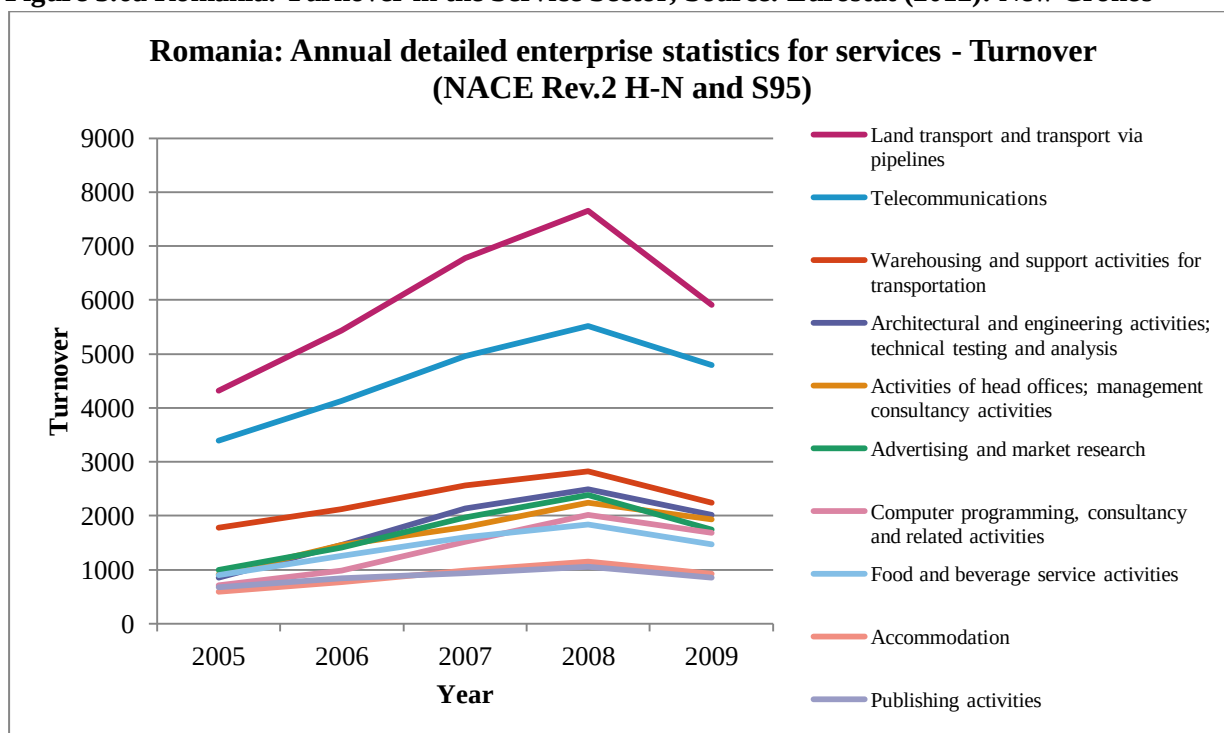
Figure 3.5r Romania: Employment in Other Non-Metallic Products (2006 to 2011) Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



3.6 Service Sector Performance

While manufacturing is important in the Romanian context for value added the service sector overall has a similar contribution level. This section will determine the most important areas of the service sector economy and assess which areas have potential to be considered within a smart specialisation strategy approach based on a review of the number of businesses, value added, employment and wages and salaries.

For the service sector our analysis of specialisation is based only on skills. Considering turnover growth in the service sector, the highest ranking sectors have been profiled (figure 3.6a). Of these sub-sectors, computing and related activities (linked to computer programming and information services) is identified as a highly skilled and postal and telecommunications identified as high intermediate skill. Although not listed within the skills taxonomy the sub-sectors of Architecture, professional and scientific services and legal, accounting and management consulting activities can all be considered highly skilled.

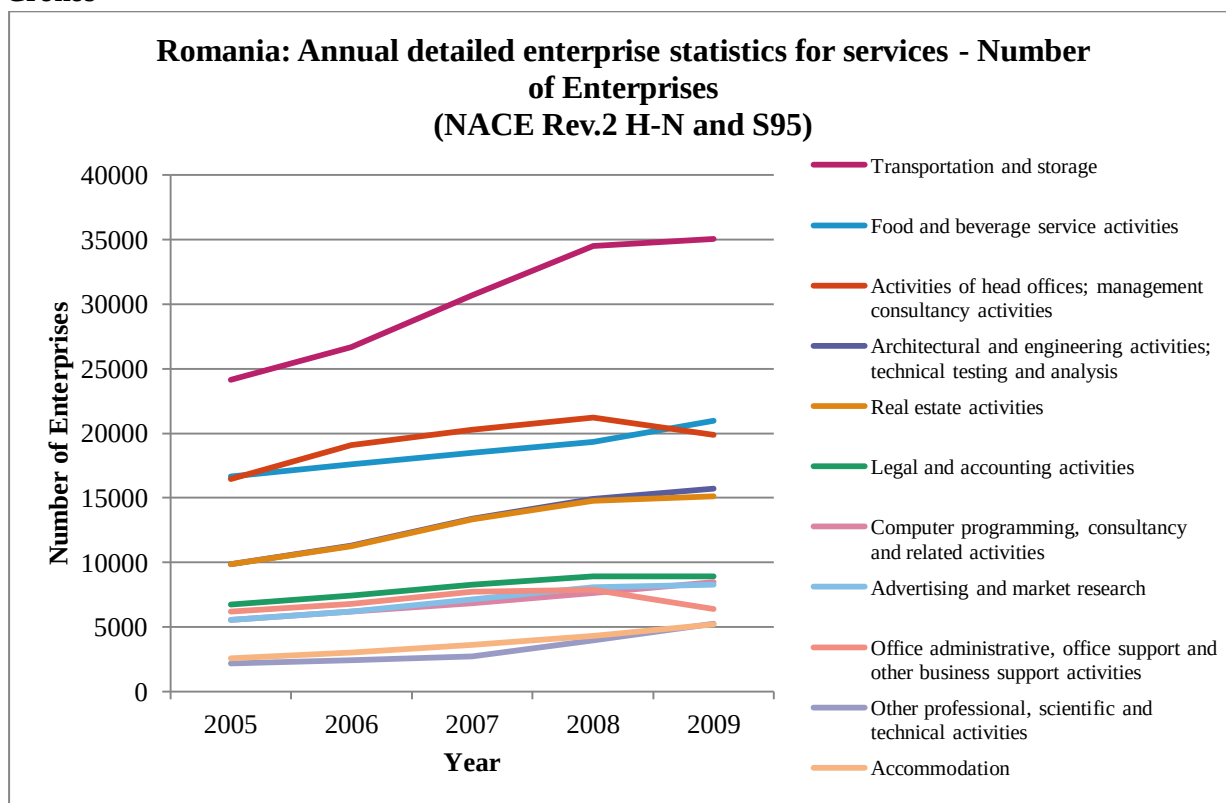
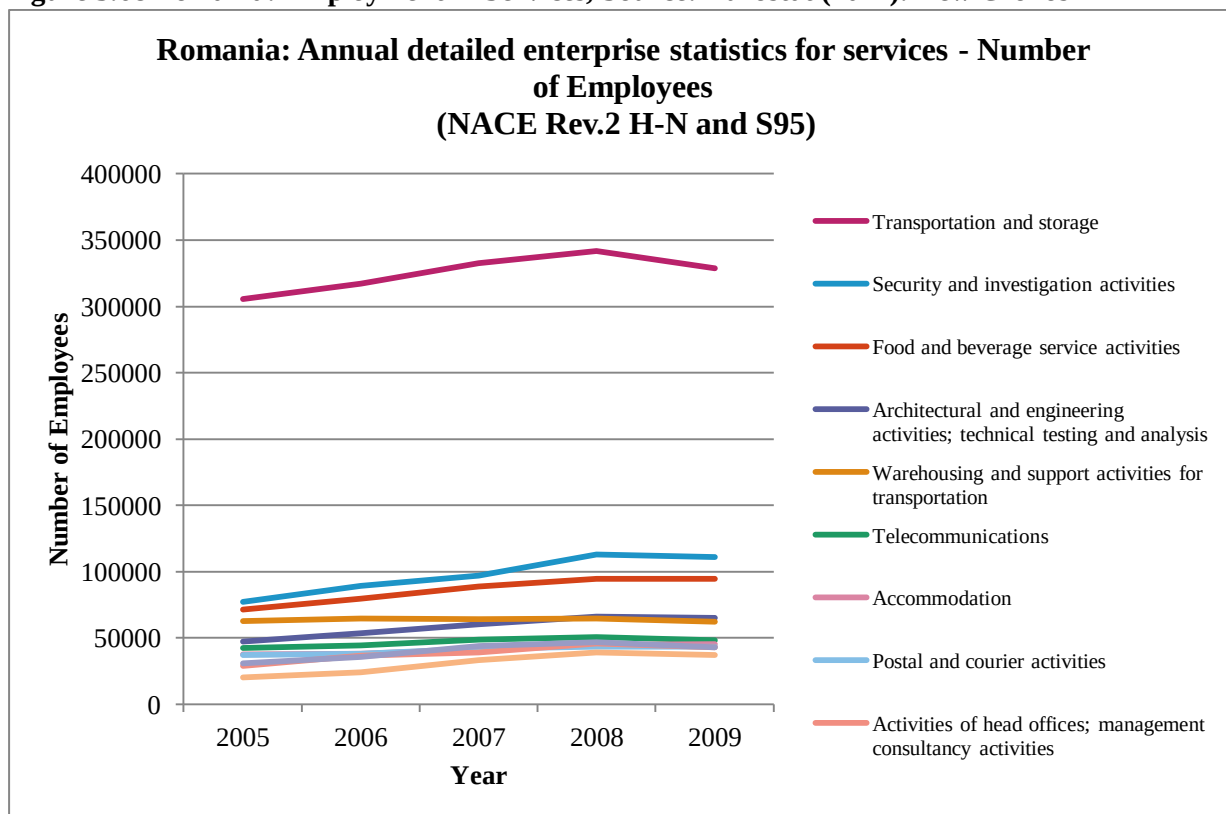
Figure 3.6a Romania: Turnover in the Service Sector, Source: Eurostat (2012): New Cronos

An analysis of the number of service sector businesses in Romania (figure 3.6b) reveals a dominance of professional scientific and technical activities.

Along with real estate and information and communications activities these are the areas of high skill intensity. While important and representing a significant part of the business population the sub-sectors of accommodation and food, food and beverage services and transportation and storage represent low or low intermediate skills.

Similarly considering employment (figure 3.6c) the importance of transportation and storage can be seen. Professional, scientific and technical activities alongside information and communication both rank relatively highly in employment with real estate employing less people.

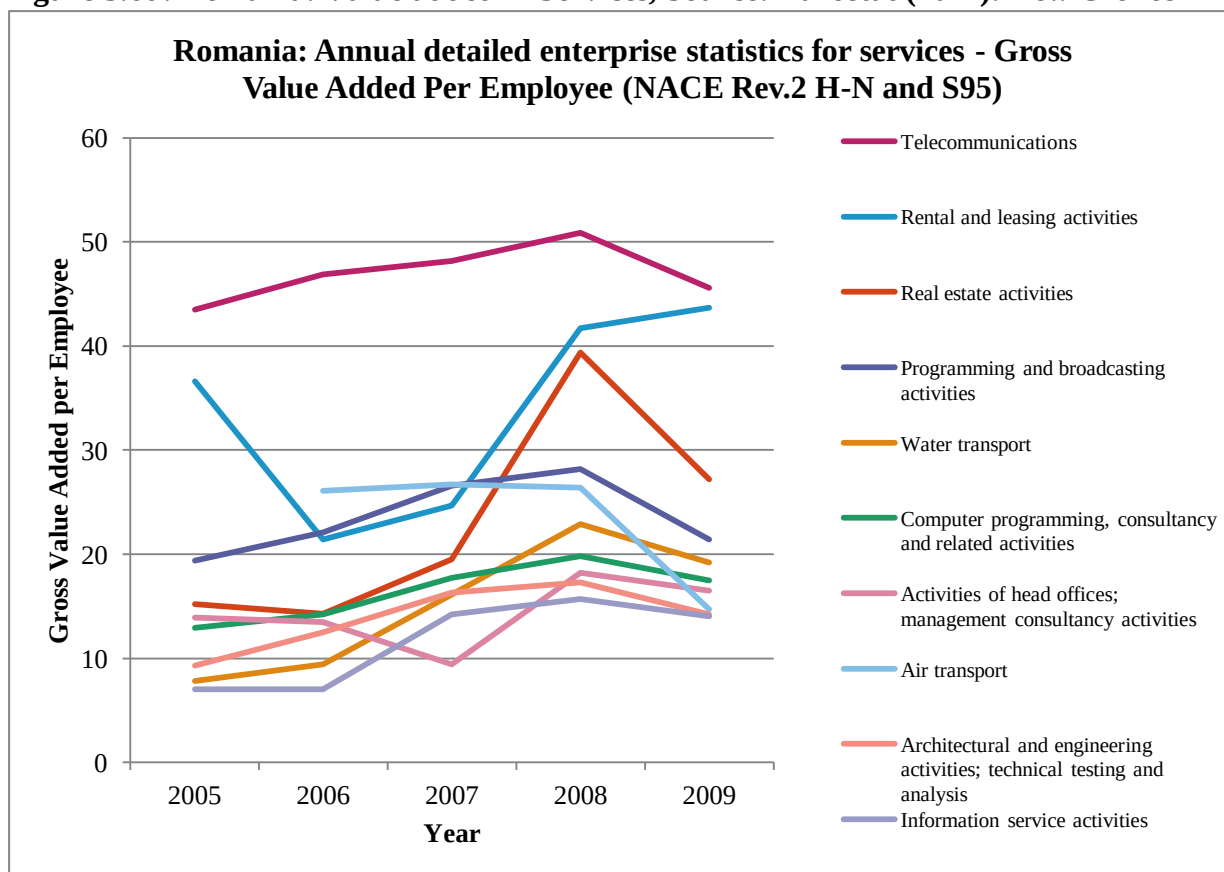
Data available of wages and salaries for 2008 and 2009 overall ranks transportation and storage at the highest level reflecting the level of employment and number of businesses overall. The wages and salaries for information and communications and professional, scientific and technical activities are ranked second and third respectively.

Figure 3.6b Romania: Number of Enterprises in the Service Sector, Source: Eurostat (2012): New Cronos**Figure 3.6c Romania: Employment in Services, Source: Eurostat (2012): New Cronos**

Considering value added per employee (figure 3.6d) the importance of high-level skills can be seen with highest levels of value added per employee seen in information and communications activities and in professional, scientific and technical services. The low skills and low intermediate skill sectors as expected rank lower in this measure of value added per employee.

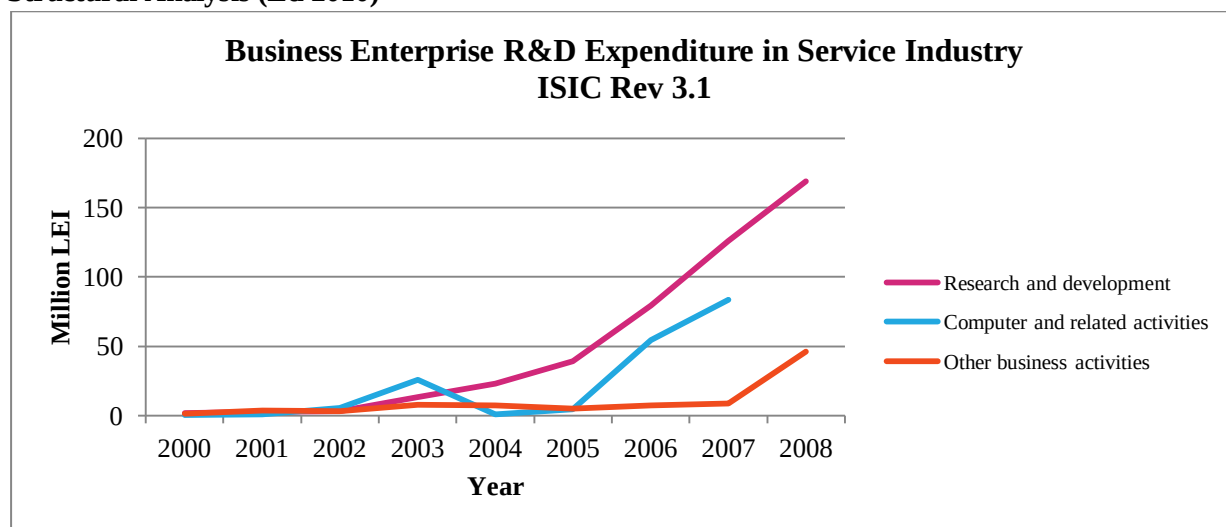
An analysis of business expenditure in research and development in the subsectors of other services (figure 3.6e) confirms this focus on high-level skills with research and development activities and information and communication represented strongly through the representation of software, consultancy and supply, computing and related activities and other computer services.

Figure 3.6d: Romania: Value added in Services, Source: Eurostat (2012): New Cronos



Overall this assessment of other service activities highlights for Romania the importance of information and communications and professional, scientific and technical services. The ICT sector in Romania has been identified (Romanian Centre for Trade and Investment Promotion, 2012) as one of the key economic areas in the country. It represents one of the fastest growing markets in Central and Eastern Europe with over 8000 software and IT service companies with 23% of the workforce employed in science and technology activities. Key centres for development are based in Bucharest, Cluj-Napoca, Timisoara and Iasi. The sector is represented by key global players in Romania including Siemens, Intel, Oracle, Microsoft, HP and IBM. Growth within the sector is foreseen in hardware, PC sales, software and IT services. The ICT skills base in Romania is strong with a high number of ICT specialists and ICT graduates.

Figure 3.5e Romania: Business R&D Expenditure in ‘Other Services’ Sub Sectors, Source: OECD Structural Analysis (Ed 2010)



The software and IT services market depends on corporate and public sector customers. The biggest purchasers of software and IT services are in production, telecommunication, banking, and public industries. Spending takes the form of licenses, consultancy, system integration, specific applications development, training, and external services. Demand from verticals like utilities, government, retail, manufacturing and telecommunications will continue to grow significantly as the economic conditions improve. The market structure will develop toward a higher significance of IT services and software and decline in the share of hardware in the overall IT market value. This should cause the Romanian IT market to begin to follow the path of more matured IT markets (both in other CEE countries and Western Europe). Both software and IT services sectors over the long term will grow significantly faster than the hardware segment (US Commercial Service, 2012).

An article published in Romania Business Review in December 2011 (Haraga, IT market in Romania will grow by 12.7 percent next year, says Erste Group report, 2011) identified that “the IT market in Romania is set to grow by 12.7 percent in 2012, according to a report by Erste Group on the Central and Eastern European region. “After a drop over the last three years, the Romanian IT market is on a positive trend. In the private sector, SMEs are increasingly interested in IT products and services.”

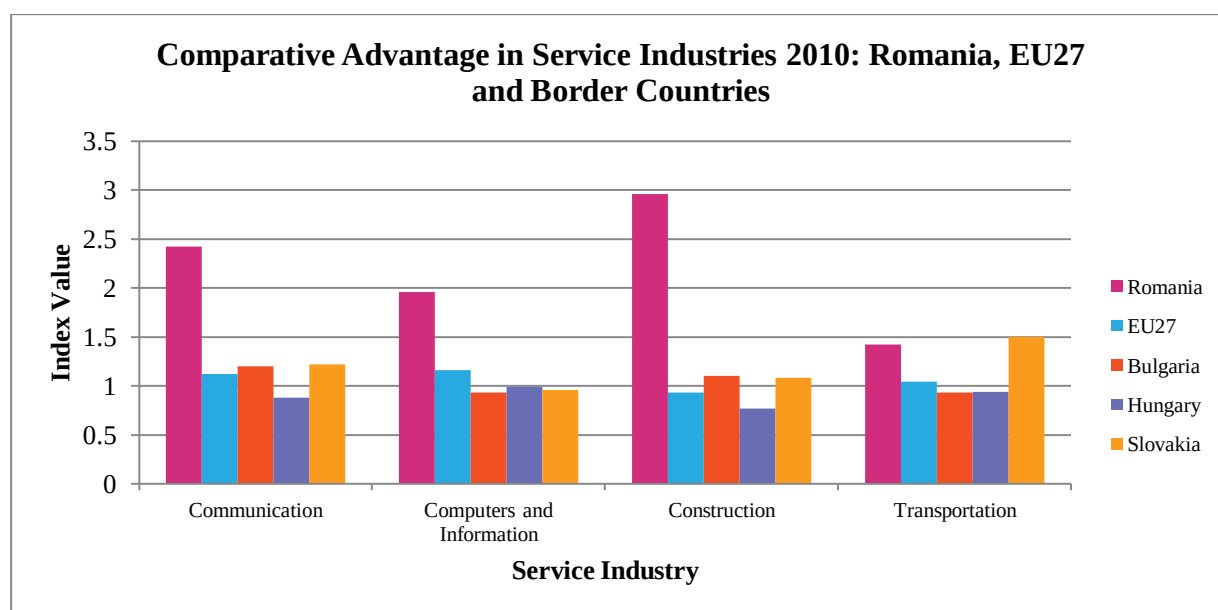
The article highlighted that “growth driver number one will be cloud computing, which will be particularly attractive to SMEs and start-ups in Central Europe, found the Erste report. A second growth driver is mobile communication networks, which goes hand-in-hand with the dynamic growth of smart phones, tablets and internet-based applications like cloud computing, machine-to-machine communication, video streaming, or data and voice communication. Thirdly will increase the efficiency, operational and strategic excellence.”

An additional article in Business Review from August 2012 (Haraga, 2012) has also identified that “Romania is a more and more attractive emerging market for software developers, especially applications for mobile platforms, according to an Ernst & Young survey called *“Opportunities and optimism: how CEOs are embracing digital growth.”* In upstore there over 400 Romanian applications and a similar number is found on the Android market, according to Syscom Digital. “The number of applications developed in Romania is continually growing and it is estimated it will grow five times by the end of the year,” says the Ernst& Young survey.

In Romania, the total IT&C turnover has grown by 8 percent in 2010 and by 2 percent in 2011, recovering at the EUR 9.4 billion levels registered in 2008, says E&Y, quoting a report published this year by the Institute for Computer Technology. Exports continued to grow in this sector throughout the post-crisis period, exceeding by 37 percent the level registered in 2008, while incomes from the domestic market have grown slower, by only 6 percent. However, even if Romania is an attractive market for software development, the domestic consumption is relatively low, says the survey. “IT&C representatives have repeatedly underlined that the market needs to be educated and those consumers have to be supported to adapt to new technologies and media consumption trends,” it adds. One of the most important findings of the survey is that applications will define how people will consume content for the next five years. This spells opportunities for start-ups in the virtual domain.

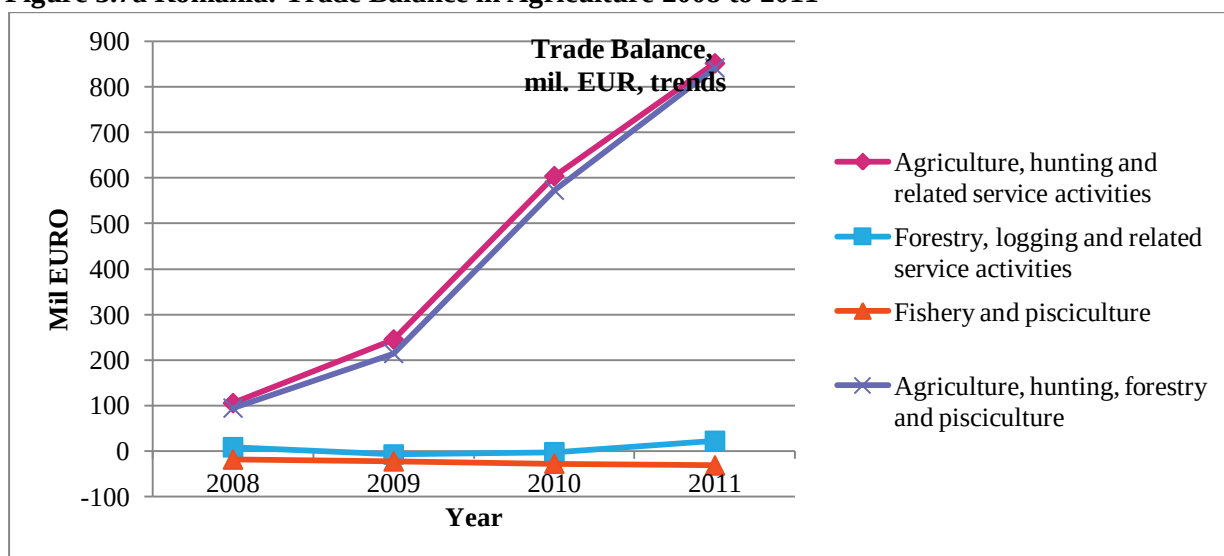
The European Union Competitiveness Report for the 2012 (European Commission, 2012) explores the comparative advantage of sectors industries in both manufacturing and service industries. This Revealed Comparative Advantage is based on export competitiveness considering the European Union in global export markets. Only those sectors where Romania is ranked above the European Union have been profiled in the chart. In the service industries Romania is ranked 1st in Construction, 2nd in communication and 3rd in Computers and information.

Figure 3.5f Comparative Advantage in Service Industries 2010



3.7 Agricultural Sector

The study conducted by the National Commission of Prognosis on Employment (Albu., 2012) shows that 35% of the active population is employed in agriculture, however only 4.89% are registered as employed. This significant difference can be explained by the “subsistence agriculture”. Over 65% of Romanian farms have less than 2 ha, and over 90% less than 5 ha. 81% of farms produce more than 50% for self consumption. In absolute values, out of 3859 farms, only 31 had the status of a legal entity, according to (Luca, 2012).

Figure 3.7a Romania: Trade Balance in Agriculture 2008 to 2011

Interestingly this market is being actively targeted by importers as is evidenced by the US Commercial Service in its Romania 2012 commercial guide (US Commercial Service, 2012). They highlight that “agricultural machinery including tractors and harvesting equipment such as combines have excellent prospects for growth. There are additional opportunities in silos, grain handling equipment, agricultural inputs such as fertilizers and livestock equipment for poultry, swine and cattle”.

In particular they highlight equipment and systems for viticulture (vineyards), quality and yields in vegetable production and greenhouse technology are seen as key growth areas. The importance of agricultural equipment in particular is highlighted where data from the Romanian association APIMAR (Romanian Association of Producers and Importers of Agricultural Machinery), is cited which highlights that “in order to reach the European average concentration of tractors, the Romanian market would need to put into operation 30,000 tractors per year for more than a decade”. And based on the Romanian "National Strategy for Sustainable Development of Agriculture and the Food Industry" and to industry experts that “if the country’s farmlands were exploited with the intensity of the rest of the EU, Romania would need approximately 300,000 tractors, producing a bill of demand worth approximately \$14 billion”.

Regarding the link between agriculture and the food industry, the contribution of the two to the formation of the gross value added reached similar values in Romania (the GVA of the food industry representing approximately 80% of the GVA of agriculture, as in other Member States), while, during the period 2003-2009, the gross value added of agriculture, forestry and fishing decreased annually, on average, by 1.9%, and the gross value added of the food industry increased by 5.9% per year.

By analysing the differences between labour productivity in agriculture and in the food industry in Romania, one may notice that the latter grew at a rate of 5.5% per year between 2005-2008, while the labour productivity in agriculture has varied very little (+1.1% annually between 2003-2008), being one of the lowest in the EU (which is unsurprising, given, on the one hand, the size and persistence of subsistence and semi-subsistence agricultural production, and on the other, the fact that the manufacturing industry went through fast modernization, adopting new technologies and equipment).

The data from 2008 on some EU member states shows that the trade between agricultural production (including hunting and related services) and food production (including beverages and tobacco) for

Romania is well below that of other Member States. Thus, the share of agricultural output used by the food industry represents 33.5% of Romanian production (excluding the final consumption), a relatively low proportion compared to France (which used 67.8%), Hungary (57.1%) or Poland (with almost 62% in 2005). In addition, the final consumption of agricultural products in Romania was with almost a third higher than that of France and double, compared to Hungary, as share of total utilisation.

The total value of exports, raw materials and intermediate products (with a low degree of processing) have a combined share of 68%, which is comparable (70%) with EU partner countries. Final products represent only 32% of Romania's agricultural exports, in comparison Hungary exported 52%, final products, Poland 82%, and Bulgaria 33%. Of the total value of goods imported by Romania, 54% are final products (and of those that originate in the EU, 60% are in this category). However, the export of final products to the EU increased by almost 25% in 2011, compared to the previous year, while imports of such goods with high processing originating in the European Community increased only by 10%. The main food products exported by Romania in 2010 are corn (390 thou EUR), wheat (381 thou EUR), followed by tobacco cigars and cigarettes (379 thou EUR) and sunflower seeds (214 thou EUR).

Regarding the link between agriculture and the machinery and equipment dedicated to agriculture, it is worth mentioning that one of the main problems lies in equipping Romanian farms with tractors. Out of the imported tractors (17.016 units at the end of 2011), the number of second-hand tractors (9.903) exceeded that of the new ones (7.113). In 2011 the share of 65 Horse Power (HP) tractors was 60.4% (followed by 45 HP tractors, with 24.3%, an increasing share compared to 2010). The share of very small Romanian farms using a tractor (under 5 ha) was of 68.6% in 2005, less than those of France (83.6%) and Poland (89.4%). As for medium sized Romanian farms, the situation was similar, with 75.1% of these farms using a tractor, compared to 99.1% in France and 99.6% in Poland. Large Romanian farms had an even smaller share of tractors in use, compared to those of France and Poland, only 71.5%.

Business Review in February 2012 (Simona Bazavan, 2012) identified Agriculture as a key area for investment. They highlighted that “Soaring food prices worldwide and an ever increasing global population make agriculture and farmland acquisition two very lucrative business options and Romania offers plenty of opportunities in both fields”. The article identified that “Romanian farmland is valued on average at less than 20 percent of its Western European equivalent, making it a fertile investment opportunity. The good quality of the soil here, large surfaces of available land and, most of all, cheap prices have made many foreign companies and investment funds buy land and many more state their interest. The 2010-2011 national agriculture censuses reveals that there are about 8.2 million hectares of arable land in Romania, placing it in fifth position in the EU, after France, Spain, Poland and Germany. About 8.5 percent of the country's total farmland is owned by foreigners according to data from the Ministry of Agriculture. When it comes to farmland and forests, the market has been less affected than the general real estate sector, and looking both at global trends and the local offer, things should take a turn for the better in the years to come. Demand is on the rise and prices are set to follow suit.”

The Romanian Business Review has also profiled the niche segment of organic products identifying in April 2012 (Bazavan, Number of local organic farmers up 2.4 times in 2012, 2012) that it “has been on an upward trend for several years now, bringing healthy profits for local organic farmers and producers. The Romanian organic food market is estimated to have reached up to EUR 70 million last year and could well surge by another 30 percent in 2012 as more health-conscious consumers choose to go green. But the economic crisis has also taken its toll”.

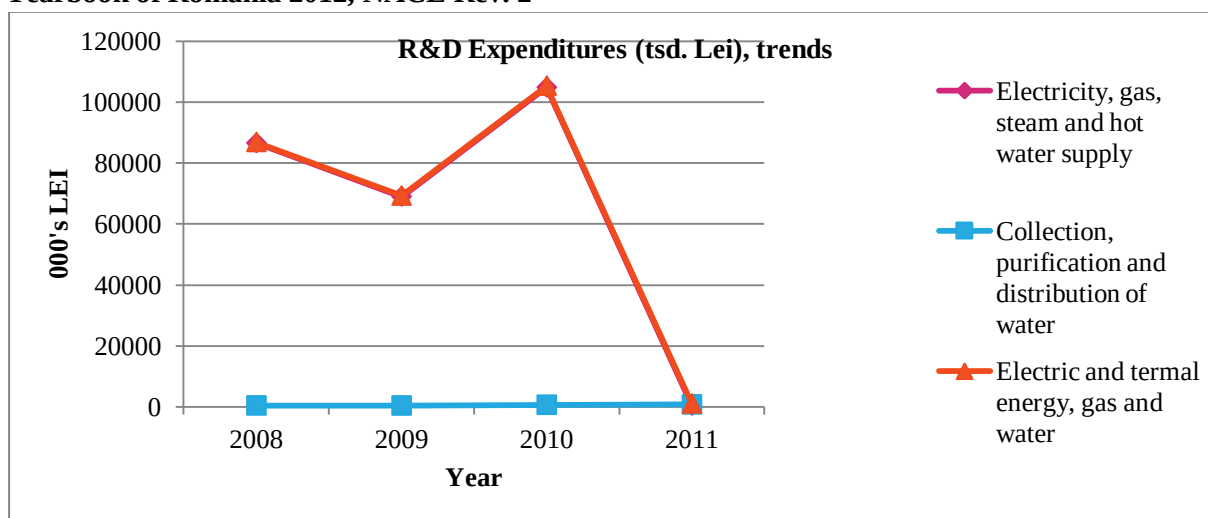
3.8 Energy Sector

As with agriculture, the energy sector is being actively targeted by importers as is evidenced by the US Commercial Service in its Romania 2012 commercial guide (US Commercial Service, 2012). They highlight that “like other industrialized countries, Romania is seeking to derive more of its energy needs from renewable sources” and that. “Romania’s desire to increase its energy security and exploit its physical attributes favourable to solar and wind development has coincided with private investor interest in alternatives to property products”.

In addition the US Commercial Service report highlights that “Romania is seen as the fastest growing market for wind energy in the region”, also citing a report by Ernst & Young, highlighting Romania as one of the fastest growing countries (ranked 16th) in the Renewable Energy. In addition to wind energy they also note the potential for growth in solar energy based in part on reduced production costs and increased production predictability.

The study of the National Commission of Prognosis (Musatescu, 2012), highlights that Romanian energy usage (indicator showing energy consumption for 1 unit of GDP) is 25% higher than the EU average. The sustainability of the sector can be assured by increasing the share of renewable energies (e.g. hydropower potential is currently used only at 54% level), and by exploiting new gas resources in the Black Sea and in the NW of the country.

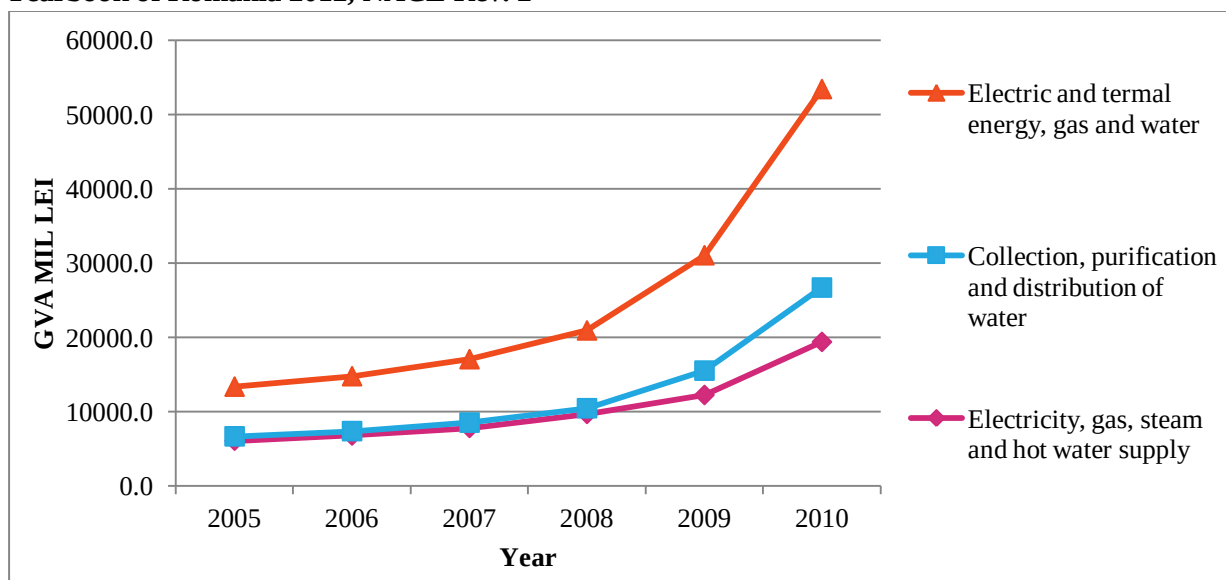
Figure 3.8a Romania: R&D Expenditure in the Energy Sector 2008 to 2011 Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



The renewable sector has gained traction in recent years, mainly in wind installments, but the other clean energy sources represent good investments as well. The Romanian Business Review of May 2012 (Posirca, Renewable energy remains hot in Romania, 2013) identified that “wind is still the most popular clean source in Romania’s renewable sector, recently climbing to 1,222 MW of installed capacity, but there is a window of opportunity for photo-voltaic “. They highlighted that “at present, Romania is perceived as the country with the friendliest support scheme for renewable energy” with “the prices of green certificates (GC) have a minimum limit of EUR 27 per GC in order to protect producers, while the ceiling is EUR 55 per GC to protect consumers”. The largest share of wind projects are located in Dobrogea (south Romania), totaling 1,100 MW, but the Moldova and Banat regions are also starting to attract investments. At present, Romania has 826 MW of wind capacities, 380 MW in micro-hydro plants, 1 MW in solar and 25 MW for biomass.

As highlighted previously consideration should be given to the potential of decontamination services, which statistically is categorised within “Electricity, steam and hot water supply”. This subsector has increased its contribution to Gross Value Added between 2005 and 2009 and is based on the use of environmental structural funds which have been used to bridge the gap between Romania and Western Europe in ecological services.

Figure 3.8b Romania: Gross Value Added in the Energy Sector 2005 to 2009 Source: Statistical Yearbook of Romania 2012, NACE Rev. 2



3.9 Analysis of National Business Structure

This high level analysis of Romanian Sectors and Sub Sectors of the economy has provided valuable insights into the dynamics of the economy and their linkage to skills and technology.

The quantitative analysis of the Romanian Cluster Association used for this report at a National Level identifies the sector of motor vehicles and transport equipment as the most important based on a ranking utilising the ‘index of competitiveness’ and ‘star method’. It takes into consideration 4 indicators (contribution to GVA, employment, Innovation and Exports calculated both at the level of sectors and clusters). Innovation is a most complex indicator calculated according to the Innovation Scoreboard Methodology. Sectors passing over the threshold of 10% weight inside the indicator are awarded one star so are those subsectors of the manufacturing industry passing over 10% inside the manufacturing industry. The automotive sector is the only 3 star sectors (contribution to GVA, Innovation and Exports).

The sectors of electronics, trade, textiles and metallurgy ranked relatively well on competitiveness and were each awarded two stars from the overall quantitative analysis. The remaining two-star sectors were the food industry and the wood sector although it should be noted that these had a lower ranking on the index of competitiveness. The sectors of real estate, construction, logistics, chemicals and research and development each received a one-star rating based on the quantitative analysis although it should be noted that the real estate sector ranks second highest overall in the index of competitiveness.

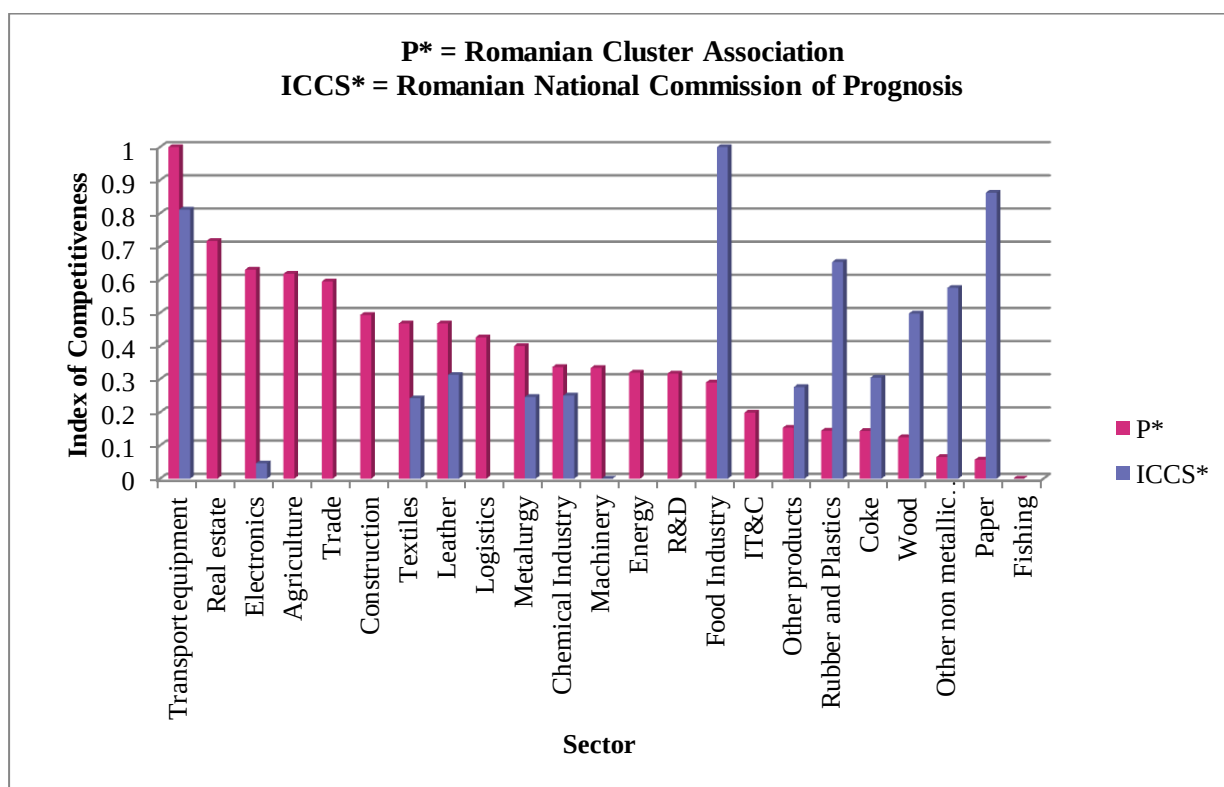
One of the most recent studies of sector competitiveness has been undertaken by the Romanian National Commission of Prognosis. The correlation between the assessments of competitiveness from the

Commission of Prognosis and the Romanian Cluster Association can be seen in the figure 3.9a below. It should be noted that both methods work with a composite index, i.e. P with importance, size, innovation, exports and ICCS with production, technology, structure and exports (Cojanu, 2012), however both studies have adopted different indicators. In addition the analysis by the Romanian Cluster Association takes into consideration the consistency between the national (sectors) and regional (clusters) level. Therefore, it comprises more economical sectors (e.g. non-industrial); including services e.g. IT and logistics; and additionally some of the sectors have been combined e.g. textile and leather or wood, furniture and paper, reflecting the actual composition of clusters and sectors in Romania.

The study by the Romanian National Commission of Prognosis identifies the following sectors in order of competitiveness; food, paper, transport, rubber and plastics, non-metallic products, leather, coke and petroleum refined products, metallurgy, textiles, chemicals, machinery and electronics.

Analysing the two studies the sectors of transport equipment, textiles, leather, and chemical industry, other industrial products and coke and petroleum refined products show similar normalised values for competitiveness. Importantly this validates the consideration of their relative importance in the Romanian economy.

Figure 3.9a Comparison of Sector Competitiveness



Important differences can be seen in the ranking of the food sector (ranking 1st in ICCS but rather low in P), this reflects the importance of the sector to the Romanian economy in terms of businesses, employment and value added but its low-tech and low-skill focus with limited expenditure in Research and Development. There are also differences in the analysis of the wood and paper sectors and again this reflects the importance of the sector to the Romanian economy in terms of businesses, employment and value added but the low-tech and low-skill focus with limited expenditure in Research and Development. Differences can be seen in the sectors of electronics, rubber and plastics and other non-

metallic products. This should be considered in the context of the number of businesses employment, international trade, value added and research and development.

Table 3.9a below is based on the taxonomy of skills and technology identified within the European Commission Industrial Structure Report of 2011 (European Commission, 2011). It highlights the relative positioning of the key Romanian sectors identified through the assessment of manufacturing sub-sectors based on number of businesses, turnover, number of employees, value added and research and development expenditure by business. Table 3.9b highlights the relative positioning of service sub-sectors based on skills only.

It is recognised that the sub sectors included within the areas of high-intermediate tech and high tech are those where there is a higher level of R&D intensity and expenditure on research and development and this provides a valuable starting point for examining the potential for smart specialisation in Romania. This is not to exclude low tech sub sectors e.g. food, textiles where they may be particular parts of the sector which are more advance in technology e.g. technical textiles, agro-food. It should also be noted that there are differences in the European Commission categorisation of sectors with regard to technology and skills. The Industrial Structure Report of 2011 (European Commission, 2011) on which this report has based its assessment has a different interpretation to the commission staff working document (SWD (2012) 298) (European Commission, 2012) on Member State Competitiveness which identifies both textiles and basic metals as medium-high innovation sectors.

Table 3.9a Romania: Key -Manufacturing Sub Sectors profiled by Skills and Technology

High -Skill	Manufacture of coke and refined petroleum products				Chemical products
High Intermediate Skill					Medical Precision and Optical Instruments
Low Intermediate Skill	Wood Products Paper Products	Manufacture of Metal Products	Machinery and Equipment Electrical Machinery		
Low Skill	Food Products Textile products Leather products	Basic Metals Rubber and plastics Non-Metallic Products	Motor Vehicles Other transport		
	Low Tech	Low Intermediate Tech	High Intermediate tech	High Tech	

In addition to this analysis a series of four workshops was held in Bucharest on the 12th and 13th of February 2013 represented by public authorities at the National level, public authorities at a regional level, business representation and representation from research institutions and Universities. The workshops discussions were conducted in a moderated process, allowing a focused and objective oriented approach. The participants were asked to comment on the findings of a summary presentation of the quantitative analysis undertaken in this report and to express their opinion in terms of the importance of sectors, subsectors and research which can be regarded as a basis for the future smart specialisation in Romania. The results of the moderated discussion from the national level are identified in table 3.9c

Table 3.9b Romania: Key Non-Manufacturing Sub Sectors profiled by Skills (NACE rev1)

High -Skill	Real Estate Activities Computer and related Activities Research and Development Education
High Intermediate Skill	Post and Telecommunications Electricity, Gas and Water Supply
Low Intermediate Skill	Construction Land Transport
Low Skill	Agriculture, Hunting and Forestry Hotels and Restaurants

The feedback from the workshop identified new potential areas for a sector focus. Sectors 1 through to 7 were initially identified prior to the workshop and sectors 8 to 21 during the workshop on the 12th February. The new sectors can be incorporated in certain cases with the sectors originally identified and this relates specifically to environment, water and green industry / green construction which can be integrated into a combined energy and environment theme. The agricultural theme can be integrated with the food theme.

In conclusion this section of this chapter has aimed to highlight at a national level the key sectors which may provide a basis for smart specialisation. A more detailed analysis of sectors at the regional level is provided in the following chapter of this report. Smart specialisation within the context of the next programming period of the structural funds is considered within the context of the priority for research and development. Identifying key potential areas represents a conundrum specifically in the manufacturing sector between a focus on larger scale sectors e.g. textiles, leather and wood which are considered low-tech and low skill with other sectors which are more high technology based e.g. motor vehicles and other transport.

In this context in the service sector computer programming and telecommunications are strong and should be considered prime for a specialisation focus. In manufacturing, motor vehicles and other transport should be actively considered as focus areas while sectors including electronics, chemicals, environment and energy, machinery and equipment, wood, textiles and leather are well represented in the Romanian economy. Food is linked with both the agricultural sector and in manufacturing, it is significant to the Romanian economy and while the investment in research is not as strong as for manufacturing and services it is still important and this should be considered as a focus area.

Table 3.9c National Level Workshop: Identified Sector and Research Specialisation Themes

Sector	Sector Specialisation	Research	Research Specialisation
1. Food	Agro-Food, Biotechnology, Functional food, wine	Food and Agriculture	Agronomy, crop science, food science and agricultural and biological science, agricultural biotech ,
2. ICT	Telecommunications and Software / Computer Programming Mechatronics, security, e-health, ict for transport	ICT	Networks of the future, internet of services, software and visualisation, networked media and 3d internet, flexible organic and large area electronics, embedded system design, personal health systems, ICT for energy efficiency and accessible and assistive ICT, Computer science and artificial intelligence.
3. Motor Vehicle Manufacturing and Other Transport	Materials, Components and Fabrication, Ship Building, Aviation, ship design	Engineering and Technology	Electrical and electronic engineering, nanotechnology, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering, motor vehicle transport and other transport. Key enabling technologies , Electro car
4. Electronics	Computer, Electronics and Optical Products, Medical precision Instruments, Mechatronics		
5. Machinery and Equipment,	Intelligent Agriculture, Automation, Mechatronics		
6. Textiles	Technical Textiles		
7. Energy	Renewable Energy, Wind Power, Solar Power, Green construction. Biomass, Ecological Services, geothermal	Energy and Environment, Renewable energy	Pollution, management and monitoring, environmental engineering, ecology and environmental science, network technologies, renewable energy and bio fuels,
8. Nuclear Research	ELI Project		
9. Health	Wellness, geriatrics,		
10. Pharmacy	Plant and other natural treatments, derma cosmetics		
11. Logistics	Design for logistics		
12. Wood and	Personalised furniture, design		

Sector	Sector Specialisation	Research	Research Specialisation
Furniture			
13. Water	Freshwater supply		R&D Danube Delta
14. Agriculture	Bio Processing, fishing		Agriculture and rural development
15. Creative and Cultural Industries	Design		
16. Green Industry	Construction		
17. Assurance and Reassurance			
18. Chemistry	Pesticides		Petro chemistry
19. Construction	Green Houses		
20. Environment	Climate Change		The Danube Strategy
21. Tourism			

The findings of this report are consistent with a European commission staff working document (SWD (2012) 298) on Member State Competitiveness which identifies that Romania is highly specialised in labour intensive industries (preparation and spinning of textile fibres, sawmilling , clothing and accessories” and at “the more aggregated sector level Romania features specialisation in low innovation sectors and education sectors (clothing, leather) but also in medium high-tech innovation sectors (textiles, basic metals).

The potential of ICT is recognised in the member state competitiveness report which highlights that “the rapid growth of ICT related services – supported by the valorisation of skills and the good quality of math and science education - is one of the country’s major competitive advantages. In conclusion they identify the key long-term challenge as ensuring a “paradigm shift away from unskilled labour and energy intensive sectors towards more smart, low carbon and resource efficient activities.

4 Structural Business Assessment: Regional Level

4.1 Introduction

As highlighted on the European Commission Factsheet for Smart specialisation for Research and Innovation (European Commission) Smart Specialisation means identifying the unique characteristics and assets of each country and region, highlighting each region's competitive advantages, and rallying regional stakeholders and resources around an excellence-driven vision of their future. The European Commission Guide to Research and Innovation Strategies for Smart Specialisation (RIS3) (European Commission, 2012) identifies that:

- Clusters offer a huge potential to implement smart specialisation strategies by providing and mobilising the necessary resources for that purpose.
- Their knowledge, networks, and dynamism are the right ingredients that are available at local level allowing regions creating more value, reaching higher levels of excellence and thriving in the global economy.
- Clusters can be used at both the design and the implementation phase of smart specialisation strategies. In the design phase, they can be used to identify the industrial strengths and assets in a region, contribute to set strategic priorities and take the right political decisions.
- Cluster mapping and benchmarking are valuable tools that can be used to identify regional specialisation patterns and compare economic activities, including agriculture, and strengths with other regions in the EU.

It has been identified earlier in this report that Romania 40 has clusters with a further 12 potential clusters identified. The analysis of regional clusters in Romania identifies the following smart specialisation within the 15 clusters within Romania for which data is available. Unfortunately data is unavailable for the remaining clusters.

Bucharest Ilfov:	Electronics – Mechatronics; Machinery and Equipment – Agricultural Machinery; Textiles – Technical Textiles,
Nord Est:	Textiles – Technical Textiles,
Sud-Muntenia:	Automotive – Research,
Sud Vest:	Tourism – Danube
Centre:	Energy – Biomass
West:	Agro Food – Biotechnology; Energy – Renewable Energy (solar); IT – IT solutions for non IT enterprises

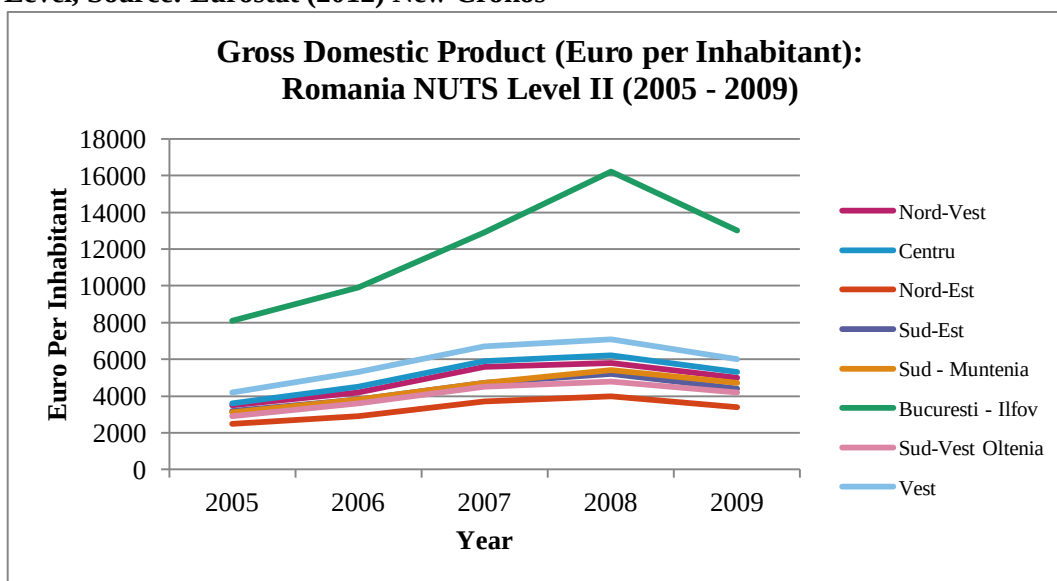
Regarding the other Romanian regions, although “core” smart specialisms could not be identified at this time there is future potential in relation to; smart logistics in the Sud Est region linked to the port of Constanta; Automotive in the Vest Region; geothermal in the Nord Vest region; and Health and ICT in the Nord Est and Nord Vest regions.

The next section of this report profiles each Romanian region in relation to business structure, its dominant manufacturing and service sectors and outlines its profile in relation to cluster development. At the end of this section a summary assessment of skills

and technology is provided which will provide a basis for identifying potential focus areas for smart specialisation.

GDP at a regional level, profiled by Euro per inhabitant highlights the capital region of Bucharest-Ilfov has having the highest level of GDP with the remaining regions are clustered together at a lower level.

Figure 4.1 Gross Domestic Product (Euro per Inhabitant) at Romanian NUTS II Level, Source: Eurostat (2012) New Cronos



4.2 Nord Vest Region

Nord-Vest (*North West*) is a development region in Romania, created in 1998. The Nord-Vest region is made up of the following counties; Bihor, Bistrița-Nășăud, Cluj, Maramureș, Satu Mare and Sălaj. The economy of Nord-Vest is mainly agricultural (46% of its population having agriculture as their main occupation), even though there is some heavy and light industry in the major regional industrial centres of Cluj-Napoca, Oradea, Baia Mare, Bistrița, Satu Mare and Zalău. Table 4.2a below shows the business structure of the Nord Vest region in 2009.

The overall business structure of the region is dominated by manufacturing, wholesale and retail trade (Low Intermediate skill), construction and transportation and storage. Table 4.2b provides a detailed breakdown of the manufacturing sector into sub sectors for those subsectors where the overall calculated average of percentage employment, wages and salaries and number of enterprises is greater than 5%. For the Nord-Vest region this identifies a concentration on low-skill, low-tech sectors including food, textiles, and wood, leather, and rubber, plastic and metal products. Only the manufacture of motor vehicles within the region is considered high intermediate tech. Table 4.2c provides a detailed breakdown of the service sector into sub sectors. For the region this identifies the importance of telecommunications and computer programming and related activities which are considered high-skill, high-tech. Other dominant high-skill sub sectors include real estate, architectural and engineering activities and management consultancy.

Table 4.2a Nord vest: Business Structure in 2009, Source: Eurostat (2012) New Cronos, NACE Rev 2

Sector	No of Enterprises		Wages and Salaries		Employment	
	2009	%	2009	%	2009	%
Mining and quarrying	314	0%	28.3	2%	4338	1%
Manufacturing	8890	12%	654.4	37%	179954	36%
Electricity, gas, steam and air conditioning supply	118	0%	60.3	3%	6561	1%
Water supply; sewerage, waste management and remediation activities	294	0%	39.7	2%	8570	2%
Construction	10671	15%	221.9	13%	66583	13%
Wholesale and retail trade; repair of motor vehicles and motorcycles	25787	36%	366.3	21%	120660	24%
Transportation and storage	6728	9%	161.5	9%	43795	9%
Accommodation and food service activities	3963	6%	42.6	2%	20161	4%
Information and communication	2448	3%	70.9	4%	11988	2%
Real estate activities	1864	3%	14.3	1%	4921	1%
Professional, scientific and technical activities	7826	11%	62.8	4%	20257	4%
Administrative and support service activities	2437	3%	44.9	3%	17792	4%
Total	71340	100%	1767.9	100%	505580	100%

Table 4.2b Nord Vest: Manufacturing Sub-Sectors by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

Manufacturing Sector	No of Enterprises		Wages and Salaries		Employment		
	2009	%	2009	%	2009		Av %
Manufacturing	8890	100%	654.4	100%	179954	100%	100.0%
Manufacture of food products	1290	15%	61.7	9%	20918	12%	11.9%
Manufacture of wearing apparel	838	9%	65.1	10%	22168	12%	10.6%
Manufacture of furniture	856	10%	65.6	10%	20348	11%	10.3%
Manufacture of fabricated metal products, except machinery and equipment	1145	13%	46.2	7%	12829	7%	9.0%
Manufacture of leather and related products	449	5%	54.2	8%	18508	10%	7.9%
Manufacture of wood and of products of wood and cork	1071	12%	20.5	3%	8837	5%	6.7%
Manufacture of motor vehicles, trailers and semi-trailers	80	1%	60.2	9%	13895	8%	5.9%
Manufacture of rubber and plastic products	511	6%	41.2	6%	9770	5%	5.8%
Manufacture of other non-metallic mineral products	600	7%	35.9	5%	8595	5%	5.7%

Table 4.2c: Nord Vest Service Sector Activities by Sub Sector and by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	No of Enterprises		Wages and Salaries		Employment		Average
	2009	%	2009	%	2009	%	%
Information and communication	2448	100%	70.9	100%	11988	100%	100%
Computer programming, consultancy	1143	47%	25.2	36%	4465	37%	40%
Telecommunications	350	14%	25.7	36%	3176	26%	26%
Publishing activities	464	19%	13.3	19%	2687	22%	20%
Information service activities	265	11%	1.5	2%	654	5%	6%
Programming and broadcasting activities	74	3%	4.2	6%	614	5%	5%
Motion picture, video and television programme production, sound recording and music publishing activities	152	6%	0.9	1%	392	3%	4%
Real estate activities	1864	100%	14.3	100%	4921	100%	100%
Professional, scientific and technical activities	7826	100%	62.8	100%	20257	100%	100%
Architectural and engineering activities; technical testing and analysis	2256	29%	25	40%	6853	34%	34%
Activities of head offices; management consultancy activities	2405	31%	15.9	25%	5148	25%	27%
Legal and accounting activities	1234	16%	5.2	8%	2456	12%	12%
Advertising and market research	875	11%	5.6	9%	2350	12%	11%
Other professional, scientific and technical activities	731	9%	3.5	6%	1810	9%	8%
Scientific research and development	74	1%	6.5	10%	1084	5%	6%

The cluster development process started rather late in the Nord Vest region; 4 clusters are registered so far; Water; Geothermal; ICT and renewable energy. A detailed evaluation of the clusters in the Nord Vest region has yet to be undertaken and data suggests no specialisation at this time although it should be noted that renewable energy which is a cluster in the region is identified as a specialisms in other regions of Romania. Another promising sector is ICT relying on Cluj as a strong university centre.

4.3 Centru Region

Located in the centre of Romania it covers a large proportion of the region of Transylvania. Brasov, Sibiu, Targu Mures, Alba Iulia, Miercurea Ciuc and Sfantu Gheorghe are the most important cities in the region. It is the region with the smallest intra-regional discrepancies between counties.

Table 4.3a Centru: Business Structure in 2009, Source: Eurostat (2012) New Cronos, NACE Rev 2

Sector	No of Enterprises		Wages and Salaries		Employment	
	2009	%	2009	%	2009	%
Mining and quarrying	199	0%	92.3	5%	8859	2%
Manufacturing	8700	14%	745.4	38%	188151	37%
Electricity, gas, steam and air conditioning supply	72	0%	119.3	6%	10884	2%
Water supply; sewerage, waste management and remediation activities	342	1%	40.6	2%	9567	2%
Construction	7848	13%	193.9	10%	57176	11%
Wholesale and retail trade; repair of motor vehicles and motorcycles	22804	37%	367.1	19%	113718	23%
Transportation and storage	4586	7%	175.3	9%	42893	9%
Accommodation and food service activities	4253	7%	48.2	2%	22215	4%
Information and communication	2127	3%	59.9	3%	10113	2%
Real estate activities	1599	3%	11.1	1%	3953	1%
Professional, scientific and technical activities	6761	11%	53	3%	17127	3%
Administrative and support service activities	2318	4%	58.5	3%	19605	4%
Total	61609	100%	1964.6	100%	504261	100%

The overall business structure of the region (Table 4.3a) is dominated by manufacturing, wholesale and retail trade (Low Intermediate skill), construction and transportation and storage. Table 4.3b provides a detailed breakdown of the manufacturing sector into sub sectors for those subsectors where the overall calculated average of percentage employment, wages and salaries and number of enterprises is greater than 5%. For the Centru region this identifies a concentration on low-skill, low-tech sectors including food, textiles, wood, leather, rubber, plastic and metal products. The manufacture of motor vehicles and machinery and equipment within the region is considered high- intermediate tech.

Table 4.3b Centru: Manufacturing Sub-Sectors by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		Average
	2009	%	2009	%	2009	%	Av %
Manufacturing	8700	100%	745.4	100%	188151	100%	100.0%
Manufacture of food products	1182	14%	93.5	13%	23832	13%	12.9%
Manufacture of wood and of products of wood and cork	1648	19%	49.9	7%	16371	9%	11.4%
Manufacture of wearing apparel	707	8%	73.2	10%	25003	13%	10.4%
Manufacture of fabricated metal products, except machinery and equipment	1129	13%	67.7	9%	16789	9%	10.3%
Manufacture of motor vehicles, trailers and semi-trailers	112	1%	90.7	12%	18037	10%	7.7%
Manufacture of furniture	701	8%	36.1	5%	12180	6%	6.5%
Manufacture of other non-metallic mineral products	511	6%	35.1	5%	8816	5%	5.1%
Manufacture of machinery and equipment n.e.c.	220	3%	54.3	7%	9929	5%	5.0%
Manufacture of leather and related products	265	3%	38.7	5%	12752	7%	5.0%

Table 4.3c provides a detailed breakdown of the service sector into sub sectors. For the region this identifies the importance of computer programming and related activities which is considered high-skill and high-tech. Other dominant high-skill sub sectors include real estate, architectural and engineering activities and management consultancy.

The Centru region is the most active one in terms of cluster development. The Pro Wood cluster located in the region established the Romanian model for cluster generation methodology and cluster agreement which are the necessary prerequisites to be recognised by the Romanian Ministry of Economy. The region has 12 registered clusters; Wood (3); Energy (2); Agrofood; Printing-media-design; Textiles; Aerospace; Tourism (2) and Electrical engineering. A detailed review of the Wood cluster has been undertaken and is provided in Annex 2 to this report. Based on a qualitative and quantitative analysis of market, internal factors, innovation and technology, geographical concentration, labour force, research and development and innovation, cooperation and the availability of catalyst institutions, the following table highlights the smart specialisation areas identified in the Centru Region.

Table 4.3c: Centru Service Sector Activities by Sub Sector and by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		Overall
	2009	%	2009	%	2009	%	%
Information and communication	2127	100%	59.9	100%	10113	100%	100%
Computer programming, consultancy and related activities	1023	48%	26.4	44%	4009	40%	44%
Telecommunications	286	13%	18.7	31%	2694	27%	24%
Publishing activities	375	18%	8.7	15%	1946	19%	17%
Information service activities	267	13%	2.1	4%	615	6%	7%
Programming and broadcasting activities	77	4%	3.5	6%	610	6%	5%
Motion picture, video and television programme production, sound recording and music publishing activities	99	5%	0.5	1%	239	2%	3%
Real estate activities	1599	100%	11.1	100%	3953	100%	100%
Professional, scientific and technical activities	6761	100%	53	100%	17127	100%	100%
Architectural and engineering activities; technical testing and analysis	1996	30%	25.2	48%	6430	38%	38%
Activities of head offices; management consultancy activities	1998	30%	11.9	22%	4023	23%	25%
Legal and accounting activities	1127	17%	5.3	10%	2292	13%	13%
Advertising and market research	748	11%	4.2	8%	1863	11%	10%
Other professional, scientific and technical activities	666	10%	3.2	6%	1575	9%	8%
Scientific research and development	57	1%	2.3	4%	523	3%	3%

Table 4.3d Smart Specialisation in the Centru Region

Sector	Innovation	Smart	Other cross cutting issues	Cross cluster cooperation
Energy	Biomass	Automated combustion system for biomass derived from energy plantations;	HR	Agro, wood

4.4 Nord Est Region

The poorest region in terms of GDP per capita, the Nord Est region encompasses 6 of the 8 Moldavian counties. It accounts for 11.54% of national employment but only 10.2% of the GDP (2010). Most important cities are Iasi, Suceava, Bacau, Piatra Neamt, Botosani and Vaslui.

The overall business structure of the region is dominated (Table 4.4a) by manufacturing, wholesale and retail trade (Low Intermediate skill), construction and transportation and storage. Table 4.4b provides a detailed breakdown of the manufacturing sector into sub sectors for those subsectors where the overall calculated average of percentage employment, wages and salaries and number of enterprises is greater than 5%. For the Nord Est region this identifies a concentration on low-skill, low-tech sectors including textiles, food, wood and metal products. Machinery and equipment within the region is considered high-intermediate tech.

Table 4.4a Nord Est: Business Structure in 2009, Source: Eurostat (2012) New Cronos, NACE Rev 2

Sector	No of Enterprises		Wages and Salaries		Employment	
	2009	%	2009	%	2009	%
Mining and quarrying	137	0%	:		6217	2%
Manufacturing	7323	13%	436	34%	126356	32%
Electricity, gas, steam and air conditioning supply	68	0%	64.1	5%	7322	2%
Water supply; sewerage, waste management and remediation activities	229	0%	39.9	3%	8650	2%
Construction	6260	11%	172.9	13%	52419	13%
Wholesale and retail trade; repair of motor vehicles and motorcycles	24647	45%	293.6	23%	107044	27%
Transportation and storage	3605	7%	124.2	10%	30975	8%
Accommodation and food service activities	3308	6%	31.6	2%	15748	4%
Information and communication	1659	3%	50.7	4%	8514	2%
Real estate activities	1159	2%	9.1	1%	3381	1%
Professional, scientific and technical activities	5129	9%	34.4	3%	12626	3%
Administrative and support service activities	1632	3%	39.3	3%	15376	4%
Total	55156	100%	1295.8	100%	394628	100%

Table 4.4b Nord Est: Manufacturing Sub-Sectors by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		
	2009	%	2009	%	2009		Av %
Manufacturing	7323	100%	436	100%	126356	100%	100.0%
Manufacture of wearing apparel	891	12%	71.9	16%	27121	21%	16.7%
Manufacture of food products	1164	16%	68.6	16%	21325	17%	16.2%
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1407	19%	33.5	8%	12332	10%	12.2%
Manufacture of fabricated metal products, except machinery and equipment	718	10%	20.4	5%	6221	5%	6.5%
Manufacture of machinery and equipment n.e.c.	155	2%	37.9	9%	8358	7%	5.8%
Manufacture of furniture	567	8%	18	4%	6984	6%	5.8%

Table 4.4c provides a detailed breakdown of the service sector into sub sectors. For the Nord Est Region this identifies the importance of telecommunications and computing which are both high-skill and high tech and real estate, and professional, scientific and technical services which are high skill.

There are currently 4 clusters in the region; ASTRICO NE (textiles); Tourism Bucovina; IT New Media and Creative Industries. A detailed review of the IT New Media cluster has been undertaken and is provided in Annex 2.4 to this report. Based on a qualitative and quantitative analysis of market, internal factors, innovation and technology, geographical concentration, labour force, research and development and innovation, cooperation and the availability of catalyst institutions, the following table highlights the smart specialisation areas identified in the Nord Est Region.

Table 4.4d Smart Specialisation in the Nord Est Region

Sector	Innovation	Smart	Other cross cutting issues	Cross cluster cooperation
Textiles	Technical Textiles	Multifunctional textiles for protective garments	Human Resources	Health

Table 4.4C: Nord Est Service Sector Activities by Sub Sector and by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		Overall
	2009	%	2009	%	2009	%	%
Information and communication	1659	100%	50.7	100%	8514	100%	100%
Telecommunications	388	23%	26.8	53%	3503	41%	39%
Computer programming, consultancy and related activities	679	41%	13	26%	2218	26%	31%
Publishing activities	267	16%	6.6	13%	1648	19%	16%
Programming and broadcasting activities	93	6%	3.2	6%	595	7%	6%
Information service activities	155	9%	0.5	1%	276	3%	5%
Motion picture, video and television programme production, sound recording and music publishing activities	77	5%	0.6	1%	274	3%	3%
Real estate activities	1159	100%	9.1	100%	3381	100%	100%
Professional, scientific and technical activities	5129	100%	34.4	100%	12626	100%	100%
Architectural and engineering activities; technical testing and analysis	1625	32%	16.1	47%	4931	39%	39%
Activities of head offices; management consultancy activities	1363	27%	8	23%	3068	24%	25%
Legal and accounting activities	761	15%	2.6	8%	1402	11%	11%
Advertising and market research	592	12%	1.8	5%	1096	9%	8%
Other professional, scientific and technical activities	470	9%	2.1	6%	1116	9%	8%
Scientific research and development	64	1%	2.8	8%	475	4%	4%

4.5 Sud Est Region

The Sud Est region is the most “artificial” region from a historical point of view with the 2 Southern Moldavian counties, 2 Eastern Wallachian ones and Dobrogea. It is divided by the Danube and has access to the Black Sea. It is a region with high discrepancies between various counties with Constanta having a GDP per capita index twice as high as Vrancea. The industrial landscape is dominated by 2 companies: Acellor Mittal (steel) and Rompetrol Refinery (oil industry). The most important cities are Constanta, Galati, Braila, Focsani, Tulcea, Buzau.

Table 4.5a Sud Est: Business Structure in 2009, Source: Eurostat (2012) New Cronos, NACE Rev 2

Sector	No of Enterprises		Wages and Salaries		Employment	
	2009	%	2009	%	2009	%
Mining and quarrying	135	0%	:		4431	1%
Manufacturing	6258	11%	617.2	35%	138897	31%
Electricity, gas, steam and air conditioning supply	111	0%	110.5	6%	10251	2%
Water supply; sewerage, waste management and remediation activities	422	1%	48.3	3%	11207	3%
Construction	6362	11%	195.6	11%	53995	12%
Wholesale and retail trade; repair of motor vehicles and motorcycles	27404	46%	314.9	18%	111265	25%
Transportation and storage	4931	8%	249.2	14%	48409	11%
Accommodation and food service activities	3688	6%	49.3	3%	19909	4%
Information and communication	1391	2%	33.2	2%	6537	1%
Real estate activities	1448	2%	12.4	1%	4288	1%
Professional, scientific and technical activities	4924	8%	54.9	3%	14797	3%
Administrative and support service activities	1971	3%	55.9	3%	21990	5%
Total	59045	100%	1741.4	100%	445976	100%

The overall business structure of the region (table 4.5a) is dominated by manufacturing, wholesale and retail trade (Low Intermediate skill), construction and transportation and storage. Table 4.5b provides a detailed breakdown of the manufacturing sector into sub sectors for those subsectors where the overall calculated average of percentage employment, wages and salaries and number of enterprises is greater than 5%. For the Sud Est region this identifies a concentration on low-skill, low-tech sectors including

food, textiles and metal products. The manufacture of other transport equipment within the region is considered high-intermediate tech.

Table 4.5b Sud Est: Manufacturing Sub-Sectors by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		
	2009	%	2009	%	2009		Av %
Manufacturing	6258	100%	617.2	100%	138897	100%	100.0%
Manufacture of food products	1138	18%	62.2	10%	19903	14%	14.2%
Manufacture of wearing apparel	583	9%	70.1	11%	25740	19%	13.1%
Manufacture of fabricated metal products, except machinery and equipment	845	14%	43.9	7%	11589	8%	9.7%
Manufacture of other transport equipment	268	4%	:		19221	14%	6.0%

Table 4.5c: Sud Est Service Sector Activities by Sub Sector and by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		Overall
	2009	%	2009	%	2009	%	
Information and communication	1391	100%	33.2	100%	6537	100%	100%
Telecommunications	384	28%	20.7	62%	2797	43%	44%
Computer programming, consultancy and related activities	533	38%	5.5	17%	1495	23%	26%
Publishing activities	196	14%	2.9	9%	1041	16%	13%
Information service activities	154	11%	0.9	3%	381	6%	7%
Programming and broadcasting activities	45	3%	2.3	7%	376	6%	5%
Motion picture, video and television programme production, sound recording and music publishing activities	79	6%	1	3%	447	7%	5%
Real estate activities	1448	100%	12.4	100%	4288	100%	100%
Professional, scientific and technical activities	4924	100%	54.9	100%	14797	100%	100%
Architectural and engineering activities; technical testing and analysis	1295	26%	30.1	55%	5902	40%	40%

Activities of head offices; management consultancy activities	1422	29%	8.4	15%	2777	19%	21%
Legal and accounting activities	767	16%	3.5	6%	1600	11%	11%
Advertising and market research	626	13%	3	5%	1448	10%	9%
Other professional, scientific and technical activities	515	10%	3.6	7%	1419	10%	9%
Scientific research and development	33	1%	4.9	9%	942	6%	5%

Table 4.5c provides a detailed breakdown of the service sector into sub sectors. For the Sud Est region this identifies the importance of high skill sectors including real estate, architectural and engineering activities, management consultancy, and the high-tech and high-skill sectors of telecommunications and computer programming. 3 clusters are registered in the region: Ship Building, Textiles and Renewable Energy. A detailed evaluation of the clusters in the Sud Est region has yet to be undertaken and data suggests no specialisation at this time although it should be noted that both textiles and renewable energy which have clusters in the region are both identified as specialisms in other regions of Romania.

4.6 Sud-Muntenia Region

The Sud-Muntenia Region is located in the South-East of Romania,. The South Region is composed of seven counties (Arges, Calarasi, Dambovita, Islamite, Giurgiu, Pahoia and Telegram), 16 cities, 32 towns and 519 communes with 2019 villages. The South region represents almost the entire historical region of Muntenia (except for Braila and Buzau in SE region). Although the second wealthiest region after Bucharest (13.4% of the GDP in 2010), it encompasses also the poorest county in Romania, whose GDP is equal to the turnover of Vodafone. Dacia Pitesti is the most representative company in the region. Most important cities are Ploiesti, Pitesti, Targoviste, Calarasi, Slobozia, Giurgiu and Alexandria. The economy is strongly interlinked with that of Bucharest, which lies in the region, although treated separately. There is only one cluster registered in the region, i.e. Dacia Renault, but most clusters registered in the region are connected to Bucharest through value chains and employment.

The overall business structure of the region (table 4.6a) is dominated by manufacturing, wholesale and retail trade (Low Intermediate skill), construction and transportation and storage. Table 4.6b provides a detailed breakdown of the manufacturing sector into sub sectors for those subsectors where the overall calculated average of percentage employment, wages and salaries and number of enterprises is greater than 5%. For the Sud Muntenia region this identifies low-skill, low-tech sectors including food, textiles and metal products alongside high intermediate tech sectors including the manufacture of motor vehicles and machinery and equipment.

Table 4.6a Sud Muntenia: Business Structure in 2009, Source: Eurostat (2012) New Cronos, NACE Rev 2

Sector	No of Enterprises		Wages and Salaries		Employment	
	2009	%	2009	%	2009	%
Mining and quarrying	201	0%	:		18606	4%
Manufacturing	6165	11%	777.2	45%	172158	37%
Electricity, gas, steam and air conditioning supply	92	0%	65.3	4%	6663	1%
Water supply; sewerage, waste management and remediation activities	450	1%	36.5	2%	8405	2%
Construction	6952	13%	195.8	11%	56114	12%
Wholesale and retail trade; repair of motor vehicles and motorcycles	25369	47%	309.8	18%	105075	23%
Transportation and storage	4189	8%	158.4	9%	35819	8%
Accommodation and food service activities	2523	5%	33	2%	14014	3%
Information and communication	1440	3%	27	2%	6467	1%
Real estate activities	951	2%	8.8	1%	2800	1%
Professional, scientific and technical activities	4418	8%	80.8	5%	16350	4%
Administrative and support service activities	1527	3%	53.6	3%	19854	4%
Total	54277	100%	1746.2	100%	462325	100%

Table 4.6c provides a detailed breakdown of the service sector into sub sectors. For the Sud Muntenia region as with other Romanian regions this identifies the importance of high skill sectors including real estate, architectural and engineering activities, management consultancy and the high- tech and high-skills sectors of telecommunications and computer programming.

Table 4.6b Sud Muntenia: Manufacturing Sub-Sectors by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		Average
	2009	%	2009	%	2009		Av %
Manufacturing	6165	100%	777.2	100%	172158	100%	100.0%
Manufacture of food products	1156	19%	87.2	11%	25821	15%	15.0%
Manufacture of wearing apparel	629	10%	63.7	8%	25076	15%	11.0%
Manufacture of fabricated metal products, except machinery and equipment	888	14%	64.4	8%	14684	9%	10.4%
Manufacture of motor vehicles, trailers and semi-trailers	103	2%	:		30878	18%	6.5%
Manufacture of machinery and equipment n.e.c.	142	2%	68.9	9%	12498	7%	6.1%

Table 4.6c: Sud Muntenia Service Sector Activities by Sub Sector and by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		Overall
	2009	%	2009	%	2009	%	%
Information and communication	1440	100%	27	100%	6467	100%	100%
Telecommunications	303	21%	15.4	57%	2865	44%	41%
Computer programming, consultancy and related activities	553	38%	4.9	18%	1330	21%	26%
Publishing activities	283	20%	4.2	16%	1385	21%	19%
Information service activities	151	10%	0.8	3%	293	5%	6%
Programming and broadcasting	60	4%	1.3	5%	389	6%	5%
Motion picture, video and television programme production, sound recording and music publishing activities	90	6%	0.4	1%	205	3%	4%
Real estate activities	951	100%	8.8	100%	2800	100%	100%
Professional, scientific and technical activities	4418	100%	80.8	100%	16350	100%	100%
Architectural and engineering activities; technical testing and analysis	1335	30%	51.2	63%	8003	49%	48%
Activities of head offices; management consultancy activities	1251	28%	9.8	12%	2482	15%	19%
Legal and accounting activities	660	15%	3	4%	1323	8%	9%
Scientific research and development	52	1%	11.2	14%	1869	11%	9%
Advertising and market research	523	12%	2.2	3%	1132	7%	7%
Other professional, scientific and technical activities	453	10%	2.7	3%	1186	7%	7%

Based on a qualitative and quantitative analysis of market, internal factors, innovation and technology, geographical concentration, labour force, research and development and innovation, cooperation and the availability of catalyst institutions, the following table highlights the smart specialisation areas identified in the Sud-Muntenia Region. The specialisation within the automotive sector is seen as Materials and semi-finished parts;

Experimental studies for optimisation of components; Concept of new and modernised components; Fabrication support; Fabrication technologies and Passive safety.

Table 4.6d Smart Specialisation in the Sud-Muntenia Region

Sector	Innovation	Smart	Other cross cutting issues	Cross cluster cooperation
Automotive	Research nuclei	Materials Experimental studies Modernised components; Fabrication technologies; Passive Safety		Mechatronics, Electronics

4.7 Bucuresti – Ilfov Region

Located in the South East of Romania, the region is represented by the capital, Bucharest, and the surrounding county, Ilfov, with a population of 2.2 million (with 1.9 million in Bucharest). The regional economy accounts for 21% of national GDP (2010) and for 21% of employment (2010).

The overall business structure of the Bucharest Ilfov region (table 4.7a) is dominated by wholesale and retail trade (Low Intermediate skill) and has a wider of other important sectors including, manufacturing, construction, transportation and storage, information and communication (High-tech / High Skill) and professional, scientific and technical activities.

Table 4.7b provides a detailed breakdown of the manufacturing sector into sub sectors for those subsectors where the overall calculated average of percentage employment, wages and salaries and number of enterprises is greater than 5%. For the Bucharest Ilfov region this identifies low-skill, low-tech sectors including food, textiles and metal products alongside the high intermediate tech sector of machinery and equipment.

Table 4.7c provides a detailed breakdown of the service sector into sub sectors. For the Bucharest Ilfov region this identifies the importance of knowledge intensive services including the high-tech and high-skill sectors of computer programming and telecommunications and the high-skill sectors of publishing, management consultancy and architectural and engineering services.

**Table 4.7a Bucharest - Ilfov Business Structure in 2009, Source: Eurostat (2012)
New Cronos, NACE Rev 2**

Sector	No of Enterprises		Wages and Salaries		Employment	
	2009	%	2009	%	2009	%
Mining and quarrying	155	0%	:		2461	0%
Manufacturing	9025	8%	726.4	14%	135783	15%
Electricity, gas, steam and air conditioning supply	209	0%	199.1	4%	17333	2%
Water supply; sewerage, waste management and remediation activities	393	0%	87.1	2%	16707	2%
Construction	13407	11%	515.1	10%	108067	12%
Wholesale and retail trade; repair of motor vehicles and motorcycles	43070	36%	1369.2	26%	249608	27%
Transportation and storage	5450	5%	517.8	10%	76222	8%
Accommodation and food service activities	3432	3%	114.8	2%	31684	3%
Information and communication	8665	7%	739.1	14%	78776	9%
Real estate activities	5837	5%	87.9	2%	19955	2%
Professional, scientific and technical activities	23573	20%	655.5	12%	97423	11%
Administrative and support service activities	6079	5%	339.8	6%	91262	10%
Total	119295	100%	5351.8	100%	925281	100%

Table 4.7b Bucharest Ilfov: Manufacturing Sub-Sectors by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		
	2009	%	2009	%	2009	%	Av %
Manufacturing	9025	100%	726.4	100%	135783	100%	100.0%
Manufacture of food products	1040	12%	99	14%	22523	17%	13.9%
Manufacture of fabricated metal products, except machinery and equipment	997	11%	65.2	9%	13080	10%	9.9%
Manufacture of wearing apparel	879	10%	37.4	5%	11995	9%	7.9%
Printing and reproduction of recorded media	845	9%	47	6%	9124	7%	7.5%
Manufacture of other non-metallic mineral products	420	5%	64	9%	7634	6%	6.4%
Manufacture of machinery and equipment n.e.c.	372	4%	56.3	8%	8158	6%	6.0%
Manufacture of rubber and plastic products	619	7%	37.2	5%	7762	6%	5.9%
Manufacture of furniture	689	8%	20.6	3%	5963	4%	5.0%

Table 4.7c: Bucharest Ilfov Service Sector Activities by Sub Sector and by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		Overall
	2009	%	2009	%	2009	%	%
Information and communication	8665	100%	739.1	100%	78776	100%	100%
Computer programming, consultancy and related activities	3432	40%	224.6	30%	20893	27%	32%
Telecommunications	1165	13%	274.6	37%	25108	32%	27%
Publishing activities	1602	18%	91.2	12%	13469	17%	16%
Motion picture, video and television programme production, sound recording and music publishing activities	1387	16%	23.3	3%	5792	7%	9%
Programming and broadcasting activities	125	1%	82	11%	8480	11%	8%
Information service activities	954	11%	43.5	6%	5034	6%	8%
Real estate activities	5837	100%	87.9	100%	19955	100%	100%
Professional, scientific and technical activities	23573	100%	655.5	100%	97423	100%	100%
Activities of head offices; management consultancy activities	9263	39%	162.9	25%	25192	26%	30%
Architectural and engineering activities; technical testing and analysis	4965	21%	210.6	32%	27817	29%	27%
Advertising and market research	4115	17%	107.5	16%	17821	18%	17%
Legal and accounting activities	2868	12%	60.4	9%	9275	10%	10%
Scientific research and development	467	2%	94.1	14%	11769	12%	9%
Other professional, scientific and technical activities	1675	7%	16.9	3%	4532	5%	5%

All major industrial sectors are well represented in the region. 7 clusters are registered in the region so far; Elinclus Innovative Cluster (Electronics); Romanian Textile Concept Cluster (Textiles); Ind Agro Competitiveness Pole (machinery); Romanian Aerospace Cluster Bucharest; Electrical Engineering Pole Bucharest; Integrated Automation Systems Pole and the Mechatronics Cluster.

A detailed review of the Romanian Textile Concept Cluster (Annex 2.1), the Ind Agro Competitiveness Pole (Annex 2.2) and the Integrated Automation Systems Pole (Annex 2.3) has been undertaken and is provided in the annexes to this report.

Based on a qualitative and quantitative analysis of market, internal factors, innovation and technology, geographical concentration, labour force, research and development and innovation, cooperation and the availability of catalyst institutions, the following tables highlights the smart specialisation areas identified in Bucharest Ilfov.

Table 4.7d Smart Specialisation in the Bucharest Ilfov Region

Sector	Innovation	Smart	Other cross cutting issues	Cross cluster cooperation
Electronics	Mechatronics	Intelligent marine energetic systems	Human Resources	Energy, Environment
Machinery and Equipment	Agricultural machinery	Intelligent Agriculture	Entrepreneurship (business incubation)	Textile, Agro
Textiles	Technical Textiles	Technical textiles for health, automotive, Agrofood	Marketing (brand)	Automotive, AgroFood

4.8 Sud Vest Region

Also known as South-West Oltenia, the Sud-Vest Region of Romania covers an area of 29,212 km sq and is home to 2.3 million people. The region is composed of five counties: Dolj, Gorj, Mehedinti, Olt and Valcea. Natural features of the region include the Carpathian Mountains and the Danube.

The largest city in Sud-Vest Romania is Craiova, capital of Dolj County and the 6th largest city in Romania. The economy of Sud-Vest Romania is highly diverse with agriculture, textiles, and various forms of manufacturing, tourism, and heavy industries. The Danube is a resource which is exploited by several hydroelectric power stations, as well as for its natural beauty as a major tourist attraction. Other natural resources in the region include coal, salt and wood, all of which are extracted, refined and processed in the region.

Table 4.8a SUD VEST Business Structure in 2009, Source: Eurostat (2012) New Cronos, NACE Rev 2

Sector	No of Enterprises		Wages and Salaries		Employment	
	2009	%	2009	%	2009	%
Mining and quarrying	137	0%	161.8	13%	17325	6%
Manufacturing	4006	11%	397.2	31%	91848	30%
Electricity, gas, steam and air conditioning supply	76	0%	138.9	11%	13819	5%
Water supply; sewerage, waste management and remediation activities	253	1%	23	2%	5297	2%
Construction	3667	10%	135.8	11%	36924	12%
Wholesale and retail trade; repair of motor vehicles and motorcycles	17927	50%	185.3	15%	71249	24%
Transportation and storage	2882	8%	107.2	8%	25874	9%
Accommodation and food service activities	2310	6%	21	2%	9859	3%
Information and communication	962	3%	26	2%	4715	2%
Real estate activities	589	2%	3.6	0%	1493	0%
Professional, scientific and technical activities	2493	7%	27.9	2%	7599	3%
Administrative and support service activities	906	3%	40	3%	15957	5%
Total	36208	100%	1267.7	100%	301959	100%

The overall business structure of the region (table 4.8a) is dominated by manufacturing, wholesale and retail trade (Low Intermediate skill), construction and transportation and storage.

Table 4.8b provides a detailed breakdown of the manufacturing sector into sub sectors for those subsectors where the overall calculated average of percentage employment, wages and salaries and number of enterprises is greater than 5%. For the Sud West region this identifies the low-skill, low-tech sectors including food, textiles and metal products alongside high intermediate tech sectors including the manufacture of motor vehicles, other transport and the high-skill and high-intermediate tech sector of chemicals. Table 4.8c provides a detailed breakdown of the service sector into sub sectors. For the Sud West region as with other Romanian regions this identifies the importance of real estate, architectural and engineering activities, management consultancy, telecommunications and computer programming.

Table 4.8b SUD VEST: Manufacturing Sub-Sectors by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		
	2009	%	2009	%	2009		Av %
Manufacturing	4006	100%	397.2	100%	91848	100%	100.0%
Manufacture of food products	869	22%	37.3	9%	12934	14%	15.1%
Manufacture of fabricated metal products, except machinery and equipment	583	15%	42.2	11%	9525	10%	11.8%
Manufacture of wearing apparel	399	10%	36.6	9%	14697	16%	11.7%
Manufacture of chemicals and chemical products	108	3%	55.4	14%	7999	9%	8.5%
Manufacture of rubber and plastic products	236	6%	23.6	6%	5333	6%	5.9%
Manufacture of other transport equipment	28	1%	34.3	9%	6822	7%	5.6%
Manufacture of motor vehicles, trailers and semi-trailers	25	1%	34.9	9%	5117	6%	5.0%

Automotive, Tourism (2) and ICT are the 4 registered clusters in the region. A detailed review of the Tourism cluster has been undertaken and is provided in Annex 2.5 to this report. Based on a qualitative and quantitative analysis of market, internal factors, innovation and technology, geographical concentration, labour force, research and development and innovation, cooperation and the availability of catalyst institutions, the following table highlights the smart specialisation areas identified in the Sud Vest Region.

Table 4.8d Smart Specialisation in the Sud Vest Region

Sector	Innovation	Smart	Other cross cutting issues	Cross cluster cooperation
Tourism	Danube Strategy	Danube Tourism, tool for Regional Economic Development		ICT

Located in the region, the *Danube International Centre for River-Delta-Sea systems*, comprises a physical hub in the Danube Delta and a network of nodes distributed throughout Europe. The entire International Centre, as a pan-European distributed Research Infrastructure will be coordinated by the *Hub* in the Danube Delta. This will provide educational facilities, an administrative centre, the gate to the Danube Delta natural laboratory, and the physical location for new laboratories. The *Hub* will link with *Nodes*, representing leading facilities and centres of research excellence. In addition to

the scientific advantages of locating the Hub in the Danube Delta, this offers new opportunities for the development of the regional economy. The new science and innovation hub in the Danube Delta Biosphere Reserve will work with local communities; offering significant educational outreach and developing the knowledge-based economy.

Table 4.8c: SUD VEST Service Sector Activities by Sub Sector and by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		Overall
	2009	%	2009	%	2009	%	%
Information and communication	962	100%	26	100%	4715	100%	100%
Computer programming, consultancy and related activities	424	44%	8.2	32%	1483	31%	36%
Telecommunications	191	20%	11.7	45%	1535	33%	32%
Publishing activities	205	21%	2.8	11%	855	18%	17%
Programming and broadcasting activities	40	4%	2.6	10%	563	12%	9%
Information service activities	65	7%	0.4	2%	180	4%	4%
Motion picture, video and television programme production, sound recording and music publishing activities	37	4%	0.3	1%	99	2%	2%
Real estate activities	589	100%	3.6	100%	1493	100%	100%
Professional, scientific and technical activities	2493	100%	27.9	100%	7599	100%	100%
Architectural and engineering activities; technical testing and analysis	780	31%	10.2	37%	2815	37%	35%
Activities of head offices; management consultancy activities	591	24%	6	22%	1444	19%	21%
Scientific research and development	36	1%	6.5	23%	833	11%	12%
Legal and accounting activities	424	17%	1.5	5%	778	10%	11%
Other professional, scientific and technical activities	240	10%	1.6	6%	741	10%	8%
Advertising and market research	273	11%	1.3	5%	606	8%	8%

4.9 Vest Region

The West Region accounts for 9.9% of the national GDP. It is one of the most innovative regions, being the first one to implement an RIS I strategy and the only Romanian region so far which registered to the Smart Specialisation Platform. Timisoara, Arad, Resita and Deva are the most important cities in the region.

The overall business structure of the region (table 4.9a) is dominated by manufacturing, wholesale and retail trade (Low Intermediate skill), construction and transportation and storage.

Table 4.9b provides a detailed breakdown of the manufacturing sector into sub sectors for those subsectors where the overall calculated average of percentage employment, wages and salaries and number of enterprises is greater than 5%.

Table 4.9a VEST Business Structure in 2009, Source: Eurostat (2012) New Cronos, NACE Rev 2

Sector	No of Enterprises		Wages and Salaries		Employment	
	2009	%	2009	%	2009	%
Mining and quarrying	185	0%	122.2	7%	14195	3%
Manufacturing	5623	12%	682	40%	156133	38%
Electricity, gas, steam and air conditioning supply	65	0%	69.7	4%	7387	2%
Water supply; sewerage, waste management and remediation activities	272	1%	33.1	2%	7701	2%
Construction	5596	12%	164.2	10%	46483	11%
Wholesale and retail trade; repair of motor vehicles and motorcycles	18141	38%	258.2	15%	83680	20%
Transportation and storage	3486	7%	147	9%	33002	8%
Accommodation and food service activities	3120	7%	31.3	2%	14662	4%
Information and communication	1469	3%	88.6	5%	10124	2%
Real estate activities	1763	4%	11.3	1%	4112	1%
Professional, scientific and technical activities	5582	12%	55.7	3%	16395	4%
Administrative and support service activities	1943	4%	44	3%	18369	4%
Total	47245	100%	1707.3	100%	412243	100%

Table 4.9b VEST: Manufacturing Sub-Sectors by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		
	2009	%	2009	%	2009		Av %
Manufacturing	5623	100%	682	100%	156133	100%	100.0%
Manufacture of motor vehicles, trailers and semi-trailers	80	1%	182.1	27%	36492	23%	17.2%
Manufacture of food products	878	16%	47.6	7%	14973	10%	10.7%
Manufacture of wearing apparel	506	9%	47.2	7%	15257	10%	8.6%
Manufacture of fabricated metal products, except machinery and equipment	701	12%	38.2	6%	9143	6%	8.0%
Manufacture of leather and related products	262	5%	41.7	6%	12671	8%	6.3%
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	620	11%	16.8	2%	6137	4%	5.8%
Manufacture of furniture	471	8%	23.8	3%	6962	4%	5.4%
Manufacture of computer, electronic and optical products	130	2%	52	8%	8031	5%	5.0%

For the Vest region this identifies high tech sector of computer, electronic and optical products and the high intermediate tech sector of the manufacture of motor vehicles. In addition the region has a profile of low-skill, low-tech sectors including food, textiles and metal products, wood, leather and furniture. 4 clusters are registered so far in the region; ROSENC, renewable energy; AgroFood Vest; Automotive Vest and ICT Vest.

Table 4.9d Smart Specialisation in the Vest Region

Sector	Innovation	Smart	Other cross cutting issues	Cross cluster cooperation
Agro Food	Biotechnology	Detection and quantification of genetically modified organisms in agricultural products and food		
Energy	Renewable Energy	Solar power for use with irrigation systems		AgroFood
IT	IT for non IT	Personalised IT business solutions	Entrepreneurship Internationalisation	Energy, automotive

Table 4.9c provides a detailed breakdown of the service sector into sub sectors. For the Vest region as with other Romanian regions this identifies the importance of real estate, architectural and engineering activities, management consultancy, telecommunications and computer programming.

Table 4.9c: VEST Service Sector Activities by Sub Sector and by Enterprises, Wages and Salaries and Employment, Source: Eurostat (2012) New Cronos, NACE Rev 2

	Number of local units		Wages and Salaries		Number of persons employed		Overall
	2009	%	2009	%	2009	%	%
Information and communication	1469	100%	88.6	100%	10124	100%	100%
Telecommunications	236	16%	54.4	61%	4851	48%	42%
Computer programming, consultancy and related activities	700	48%	23.3	26%	3045	30%	35%
Publishing activities	248	17%	6.1	7%	1186	12%	12%
Information service activities	159	11%	0.8	1%	365	4%	5%
Programming and broadcasting activities	46	3%	3.6	4%	534	5%	4%
Motion picture, video and television programme production, sound recording and music publishing activities	80	5%	0.3	0%	143	1%	2%
Real estate activities	1763	100%	11.3	100%	4112	100%	100%
Professional, scientific and technical activities	5582	100%	55.7	100%	16395	100%	100%
Architectural and engineering activities; technical testing and analysis	1581	28%	20.7	37%	5410	33%	33%
Activities of head offices; management consultancy activities	1650	30%	13.8	25%	4307	26%	27%
Legal and accounting activities	1065	19%	5.9	11%	2161	13%	14%
Other professional, scientific and technical activities	523	9%	4.5	8%	1608	10%	9%
Advertising and market research	547	10%	2.9	5%	1417	9%	8%
Scientific research and development	50	1%	6.6	12%	998	6%	6%

4.10 Regional Clusters: Additional Information

In the last 2 years, regional clusters have concluded several international cooperation agreements with similar structures in Europe. Concerning the direct cross-border cooperation, the most intense cooperation is to be found between the Vest Region of Romania and South Great Plain Region of Hungary. The topics of cross border cluster cooperation are detailed in the following table 4.10a.

Table 4.10a Interaction with partner Regions and Countries

No	Region	Cluster/Organisation	Topic	Country
1	Vest	ROSENC (cluster)	Renewable energy	Hungary
2	Vest	ICT Vest	Generation of cross border IT cluster; IT solutions for non IT businesses	Hungary
3	Vest	Chamber of Commerce Timis	Enhancing cross border cooperation in the field of “green construction”	Hungary
4	Vest	ICT Vest	Enhancing cross border cooperation in ICT	Serbia
5	Sud Vest	Dolj County Council	Enhancing cross border cooperation in agro food	Bulgaria
5	Sud Est	Chamber of Commerce Constanta	Enhancing cross border cooperation in tourism and agro food	Bulgaria
6	Nord Est	Iasi County Council	Enhancing agro food cooperation	Moldova, Ukraine
7	Nord Est	Several institutions: Water Management Direction, University of Iasi etc.	Environment protection: water management on the river Prut	Moldova, Ukraine

At European level worth mentioning are the cooperation between the Energy Cluster in the Centre Region and the land of Brandenburg in Germany, and the cooperation of Green Energy, Agro Food and Pro Wood clusters in Covasna County (Centru Region) with similar clusters in Hungary.

At a more general level several SEE Europe (e.g. Polisee, ADC), INTERREG IV C (Clusterix) and CIP (SEENECO) projects are currently running, aiming at integrating Romanian clusters into the European landscape.

In order to consolidate the development of the emerging clusters in Romania, the Ministry of economy organised in June 2012 a foresight exercise for the sectors of electrical engineering & electronics, machinery and equipment and textiles in order to evaluate key industrial trends. The financing of Research and Development and cluster management have been highlighted as critical factors for further cluster development.

A further peer review seminar organised in November 2012 gathered representatives of innovative clusters including wood, mechatronics, electrical engineering and textiles, and

they were asked to evaluate current performance of structural funds interventions and to highlight the most important challenges for the coming programming period.

Table 4.10b Proposed Cluster Innovation Projects

No	Sector	Topic	Cluster	Region	Cross clustering
1	Energy	Automated combustion system for biomass derived from energy plantations	Green Energy Covasna	Centre	
2	Energy	Creating a protective strip of energy willow plantations next to waste storage facilities	Green Energy Covasna	Centre	
3	Energy	Solid biomass from wood waste out of pasture cleaning and maintenance	Green Energy	Centre	Agriculture
4	Textiles	Reuse of textile waste	Transylvania Fashion Cluster	Centre	
5	Textiles	Anthropometric Research for ergonomic fashion and innovative products in various industries (automotive, aeronautics, maritime, furniture)	R&D Institute for Textiles	Bucharest Ilfov	Transport, wood
6	Textiles	New generation of textile filters for food liquids	R&D Institute for Textiles	Bucharest Ilfov	AgroFood
7	Textiles	New generation of agro-textiles	R&D institute for Textiles	Bucharest -Ilfov	Agriculture
8	Textiles	New generation of technical textiles for the automotive sector	R&D Institute for Textiles	Bucharest -Ilfov	Automotive
9	Textiles	Innovative Processes of textile impregnation with nanoparticles with antiseptic, antifungal and self-cleaning properties	R&D Institute for Textiles	Bucharest -Ilfov	Health
10	Textiles	Customised clothing: Made to Measure	R&D Institute for textiles	Bucharest Ilfov	
11	Electrical engineering	Transformer performance improvement taking into account EU Eco design Directive requirements on electric loss reduction	R&D Institute for Electrical Engineering	Sud Vest	

12	Electrical engineering	Pilot station for high energetic efficiency alternative electric power generation using biomass and dedicated Stirling motors	R&D Institute for Electrical Engineering	Sud Vest	Energy, agriculture
13	Electrical engineering	Development of new testing methods for high voltage electric power transportation cables	R&D Institute for Electrical Engineering	Sud Vest	
14	Electrical engineering	Energetic efficiency improvement using superconducting coils when preheating the aluminium ingots with a view to extrusion	R&D Institute for Electrical Engineering	Sud Vest	Energy
15	Mechatronics	Intelligent mechatronics marine energetic system	Mecathrec	Bucharest Ilfov	Energy
16	Mechatronics	Mechatronic integrated system for the determination of wave forces developed in different areas and at different depths.	Mecathrec	Bucharest Ilfov	Energy, Environment

Moving forward into the next operational programme the Ministry of Economy has conducted a “project generation pipeline” exercise, where clusters have been asked to describe future projects in terms of topic, envisaged actions, budget, partners, and transnational relevance. Over 50 projects have been submitted with a total estimated budget of approximately 75 mil EUR and engaging over 350 partners. Of these projects 27% are related to the textile sector, 20% to energy, 14% to machinery and equipment and 9% to automotive. The nature of the proposed innovative projects is highlighted in table 4.10b. Cross sectoral collaborations relating to “technical textiles” and “clean technology” are seen as particularly important.

4.11 Regional Structural Business Assessment: Analysis

The assessment of the Romanian economy at a regional level reveals significant commonality between the majority of the regions and this can be observed in table 4.11a below which summarises the key sub-sectors by skills and technology.

The dominance of sectors at a national level is continued at a regional level with the importance of computer programming and telecommunications being identified for each region and motor vehicles and other transport being identified within specific regions. The chemical sector which was identified as important based on the national level analysis has been identified as being of most significant importance in the Sud Vest region. High-skill and low-tech sectors play an important role at the regional level with a strong dominance of real estate, management consultancy, architectural and engineering

activities. The analysis at a national level revealed the importance of the food sector and this mirrored in this regional assessment along with the sectors of textiles, wood and leather which are considered as; Low-Skill or Low Intermediate Skill and Low Tech or Low Intermediate Tech.

In addition to this analysis a series of four workshops was held in Bucharest on the 12th and 13th of February 2013 represented by public authorities at the National level, public authorities at a regional level, business representation and representation from research institutions and Universities. The workshops discussions were conducted in a moderated process, allowing a focused and objective oriented approach.

The participants were asked to comment on the findings of a summary presentation of the quantitative analysis undertaken in this report and to express their opinion in terms of the importance of sectors, subsectors and research which can be regarded as a basis for the future smart specialisation in Romania. The results of the moderated discussion from the regional level workshop are identified in table 4.11b and from the business / economic cluster workshop in table 4.11c. In addition, experts have been asked to rank various economic sectors according to their relative importance in the regions by awarding a maximum of 6 votes, the results can be seen in Table 4.11a

Table 4.11a Importance of Economic Sectors in Romanian Regions

Region/Sector	NE	SE	S	BI	SV	V	C	NV
Agro-Food	1	1	1	3	1	1	2	
ICT	1	1		2		2		2
Transport Equipment		2	2			2		
Electronics								1
Machinery and Equipment	1						1	1
Textiles and Footwear	1					1		
Energy and Environment			1	1				1
Tourism	1	1			3			
Wood and Furniture							3	1
Oil Industry			2					
Chemistry					2			
Pharmaceuticals and Cosmetics	1	1						

The feedback from the workshops confirms the importance of food and agriculture, ICT, transport, machinery and equipment and energy and the environment. Additionally the regional representatives identified significantly the importance of tourism and wood and furniture, although it should be noted that both of these sectors are considered less knowledge intensive and low skills based.

In conclusion this section of the report has aimed at a regional level to highlight the key sectors which may provide a basis for smart specialisation. A more detailed analysis of sectors relating to their research profile is provided in the following section of this report.

Smart specialisation within the context of the next programming period of the structural funds is considered within the context of the priority for research and development. In this context the sectors of computer programming, telecommunications, computer electronics and optical products, chemicals, machinery and equipment, other transport and motor vehicles should be actively considered as focus areas.

Table 4.11B Regional Level Workshop: Identified Sector and Research Specialisation Themes

Sector	Sector Specialisation	Research	Research Specialisation
Food Agriculture	Agro-Food, Biotechnology	Food and Agriculture	Agronomy, crop science, food science and agricultural and biological science, agricultural biotech , wine
ICT	Telecommunications and Software / Computer Programming Mechatronics New Media (NE),	ICT	Networks of the future, internet of services, software and visualisation, networked media and 3d internet, flexible organic and large area electronics, embedded system design, personal health systems, ICT for energy efficiency and accessible and assistive ICT, Computer science and artificial intelligence. IT for Transport (maritime), Robotics (NV, V, C)
Motor Vehicle Manufacturing and Other Transport	Materials, Components and Fabrication Ship Building, Aviation equipment (NE,C)	Engineering and Technology	Electrical and electronic engineering, nanotechnology, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering, motor vehicle transport and other transport Railway transport (V), welding (V),aeronautics (Galati, SE), Design (V)
Electronics	Computer, Electronics and Optical Products, Medical precision Instruments, Mechatronics		
Machinery and Equipment,	Intelligent Agriculture, Automation Mechatronics		
Textiles and Footwear	Technical Textiles		

Sector	Sector Specialisation	Research	Research Specialisation
Energy, Environment,	Renewable Energy, Wind Power, Solar Power, Green construction. Biomass, Ecological Services, fossil energy (S), gas & electricity (SV), maritime oil extraction (SE)	Energy and Environment	Pollution, management and monitoring, environmental engineering, ecology and environmental science, network technologies, renewable energy and bio fuels, decontamination (SE), energy efficiency
Tourism	Wellness/Health Tourism, adventure holidays		Cosmetics (SE), life science (pharmacy), health (V, NE)
Printing			
Wood and Furniture			Conversion of wood waste
Security			Mining Security
Oil Extraction			Oil engineering, petrochemistry (S)
Construction	Materials		Building materials,
Chemistry			
Pharmaceuticals and cosmetics			Cosmetics (SE), life science (pharmacy), health (V, NE), antibiotics

Table 4.11C National Level Workshop (Clusters and Businesses): Identified Sector and Research Specialisation Themes

Sector	Sector Specialisation	Research	Research Specialisation
Food Agriculture	Agro-Food, Biotechnology, bio-bee keeping, fisheries	Food and Agriculture	Agronomy, crop science, food science and agricultural and biological science, agricultural biotech ,
ICT	Telecommunications and Software / Computer Programming Mechatronics, apps	ICT	Networks of the future, internet of services, software and visualisation, networked media and 3d internet, flexible organic and large area electronics, embedded system design, personal health systems, ICT for energy efficiency and accessible and assistive ICT, Computer science and artificial intelligence.
Motor Vehicle Manufacturing and Other Transport V,S	Materials, Components and Fabrication Ship Building, agricultural equipment	Engineering and Technology	Electrical and electronic engineering, nanotechnology, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering, motor vehicle transport and other transport, Monitoring systems, charging of electrical vehicles, technical equipment for agriculture
Electronics	Computer, Electronics and Optical Products, Medical precision Instruments, Mechatronics, chip design, technological support services, telecomm applications		Smart textiles, textiles for agriculture
Machinery and	Intelligent Agriculture,		

Sector	Sector Specialisation	Research	Research Specialisation
Equipment	Automation Mechatronics, Agricultural engineering,		
Textiles RO	Technical Textiles, Shoes, leather, fur,		
Energy RO	Renewable Energy, Wind Power, Solar Power, Green construction. Biomass, Ecological Services, energetic crops	Energy and Environment	Pollution, management and monitoring, environmental engineering, ecology and environmental science, network technologies, renewable energy and bio fuels, trigeneration, cogeneration, micro windmills for cities, heat pumps, waste to energy, energy autonomous irrigation systems, energetic building efficiency, molecular structures for photovoltaic panels, intelligent monitoring systems and sensors for energy production, energy production and management (especially in urban areas)
Wood and Furniture C. NE. SE	Wood processing		
Tourism NE, SE, SV, V, NV, C	Wellness, traditional village		
Rural Development NV, NE, C, SV, SE			
Cultural Heritage RO	Traditional industries		

4.12 Regional Structural Business Assessment: Concluding Remarks

In conclusion this section of the report has aimed at a regional level to highlight the key sectors which may provide a basis for smart specialisation. A more detailed analysis of sectors relating to their research profile is provided in the section 5 of this report and a national profile has been reported in section 4. Smart specialisation within the context of the next programming period of the structural funds is considered within the context of the priority for research and development. In this context the sectors of ICT (e.g. computer programming, telecommunications, computer electronics and optical products), other transport and motor vehicles and food and agriculture have been identified as key areas of focus for the Romanian regions and business clusters and this is consistent with our national level analysis.

Table 4.12a Assessment of Manufacturing Sector Skills and Technology within Romanian Regions

HIGH SKILL			Chemical (SV)	Computer, Electronics and Optical Products (V)
HIGH INTERMEDIATE SKILL			Electronics and Electrical Engineering (BI, C, V, NV)	
LOW INTERMEDIATE SKILL	Wood (C, NE, V, NV, SE)	Manufacture of Metal Products (NV, C, NE, SE, SM, SV,	Machinery and Equipment (C, NE, SM, BI, NV, SV)	
LOW SKILL	Food (NV, C, NE, SE, SM, BI, SV, V) Textiles (NV, SV, C, NE, SE, SM, BI, V) Leather (C, V) Furniture (V, NE, C)	Rubber and Plastics (NV, BI, SV) Non Metallic Products (NV, C, BI)	Other Transport (C, SE, SV) Motor Vehicle Manufacturing (NV, C, SM, SV, V, SE)	
	LOW TECH	LOW INTERMEDIATE TECH	HIGH INTERMEDIATE TECH	HIGH TECH

Outside of these three sectors the following areas have also been identified; tourism, wood and furniture, machinery and equipment, energy and environment, textiles, petrochemicals, chemicals and pharmaceuticals, rural development, security, printing and cultural heritage.

Table 4.12a identifies manufacturing economic sub-sectors by skill and technology level and their regional focus based on initial desk research and the stakeholder workshops undertaken on the 12th and 13th February 2013. Table 4.12b identifies those non manufacturing sectors by skill intensity and their regional focus again based on both initial desk research and the stakeholder workshops.

Table 4.12b Assessment of Sector Skills in Romanian Regions

HIGH SKILL / HIGH INTERMEDIATE SKILL (KNOWLEDGE INTENSIVE SERVICES)	Computer and Related Activities (NV, C, NE, SE, SM, BI, SV, V) Management Consultancy (NV, C, SE, SM, BI, SV, V, NE) Architectural and engineering activities (NV, C, SM, SV, V, NE, SE, BI) Publishing Activities (BI, C, NV, C, NE) Real Estate (NV, C, NE, SE, SM, V, BI) Telecommunications (NV, NE, SE, SM, BI, SV, V) Renewable Energy (V, NV, C, SE) Legal and Accounting (NV, C, NE, SE) Advertising and Market Research (BI) Security
LOW INTERMEDIATE SKILL / LOW SKILL (LESS KNOWLEDGE INTENSIVE SERVICES)	Construction (NV, C, SE, SM, V, BI, SV) Wholesale and Retail Trade (NV, C, SV, NE, SE, V, SM, BI) Transportation and Storage (NV, C, NE, SE, SM, V) Tourism (SE, C, NE, SV)

Table 4.12C Potential Areas for Smart Specialisation Focus

Sector	Specialisation	Observations
Core Priorities		
Food Agriculture	Agro-Food, Biotechnology	Food is generally considered low-skill, low-tech. The concentration on Agro-Food should be driven by R&D.
ICT	Telecommunications and Software / Computer Programming, Mechatronics, New Media, Application Development	An established part of the Romanian economy and a key strength within a majority of Romanian regions
Motor Vehicle Manufacturing and Other Transport	Materials, Components and Fabrication, Ship Building, Aerospace, Agricultural machinery.	Automotive research and other transport has a high expenditure from the private sector in Romania and is a leading sector in economic performance
Other Potential Priorities		
Tourism	Health Tourism, Wellbeing	Tourism is considered as a less knowledge intensive market service. The linkage to research and development is currently undefined however this sector could make valuable use of research and skills in the ICT and Medical research themes.
Wood and Furniture	Wood Processing, Conversion of Waste	Identified by four regions as important, this is a low-intermediate skill, low-technology sector. This sector could be targeted as an application environment for ICT and machinery and equipment.
Energy	Renewable Energy, Wind Power, Solar Power, Green construction. Biomass, Ecological Services, Fossil Energy, Gas and Electricity, Maritime Oil Extraction	A global industry, Romania has a relatively large energy sector and a move towards sustainable energy is essential.
Machinery and Equipment	Intelligent Agriculture, Automation Mechatronics	Machinery and Equipment ranks well from an economic perspective and is located strongly in half of all regions. Particular focus should be given to new application areas
Textiles	Technical Textiles	Textiles are generally considered low-skill,

		low-tech. A concentration on technical textiles will diversify this part of the economy into high-intermediate technology and skills.
Chemicals and Pharmaceuticals	Cosmetics, Life Science, Health	Identified in four regions (1 x Chemicals, 3 x Pharmacy) this area is considered high-technology, high skill. The chemicals sector is a significant contributor to gross value added however the industry has suffered from reductions in output. Pharmaceuticals have grown particularly in 2012 and there is significant investment in clinical testing. Romania would not be identified currently as a leading producer of pharmaceuticals.

Concluding this analysis and considering the assessment of sectors at a national level and at a regional level analysing economic sectors of the economy, clusters and existing specialisations the economic areas (see table 4.12 c); food and agriculture, ICT and motor vehicles and other transport are considered by the authors of this report to be core priorities for a smart specialisation focus and the economic areas of tourism, wood and furniture, energy, machinery and equipment, textiles and chemicals and pharmaceuticals are potential areas for a focus on smart specialisation based on an assessment of R&D capability and wider discussion with stakeholders.

5 Research, Technological Development and Innovation

5.1 Introduction

Research infrastructures are an important part of Smart Specialisation as they are a driving force behind innovation. The European Commission Guide to Research and Innovation Strategies for Smart Specialisation (RIS3) (European Commission, 2012) identifies that:

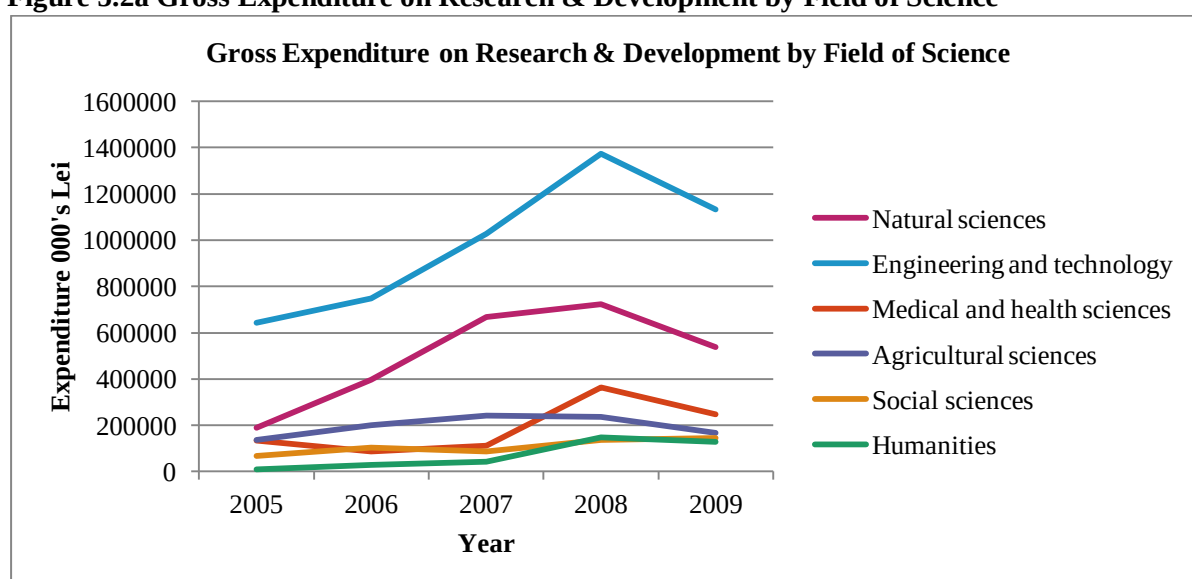
- The term 'research infrastructures' refers to facilities, resources, systems and related services that are used by research communities to conduct top-level research in their respective fields. This definition covers:
  - major scientific equipment or sets of instruments;
  - knowledge based-resources such as collections, archives or structured scientific information;
  - ICT-based e-Infrastructures (networks, computing resources, software and data repositories) for research and education; and
  - Any other entity of a unique nature essential to achieving or enabling excellence in research.

Research Infrastructures are often integrated in a wider eco-system encompassing science parks, incubators, sectoral excellence centres, living labs, prototyping centres, intellectual property rights (IPR) centres, technology transfer offices, etc. which often facilitate the commercialisation of research results into market applications.

5.2 National RTDI Overview

This section of the report will provide a high-level assessment of the current focus of Romanian research by area of science based on the number of researchers; expenditure; number of PhD's and number of publications. This will highlight the current key areas of focus and provide a basis for a more detailed examination of each area of science which will follow in this section of the report.

Figure 5.2a Gross Expenditure on Research & Development by Field of Science



Overall investment in Research grew significantly up to 2008 (figure 5.2a) and then declined following the impact of the economic crisis in 2009. Gross expenditure overall is dominated by engineering and technology and the natural sciences.

Table 5.2a: Romanian Institutions in the Top 3000 Research and Development Institutions, Source Scimago Institutional Rankings World Report 2012

World Rank	Regional Rank	Country Rank	Organization
659	20	1	Politehnica University of Bucharest
869	34	2	Romanian Academy
972	42	3	Babes-Bolyai University
986	43	4	Institute of Atomic Physics
1146	54	5	University of Bucharest
1417	71	6	Gheorghe Asachi Technical University of Iasi
1435	72	7	Alexandru Ioan Cuza University
1450	74	8	Politehnica University of Timisoara
1548	78	9	Technical University of Cluj-Napoca
1904	100	10	University of Craiova
2184	124	11	Transilvania University of Brasov
2213	129	12	Carol Davila University of Medicine and Pharmacy
2221	130	13	Iuliu Hatieganu University of Medicine and Pharmacy Cluj
2457	146	14	Bucharest Academy of Economic Studies
2546	154	15	West University of Timisoara
2701	167	16	University of Medicine and Pharmacy Victor Babes
2767	171	17	University Dunarea de Jos of Galati
2823	177	18	University of Oradea
2979	187	19	Ovidius University Constanta

The Romanian RTDI System is based on institutions that are public, private, and public-private initiatives. The public research organisations include; 47 National Research and Development Institutes (NRDI), 66 Institutes and Research Centres of the Romanian Academy (52 Institutes, 14 Research Centres), 17 Institutes and Agricultural RDI centres and 51 RDI stations of the Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu-Sisesti".

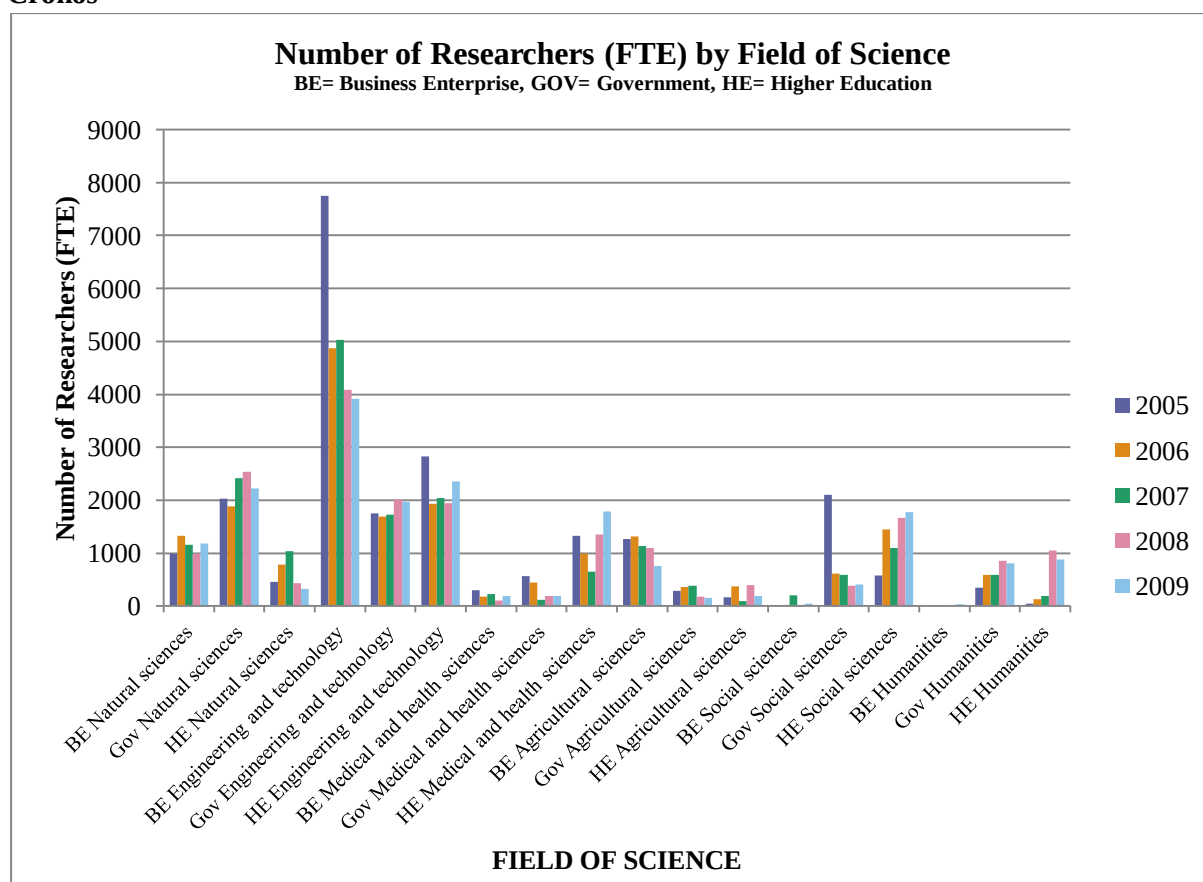
The 47 National RDI Institutes (Annex 3.2) participate in the construction of development strategies for their respective sectors and undertake RDI activities to deliver against the objectives of the National RDI Strategy. They provide scientific and technological expertise and undertake secondary commercial and production activities.

The Romanian Academy is a network of 66 institutes and research centres (52 institutes, 14 research centres), which contribute to achieving the objectives of the 2007-2013 National RDI Strategy and participates in National RDI programmes. In addition the Universities in Romania have recently been evaluated and categorised and are strong in infrastructure, research laboratories, international cooperation, joint working with industry and technology transfer. The Universities ranked strongly are

highlighted in table 5.3b below. These Universities have a strong profile in accessing funds from the National Partnership Programme. In an international ranking of the top 3000 Research and Development Institutions Romania has 19 organisations profiled (Table 5.2a).

Figure 5.2b highlights the number of researchers by field of science between 2005 and 2009. It highlights the dominance of engineering and technology research. It is noteworthy that a high proportion of researchers in some fields are employed within business enterprises. This particularly includes the Engineering and Technology, and Agricultural Science, sectors. The business enterprise sector includes; all firms, organisations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price, and the private non-profit institutes mainly serving them. The government sector is composed of; all departments, offices and other bodies which furnish but normally do not sell to the community those common services, other than higher education, which cannot otherwise be conveniently and economically provided and administer the state and the economic and social policy of the community; and non-profit institutions (NPIs) controlled and mainly financed by government; public enterprises are included in the business enterprise sector. The higher education sector is composed of all universities, colleges of technology, and other institutes of post-secondary education, whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education establishments (Eurostat, 2011)

Figure 5.2b Number of Researchers (FTE) by Field of Science, Source: Eurostat (2012): New Cronos



This predominant focus on engineering and technology can also be seen in the analysis of gross expenditure on research and development reflecting the strong investment by business enterprise,

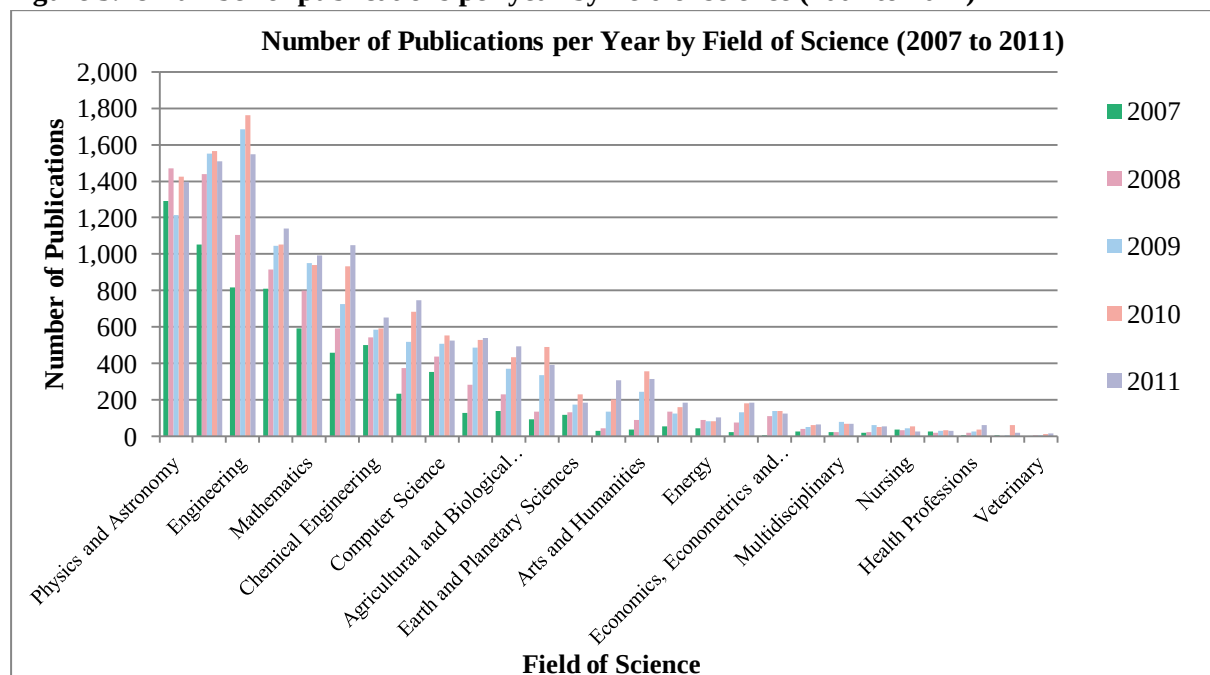
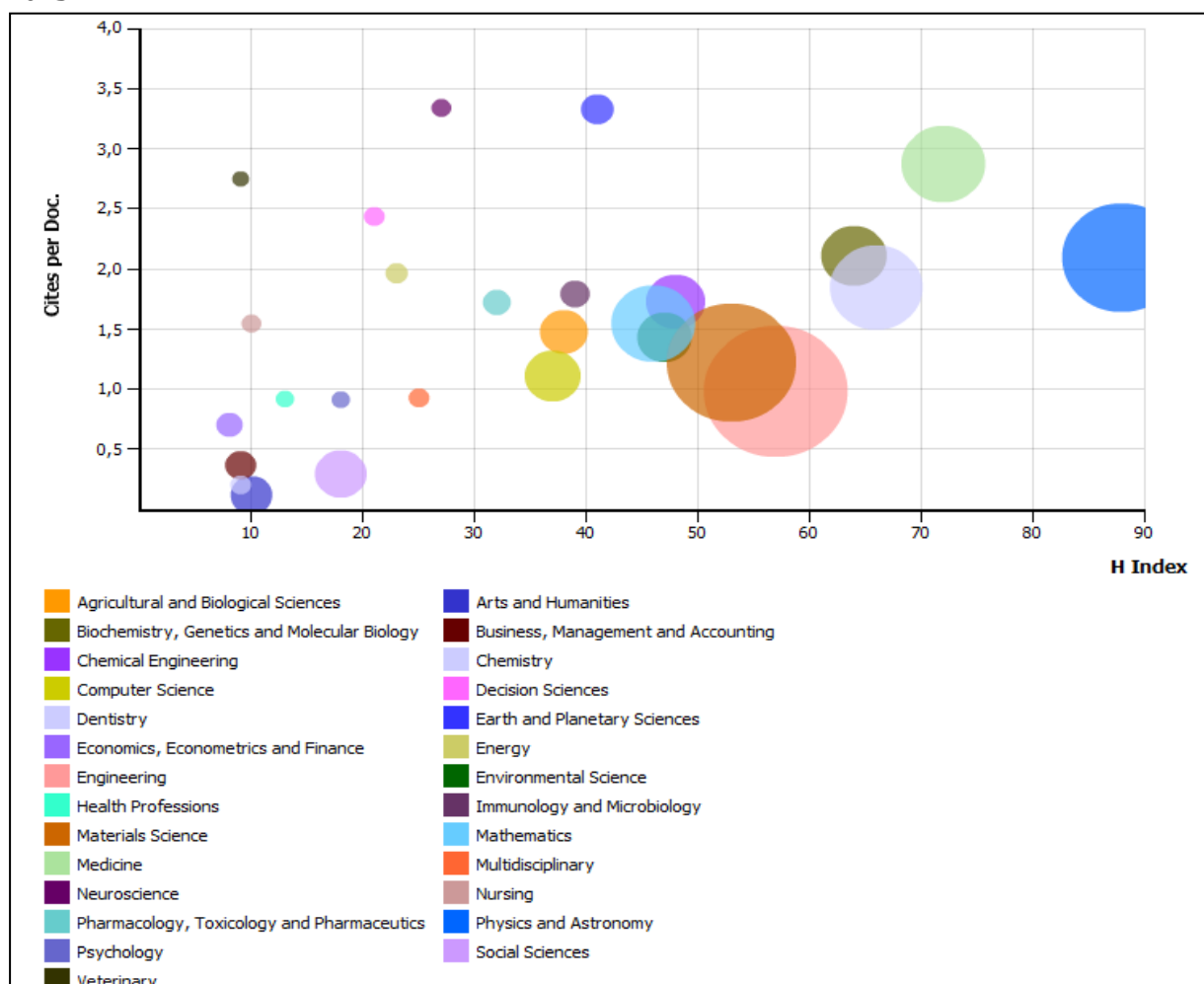
government and higher education. The natural sciences along with medical and health sciences (funded largely through government and higher education) followed by agriculture (funded largely by Business Enterprise) are also highlighted.

Data from Scimago (table 5.2b) also provides for an analysis of the overall numbers of publications in different fields. It should be noted, however, that this metric applies almost exclusively to University and Research Institute staff as industry researchers generally do not publish their work. It should also be noted that comparison of number of publications between fields is not appropriate as different disciplines tend to have very different patterns and frequencies of publication. If the analysis is restricted to only science and medicine, Romania ranks 40th in the world in publication output, with a combined 1996-2011 output of 76,361 publications. Within the Eastern European region, it ranked 6th between Hungary and Slovakia. However, the H index of these papers (which is a qualitative index which measures both output and the extent to which other researchers have referred to these papers) is low so that the ranking by H index puts Romania at No. 46 worldwide or No. 10 in Eastern Europe.

Table 5.2b Analysis of papers published by Romanian researchers 1996-2011.

Analysis of papers published by Romanian researchers 1996-2011.				
Discipline	1996-2011	2007-11	E. Europe Rank in no. of research publications	E. Europe Rank in H index *
Materials	10,395	17,301	4	7
Engineering	7,523	12,873	4	5
Medicine	4,358	6,755	9	9
Computer Science	3,443	5,239	5	7
Environment	4,166	5,206	7	9
Agriculture & Biol Science	2,008	2,684	10	12
Energy	519	1,635	6	7
Earth Science	11	13	10	12
* H index is a complex quality metric, based on a combination of publication output and the extent of citation of the paper by other researchers.				

This analysis of papers between 1996 and 2011 highlights the dominance of engineering, materials, computer science and energy and the environment. In analysis from 2007 to 2011 (figure 5.2c) materials and engineering both dominate at a national level along with physics and astronomy. The evidence of this focus on materials, engineering, medicine and physics can also be seen (figure 5.2d) in a 2010 -2011 assessment from Scimago of the H-Index and Document Citations.

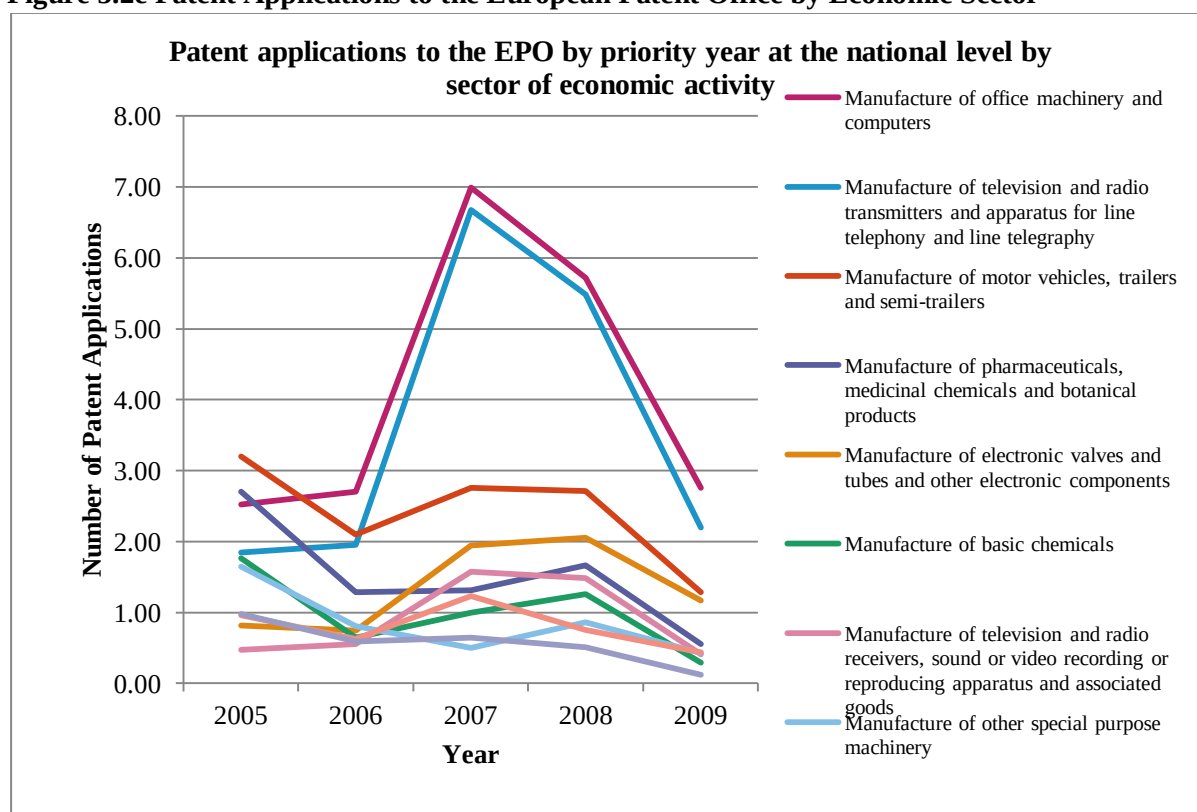
Figure 5.2c Number of publications per year by field of science (2007 to 2011)**Figure 5.2d Publication Citations and H-Index Calculations 2010 / 11, Source: Scimago, 2013**

An additional perspective at the national level is the consideration of patents which alongside publications are an important visible result of research activity. This metric is more likely to reflect activity in applied research and industrial interest.

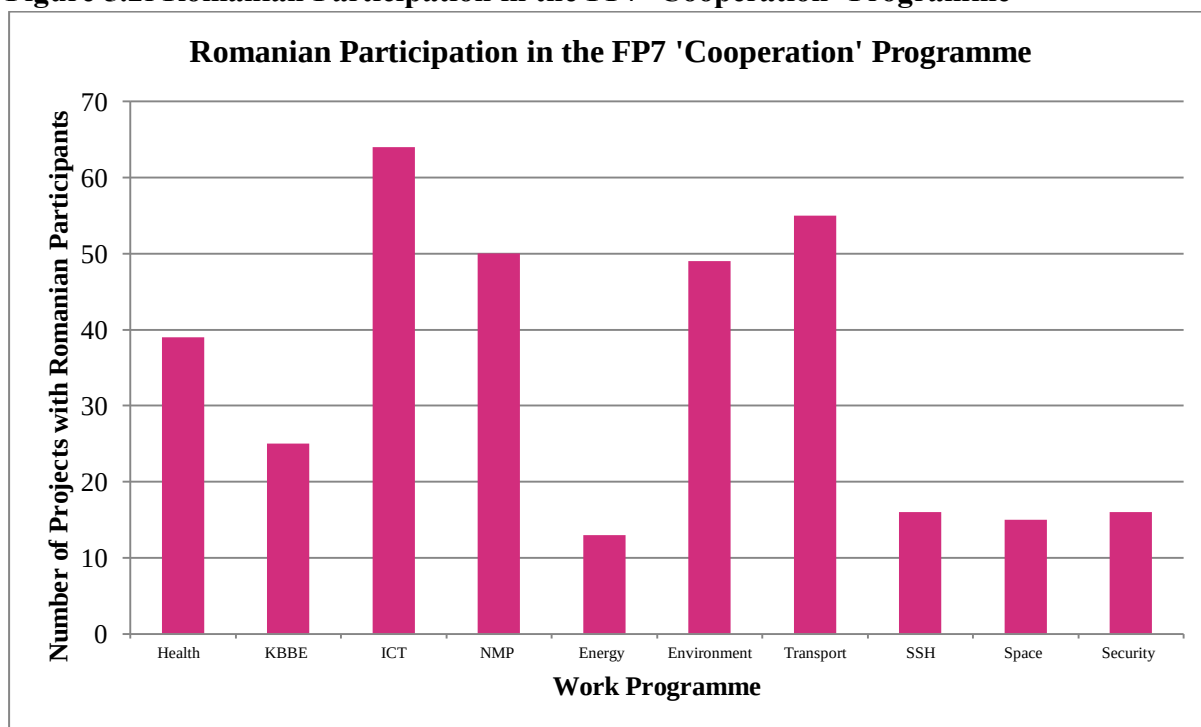
Figure 5.2e highlights the profile of Romanian patent applications to the European Patent Office by NACE activity. In line with our sector and cluster analysis and research profile it highlights a focus on; engineering and technology, specifically electronics and motor vehicles and transport and chemicals and pharmaceuticals

Overall this analysis of research employment, funding and results identifies a core capacity and capability in Romania linked to engineering and technology, natural sciences, medical and health sciences and agricultural science. This is consistent with a draft European Commission Report on Research and Development in Romania (REF) which highlights six key science and technology areas where Romania has real strengths in a European context. This analysis is based on the number of scientific publications and patents produced by authors (Science Matrix using Scopus) and inventors based in the regions (based on European Patent Office Applications from 2001 to 2010) The report identifies the following Romanian Strengths in science and technology at European level; Automobiles, Information and Communication Technologies, Materials, Aeronautics, New production technologies, Nan science and Nanotechnologies and Security.

Figure 5.2e Patent Applications to the European Patent Office by Economic Sector



An additional analysis concerns Romanian participation in the Framework 7 funding programme. Considering the ‘cooperation’ work programmes a focus on ICT and transport can be clearly seen alongside environment and the new materials and processes. This is consistent with the profile of research at a national level including the number of researchers, publications and funding.

Figure 5.2f Romanian Participation in the FP7 ‘Cooperation’ Programme

5.3 National RTDI Research Theme Profiles

Investment in Romanian RTDI has been designed to address multiple dimensions of the research and innovation system including thematic priorities, target groups, structural and infrastructural issues and organisational and managerial capacity and capability. Of these the thematic priorities are the most important indicator for assessing RTDI assets. Nine thematic priorities were established in 2006 as the result of a foresight exercise. The thematic priorities are:

- D1. Information and communication technology
- D2. Energy
- D3. Environment
- D4. Health
- D5. Agriculture, food security and safety
- D6. Biotechnologies
- D7. Innovative materials, processes and goods
- D8. Space and security
- D9. Socio-economic and humanities research

The methodology for this assessment of RTDI capacity and capability and its linkage to Smart Specialisation is based on an evaluation of funding under the National Competitiveness Programme; the European Structural Funds Competitiveness Operational Programme, Framework 7 and other sources of financing and the outcome of research and development in the form of publications. In addition consideration is given to the number of projects delivered under each funding source alongside alternative indicators including the profile of researchers by sector publications and patents.

Each organisation (University, National RDI Institute and Institutes of the Romanian Academy) ranked high on the list of projects in the National Competitiveness Programme has been profiled to understand their key specialisms and infrastructure. In addition the profile of four Romanian Science and Technology Parks has been undertaken to understand their key specialisms and infrastructure.

5.3.1 National Partnership Programme

The National Partnership programme is the largest within the National Research Development and Innovation Plan accounting for approximately 1682million euro and 36% of the overall budget for the plan, and is designed to support cooperative projects between stakeholders within the nine thematic priorities. An analysis of projects approved under the National Programme between 2007 and 2009 and for FP7, highlights the focus on each of the nine thematic priorities (Annex 3.1). The most supported priority is D7. Materials, Innovative Processes and Products (MPPI) which has the highest level of financed projects accounting for between 17.6% and 54.1% across the programmes. A range of priorities are then supported at more moderate levels as identified in the summary table below:

Table 5.3.1a Funding Profile by Thematic Priority

Thematic Priority	Funding Range
D1.ICT	9.9% to 15.6%
D9.Socio-Economic and Humanities Research	3.6% to 28.5 %
D4.Health	2.6% to 14.7%
D3.Environment	5.4% to 13.5%
D5 Agriculture, Food Safety and Security	0.7% to 13%
D2 Energy	1.2% to 14 %

Funding for both D8 Space and Security and D6 Biotechnologies are overall not funded as significantly with funding ranges between 0.3% to 7.3% and 3.2% to 8% respectively.

In addition to the national competitiveness programme, the operational programme 'Increase of Economic Competitiveness has the general objective to increase Romanian companies' productivity, in compliance with the principles of sustainable development, and reducing the disparities compared to the average productivity of the European Union. The thematic priority D7 Materials, Innovative Processes and Products (MPPI) has the highest level of funded projects (38.5%) within this programme, followed by Health (13.8%), Energy (8.4%), Environment (8.1%) and Agriculture (6.8%) (Annex 3.1).

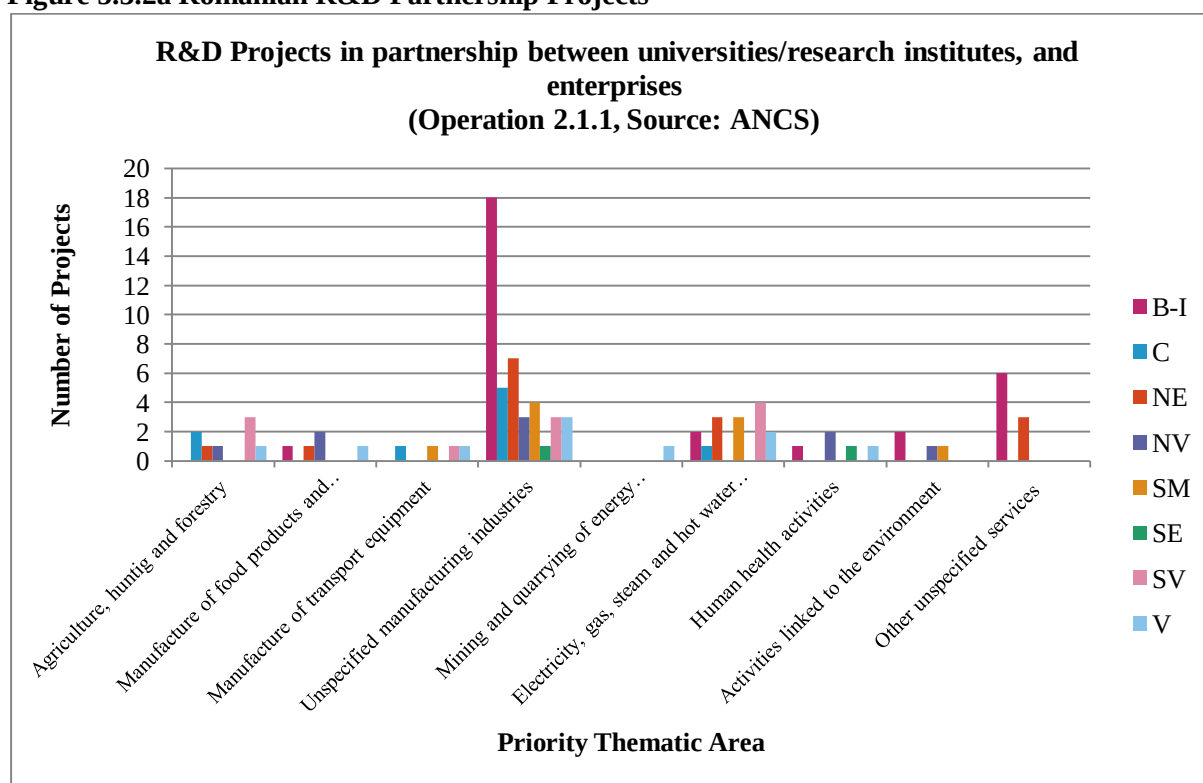
5.3.2 Sectoral Operational Programme

The Sectoral Operational Programme "Increase of Economic Competitiveness" (SOP-IEC) is one of the seven instruments to achieve the convergence objectives with the help of structural funds. The general objective of SOP-IEC is to increase Romanian companies' productivity and competitiveness, in compliance with the principle of sustainable development, and reduce the gap to the average EU productivity.

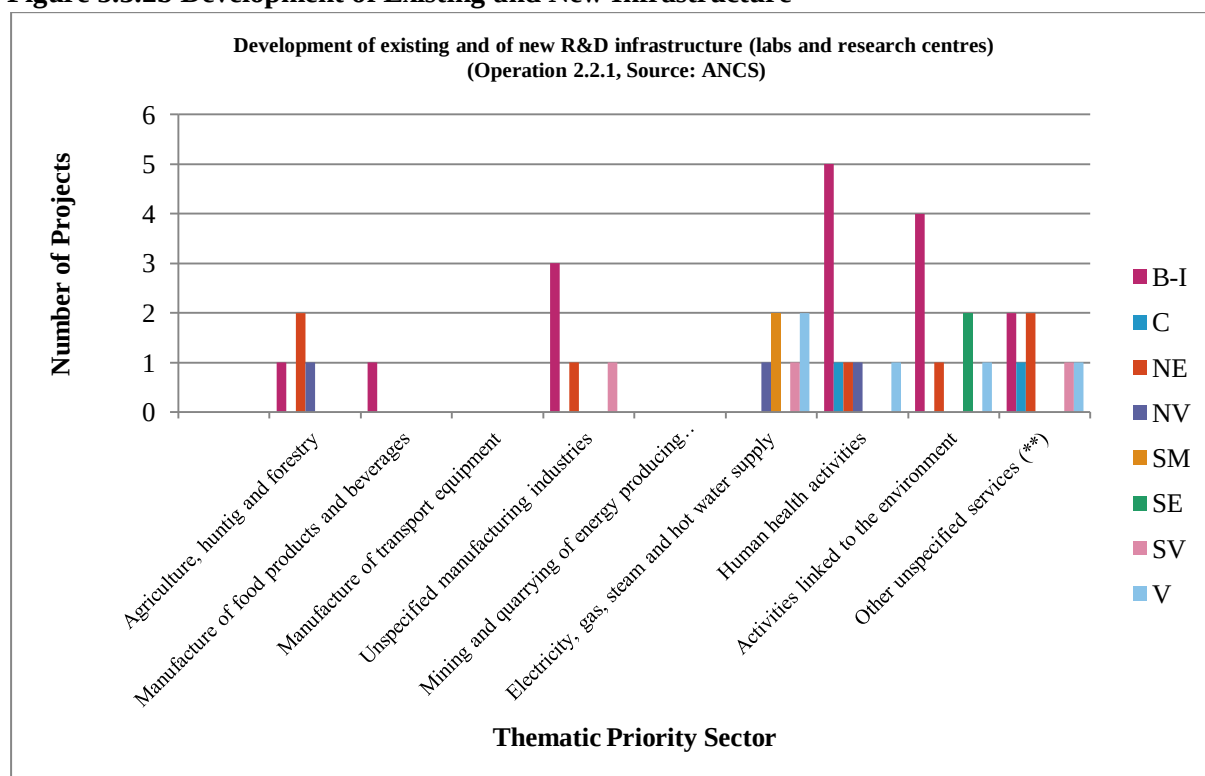
The thematic priority D7 Materials, Innovative Processes and Products (MPPI) has the highest level of funded projects (41%) that support partnerships between research institutes and universities with enterprise followed by Health (12%), Agriculture (11%), ICT (8%), Biotechnology (8%) and Energy (8%).

Figure 5.3.2a highlights the projects funded by ANCS in Romania to support partnerships between universities and research institutes with enterprise. Of these projects the biggest profile is in manufacturing industry with energy projects having a relatively strong profile.

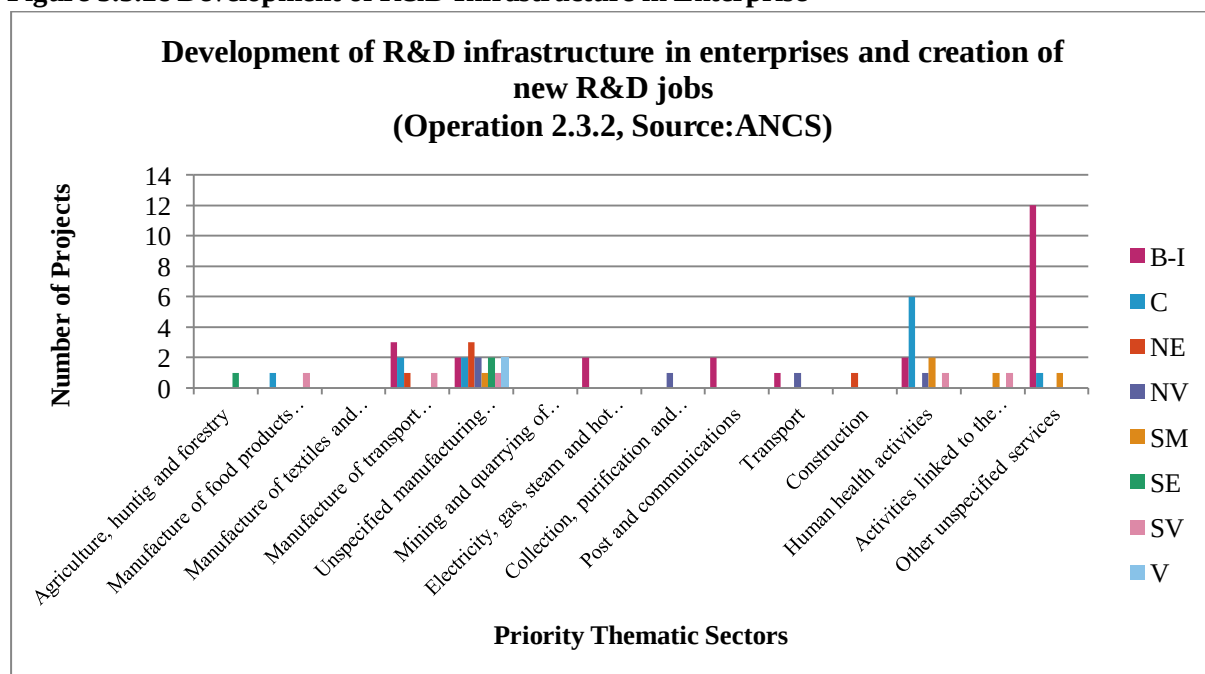
Figure 5.3.2a Romanian R&D Partnership Projects



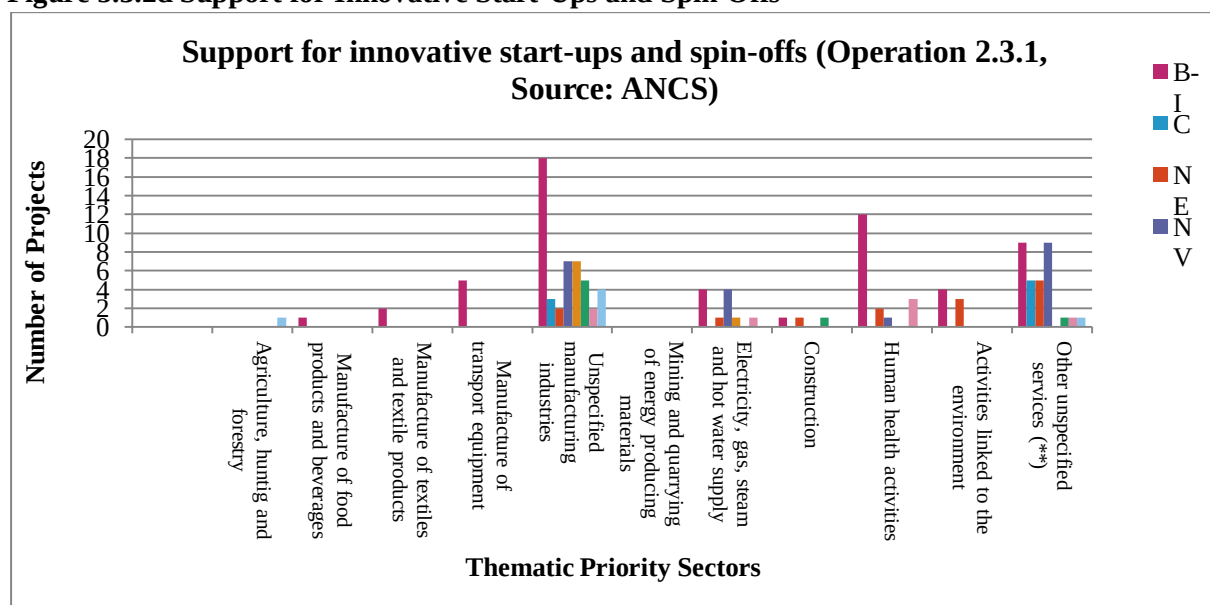
Access to infrastructure is an important aspect of the smart specialisation approach. Funding from ANCS to support the development of existing and new labs and research centres is focussed on human health, environment and energy.

Figure 5.3.2b Development of Existing and New Infrastructure

In comparison funding for the development of infrastructure in enterprises (Figure 5.3.2c) is dominated by manufacturing including transport and a focus on health can also be seen.

Figure 5.3.2c Development of R&D Infrastructure in Enterprise

This profile is also consistent with an analysis of start-ups and spin-offs supported by ANCS, where the dominance of manufacturing can be seen but also the sectors of health and energy.

Figure 5.3.2d Support for Innovative Start-Ups and Spin-Offs

The analysis of both the National Partnership Programme and the Operational Programmes highlight the importance of Materials, Innovative Processes and Products to Romanian Research, Development and Innovation and this is consistent with the sector and cluster analysis undertaken in section three of this report. Manufacturing as one of the core elements of Materials, Innovative Processes and Products plays an important role and indeed manufacturing in Romania ranks higher (22.4%) in value added than the European Union average (14.9%). Romania is highly specialised in labour-intensive industries (e.g. textile fibres, wood, clothing and accessories), in capital-intensive industries (e.g. cement), and market-driven sectors (e.g. footwear) which range in the degree of innovation from both low (e.g. clothing and leather) to medium-high (e.g. textiles and metals).

5.4 Research Themes and Research Institutions

The leading organisations participating in projects funded by the National Partnership Programme (see 5.4a) are outlined below in relation to the thematic priorities. This excludes Socio Economic and Humanities Research (D9) which is well recognised in research publications but which has a low economic impact in sector and cluster development.

Table 5.4a Advanced Research Universities in Romania

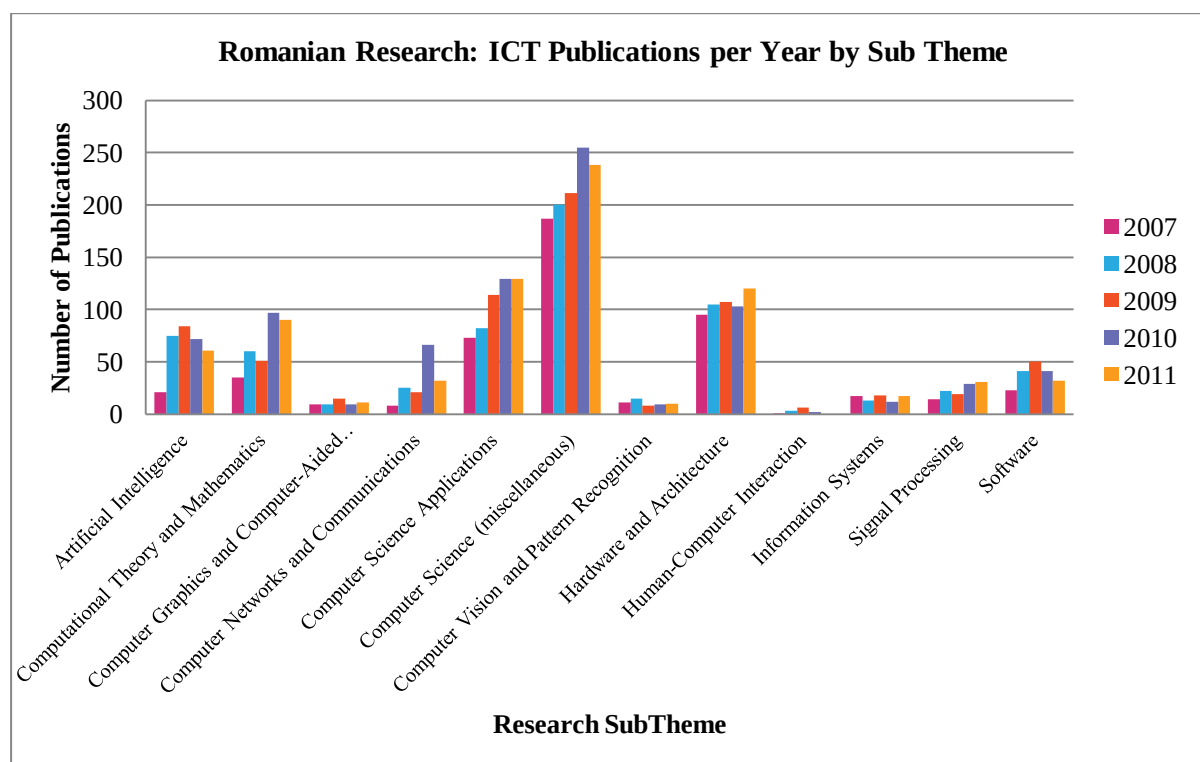
Advanced Research Universities in Romania	
Universitatea din Bucuresti	Universitatea „Babes-Bolyai” din Cluj-Napoca
Universitatea „Alexandru Ioan Cuza” din Iasi	Academia de Studii Economice din Bucuresti
Universitatea de Stiinte Agricole si Medicina Veterinara din Cluj-Napoca	Universitatea de Medicina si Farmacie „Carol Davila” din Bucuresti
Universitatea de Medicina si Farmacie „Gr. T. Popa” din Iasi	Universitatea de Medicina si Farmacie „Iuliu Hatieganu” din Cluj-Napoca
Universitatea Politehnica din Bucuresti	Universitatea Tehnica „Gheorghe Asachi” din Iasi
Universitatea Tehnica din Cluj-Napoca	Universitatea „Politehnica” din Timisoara

5.4.1 Information and Communications Technology

An assessment of ICT publications conducted for this report (Figure 5.4.1) identifies a strong publication portfolio which is dominated by computer science but with a strong representation in hardware and architecture, artificial intelligence and computational theory and mathematics. Of the 3443 publication (2007-11) from Romanian researchers, 15% are in Hardware and Architecture and a further 15% in Applications Development. There is also activity in Computational Theory (~10% of papers) and Artificial Intelligence (~9%). Romania is 5th in E. Europe in terms of outputs of papers in Computer Science; 6th in the field of Hardware and Architecture.

An assessment of FP7 applications to the European Union undertaken by Traian Rebedea a Romanian expert to the ICT Committee from the Politehnica University of Bucharest in November 2011 highlights the organisations and areas of focus in applications by Romanian Institutions. The assessment identifies the following areas as having high-competence and a high share of proposals; Network of the Future, Internet of Services, Software and Virtualisation, Networked Media and 3D Internet, Flexible, Organic and Large Area Electronics, Embedded Systems Design, Personal Health Systems, ICT for Energy Efficiency and Accessible and Assistive ICT.

Figure 5.4.1 ICT Publications by research sub theme 2007 to 2011



Of the Romanian applicants for funding, the two most successful are the Universitatea Politehnica Bucuresti with 12 projects; and Universitatea Technica Cluj Napoca with 9 projects. In addition a number of other organisations have been successful, being involved in two projects.

These institutions are also significantly involved in the National Partnership Programme and table 5.4.1 below highlights the main institutions operating national partnership projects followed by a profile of each institution.

Table 5.4.1 Leading Organisations in the Romanian National Partnership Programme - ICT

Rank	Organisation	Number of Projects
1	Universitatea Politehnica Bucuresti	16
2	Institutul National de Cercetare Dezvoltare Pentru Microtehnologie Bucuresti	15
3	Institutul National de Cercetare Dezvoltare pentru Fizica Laserilor, Plasmei Radiatiei	12
4	Universitatea Technica Cluj Napoca	11

University Politehnica of Bucharest (D1, D2, D3, D7, D8)

The University Politehnica Bucharest (UPB) is the oldest and most prestigious engineering school in Romania with 15 faculties. UPB is involved in collaborative programmes with 74 universities in 27 countries in Europe, America, Asia and Africa. UPB is the highest ranking technical university in Romania. In the SIR international report UPB ranked first in Romania, 32nd position at regional level and 472nd position at world level. The UPB research staff includes; 1379 teachers (including 382 professors), 259 doctoral supervisors, 74 researchers and 2561 PhD students.

Key research at UPB is based on 7 research platforms:

1. Micro and Nano Structured Multifunctional Materials "3MN"
2. Bioengineering - Biotechnology "BIOINGTECH"
3. GRID Resource Centre Multi-Core High Performance "GEEA"
4. Integrated Motor Vehicle Engineering Research- INTEGRING,
5. Advanced Control and New Information Technologies
6. Renewable Energy Sources and Sustainable Development "PREDUR",
7. Quality Assessment of Materials and Products

Institutul National de Cercetare Dezvoltare Pentru Microtehnologie Bucuresti

IMT- Bucharest is active in the National R&D Plan II (PNCDI II) in Direction 1.7- ICT: Nanoelectronics, photonics and integrated Micro-nanosystems” – corresponding to FP7- ICT and D7 Innovative materials, processes and goods– corresponding to FP7- NMP. Main activity is research, education and innovation (support for industry) in: RF-MEMS, photonics, bio-nanotechnology and micro-systems, advanced materials and technologies, the potential being related to KETs as following: nanoelectronics, photonics, and bio-nanosystems. In the 2007-2012 time periods, IMT was involved as coordinator in 26 national projects in the Partnerships, 13 in Ideas and 9 in Capacities programs, respectively, with a total funding of 17 millions of Euro. IMT was involved in 15 FP6 and 12 FP7 projects (mostly in ITC and NMP priorities).

The Report on Innovation in Europe (10th of June, 2011) places IMT as the most performing national institute, as far as participation to European research programs is concerned. In the period 2007-2011- IMT has 18 published national patents and other 14 are under evaluation. A spin-off company in the field of “Modelling and simulation services for biomedical devices development” was also created (2010). IMT Bucharest is hosting the Science and Technology Park for micro- and nanotechnologies, MINATECH-RO. Companies, including Honeywell Romania, are using IMT-MINAFAB facilities and also their own equipment in the park area. Important cooperation is underway with Infineon Technologies, Munchen (Germany) and Bucharest, Thales Research and Technology (TRT), and NXP Semiconductor Netherlands BV (Philips).

The National Institute for Laser, Plasma & Radiation Physics (INFLPR)

The National Institute for Laser, Plasma & Radiation Physics (INFLPR) is an independent, national research institution with the mission to advance the knowledge in several strategic areas of the sciences and technologies related to laser, plasma, and radiation physics. In 1996 INFLPR was reorganized to include the Institute of Space Sciences

The institute currently consists of six large research departments and laboratories, the Centre for Science Education and Training and the Institute of Space Sciences. The institute employs 447 researchers and administrative staff conducting frontier research ranging from basic photonic materials and high power lasers, nanomaterials and nanotechnologies, quantum dots and information technologies, plasma physics and X-ray microtomography to industrial photonics, biophotonics and plasma coatings.

INFLPR is pursuing advanced scientific research funded by national and international agencies, private institutions and enterprises. INFLPR is currently a member of the EURATOM association, a partner in the Extreme Light Infrastructure project and a leader in many projects funded by the EU, NATO, and other international organisations. INFLPR is the coordinator of the largest investment in Romania RTDI, the ELI project. To be built in Bucharest-Magurele, ELI-NP will be one of the three pillars of ELI - the extreme light infrastructure, along with the facilities dedicated to the study of secondary sources (Dolni Brezany, near Prague) and attosecond pulses (Szeged). ELI-NP will create a new European laboratory to investigate a very broad range of science domains, from new fields of fundamental physics, new nuclear physics and astrophysics topics, to applications in material science, life sciences and nuclear materials management.

The Technical University- Cluj Napoca

In the Technical University of Cluj-Napoca, scientific research is conducted in 60 research groups, 106 laboratories, research centres and platforms. In the top ranking of the Romanian universities in RDI, conducted in 2011 Technical University of Cluj-Napoca is ranked 3 in technical universities and for the domain Systems engineering, computers and information technology which is an important part of priority D1, Information and Communication Technology.

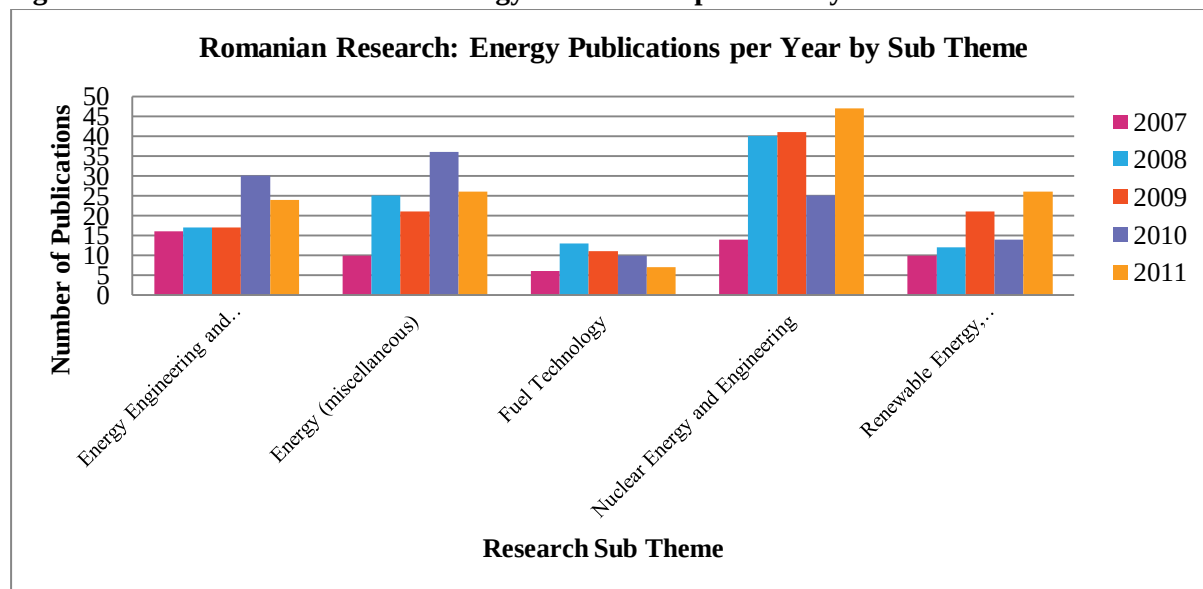
5.4.2 Energy

Promoting sustainable development is a key strategic objective in Romania (.C. Filiala ICEMENERG SA, 2011). Fundamental research in the field of green energy should be focused on issues that can be further developed and where applied research can be completed in a reasonable time with useful results in economic activity. Scientific funded research in the field of "green energy" must be oriented to specific markets. Green energy research should be structured more clearly by defined priority research directions.

- Electricity production from renewable sources,
- Renewable energy for heating and cooling,
- Grid connection of renewable green energy, smart grid energy, storing energy produced from renewable sources,
- Clean coal technologies, CO₂ capture and storage,
- Production technologies and use of biomass and biomass-derived products,
- Hydrogen and fuel cells,
- Energy efficiency in end-use sectors,
- Rationale and monitoring national policies in green energy.

An assessment of publications by energy sub theme has been undertaken for this report. Overall the level of publications is relatively low in comparison to other research themes. However a growth and focus on publications in nuclear energy can be seen and in addition an increase in publications in renewable energy. Romanian published research activity is mainly in Nuclear Energy & Engineering (32% of papers) but other fields are also addressed. Romania ranks 6th within E Europe in the overall field.

Figure 5.4.2 Romanian Research: Energy Publications per Year by Research Sub Theme



An assessment of the Framework 7 work programme for energy on Cordis identifies Romanian involvement in 17 Energy projects as a partner or coordinator. Each project can be classified in multiple subject areas. The classification of the Romanian projects highlights 8 projects classified as other energy, 5 as scientific research, 4 as renewable sources of energy, 3 as network technologies, 2 for bio fuels, climate change and electronics and 1 project each for coordination cooperation, environmental protection and energy saving.

The energy theme is represented in the national partnership programme and table 5.4.2 below highlights the main institutions operating national partnership projects followed by a profile of each institution.

Table 5.4.2

Rank	Organisation	Number of Projects
1	Universitatea Politehnica Bucuresti	21
2	Institutul National de Cercetare Dezvoltare TurboMotoare Comotisa Bucuresti	11
3	Institutul National de Cercetare Dezvoltare pentru Inginerie Electrica ICPE-CA	11
4	Institutul National de Cercetare Dezvoltare si Incercari pentru Electrotehnica – ICMET Craiova	10
5	Institutul National de Cercetare Dezvoltare pentru Tehnologii Criogenice si Izotopice – ICSI Rm. Valcea	8

Romanian R&D Institute for Gas Turbines (COMOTI)

The Romanian R&D Institute for Gas Turbines (COMOTI) was founded in 1985 as an R&D Centre for Aviation Engines within the National Institute of Aviation (INCREST). Accredited as a national R&D institute in 1996 and reaccredited in 2004, COMOTI integrates R&D activities, technology transfer, innovation, experiments and laboratory tests, as well as the manufacturing of aviation turbine engines, industrial gas turbines and high speed blade equipment. COMOTI is a member of OPIAR, the Association of Romanian Aeronautical Companies. It develops strategies and policy, supports the aviation industry and national and international co-operation.

National Institute for R&D in Electrical Engineering ICPE-CA

The National Institute for Research and Development in Electrical Engineering ICPE-CA (INCDIE ICPE-CA) is involved in; Energy Efficiency in Conversion and Consumption; Advanced Materials and Technologies and Micro-Electro Mechanical Systems. INCDIE ICPE-CA promotes and delivers applied research, in electrical engineering; materials, electrotechnology; new energy sources; electromagnetic compatibility; non-conventional engineering; electrochemical technologies and active anticorrosive protection; techniques, analysis, industrial diagnosis and vibrations control; certification of the environment management system; and technology transfer to SMEs.

The institute has been expanded to include two new facilities (CORBU ICPE-CA Branch in Constanta County and AVRIG ICPE-CA Branch in Sibiu County); one Centre for Technology Transfer (CTT ICPE-CA) and one technology and business incubator (ITA ECOMAT ICPE-CA Sf. Gheorghe, which is part of the National Network for Innovation and Technology Transfer ReNITT).

National Institute of Research-Development and Testing for Electric Technologies (ICMET Craiova)

ICMET Craiova is the national leader in the areas of; research, development and testing for high voltage and high power; research, development and monitoring of power equipment diagnosis; unconventional technologies using vibration tension easing effects; unconventional technologies using compressed air.

In addition to these centres, the “Politehnica” University in Timisoara has created a research centre, the Research Institute for Renewable Energy (RIRE) in order to exploit and develop the research potential that exists in Western Romania in the field of renewable energy. With an adequate location, equipment and training, the Institute will ensure the increase of competitiveness and international visibility of regional research results within the field of renewable energy, such as biogas, wind power and solar energy. This research centre has been positively profiled as part of the CO2 Free Interreg 4c project.

The National Research & Development Institute for Isotope and Cryogenic Technologies - ICSIM

The National Research & Development Institute for Isotope and Cryogenic Technologies Ramnicu Valcea was founded in 1970. The Institute has a staff of 225 persons, and 165 of them are directly involved in the Research & Development activities. 55% of them are highly – educated persons and 18% of them have a doctoral degree.

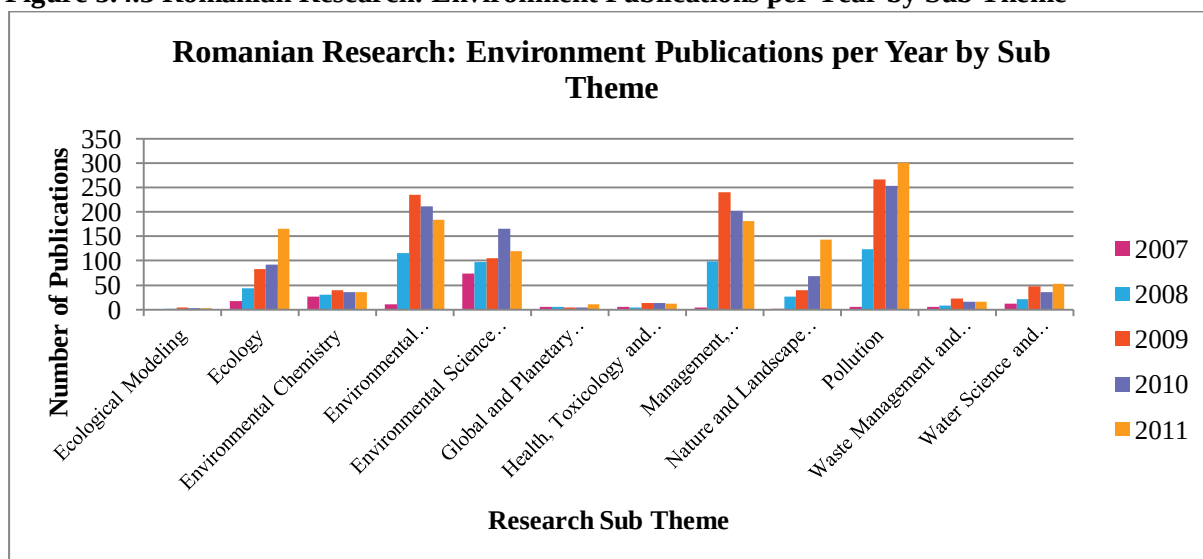
The National Research and Development Institute for Cryogenics and Isotopic Technologies – ICIT Rm. Valcea traces its roots to isotopic physics research related to the defining of the Heavy-Water production technologies. The research staff has had a tradition of research into fundamental aspects of isotopic physics and chemistry, including all the necessary aspects from analysis to separation methods.

The ICIT Rm. Valcea, by the specific nature of its research activities, successfully combines the experience of the research activities developed by its specialists in the nuclear field, isotopic exchange, cryogenics and vacuum physics and more recently, hydrogen applications in producing energy. The activity was carried out at the boundary between science and technology, consisting in theoretical and experimental studies, processes and phenomena modelling as well as in the development of some pilot plants and stands.

5.4.3 Environment

An assessment of publications by environment sub theme has been undertaken for this report. Overall the level of publications in this theme is strong with approximately 300 applications in the leading sub theme. Environmental publications are dominated by 6 sub themes; pollution, management and monitoring, environmental engineering, ecology and environmental science Romania is 7th in E. Europe in terms of production of papers in this overall field. Major fields of research include Pollution, in which field 22% of the papers were written and in which field Romania has the highest number of publications in E. Europe. Other active fields include Environmental Engineering (~18% of papers) and Environmental Management, Policy and Law (~17% of papers). It is noteworthy that several of the areas mentioned in the workshops as potential priorities (e.g. Water Science, Conservation and Ecology) show very low levels of activity.

Figure 5.4.3 Romanian Research: Environment Publications per Year by Sub Theme



In FP7 Romania is involved in 58 projects in the environment work programme. It is the coordinator of two projects; PROCEED (Promotion and coordination of environmental research in Central and Eastern Europe for a sustainable Development with the support of the Enterprise Europe Network) led by Chamber of Trade Industry and Agriculture of Arad and ENV-NCP-TOGETHER (Environment NCPs cooperating to improve their effectiveness) led by Autoritatea Nationala Pentru Cercetare Stiintifica. Each project can be classified in multiple subject areas. The classification of the Romanian projects highlights the leading subject areas as; 45 as environmental protection, 11 as scientific research, 6 as policy, 4 as coordination and cooperation, 4 as economic aspects, 3 as climate change, 3 as waste management and 3 as water resources. This reflects the publication profile with its emphasis on pollution and environmental management. The environment theme is represented in the national partnership programme and table 5.4.3 below highlights the main institutions operating national partnership projects followed by a profile of each institution.

Table 5.4.3 Main Institutions involved in the National Partnership Programme - Environment

Rank	Organisation	Number of Projects
1	Universitatea Politehnica Bucuresti	10
2	Institutul National de Cercetare Dezvoltare pentru Fizica Pamantului	7
3	Universitatea Din Bucuresti	6
4	Institutul National de Cercetare Dezvoltare pentru Ecologie Industriala INCDECOIND	5
5	Institutul National de Cercetare Dezvoltare in Constructii si Economia Constructiilor	5

National Institute for Earth Physics

The National Institute for Earth Physics, NIEP is the leading institution for seismology in Romania, responsible for the earthquake monitoring and basic and applied research in seismology. Their research includes: seismic source physics; Seismicity and seismotectonics; lithosphere structure; seismic hazard; and engineering seismology.

The University of Bucharest

The University of Bucharest was founded in 1864 by the Prince Alexandru Ioan Cuza and is one of the most important higher education institutions in Romania. The University constantly collaborates with more than 100 prestigious universities from 40 different countries and is member in several European and international academic organizations – the **European Universities Association (EUA)**, the **University Agency for Francophone (AUF)**, the **Association of Universities from European Capital Cities (UNICA)**, and the **Black Sea University Network (BSUN)**. The University has established partnerships with other governmental or non-governmental organizations such as DAAD, USIA, the Humboldt Foundations, Volkswagen, Fulbright, Nippon, and Onassis.

The University of Bucharest is a comprehensive university, oriented towards natural sciences, social sciences and humanities. The number of faculties is almost equal on each of these domains. There are naturally differences between faculties. Faculties of sciences (Mathematics, Physics, Chemistry, Biology, Geography, Geology and Geophysics) generally have fewer students but produce a large number of ISI publications and manage research contracts that bring them an important amount of financial resources. Social sciences faculties (Business and Administration, Law, History, Sociology, Psychology and Education Sciences, Political Sciences) have considerable students' effectives and contribute to public agenda setting and decision-making. Humanities (Philosophy, Journalism, Letters, Foreign Languages, Orthodox, Roman-Catholic, and Baptist Theology) sought by many students, help to the social and cultural development of the country.

In 2011, University of Bucharest was ranked by the Ministry of Education, Research, Youth and Sport as the first university for advanced research and education. The main study fields at the University of Bucharest were ranked in 2011 as follows: Category A: Business Administration, Social Care, Biochemistry, Biology, Chemistry, Law, Philology, Philosophy, Physics, Geography, Geology, Geological Engineering, Computer Science, History, Mathematics, Sociology, Cultural Studies, Education Sciences, Communication Sciences, Environmental Sciences and Political Science.

National Research and Development Institute for Industrial Ecology (INCDE ECOIND)

INCDE ECOIND is an institution with national and international activities in the field of environmental research and services. Their main activities include advanced, applied research,

technological development and services in the field of environmental protection for pollution control, assessment, prevention and reduction. **INCD ECOIND** has specialist equipment for pollution control, pollution assessment and research of environmental technologies.

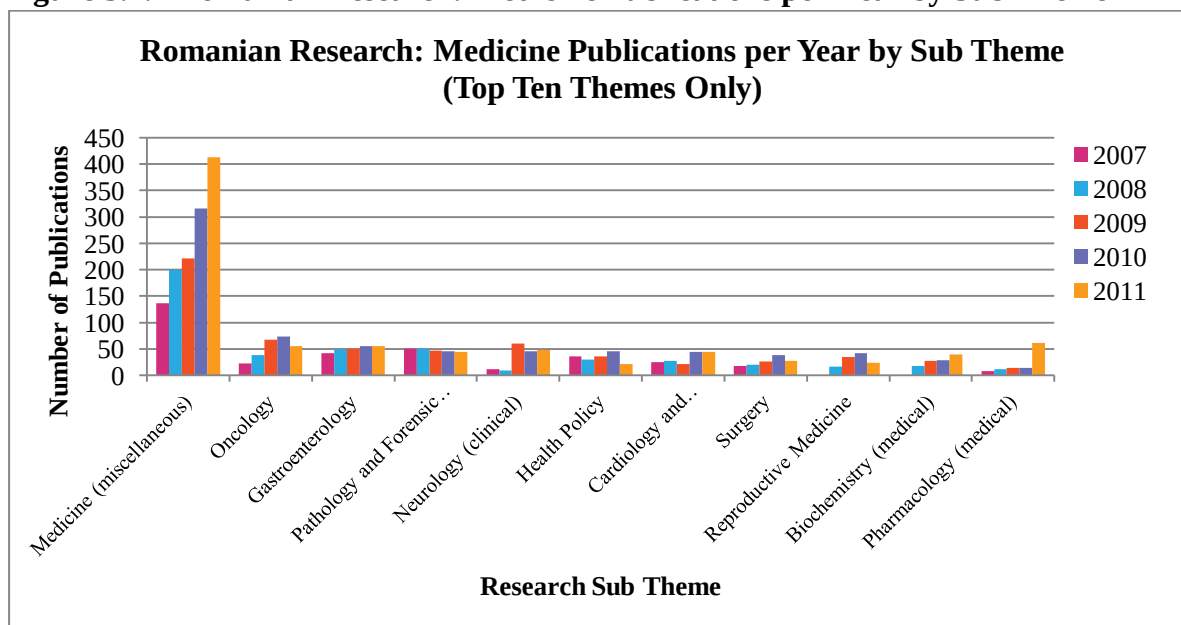
National Institute for Research & Development in Environment Protection (INCDPM)

The National Institute for Research & Development in Environment Protection (INCDPM) has expertise in waste management; natural and anthropoid hazards; global warming; environmental quality control; impact of construction on the environment, environmental protection and forecasting and numerical and mathematical simulations. The institute has activities in Constanta undertaking activities in oceanography, marine and coastal engineering and environmental protection and in Tulcea undertaking activities in biodiversity, conservation, sustainable development and the Danube Delta Technological Information Centre.

5.4.4 Health

An assessment of publications by the medicine sub theme has been undertaken for this report. Unfortunately the data categorisation identifies a dominance of papers identified as miscellaneous medicine and the remaining sub-themes are not significant enough to enable any conclusions on key research themes to be made. Romania ranks 9th in Eastern Europe in medical publication output (1996-2011). Approximately 40% of these papers are in general medical journals and cannot be assigned to a particular area of medicine. However, of the remaining papers, there is a clear specialisation in recent years (2007-11) in Pathology & Forensic Medicine (15.9% of all papers), Gastroenterology (15.7%) and Oncology (7.6%). Romania is 2nd in Eastern Europe in terms of publications in Gastroenterology but lower in H index.

Figure 5.4.4 Romanian Research: Medicine Publications per Year by Sub Theme



In FP7 Romania is involved in 43 projects as a partner in the Health work programme. Each project can be classified in multiple subject areas. The classification of the Romanian projects highlights the leading subject areas as; 27 as medicine health, 11 as life science, 10 as medical biotechnology, 10 as social aspects, 8 as scientific research, 5 as healthcare delivery, 4 as biotechnology, 4 as coordination and cooperation and 3 as policy. The health theme is represented in the national partnership

programme and table 5.4.4 below highlights the main institutions operating national partnership projects followed by a profile of each institution.

Table 5.4.4 Main Institutions involved in the National Partnership Programme - Medicine

Rank	Organisation	Number of Projects
1	University of Medicine and Pharmacy Bucharest (UMFCD) "Carol Davila"	31
2	University of Medicine and Pharmacy Iuliu Hatieganu Cluj-Napoca	29
3	Victor Babeş University of Medicine and Pharmacy, Timișoara	13
4	University of Medicine and Pharmacy Craiova -UMF Craiova	9

University of Medicine and Pharmacy Bucharest (UMFCD) "Carol Davila"

The University of Medicine and Pharmacy Bucharest (UMFCD) "Carol Davila" is the largest Romanian Medical University with approximately 6600 students and 1521 teaching staff. Within the University the Research Centre for Pathology and Treatment of Systemic Rheumatic Diseases has been identified in 2005 by the European Commission as "the best / most promising Romanian research center in life sciences". The UMFCD has a Department for Scientific Research that is an effective tool for creating and maintaining a culture of authentic research. The RTDI results are translated into more than 100 grants, nearly 200 books, over 300 papers, in proceedings of scientific meetings, conferences, symposia and seminars.

University of Medicine and Pharmacy Iuliu Hatieganu Cluj-Napoca

The University of Medicine and Pharmacy has two centres of excellence; the Centre for Research in Intensive Therapy and the Centre for Molecular Medicine and Neuroscience. In addition the University has 7 research centres; a training centre in Laparoscopic Surgery, a Centre for Research and Education in Ultrasonography, a Centre for Research in Fundamental and Clinical Immunopathology, the "Octavian Fodor" Centre for Digestive Hepatogastroenterology and Endoscopy, a Centre for Research in Genetic and Conditioned Diseases in Children, a Research Centre for Rheumatologic Diseases, and a Research Centre for Medicine Bio pharmaceuticals and Pharmacokinetics

Victor Babeş University of Medicine and Pharmacy, Timișoara

The University of Medicine and Pharmacy has 11 nationally accredited research centres focussed on; cardiovascular diseases, angiogenesis, immunofiziology and biotechnology, biological systems modelling and data analysis, interdisciplinary periodontal research, community health and health policy, oncohematologie and hematopoietic stem cell transplantation, gastroenterology and hepatology, translational medicine, diabetes and metabolic diseases and preventive medicine. In addition four new areas of research with potential for excellence within the university are being developed; innovative cancer therapies and regenerative medicine; translational research in cardiovascular disease - from pathophysiological mechanisms to therapeutic strategies; simulation and modelling techniques to biological level; and deficient and excessive angiogenesis - from molecular basis to clinical application:

University of Medicine and Pharmacy Craiova -UMF Craiova

Research activities at the University of Medicine and Pharmacy Craiova are integrated in both the educational process and in the clinical outcomes resulting from incorporating elements of basic science, clinical and public health applications. Each of the four faculties have their own research priorities, all integrated into the university's research strategy. There are three main research centres; centre for research in gastroenterology and hepatology; the centre for the study of microscopic

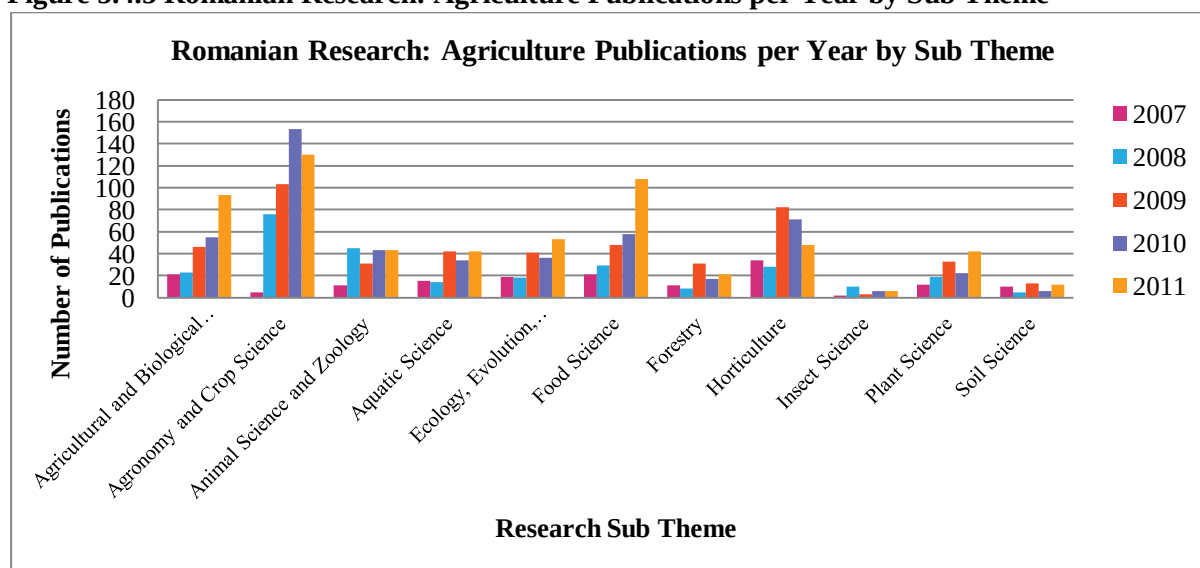
morphology and immunology and the medicine research centre. One of the major objectives of the research is to continue and improve collaboration with associated hospitals to ensure patient care is delivered to a high standard. Developing research infrastructure is one of the most important objectives of the research strategy of the University of Medicine and Pharmacy Craiova. Infrastructure projects include; a research and treatment centre in gastroenterology.

5.4.5 Agriculture, food security and safety

An assessment of publications by the agriculture sub theme has been undertaken for this report. Figure 5.4.5 below highlights the strong profile of publications in the sub theme of agronomy and crop science, agricultural and biological science and food science. Romania ranks 62 in the world or 10th in Eastern Europe in this field with 2240 publications (1996-2011). Strong specialisations within this field are Agronomy & Crop Science (5th in E Europe) and Horticulture (4th in E Europe).

In FP7 Romania is involved in 35 projects in the knowledge based bio economy work programme as a partner. Each project can be classified in multiple subject areas. The classification of the Romanian projects highlights the leading subject areas as; 13 classified as food, 8 classified as agriculture, 8 classified as scientific research, 7 classified as agricultural biotech, 4 as biotech and 4 as coordination and cooperation.

Figure 5.4.5 Romanian Research: Agriculture Publications per Year by Sub Theme



The agriculture theme is represented in the national partnership programme and table 5.4.5 below highlights the main institutions operating national partnership projects followed by a profile of each institution.

Table 5.4.5 Main Institutions involved in the National Partnership Programme - Agriculture

Rank	Organisation	Number of Projects
1	Universitatea de Stiinte Agricole si Medicina Veterinara Cluj Napoca	21
2	Universitatea de Stiinte Agronomice si Medicina Veterinara Bucuresti	14
3	Universitatea de Stiinte Agricole si Medicina Veterinara Ion Ionescu de la Brad Iasi	13

University of Agricultural Sciences and Veterinary Medicine - USAMV Cluj

The University of Agricultural Sciences and Veterinary Medicine Cluj has four faculties; Agriculture; Horticulture; Animal Science and Biotechnology, with 9 research centres and 24 research laboratories. The research laboratories provide consultancy in 17 areas including; Agro-techniques, food technology, food safety, horticultural technologies, animal technology and animal nutrition. A new Advanced Horticultural Research Institute of Transylvania has been proposed that will provide space for horticultural research activities, conferences and events.

University of Agricultural Sciences and Veterinary Medicine - USAMV Iasi

The University of Agricultural Sciences and Veterinary Medicine in Iasi has four main research centres and specialised laboratories in the fields of agricultural research; horticultural research and oenology; zoo research and veterinary medical research.

University of Agricultural Sciences and Veterinary Medicine - USAMV Bucharest

Agronomic and veterinary medicine scientific research at the University of Agricultural Sciences and Veterinary Medicine covers four thematic areas; agriculture, biotechnology; environment and economics and Social Sciences.

5.4.6 Biotechnologies

In the 2007-2013 National Plan for R&D and Innovation more emphasis was placed on promoting high quality research and innovation in the country as well as building infrastructure, strengthening human resources and increasing partnerships and cooperation. Some of the identified priority fields include ICT, new materials, bio- and eco-technologies, industry, agriculture and food safety, health, energy, environment and transportation.

During this period there is around €100m earmarked for research in the biotechnology sector that organizations can access by means of project competition. Although the government has stated this policy on paper, to date there has been limited application in practice. While in the past Romania had been considered quite biotechnology friendly in the regulation of genetically modified organisms (GMOs), the government banned the production of genetically modified soy beans in 2007 and the cultivation of GM corn in 2008. Romanian companies are not highly represented in European framework projects and EU funding is difficult for companies to obtain as co-financing of the projects can pose problems.

Most of the existing biotechnology companies are located in Bucharest with some also in Cluj. Construction of the technology park, TEHNOPOLIS, in Iasi began in 2000 and the park has been operational since June 2005. The majority of the firms represented are IT and aviation companies but there is a plan to attract biotechnology companies over the next 10-12 years. The park includes a business incubator and biotechnology labs.

Unfortunately no data is available on research publications categorised directly under the theme of biotechnology. In addition biotechnology in FP7 is addressed within the KBBE work programme the Romanian involvement in which has been explained in our review of the agricultural research theme. The health theme is represented in the national partnership programme and table 5.4.6 below highlights the main institutions operating national partnership projects followed by a profile of each institution.

Table 5.4.6 Main Institutions involved in the National Partnership Programme - Biotechnology

Rank	Organisation	Number of Projects
1	Institutul National de Cercetare Dezvoltare pentru Stiinte Biologice Bucuresti	9
2	Institutul National de Cercetare Dezvoltare pentru Microbiologie si imunologie Cantacuzino	5
3	Institutul National de Cercetare Dezvoltare pentru Chimie si Petrochimie ICECHIM Bucuresti	5
4	Spitalul Clinic Judetean de Urgenta Timisoara	5
5	Universitatea de Medicina si Farmacie Carol Davila Bucuresti	5

The National Institute of Research and Development for Biological Sciences (INCDSB)

The centre of excellence in life sciences, INCDSB promotes fundamental and applied research in domains including cellular and molecular biology, biotechnology, biodiversity, bio analysis and bioinformatics, biomedical research (including cell and molecular biology, tissue engineering, etc), agriculture and food research and biodiversity research. All these directions are supported by horizontal activities including; bio analysis, bioinformatics, bio products and biotechnologies.

The ITA-BINNOTECH, technology and business incubator was founded in 2006, as a department of INCDSB, as an entity of national infrastructure for innovation and technology transfer in; biotechnology, biomaterials and environmental protection. The incubator's mission is to encourage the private sector in developing activities in the above mentioned domains by transferring the results from the scientific research from within INCDSB. ITA-BINNOTECH offer entrepreneurs in the SME sector specialised advice to develop their business, consultancy in technology and intellectual property transfer and the provision of a suitable and modern infrastructure.

The National Institute of Research-Development for Microbiology and Immunology “Cantacuzino” (I.N.C.D.M.I. Cantacuzino)

The National Institute of Research-Development for Microbiology and Immunology “Cantacuzino” (NIRDMIC) is a national institute of research and development. Historically, it was created as a strategic institution to perform research in all domains of microbiology and related sciences in order to develop the production of therapeutic sera and vaccines. Currently, our main fields of activity consist of research in immunology and immune mediated diseases, microbiology, virology, parasitological and other infectious diseases. Other connected fields such as genomics, molecular genetics, transcriptomics, proteomics, metabolomics, bioinformatics and aetiology, diagnosis and molecular epidemiology of infectious diseases, and public health are also approached.

The National Institute for Research & Development in Chemistry and Petro chemistry (ICECHIM)

The Research & Development activity of INCDCP-ICECHIM is focused on three interrelated research areas:

- Development of innovative technologies for bio-resources valorization
- Development of new nanomaterials and biomaterials for a wide range of applications
- Sustainable management of the resources and environment

The institute addresses topics that correspond with European and National Funding programs including; bioproducts and biofuels preparation; biotechnology and bioanalysis; synthesis of nanostructured polymers, bionanocomposites and multifunctional materials; waste remediation; nanomedicine and green energy. ICECHIM has published 48 papers were in ISI-quoted journals in

the first 11 months of 2011. In 2010 and 2011 the number of registered patents and patent applications was significant due to the finalisation of projects started in 2007 and 2008.

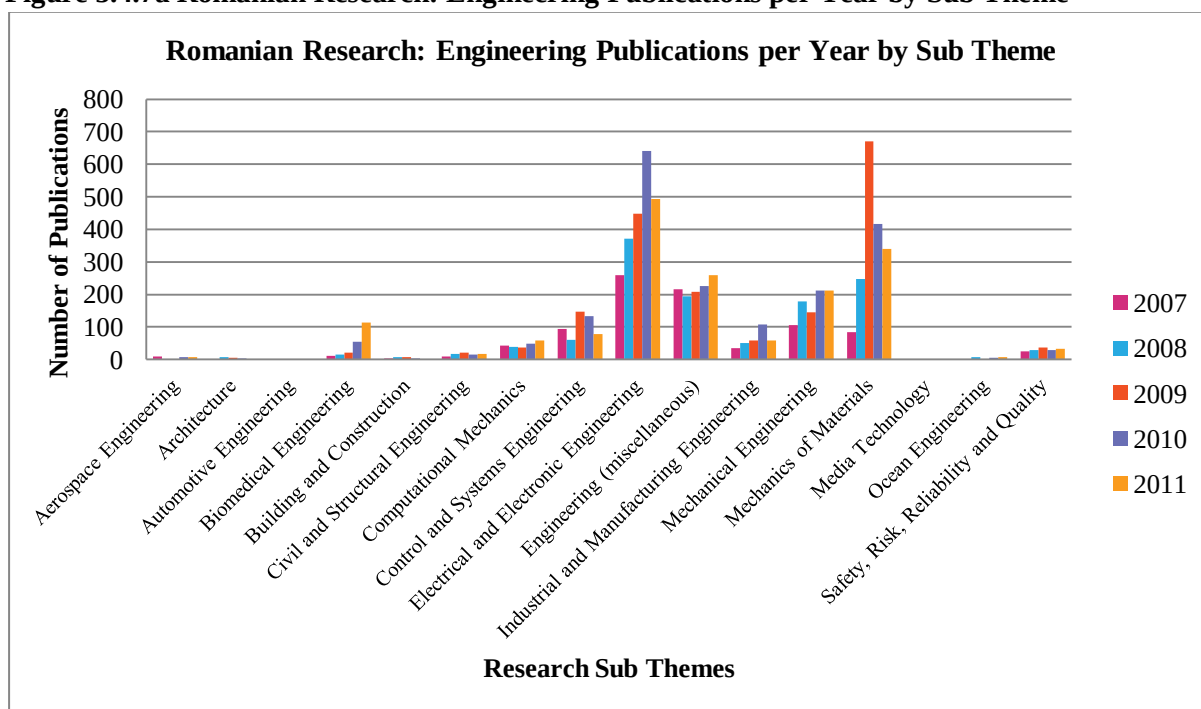
Emergency County Hospital Timisoara (SCJUT)

Timisoara Clinical Emergency Hospital undertakes medical scientific research activity in: laparoscopy, laparoscopic surgery, in vitro fertilization and embryo transfer, genetic diseases, metabolic and nutritional diseases for children, immune physiology and biotechnology.

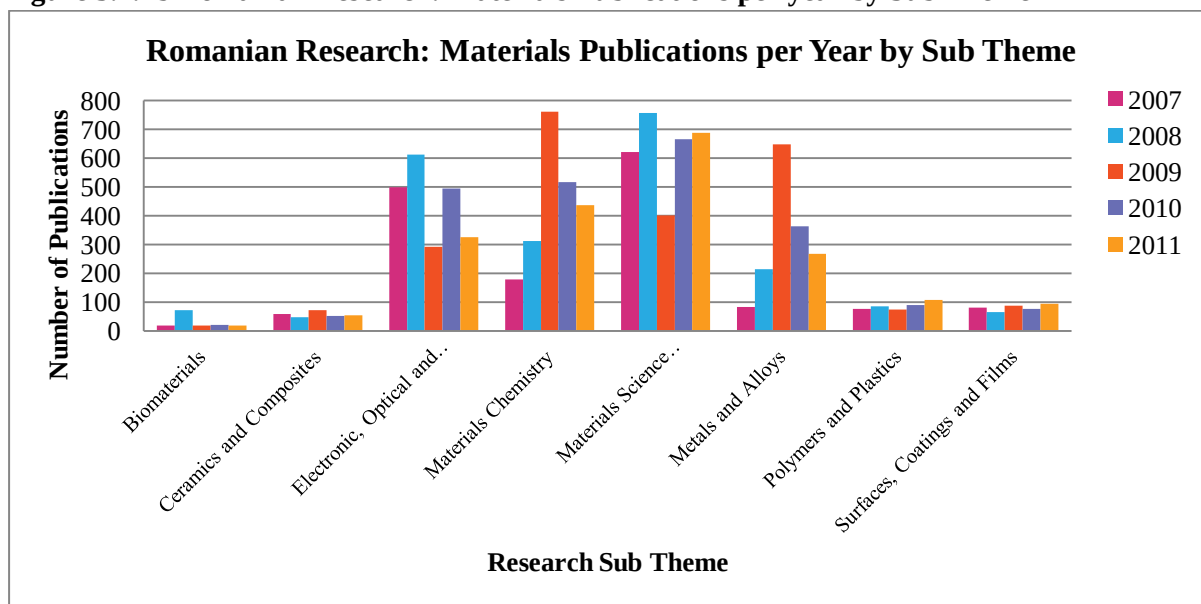
5.4.7 Innovative Materials, Processes and Goods

The theme innovative materials, processes and goods in the national partnership programme cover a wide thematic area. For the basis of this review we shall consider it within the context of materials and engineering in relation to publications and within the themes of transport and Nanosciences, nanotechnologies, materials and new production technologies in our review of Romanian participation in Framework 7.

Figure 5.4.7a Romanian Research: Engineering Publications per Year by Sub Theme



An assessment of publications by the engineering sub theme has been undertaken for this report. Figure 5.4.7a highlights the dominance in publications of electrical and electronic engineering, the mechanics of materials, mechanical engineering and miscellaneous engineering. The lack of publications relating to automotive and aerospace engineering should be noted although papers addressing these research themes may be classified under other headings. This is another active area of R&D in Romania with 7523 publications between 2007-2011. Romania is 4th in the Eastern European region in terms of publication output (1996-2011 data) and 5th in terms of H index. Strong specialties include Mechanics of Materials (23% of all papers in 2007-11) and in which Romania is 3rd in E. Europe and 5th in terms of H index. 44% of all papers in this field are in general engineering and not classified. However, it is noteworthy that two areas on activities noted within the workshops undertaken as part of this assignment in February 2013 as being potential topics for research prioritisation show almost no publishing activity. These are Automotive Engineering (8 papers from 2007-11) and Building and Construction (24 papers).

Figure 5.4.7b Romanian Research: Materials Publications per year by Sub Theme

An assessment of publications by the materials sub theme has been undertaken for this report. Figure 5.4.7b highlights this as a leading area for publications from Romanian research institutions with the research sub themes of electronic, optical and magnetic materials, materials chemistry, miscellaneous materials science and metals and alloys having the highest number of publications. Romania has significant activity in this field and particularly in Materials Science and Materials Chemistry which together account for over 50% of all the papers published in this field (which total 10,395 from 2007-2011). This compares well with output from other Eastern European countries so that Romania is 4th or 5th in the region in terms of output of Materials Science and Material Chemistry papers respectively. Once again, H indexes are lower than other Eastern European countries. The other category in which Romania is active is 'Electronic, Optical and Magnetic Materials' which represents about 20% of all papers (2007-11) and in which Romania is also 4th in Eastern Europe in terms of output.

Within the research theme of Innovative materials, processes and products, the following topics refer to Transport:

- Products and technologies aimed at transports and motor vehicle production;
- Innovative products and technologies enhancing the energy efficiency of the means of transport and reduce polluting effects;
- Products and technologies for building infrastructures: reliable railways, roadways, navigable channels, terminals etc. featuring low maintenance requirements and low social costs;
- Higher transport safety and security;
- Products and technologies intended for motor vehicle production;
- Intermodal transport systems/technologies for limiting traffic external effects and reducing resource consumption;
- Integrated supply, technological, distribution logistics, as well as reverse logistics integrating transport handling; storing; conditioning; packing; marketing; fabrication and recycling technologies;
- Transport quality management and traffic monitoring and control systems; Solutions to reducing traffic congestion in urban areas;
- Products and technologies aimed at air transport.

Transport research in Romania covers all transport modes. An analysis of the data gathered on national transport research projects, both via desk research is was evident that most research projects had “road transport”, as a theme and the most prevalent transport research theme was “competitiveness”. Transport research has a high involvement of SMEs, with over 37% of transport research projects being coordinated by SMEs between 1999 and 2006 and 35% between 2007 and 2010. SMEs register more coordinated projects than any other organization type. It was also highlighted in section 3 of this report that transport both motor vehicles and other transport is significant in terms of business expenditure in research and development and this is a significant area where business is driving research and development activity.

ANCS currently oversees technological platforms at a national level, which include a focus on sea transport and advanced systems for road vehicles and transport which are supported by both private and public organizations. Romania is also a founder member of Clean Sky, where it participates through a consortium made up of 2 research institutes and 2 private companies and is a member of the Joint Technology Initiative for Aeronautics. Romania is represented in 4 of the European technological platforms in the field of transport:

- EIRAC – European Intermodal Research Advisory Council
- WATERBORNE Technology Platform (supported by ACMARE Advisory Council),
- ERTRAC – European Road Transport Research Advisory Council,
- ACARE: Advisory Council for Aeronautics Research in Europe.

In Framework 7 Romania is involved in 52 projects in the transport work programme. Each project can be classified in multiple subject areas. The classification of the Romanian projects highlights the leading subject areas as; 33 classified as transport (including road, rail, air and shipping), 17 classified as aerospace technology, 6 as scientific research, 5 as environmental protection, 4 as business aspects and 4 as social aspects.

In Framework 7 Romania is involved in 27 projects in the nanosciences, nanotechnologies, materials and new production technologies work programme. Each project can be classified in multiple subject areas. The classification of the Romanian projects highlights the leading subject areas as; 27 considered as nanotechnology and nanoscience; 17 as scientific research, 16 as industrial manufacture, 6 as biotechnology, 5 as innovation and technology transfer and 4 as network technologies.

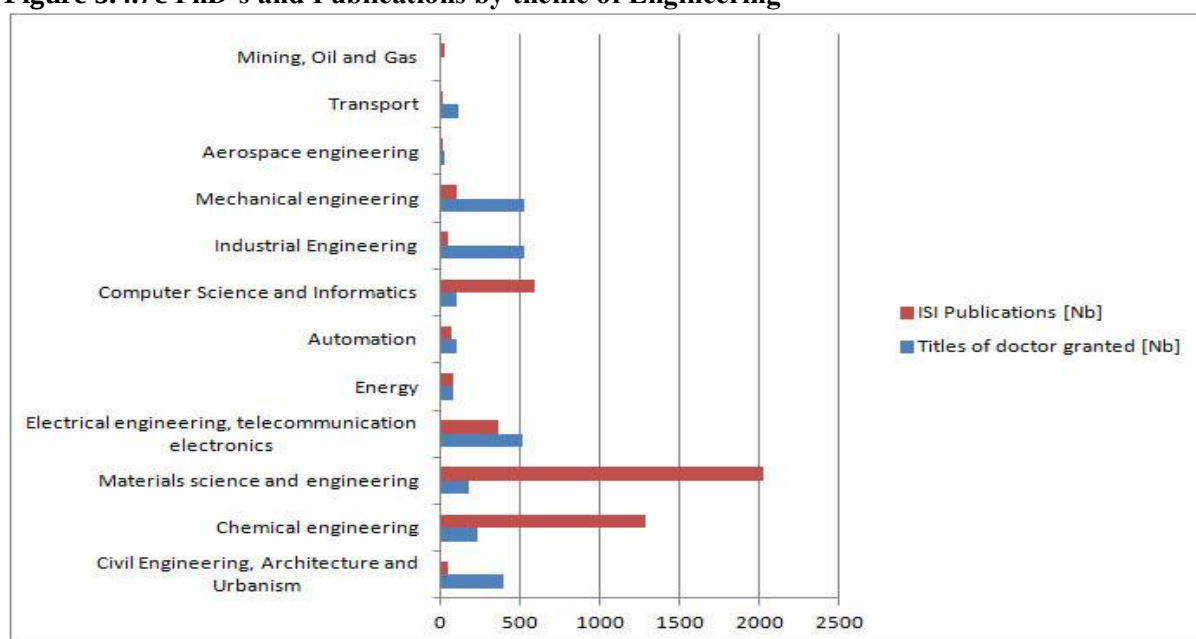
The main research activities in nanomaterials and nanotechnology in Romania include; Micro-nanotechnology for interacting, sensing, actuating and microsystems; nanobiotechnology; nanotechnology for applications in bio-medical field; nanotechnology for information processing, storage and transmission, nanotechnology for materials and surface science and nanotechnology for applications in chemistry.

In Romania nanotechnologies have appeared in Research and Development programmes since 2000, but do not have a specific research theme at a national level. An analysis undertaken in the project NANOPROSPECT (National Institute for Research and Development in Microtechnologies, 2011) and international projects, patents, technologies and products has shown that there is significant experience in nanotechnology in Romania but that this is focussed in a small number of areas, namely:

- Nanoelectronics and photonics in the application areas of the Communications industry, Automotive industry, Computer industry, Aerospace, transportation and security industry and Environmental Medicine,

- Nanoelectronics based on carbon nanomaterials, Nanoelectronic circuits at high frequency (> 60 GHz), Nanoelectronics based on organic and hybrid nano materials and artificial materials, and multifunctional electronic circuits for electric vehicles (E-mobile hybrid and mobile),
- Photonics; Nanophotonics based on silicon form of wires, dots, or monatomic layers; Lithium niobat photonic circuits and in photonic crystals; 4th generation solar cells, high efficiency and low price (together with the application "Energy"); Photonic nanosensors in construction, aviation, healthcare, automotive industry; Active displays with nanolaser and efficient LEDs with quantum dots; Quantum dots lasers sources of "single photons" quantum communications; and Nano-materials and nano-processing with ultra-intense laser (CETAL, ELI projects).
- Bio-nanosystems in nanomedicine, pharmaceutical applications, magnetic nanomaterials for biomedical applications and biotechnology.
- Applications of nanomaterials and nanotechnologies in the generation, storage, transport and energy use, resulting in more efficient use of both energy and considerable reduction of pollution, especially greenhouse gases generated in traditional energy
- Nanomaterials for specific applications in the modelling and design of nanoparticles with controlled properties and preparation methods that lead to the production of nanoparticles.

Figure 5.4.7c PhD's and Publications by theme of Engineering



In addition to our profile of applications and FP7 projects the profile of Romanian engineering PhDs and publications highlights the dominance of electrical engineering and electronics and mechanical and industrial engineering.

The Innovative materials, processes and goods theme is represented in the national partnership programme and table 5.4.7 below highlights the main institutions operating national partnership projects followed by a profile of each institution.

Table 5.4.7 Main Institutions involved in the National Partnership Programme – Innovative Materials, Processes and Goods

Rank	Organisation	Number of Projects
1	Universitatea Politehnica Bucuresti	37
2	Universitatea Tehnica Gh.Asachi din Iasi	17
3	Institutul National de Cercetare Dezvoltare pentru Fizica Materialelor Bucuresti	12
4	Institutul National de Cercetare Dezvoltare pentru Fizica si Inginerie Nucleara Horia Hulubei IFIN-HH	12

The National Institute for Materials Physics (NIMP)

The National Institute for Materials Physics (NIMP) Bucharest is devoted to fundamental and applied research and development, with particular emphasis in solid state physics and materials research. Their research activities include; the preparation, characterisation and study of the physical properties of new materials connected to high technology products and devices, the development of analytical techniques and methods applied in materials science, collaboration with the universities and other higher education establishment and the development of international collaboration, in particular based on European Union funded projects.

Institutul National de Cercetare Dezvoltare pentru Fizica si Inginerie Nucleara Horia Hulubei IFIN-HH

With a contribution of almost 10% of the national scientific output, IFIN-HH is one of the most important public R&D organizations in Romania. The institute is dedicated to the theoretical and experimental research and development in the field of physical and natural sciences, and in particular nuclear physics and nuclear engineering, and in related areas including astrophysics and particle physics, field theory, mathematical and computational physics, atomic physics and physics of condensed matter, life and environmental physics. In all these fields, IFIN-HH conducts theoretical and experimental research.

University Babes Bolyai -UBB

Scientific research from Babes-Bolyai University (UBB) covers three basic components: (1) basic and applied research, (2) development (research generated by innovative prototype products and services) and (3) innovation (socio implementation and economic services and innovative products). This work is delivered by three institutes; Institute for Interdisciplinary Research in Bio-Nano-Science focussed on molecular biology, biomaterials and biological systems, advanced materials and environment, natural and artificial nanostructure systems; the Institute for Chemical Research which is focussed on medicine (biomaterials for restorative and preventive dentistry), agriculture (Materials pheromone for monitoring / pest control), Electrical devices (luminescent materials for optoelectronic devices and gas discharge tubes) the Institute of Technology which promotes scientific research which can be undertaken through the development of technologies in partnership with business.

Technical University "Gheorghe Asachi"

The Technical University "Gheorghe Asachi" is among the oldest and most famous institutions in Romania, the custodian of an important tradition in engineering scientific research. The University is made up of eleven faculties: Faculty of Computer Science, Faculty of Civil Engineering, Faculty of Architecture, Faculty of Chemical Engineering and Environmental Protection, Faculty of Mechanical

Engineering and Industrial Management, Faculty of Electronics and Telecommunications, Faculty of Electrical Engineering, Faculty of Hydrotechnics, Geodesy and Environmental Engineering, Faculty of Mechanical Engineering, Faculty of Material Science and Engineering and the Faculty of Textile - Leather and Industrial Management.

Extreme Light Infrastructure (ELI) Project

An important project linked to this research theme is, ELI-NP which is one part of the "Extreme Light Infrastructure", which was identified in 2006 by the European Strategy Forum on Research Infrastructure (ESFRI) as a priority projects for research infrastructure in Europe. The project is the second pillar of a pan-European laser facility; the Commission approved €236 million in funding for the first ELI pillar in the Czech Republic, in April 2011.

During the project implementation (2010-2016), the representatives of the host countries (Czech Republic, Romania and Hungary) will constitute a European Research Infrastructure Consortium. It will be the first pan-European multidisciplinary network to research the state of the art in laser technology.

The Romanian project is being led by Horia Hulubei National Institute of Physics and Nuclear Engineering (IFIN-HH); ELI-NP and it will be based in the area of Măgurele (South of Bucharest) and is expected to be operational in 2015. The ELI-NP will be the most advanced research facility in the world focusing on the study of nuclear physics studies and its applications. The infrastructure will include two 10PW, ultra-short pulse lasers and a tunable gamma-ray. This €290M project will be built between 2012 and 2016. The facility will be dedicated to working in fields such as frontier fundamental physics, nuclear physics and astrophysics, as well as on applications for studying nuclear materials and radioactive waste management, materials science and life sciences.

5.4.8 Space and Security

In Framework 7 Romania is involved in 17 projects in the space work programme and 25 in the security work programme. Each project can be classified in multiple subject areas. The classification of the Romanian projects highlights the leading subject areas as; 7 classified as space and satellite research, 21 as security (including transport, technology, sectors, citizens and disaster management), 9 as scientific research and 4 as environmental protection.

The Space and Security theme is represented in the national partnership programme and table 5.4.8 below highlights the main institutions operating national partnership projects followed by a profile of each institution.

Table 5.4.8 Main Institutions Involved in the National Partnership Programme – Space and Security

Rank	Organisation	Number of Projects
1	Agentia Spatiale Romana ROSA	16
2	Universitatea Politehnica Bucuresti	12
3	Institutul de Stiinte Spatiale	10
4	Institutul National de Cercetari Aeronautice Elie Carafoli	8
5	Institutul pentru Calculul si Experimentarea Structurilor Aero-Astronautice S.C. Straero S.A	8

Romanian Space Agency- ROSA

The Romanian Space Agency (ROSA) was established in 1991 and reorganised by a Government Decision in 1995 as an independent public institution under the auspices of the Ministry of Research and Technology. ROSA is the national co-ordinating body of the space activities. The missions of ROSA are to promote and coordinate development and national efforts in the field, and, as a government representative, to promote international cooperation. In particular, ROSA is authorised to establish research and development centres oriented on specific objectives of the Romanian Space Programme. ROSA is developing its own research and development projects. On behalf of the Government, ROSA is the national representative in cooperative agreements with international organizations, such as European Space Agency (ESA) and the Committee on Space Research (COSPAR), as well as bilateral governmental agreements. Together with the Ministry of Foreign Affairs, ROSA is representing Romania in the sessions of the United Nations Committee on the Peaceful Use of Outer Space (COPUOS).

The Institute of Space Science (ISS)

The **Institute of Space Science** is carrying out fundamental and advanced scientific and engineering research in Cosmic Space Physics, High Energy Physics and related fields. The Institute's research and development activities are based on the concept of covering all experimental and theoretical stages: equipment development, data processing and interpretation, theoretical research and cosmic space utilisation.

Its research includes; theoretical research of complex structures and processes in astrophysics, gravitation and cosmology; the development of high performance computing resources for high energy elementary particle physics, astrophysics and space science; the development of satellite test facilities and of microsatellite design, test and integration facilities and the development of space technology with applications to remote sensing, telemedicine, disaster management and countermeasures for human space flight in adverse conditions.

National Institute for Aerospace Research "Elie Carafoli" (INCAS)

INCAS, the National Institute for Aerospace Research is the leading research institute in aerospace science in Romania, with more than 60 years of experience in aerospace engineering, flow physics and applied aerodynamics, structures and materials, using state-of-the-art technologies and unique infrastructure of national strategic importance. INCAS has been involved in major national aeronautical projects for civil and military activities, and currently is involved as a major player in the European Union policy for Research and Development under the FlightPath 2050 vision and future Horizon 2020 programme.

Institutul pentru Calculul si Experimentarea Structurilor Aero-Astronautice S.C. Straero S.A

The Institute for the Analysis and Experimenting of Aero-Astronautically Structures (STRAERo), Is a private research centre providing leading aerospace research and development R&D services and consulting in Romania. STRAERO was established as an independent institute in 1991 and its main activities are R&D applications focused on:

- analysis and experimental testing of structures and materials;
- analysis of flight control systems;
- design and manufacture of testing installations;
- IT solutions

The main objective of STRAERO is to provide qualified services in aeronautical field and to transfer knowledge and experience on non – aerospace applications. STRAERO is a leading organization in the design of experimental programs and the development of Romanian aeronautical products.

5.4.9 Socio-Economic and Humanities Research

The “Socio-Economic and Humanities Programme (SSH)” of the European Union Seventh Framework Research Programme (FP7) is considered a gateway for researchers into international research cooperation. Romania’s participation in FP7 in the socio-economic and humanities area is one of the lowest among the other FP7 areas with only 13 signed projects with Romanian participants and funding of only 1,203, 839 EURO from the European Union.

The assessment of publications by SSH shows a relatively low level of publications in comparison to other research themes however a growth and focus on publications in Economics, Econometrics can be seen and in addition an increase in publications in Urban Studies, Political Science, Education. Romanian published research activity is mainly in Economics, Econometrics, Finance and Geography, Planning and Development but other fields are also addressed. The SSH theme is represented in the national partnership programme and table 5.4.9 below highlights the main institutions operating national partnership projects followed by a profile of each institution.

Table 5.4.9 Main Institutions Involved in the National Partnership Programme – socio-economic and humanities

Rank	Organization	Nb Projects
1	Academia de Stiinte Economice Bucuresti	27
2	Institutul National de Cercetare Stiintifica in domeniul Muncii si Protectiei Sociale	10
3	Universitatea Babes-Bolyai Cluj-Napoca	10
4	Centrul de Economia Industriei si Serviciilor al Academiei Romane	3
5	Institutul de Economiei Nationala Bucuresti	3

Bucharest University of Economic Studies (ASE)

The Bucharest University of Economic Studies (ASE) is the oldest university of economics and business studies in Romania classified as research intensive university which ranks among the top 12 leading Romanian universities.. All the study domains offered by the university are classified in this first category at national level. ASE has about 45000 students and 1000 faculty/staff.

More than 20 research centres have been set up within the university, focusing on research areas of the highest scientific interest in economics field and is partner in over 10 European projects. The Research Center in Business of ASE coordinates a national network on service research especially focusing on the knowledge economy; indicators and measurement methods related to service sector development; entrepreneurship; business ethics and social responsibility; risk analysis for business.

National Scientific Research Institute for Labor and Social Protection

Since it was established, in 1990, the institute has performed scientific research activities in the field of labour market and social protection, thus supporting Romania’s efforts to create and develop a sustainable economy, based on modern, European principles. The Research Development and Innovation activity is focused on the following subjects: Labor market (Labor force Unemployment ;)

Lifelong learning (Evaluation of the impact of educational and training systems on labor market efficiency; Evaluation of the skills demands nationally according to the needs of the labor market). Human resources management. Social policies and social phenomena (Poverty and social exclusion. Socio-human aspects involved in the process of change, modernization and integration of Romania in the European structures. Strategies and models of socio-economic development nationally, regionally and on activities of the national economy). Macro and microeconomic management

Centre for Industrial Economics and Services (CEIS)

Centre for Industrial Economics and Services (CEIS) is part of the National Institute of Economic Research (INCE) of the Romanian Academy. The Centre's mission is the development of fundamental and applied research in the following fields: natural resources, energy policies, strategies and policies in manufacturing, environmental economics, environmental policy, microeconomics, industrial management, regional development, economy and information society services, and sustainable development.

The CEIS research projects are focused on major issues of development and modernization of industry and services in Romania as a member state of the European Union according to the European Research Area. The Centre has nationally and international research partnerships and has obtained prestigious national awards research of the Romanian Academy, and prizes awarded by MEC-NASR for partnership.

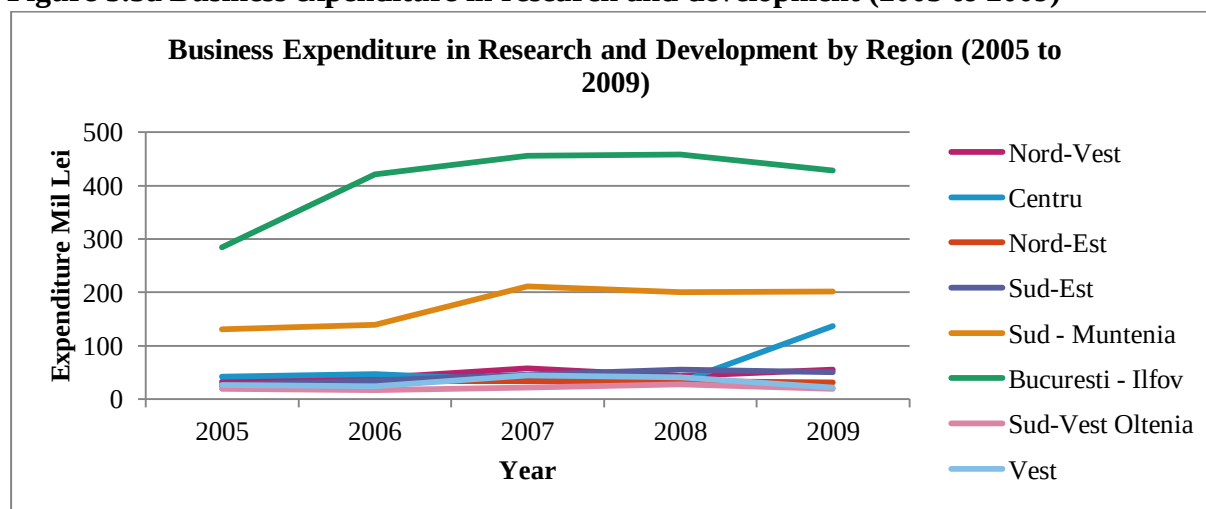
The Institute of National Economy

The Institute of National Economy is the oldest public institutional establishment of economic research from Romania. The research programme of the Institute comprised works of a rich thematic area with respect to: macroeconomic effects of restructuring and privatisation in Romania; the correlation between economic development, employment, formation and distribution of incomes, living standard and human development; corporative governance within the Romanian economy; industrial relations; impact of association and pre-accession of Romania to the European Union on companies' competitiveness; integration of the research-development system into the European Research Area, environmental protection, resources and economic development, etc. The Institute participated in the realisation of several works financed through national research grants and FP7 grants.

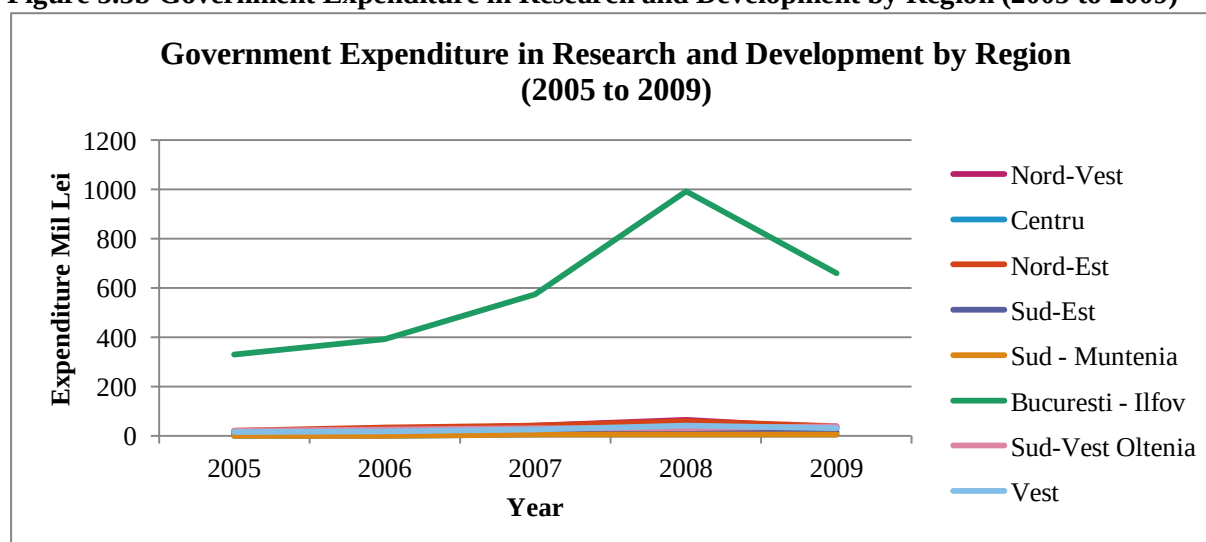
5.5 Regional RTDI Profile

The next section of this report profiles each Romanian region in relation to RTDI capacity in the form of researchers and expenditure and in the form of outputs based on patents. At the end of this section a summary assessment of research capacity is provided which will provide a basis for identifying potential areas of smart specialisation.

Our first analysis of research at the regional level is based on expenditure in research and development for the period 2005 to 2009. Overall the data highlights the dominance of Bucharest-Ifov in expenditure by business, government and higher education.

Figure 5.5a Business expenditure in research and development (2005 to 2009)

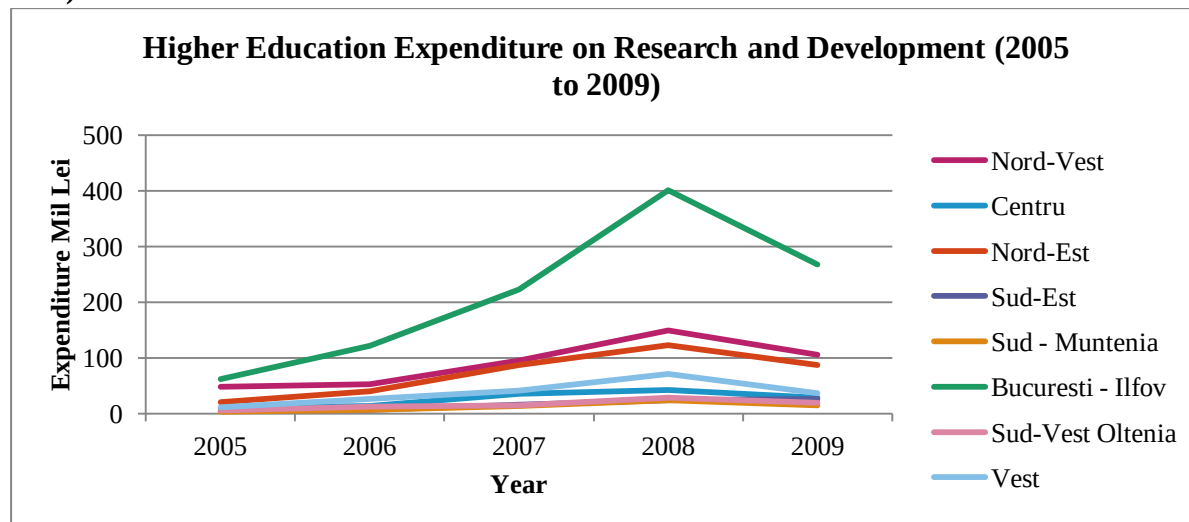
Direct Government research (Figure 5.5b) is almost exclusively undertaken in the capital region. The government sector is composed of; all departments, offices and other bodies which furnish but normally do not sell to the community those common services, other than higher education, which cannot otherwise be conveniently and economically provided and administer the state and the economic and social policy of the community; and non-profit institutions (NPIs) controlled and mainly financed by government; public enterprises are included in the business enterprise sector. However expenditure in Higher Education (figure 5.4c) reflects a regional dimension with a higher level of funding both in the Nord Vest and Nord EST regions. The higher education sector is composed of all universities, colleges of technology, and other institutes of post-secondary education, whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education establishments (REF).

Figure 5.5b Government Expenditure in Research and Development by Region (2005 to 2009)

But there are regional disparities in research expenditure. Expenditure in the Nord EST region and Nord Vest region is predominantly driven through higher education. In comparison expenditure in the Sud-Muntenia and Centru regions is driven predominantly by Business and Enterprise. This is explained in the Sud-Muntenia region by the presence of Dacia Renault. The business enterprise

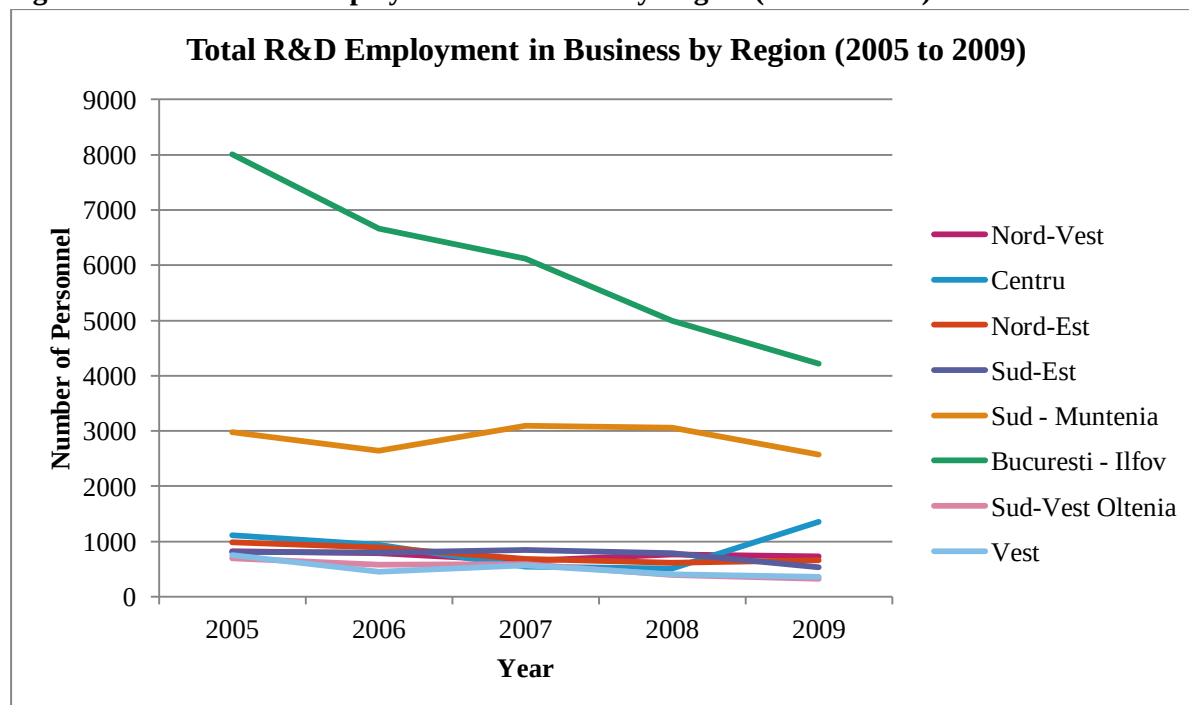
sector includes; all firms, organisations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price, and the private non-profit institutes mainly serving them.

Figure 5.5c Higher Education Expenditure in Research and Development by Region (2005 to 2009)



Our second analysis at the regional level concerns employment. While expenditure over the period 2005 to 2009 has seen moderate increases employment in business particularly in Bucharest Ilfov has seen a significant decline (figure 5.5d), while in other regions a decline in employment, although less significant can still be observed.

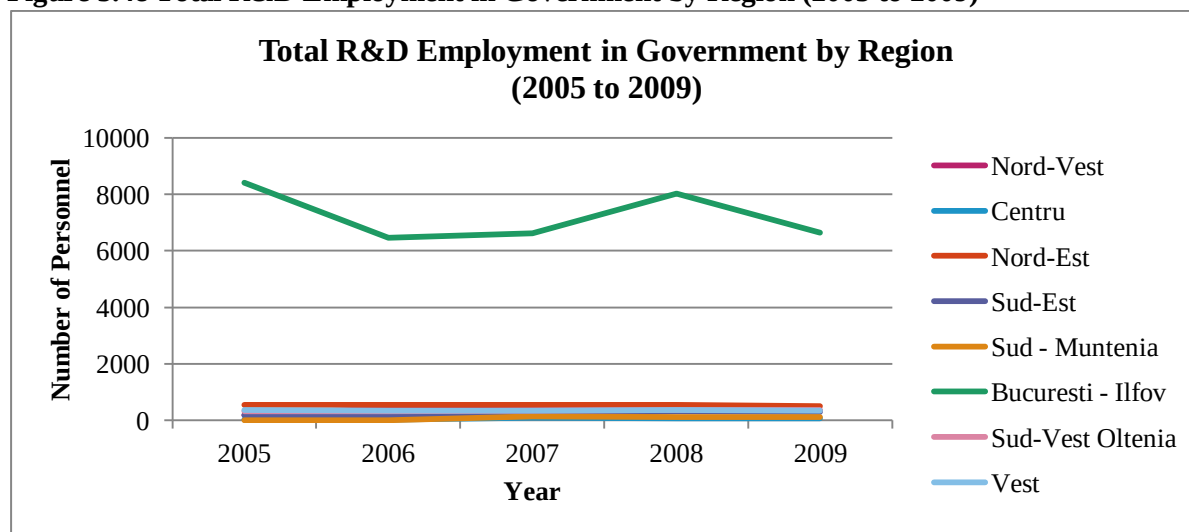
Figure 5.5d Total R&D Employment in Business by Region (2005 to 2009)



Employment of research personnel in Government (figure 5.5e) reflects the level of expenditure and similarly this highlights the focus of Government research predominantly in the capital region of

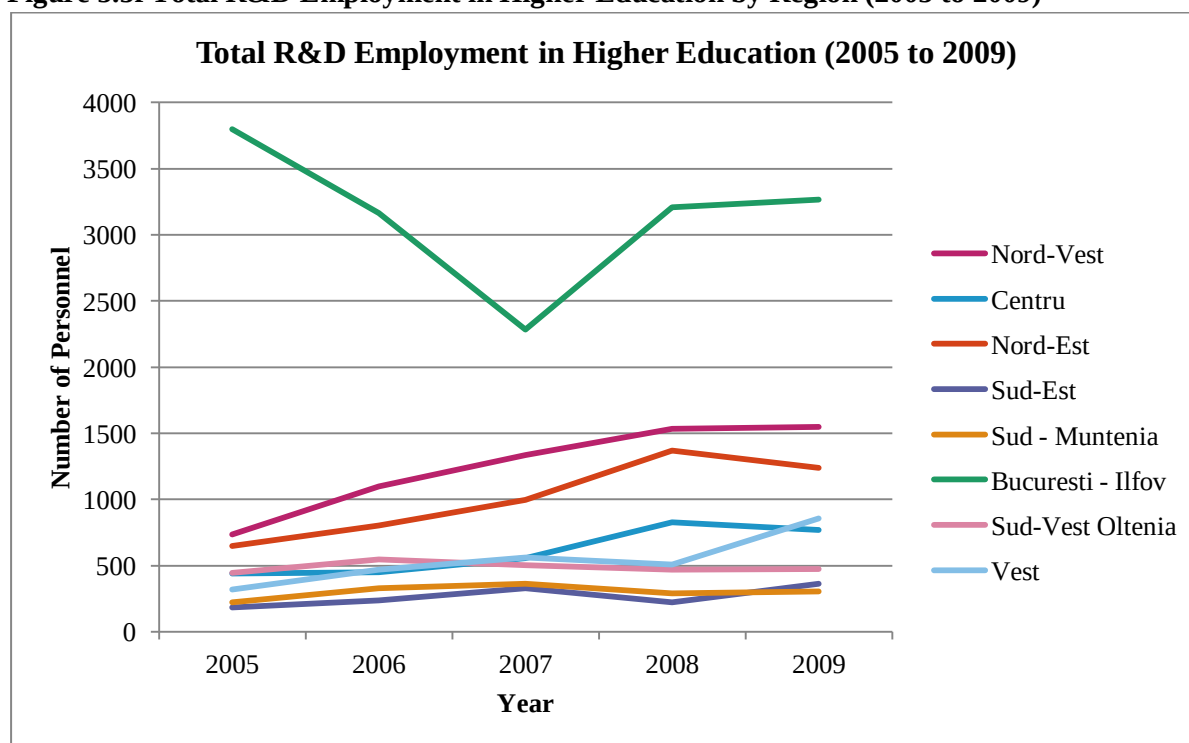
Bucharest Ilfov. While a decline in researchers can be observed in Bucharest Ilfov this decline is less significant than that observed in Business and Enterprise.

Figure 5.4e Total R&D Employment in Government by Region (2005 to 2009)



The situation in Higher Education (figure 5.5f) reflects the profile of expenditure with the exception of Bucharest Ilfov where a significant decline is seen in the 2005 to 2007 period when funding was increasing. The growth of Employment in Higher Education at a regional level particularly in the Nord Vest and Nord EST can once again be observed.

Figure 5.5f Total R&D Employment in Higher Education by Region (2005 to 2009)



An incipient regional focus in the implementation of the national RDI policy has only recently been adopted by NASR (since 2008) in the form of: (I) monitoring the regional distributions of projects

funded by the 2007-2013 National RDI Plan, (ii) nine regional Research Exhibitions organized in 2008 by the regional Chambers of Commerce and Industry in collaboration with accredited entities of the Remit network to enhance collaboration between R&D units and business firms; (iii) the Innovation Roadshow, meant to raise business community's awareness on public funding opportunities and on new products and technologies realized in national R&D institutes and in universities, and (iv) the production of INNOBAROMETER in 2008 as an annual analysis of innovation at regional and national level.

The Regional Innovation Strategies (RIS) were developed in the early 2000s by six Romanian regions on the basis of their affiliation to the Innovating Regions in Europe (IRE) Network. West Region's 2004-2008 RIS was continued with the 2009-2013 RIS of the Vest Region, while RIS - Bucharest Ilfov Region, RIS - Nord Est Region, RIS - Nord Vest Region, RIS - Sud Est Region, RIS - Sud Muntenia Region have been developed during 2005-2008, but no follow-up strategies are available to date. Overall, the RIS comprise ambitious objectives that are relevant and necessary to the respective regions but they have only an orientation character for regional stakeholders and have no formal implementation framework, budgets, etc. There is no evidence of synergies between the six RIS, or between the RIS and the National RDI Strategy, or evidence of inter-regional collaborations supported by the RIS.

The assessment of the innovation and technology transfer policies at regional level is revealed in the results of Study Inobarometru 2011 which measures the quantitative impact of these policies at regional level and is given by scores developing regions obtained in the degree of innovation. The Inobarometer ranks the capacity of the development regions to create and maintain an environment that support innovation among enterprises. The evaluation model utilises 5 factors:

1. leadership potential innovation,
2. knowledge creation potential,
3. innovation and integration potential into a relational system
4. performance of innovation activities
5. Intellectual property.

Each factor was divided into sub factors of characterisation obtaining a total of 16 sub factors of innovation, and each sub factors have been assigned indicators evaluation. A total of 68 indicators were included in the analysis: 65 quantitative indicators and 3 qualitative indicators. By aggregating the results of the 16 sub factors was obtained the degree of regional innovation. The analysis is available for indicators of innovation for the period 2008-2010. Table 5.5a highlights the ranking of each region by innovation indicator.

Our third Analysis explores the location of research and development institutions in Romania. Our review of institutions includes those identified under sector code NACE 72. This classification includes the activities of three types of research and development: 1) basic research: experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without particular application or use in view, 2) applied research: original investigation undertaken in order to acquire new knowledge, directed primarily towards a specific practical aim or objective and 3) experimental development: systematic work, drawing on existing knowledge gained from research and/or practical experience, directed to producing new materials, products and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed. Research and experimental development activities in this division are subdivided into two categories: natural sciences and engineering; social sciences and the humanities.

Table 5.5a Regional Innovation Ranking (Inobarometer)

Development Region	Degree of innovation Ranking	The potential of driving innovation	The potential of creating innovation	The capacity to innovate and integration within a relational system	Performance of innovative activities	Intellectual property
Bucureşti - Ilfov	1	1	1	1	1	1
Nord-Est	2	2	4	2	7	6
Centru	3	7	8	3	3	2
Sud	4	5	2	5	6	3
Sud-Est	5	6	7	4	2	7
Sud-Vest	6	3	6	8	4	8
Nord-Vest	7	4	3	7	8	4
Vest	8	8	5	6	5	5

The Universities in Romania are now also classified according the criteria of the European University Association into the following areas:

University with Advanced Research and Education (UARE): These institutions (12 in total) represent those with a higher allocation of Masters Programme and PhD studies. They represent 84% of all PhD programmes

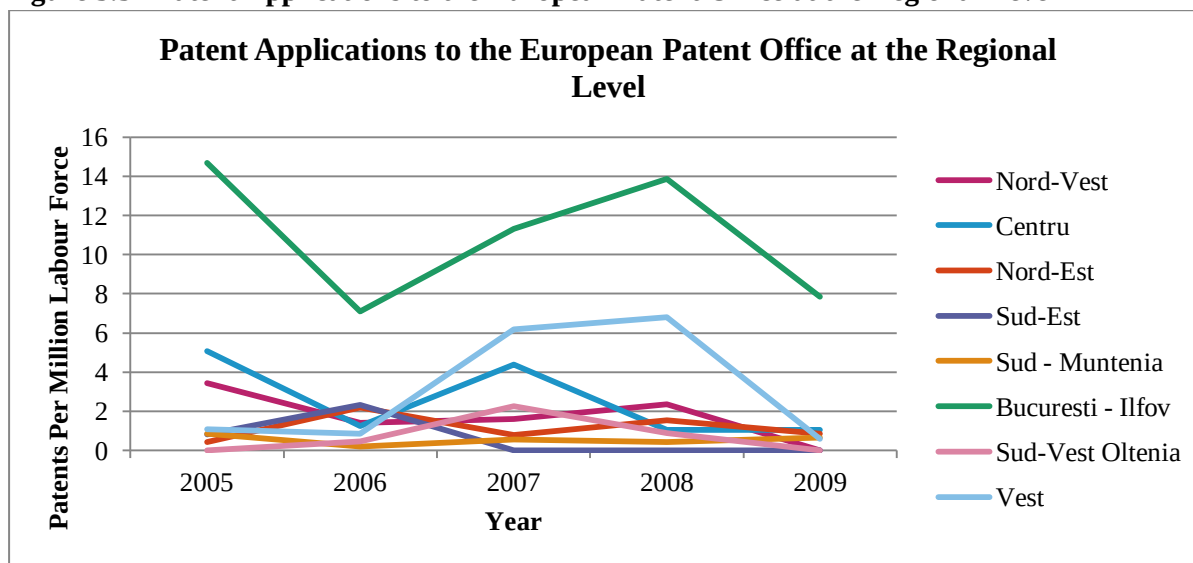
University with Education and Scientific Research (UESC): These institutions are able to deliver masters and PhD programmes although their PhD numbers will be less than the UARE category

Universities Focused on Education (UFE): These institutions have a lower level of Masters Programmes and a small number of PhDs.

Universities for education and artistic creation (UEAC)

Figure 5.5g highlights the profile of Romanian research and development organisations and higher education institutions by region in Romania. The institutions classified as Universities with Advanced Research and Education is located in four regions, Nord EST, Nord Vest, Vest and Bucharest Ilfov. The location of these institutions particularly in the North Est and Nord vest regions can be seen in the employment and higher education R&D expenditure profile of these regions. The institutions classified as Universities with Education and Scientific Research is located in all regions with the exception of Sud Muntenia.

Our final assessment at the regional level reflects the output of research and resultant patent applications to the European Patent Office. Overall this reflects the focus of research in Bucharest Ilfov, with the Vest region also performing better than other Romanian regions in the 2007 to 2008 period.

Figure 5.5h Patent Applications to the European Patent Office at the Regional Level

Overall patent data for Romanian regions is either fragmented or not available and this is the case with both high-technology patents where data is available only for Bucharest Ilfov and in Biotechnology where a fragmented dataset means that a comparative analysis cannot be undertaken.

In the field of ICT there is data available for five Romanian regions and this identifies a similar profile to patent applications overall with a dominance of applications from Bucharest Ilfov and to a lesser extent the Vest region.

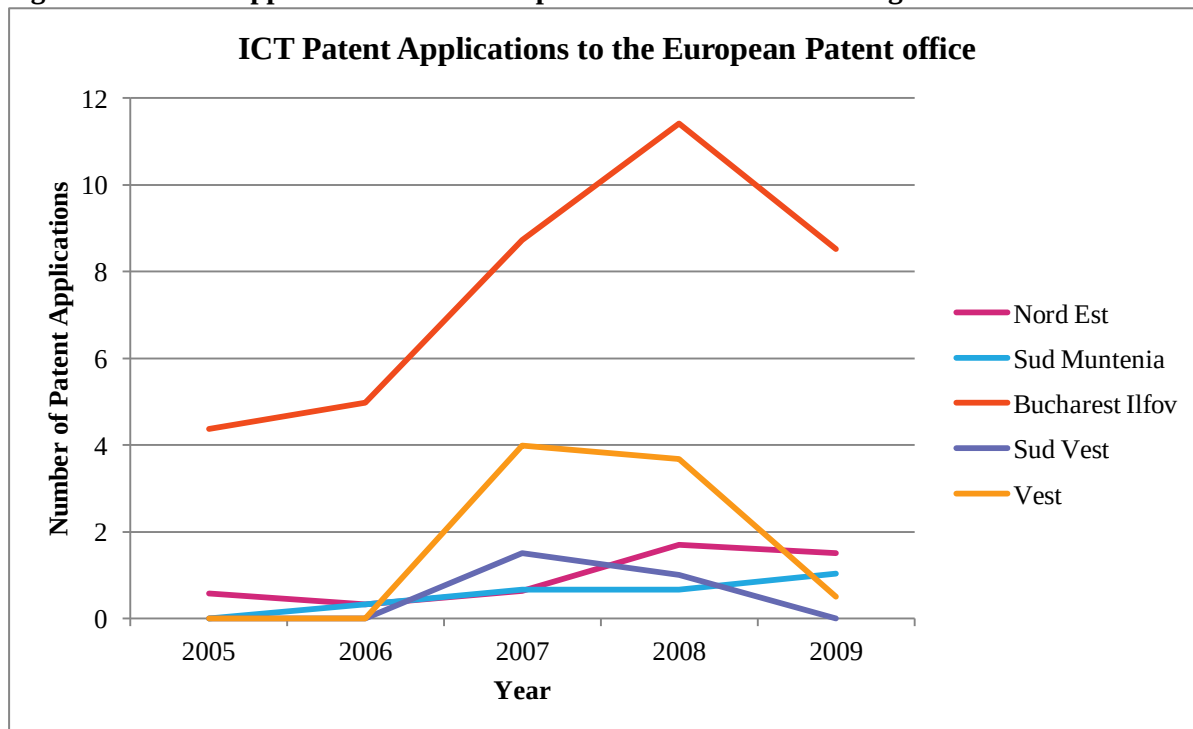
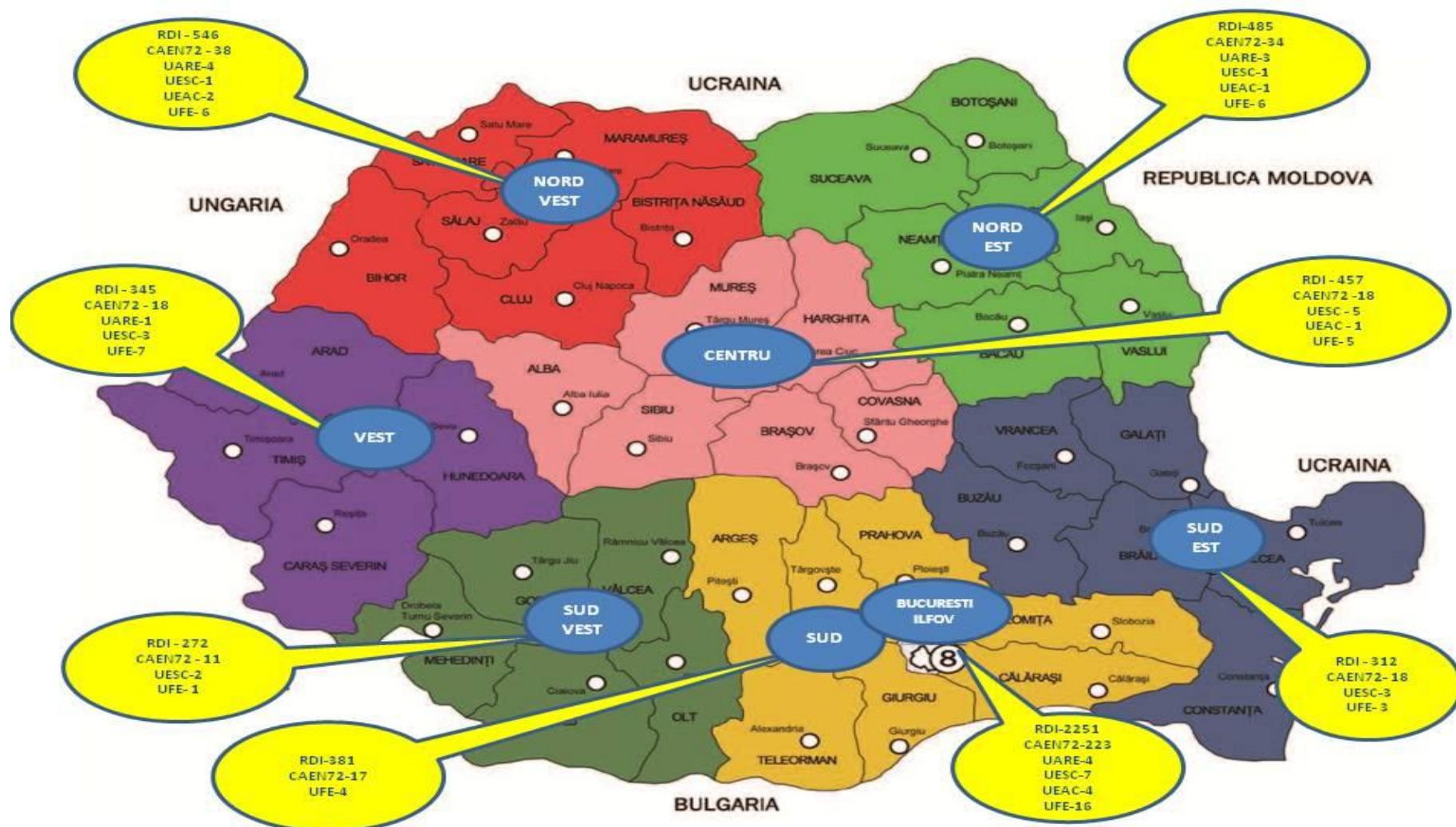
Figure 5.5i Patent Applications to the European Patent Office at the Regional Level

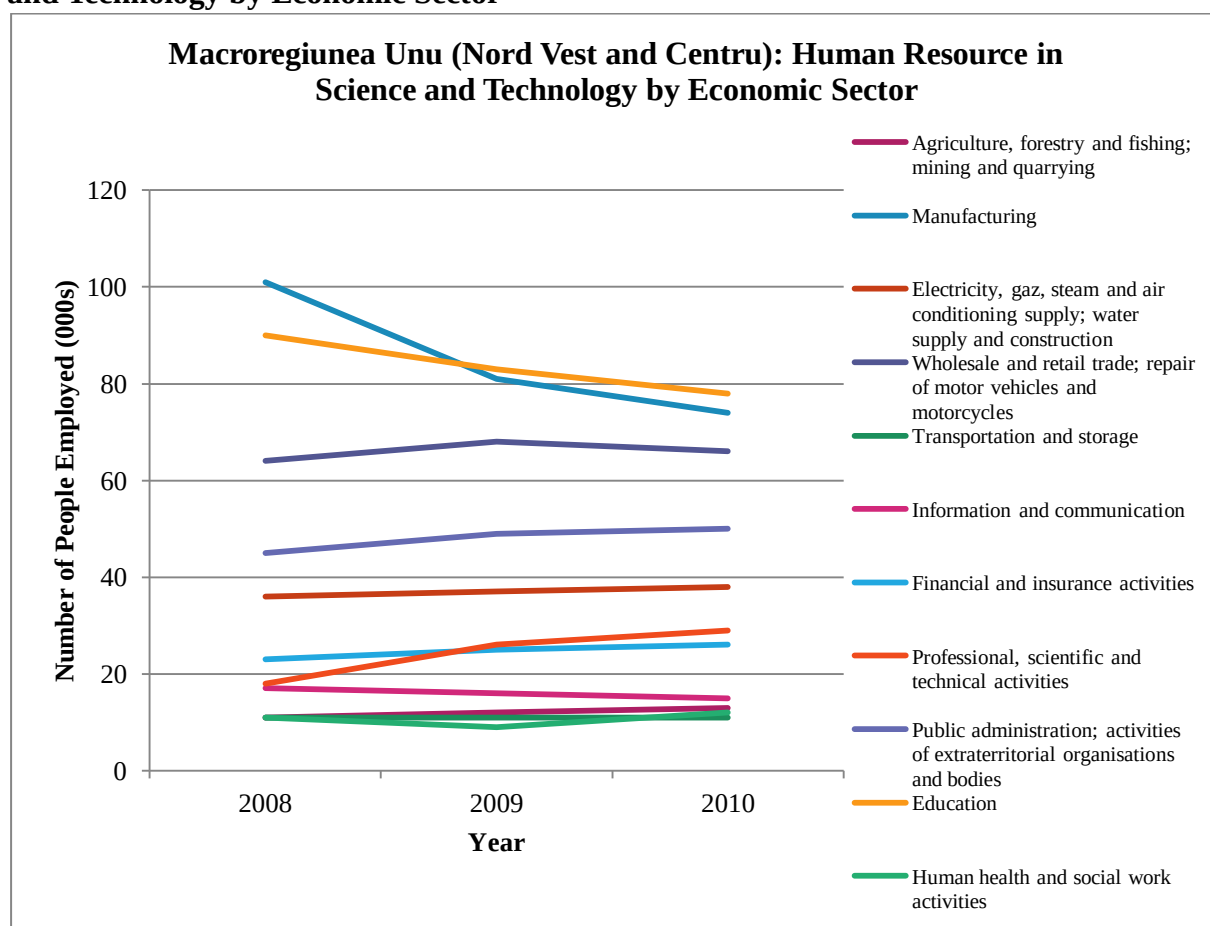
Figure 5.5g Profile of Romanian RDI Institutes and Universities by Region

5.6 Regional Human Resources in Science and Technology

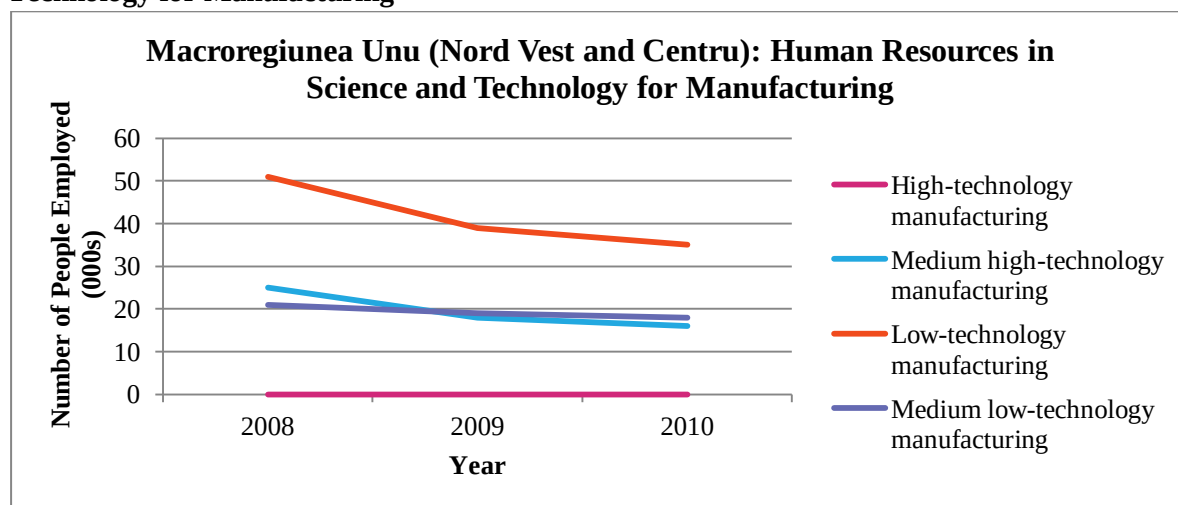
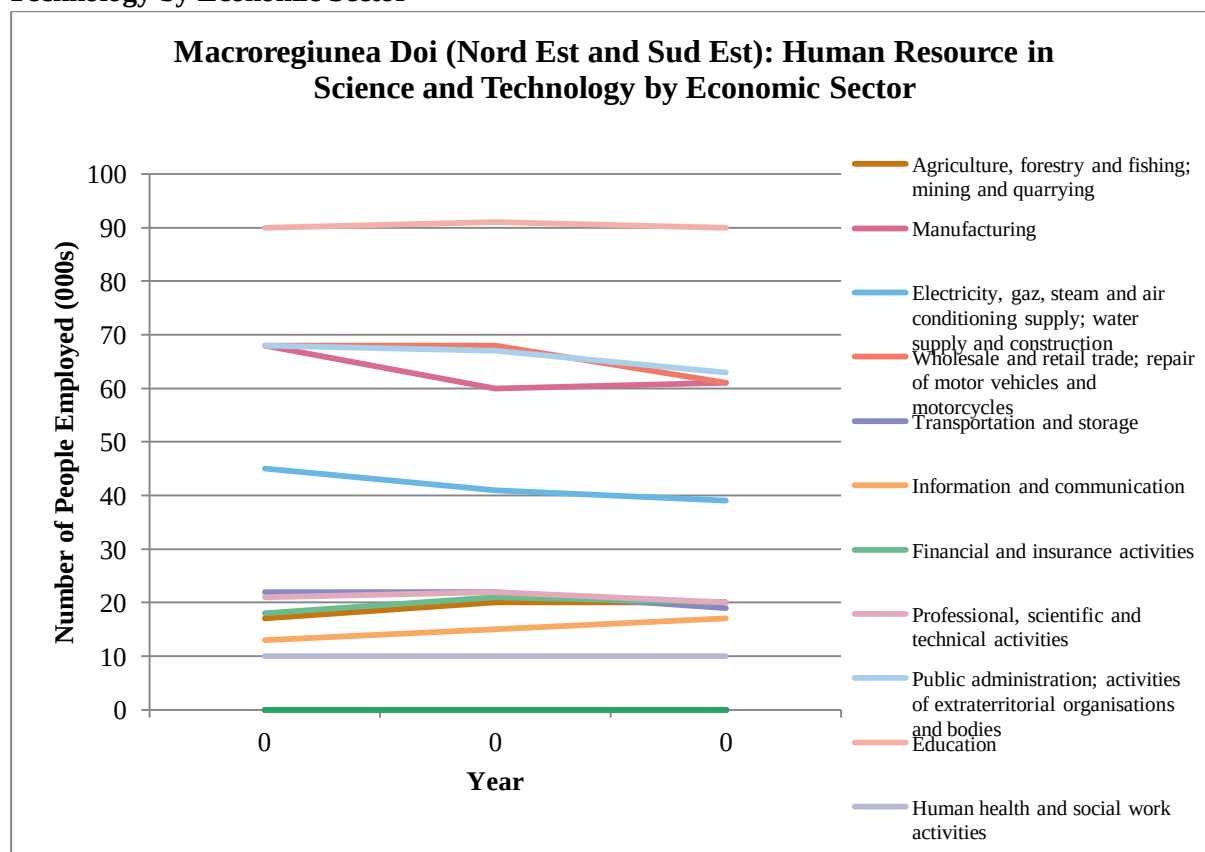
Our assessment at a regional level explores employment in science and technology by economic sector. Unfortunately 2010 data is only available at NUTS 1 level meaning that regional data is combined. In Macroregiunea One, comprising the Nord Vest and Centre regions human resource in science and technology is dominated by the service sector which reflects the dominance of sectors including education, wholesale and retail trade and professional scientific and technical activities. Manufacturing employment has seen a decline and accounts for 74,000 people in 2010.

An evaluation of manufacturing at this NUTS 1 level of manufacturing considering technology identifies that employment is dominated by low-technology manufacturing reflecting and confirming our economic analysis in section 4. Unfortunately data for high tech manufacturing is unavailable for the period, based on the data for medium-high tech we can assume this to be at a relatively low level.

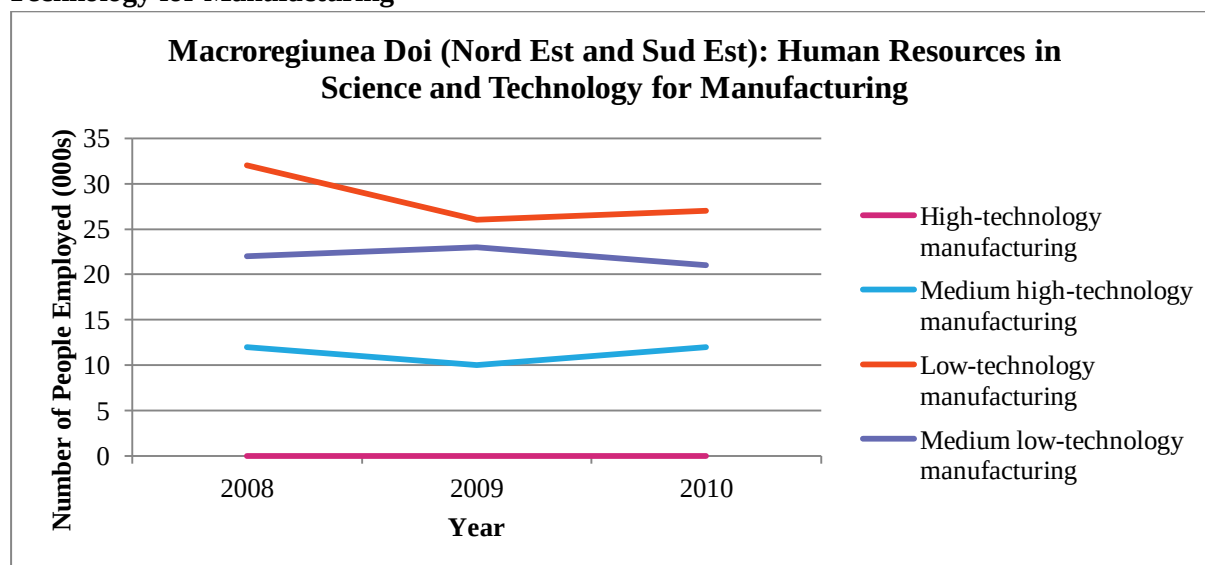
Figure 5.6a Macroregiunea One (Nord Vest and Centre): Human Resource in Science and Technology by Economic Sector



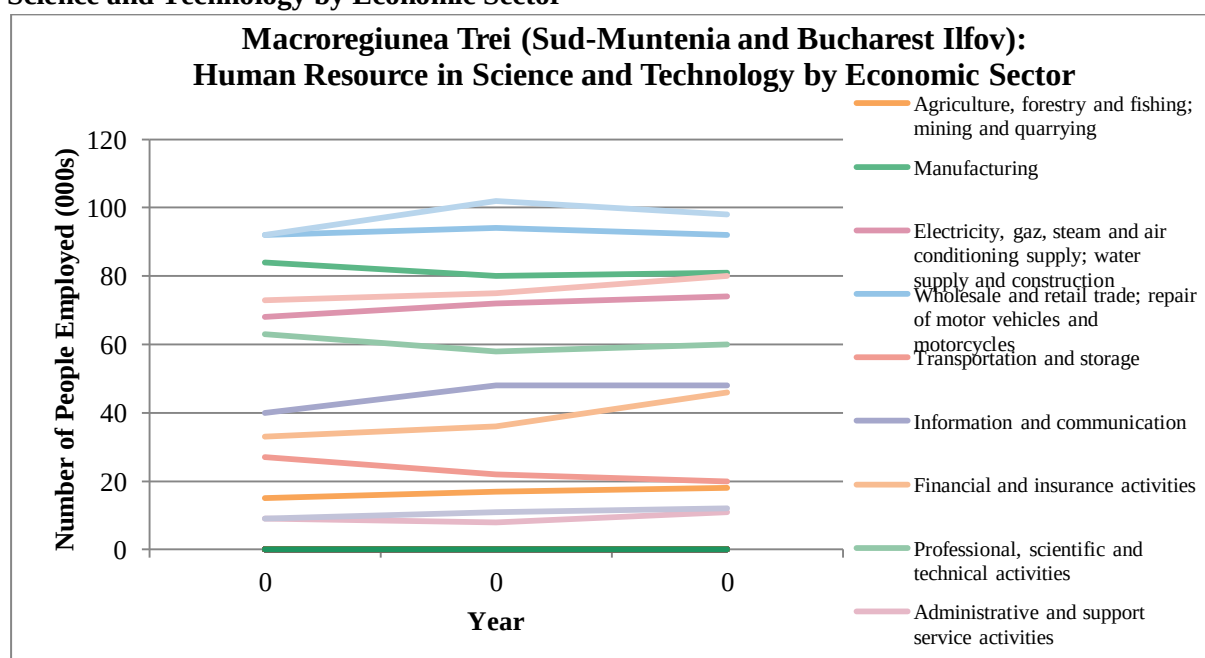
In Macroregiunea Two representing the Nord EST and Sud EST regions, human resource in science and technology is dominated by the following sectors; wholesale retail, manufacturing, education and public administration reflecting the strong profile of the service sector and to a lesser extent manufacturing.

Figure 5.6b Macroregiunea One (Nord Vest and Centre): Human Resources in Science and Technology for Manufacturing**Figure 5.6c Macroregiunea Two (Nord EST and Sud EST): Human Resource in Science and Technology by Economic Sector**

An evaluation of manufacturing at this NUTS 1 level of manufacturing considering technology identifies that employment is dominated by low-technology and medium-low tech manufacturing reflecting and confirming our economic analysis in section 4. Unfortunately data for high tech manufacturing is unavailable for the period, based on the data for medium-high tech we can assume this to be at a relatively low level.

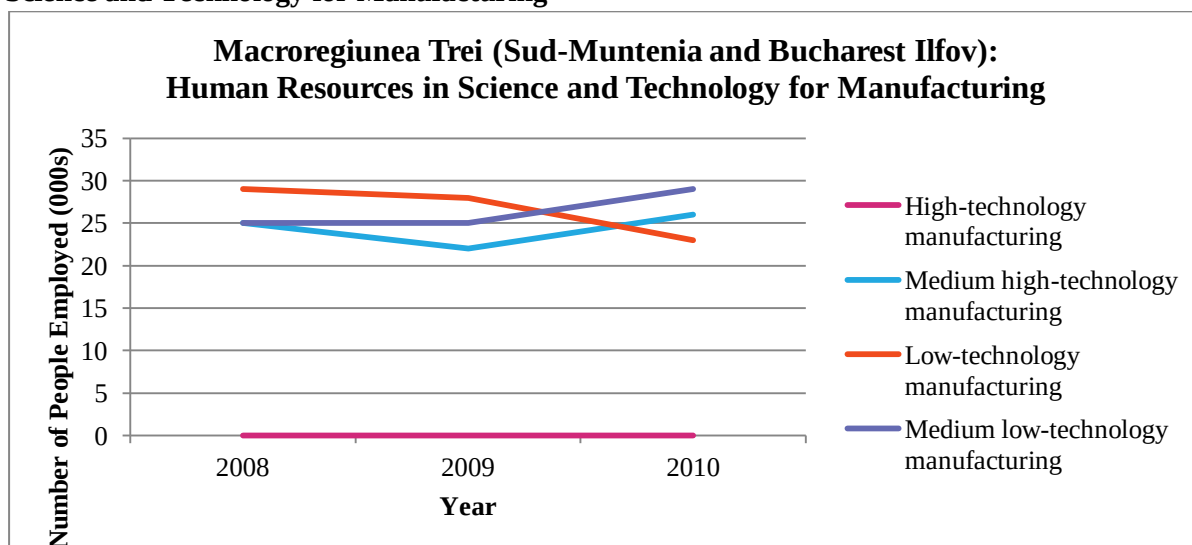
Figure 5.6d Macroregiunea Two (Nord EST and Sud EST): Human Resources in Science and Technology for Manufacturing

In Macroregiunea Three representing the Sud-Muntenia and Bucharest Ilfov Region human resource in science and technology is dominated by the following sectors; public administration, wholesale and retail, education and manufacturing, this reflects the strong profile of the service sector and to a lesser extent manufacturing in this administrative region which includes the Romanian capital city.

Figure 5.6e Macroregiunea Three (Sud-Muntenia and Bucharest Ilfov): Human Resource in Science and Technology by Economic Sector

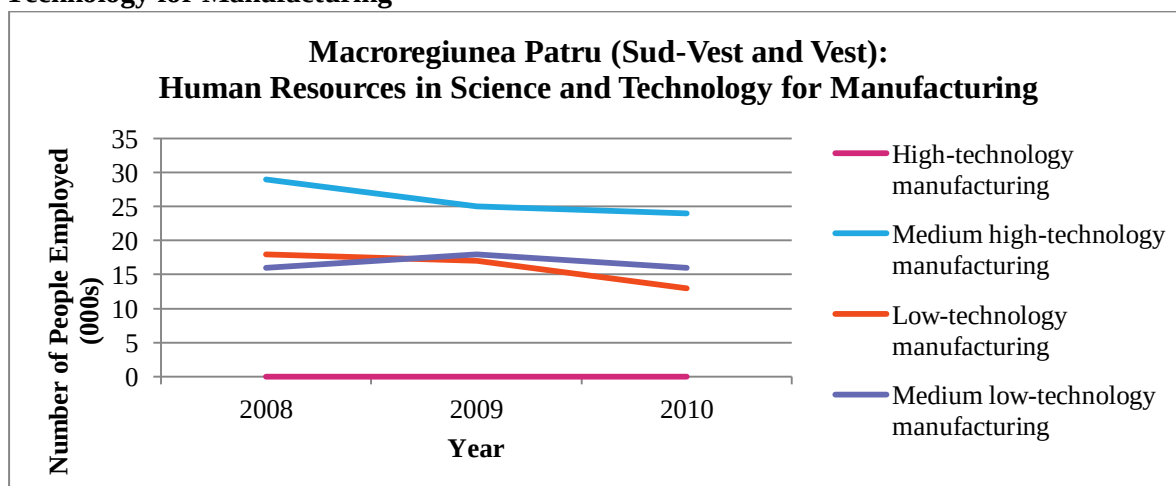
An evaluation of manufacturing at this NUTS 1 level of manufacturing considering technology identifies that employment is dominated by medium-low-technology and medium-high technology manufacturing reflecting a focus on automotive, electronics and machinery and equipment reflecting and confirming our economic analysis in section 4. Unfortunately data for high tech manufacturing is unavailable for the period.

Figure 5.6f Macroregiunea Three (Sud-Muntenia and Bucharest Ilfov): Human Resources in Science and Technology for Manufacturing

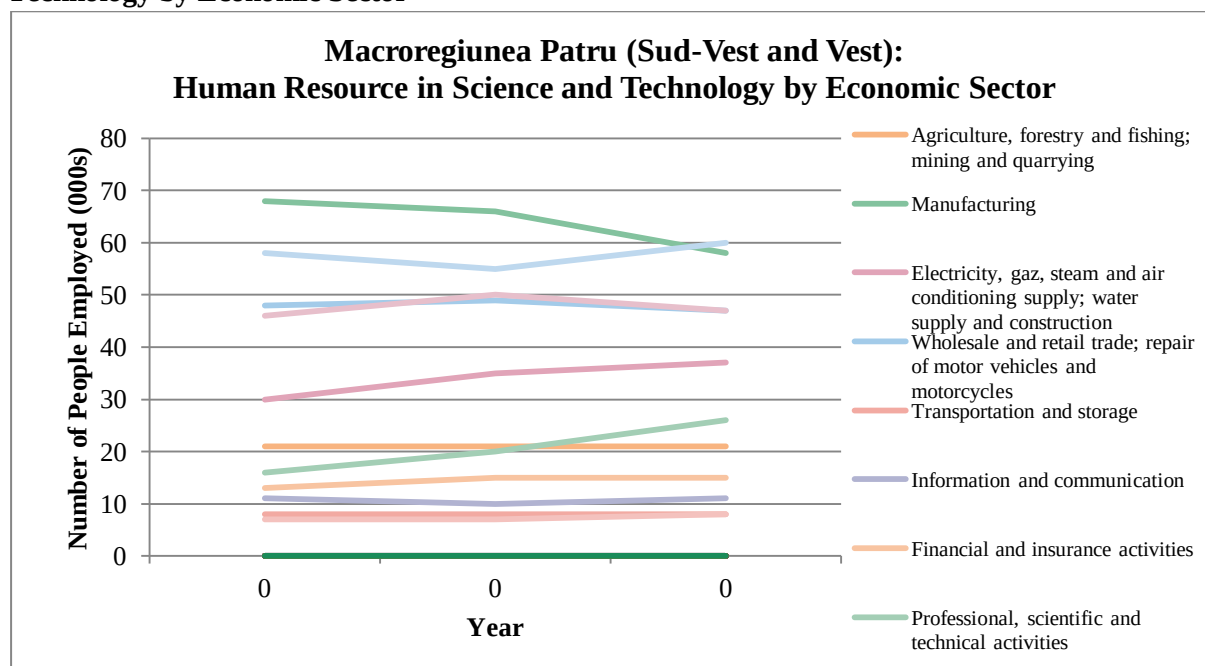


In Macroregiunea Four representing the Sud-Vest and Vest Region human resource in science and technology is dominated by the following sectors; manufacturing, education, public administration, wholesale retail and electricity which follows a similar profile to that observed in the other Romanian NUTS 1 regions. An evaluation of manufacturing at this NUTS 1 level of manufacturing considering technology identifies that employment is dominated by medium-high technology manufacturing and medium-low technology manufacturing reflecting a focus on automotive, ICT, chemicals, other transport and electronics reflecting and confirming our economic analysis in section 4. Unfortunately data for high tech manufacturing is unavailable for the period.

Figure 5.6g Macroregiunea Four (Sud-Vest and Vest): Human Resources in Science and Technology for Manufacturing



At a regional level this assessment is unable to identify research specialisations; this would require a more in-depth assessment of universities, research institutions and research organisations to profile specific capability. However our regional profile does reveal significant insights into the funding and technology profile of the Romanian regions.

Figure 5.6h Macroregiunea Four (Sud-Vest and Vest): Human Resource in Science and Technology by Economic Sector

Our profile of expenditure on research and development revealed a focus on business and enterprise expenditure in Bucharest Ilfov, Sud Muntenia and the Centru regions in comparison to higher education expenditure where alongside Bucharest Ilfov the Nord EST and Nord Vest regions had the highest levels of expenditure. If we compare this with our assessment of human resources in science and technology we see a profile of low-technology manufacturing and medium-low technology manufacturing in the Nord Vest and Nord Est regions in comparison to Sud-Muntenia and Bucharest Ilfov where manufacturing has a relatively equal profile of medium-high tech, medium-low tech and low tech manufacturing and in the Sud Vest and Vest regions where there is a profile of medium high technology manufacturing. This assessment highlights regional disparities in Romania and to a certain extent the disconnection between business enterprise and research activities.

5.7 Science and Technology Parks

In addition to the 56 public universities, 47 RDI National Institutes and 66 R&D organisations of the Romanian Academy, Romania has a National Network for Innovation and Technology Transfer which includes the Innovation and Technology Transfer Centres (which incorporate technology transfer centres, technology information centres, technology and business incubators) and four science and technology parks as highlighted in table 5.7a.

Science and Technology Park “Technopolis” Iasi

The Science and Technology Park “TEHNOPOLIS” Iasi has the aim of supporting research commercialisation, supporting technology transfer and the engagement of universities in social and economic development. The focus areas of the park are in ICT, Audio-video, Bio-technology and Food. Alongside its offices, conference rooms and exhibition spaces the park has specialist lab facilities for environmental evaluation, biotechnology and cryogenics.

Science and Technology Park Timisoara

The Science and Technology Park Timisoara have similar aims and objectives to the park in Iasi based on technology transfer and the commercialisation of research results. The focus areas of the

park are in; chemistry, electrochemistry, environmental protection; physical welding; computers, automatic management of technological systems; economics and marketing.

Science and Technology Park for Micro- and Nanotechnologies

The Science and Technology Park for Micro- and Nanotechnologies delivers support services that enhance the process of business incubation including; technology transfer (e.g. prototype development, demonstrators, experimental models and pilot production), technology services (e.g. simulation and design), training, consultancy services and support for establishing international partnerships. The park offers specialist chemical and semiconductor laboratory facilities.

Galati Software Park

The Galati Software Park has an overall aim to develop industry leading technologies, facilitate the transfer of technology and create employment opportunities in South-East Romania. The park currently employs approximately 300 people in 34 businesses with the aim to employ a total of 500 people overall on the park. The Park offers 64 offices, conference facilities along with space for consultancy research and training.

Table 5.7a Science and Technology parks in Romania

Science and Technology Parks				
Thematic Areas	PST Iasi-Tehnopolis	PST Timisoara - Tim Science Park	PST București - Micro And Nano Technologies	PST Galati –Software Park
D1 Information Technology and Communications	✓			
D2 Energy				
D3 Environment		✓		
D4 Health				
D5 Agriculture, Food Safety and Security	✓			
D6 Biotechnology	✓			
D7 Material, Processes and innovative products		✓	✓	
D8 Space and Security				
D9 Socio Economic and Humanities Research		✓		
Business Incubation	✓	✓		✓

5.8 Research Assessment Analysis

This assessment of Romanian research highlights a focus on engineering and technology that is evident in the number of business, government and higher education researchers, research expenditure and publications. Our more detailed assessment of this theme highlights the dominance of electrical and electronic engineering, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering. This engineering focus is also replicated at a European Union level with Romania participating in projects in Framework 7 of which a majority are focussed on transport including air, road, rail and shipping.

Engineering and Technology expenditure will also include ICT which is additionally well recognised in terms of publications which are dominated by computer science, hardware and architecture, artificial intelligence and computational theory and mathematics. FP7 projects are also a dominant feature of this research theme and Romania has a particular focus on networks of the future, internet of services, software and visualisation, networked media and 3d internet, flexible organic and large area electronics, embedded system design, personal health systems, ICT for energy efficiency and accessible and assistive ICT.

Also within this research theme we see the emergence of nanotechnology and nanomaterials, which includes; Micro-nanotechnology for interacting, sensing, actuating and microsystems; nanobiotechnology; nanotechnology for applications in bio-medical field; nanotechnology for information processing, storage and transmission, nanotechnology for materials and surface science and nanotechnology for applications in chemistry.

Significant investment in Business and Enterprise Research and Development is also prevalent in the natural sciences and agricultural sciences which along with Government and Higher Education expenditure in these areas are reflected in the higher levels of publications in physics, chemistry, biological science, agriculture and environmental science. These are fundamentals components of the research themes relating to energy and environment and agriculture.

Within agriculture, publications are dominated by the research themes of agronomy, crop science, food science and agricultural and biological science, while FP7 projects in which Romania is a partner are focussed on food, agriculture, agricultural biotech and biotech.

The environmental research theme is reflected very strongly in publications with a particular focus on pollution, management and monitoring, environmental engineering, ecology and environmental science. This is also consistent the Romanian profile of FP7 projects of which 45 are classified under environmental protection. Energy as research theme is relatively low in terms of publications in relation to other research themes. These publications are focussed in areas including nuclear energy and renewable energy. This area of activity has 17 FP7 projects focussed on network technologies, renewable energy and biofuels.

Reflecting on our assessment of assessment of Romanian research we can consider a perspective on areas of potential Smart Specialisation. The following areas of Romanian research are considered by the authors of this report to be candidates for a focus on smart specialisation.

Table 5.8a Potential Areas for Smart Specialisation Focus based on Research Capacity and Capability

Research Theme	Specialisation
ICT	Networks of the future, internet of services, software and visualisation, networked media and 3d internet, flexible organic and large area electronics, embedded system design, personal health systems, ICT for energy efficiency and accessible and assistive ICT, Computer science and artificial intelligence.
Engineering and Technology	Electrical and electronic engineering, nanotechnology, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering, motor vehicle transport and other transport
Energy and Environment	Pollution, management and monitoring, environmental engineering, ecology and environmental science, network technologies, renewable energy and biofuels.
Food and Agriculture	Agronomy, crop science, food science and agricultural and biological science, agricultural biotech

In addition to this analysis a series of four workshops was held in Bucharest on the 12th and 13th of February 2013 represented by public authorities at the National level, public authorities at a regional level, business representation and representation from research institutions and Universities. The workshops discussions were conducted in a moderated process, allowing a focused and objective oriented approach. The participants were asked to comment on the findings of a summary presentation of the quantitative analysis undertaken in this report and to express their opinion in terms of the importance of sectors, subsectors and research which can be regarded as a basis for the future smart specialisation in Romania. The results of the moderated discussion from the University and Research Institution Stakeholder Workshop are identified in table 5.8b

In addition to the sectors originally identified the workshop in line with the other workshops delivered highlighted additional potential areas including; construction, tourism, chemicals, agriculture, healthcare, mining and environment.

Table 5.8b National Level Workshop (Research): Identified Sector and Research Specialisation Themes

Sector	Sector Specialisation	Research	Research Specialisation
Food & Agriculture	Agro-Food, Biotechnology, fisheries, zootechnics	Food and Agriculture	Agronomy, crop science, food science and agricultural and biological science, agricultural biotech ,
ICT,	Telecommunications and Software / Computer Programming Mechatronics	ICT	Networks of the future, internet of services, software and visualisation, networked media and 3d internet, flexible organic and large area electronics, embedded system design, personal health systems, ICT for energy efficiency and accessible and assistive ICT, Computer science and artificial intelligence. Smart micro systems, intelligent micro sensors
Motor Vehicle Manufacturing and Other Transport	Materials, Components and Fabrication Ship Building, aerospace	Engineering and Technology	Electrical and electronic engineering, nanotechnology, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering, motor vehicle transport and other transport
Electronics Electrical engineering	Computer, Electronics and Optical Products, Medical precision Instruments, Mechatronics, robotics, electronics for automotive		Joining technologies, mechatronics systems, tribology, micro-nano fabrication Nano composites for textile applications, , anthropometric research for the clothing industry Magnetic nano-fluids
Machinery and Equipment,	Intelligent Agriculture, Automation Mechatronics		Electronics for aviation
Textiles	Technical Textiles, smart textiles, personalised		High power lasers/ x-rays; Medical Instruments & Biomedical engineering

Sector	Sector Specialisation	Research	Research Specialisation
	clothing		
Energy	Renewable Energy, Wind Power, Solar Power, Green construction. Biomass, Ecological Services, Nuclear energy	Energy and Environment Energy management	Pollution, management and monitoring, environmental engineering, ecology and environmental science, network technologies, renewable energy and biofuels, thermo-chemical solar pipe, TiO2 Nano composites for decontamination, high power lasers, solar cells,
Construction and urban science	Metallic construction		
Chemical industry	Oil extraction, plastics, ceramics and carbonic materials		Ceramic matrix composites
Tourism	Wellness, religious, ethnographical, Danube delta		
Agriculture	Wine, bio-agriculture,		Soil research, nano-materials for protein separation, mechatronics for agriculture
Healthcare	Invasive medicine,		Mechatronics for health, systems for aged and disabled, Medical Instruments & Biomedical engineering
Mining and coal			
Environment	soil polluting, climate change, seismology		Danube Delta Conservation, soil polluting management and control, biodiversity, earthquake systems

6 Strengthening Academic and Industrial Cooperation

6.1 Introduction

This report has identified the limited interaction between academia and industry in Romania. While the report has identified potential areas of sector and subsector linkage and potential areas for improvement in cooperation activity an important consideration in the Romanian context is not only the selection of areas for Smart Specialisation but the project and programme mechanisms for supporting cooperation for the next funding period. The aim of this section of the report is to highlight the increasing focus of academic-industry or university-business cooperation in the European Union Context and how Romania could develop new approaches that strengthen cooperation.

6.2 Background

Since the Lisbon European Union Spring Council of 2000 set a strategic goal for the European Union to become the most dynamic and competitive knowledge based economy in the world by 2010 (REF) there has been significant research, policies and projects on how to stimulate the knowledge economy and importantly the role of Universities within Triple Helix Structures. With the creation of the Europe 2020, the European Union's (EU) economic growth strategy for the coming decade, and the higher education modernisation agenda, Europe is embracing the need to create a more connected and functioning relationship between government, business and higher education institutions (HEIs) in order to increase employment, productivity and social cohesion (European Parliament, 2000). This is because successful cooperation of HEIs in synergetic relationships with governments and businesses (the 'triple helix') is considered to be an essential driver of knowledge-based economies and societies (Etzkowitz, 2008)

In this context the Knowledge economy relies on the transfer of knowledge from those who generate it to those who use it and can build on it. Research represents a key component of this approach and the role of universities is particularly important as actors in research, education and training. Universities account for 20% of European Research, 80% of fundamental research and employ one third of European researchers (European Commission, 2006). They transmit knowledge through education and training and have an increasing role in innovation and economic development at the regional level.

Brinkley, in his Knowledge Economy Report, Defining the Knowledge Economy (Brinkley, 2006) summarises the key features of the knowledge economy and knowledge economy organisations:

- The Knowledge economy represents a "soft discontinuity" from the past; it is not a "new" economy operating to a new set of economic laws.
- A growing share of GDP devoted to knowledge intangibles compared with physical capital
- Knowledge economy organisations reorganise work to allow them to handle store and share information through knowledge management practices

- The knowledge economy is present in all sectors of the economy , not just the knowledge intensive industries
- The knowledge economy has a high and growing intensity of ICT usage by well educated knowledge workers
- The Knowledge economy consists of innovating organisations using new technologies to introduce process, organisational and presentational innovation.

European policy approaches to the knowledge economy for the most part take universities as their point of reference regarding competitive research and their contribution to the European Research Area. In particular the European Commission publication (European Commission, 2010) European Universities: Enhancing Europe's Research Base identifies the entrepreneurial role of universities as a source of spin-offs and start-up companies and their role in knowledge and technology transfer. In this context universities are seen as environments that are:

- The centre of the research and teaching systems;
- The training institutions for our future researchers;
- A point where frontier knowledge meets practical applications;
- The school and library of the knowledge society

Education and training was, from the start, identified as a crucial factor in achieving the overall objectives of the Lisbon Strategy to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion. As part of this, governments asked for "not only a radical transformation of the European economy, but also a challenging programme for the modernisation of social welfare and education systems".

Research was too often the focus of policy in this area and the crucial role of education as a main contributor to innovation capacity was not as well defined and supported before. Without an "innovation-supportive" education system, Europe will not succeed. Thus the knowledge triangle became a central theme of the Lisbon Strategy, representing the integration of education, research and innovation working together as key drivers of the knowledge economy in delivering sustainable growth.

The Lisbon Strategy also stresses the importance of a partnership approach: HEIs as "providers" of knowledge, skills and competences plus companies as "users". The 2006 Communication on "Delivering on the Modernisation Agenda for Universities: Education, Research and Innovation" also highlighted the key role HEIs play in Europe's future. It stressed the need for restructuring and modernisation if Europe is not to lose out in the global competition in the knowledge triangle of education, research and innovation.

The increasing emphasis on the role of the university in economic development has been driven by a small number of success stories e.g. Cambridge, UK; Silicon Valley, Boston, USA that have impacted the local economy and the success of high-profile "blockbuster" licensing agreements on university developed and patented technology. This has led to the traditional view of the university role in innovation and competitiveness in the local economy driven by technology transfer. In this context universities have seen the growth of standard models e.g. external liaison offices, research and development offices,

technology transfer offices as central mechanisms for linking academia with industry, with a particular focus on (Lester, 2005)

- Contributing to faster and better commercialisation of research results;
- Improving innovation performance and accelerate the dissemination of new technologies;
- Better management of intellectual property and research capacities of public research organisations;
- Identifying specific research requirements through dialogue with enterprises;
- Helping companies grow and become more competitive.

6.3 Addressing the Challenges of Cooperation

Despite the creation of technology and knowledge transfer support mechanisms the strategic challenges and key issues regarding the knowledge transfer topic which are often underlined at a strategic level include:

- Little cooperation between firms and R&D Institutions
- Low level of SMEs participating in knowledge transfer activities
- Companies are more focused on distribution and assembling than on R&D activities
- Low technology transfer rates and a weak entrepreneurship culture
- Low creation rate of spin-offs

Such support mechanisms designed to raise R&D levels are likely to be most appropriate for and successful in, those economic areas where levels of innovation in product, process and service developments are already high. While such approaches are generally accepted and widely adopted there remain concerns regarding their long-term effectiveness. There is evidence of a linear relationship between the volume of research and commercialisation success. It is therefore the quality and size of the research base that is a driving factor rather than the quality of an institutional industrial opportunities team.

To support the development of their economy the Romanian Government need to examine how knowledge is transferred into Industry. The “absorptive capacity” of companies plays a key role in determining their capability to access and make use of external knowledge in particular through external collaboration with other companies (e.g. Suppliers, Customers and Partners) or with Universities and Technology Centres.

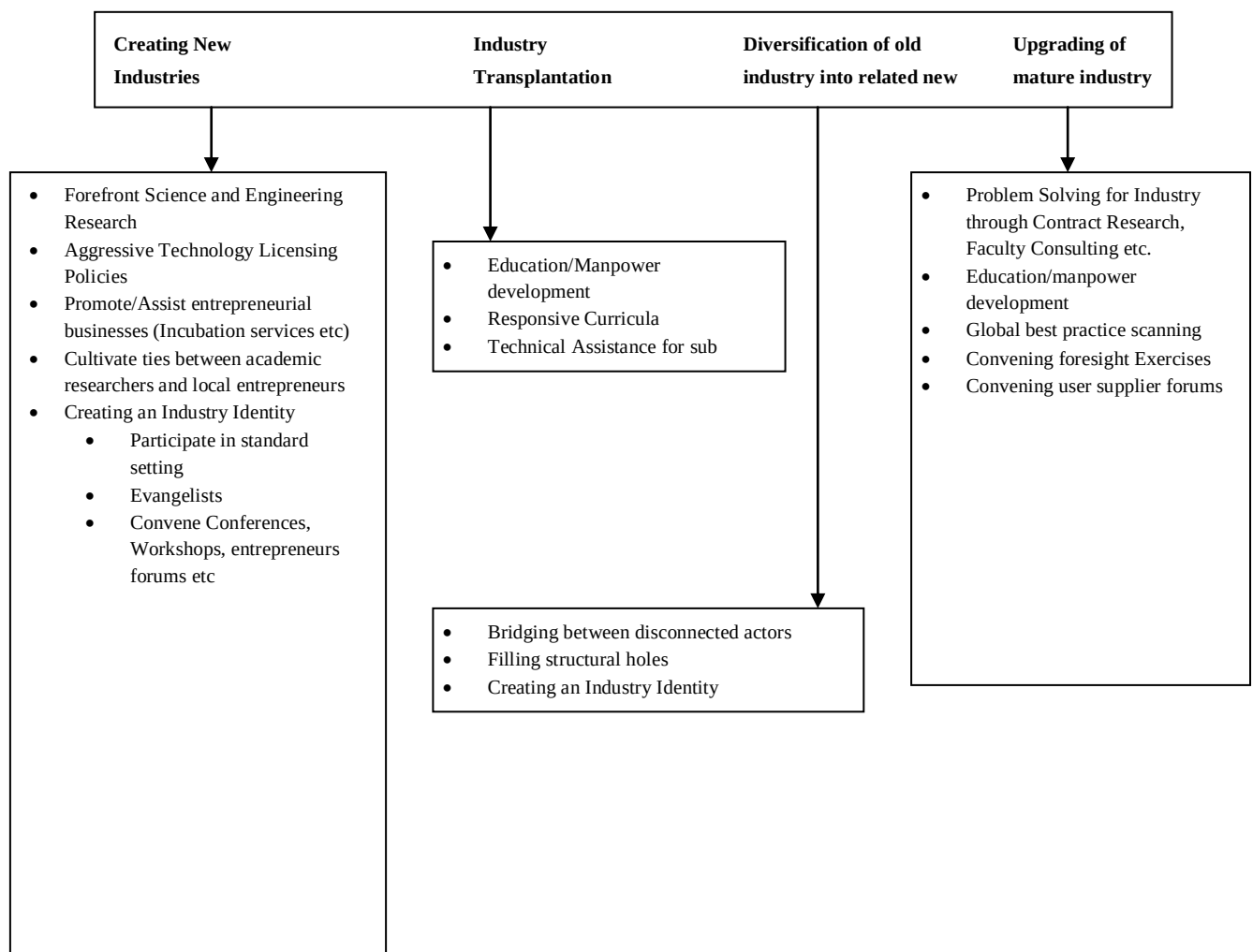
Absorptive capacity refers to the ability of the company to support problem solving and development using innovation processes. The knowledge to enable the company to do this is often “provided” to the organisation from the external environment rather than from within the company itself. Knowledge for innovation must be absorbed through interaction and cooperation with the networks available to the company.

Specific knowledge is required for the development and implementation of new business products, processes or services. Where this information cannot be found within the knowledge base of the company the company can decide to either develop knowledge themselves or obtain knowledge from the external environment. Generally it is accepted that in most cases knowledge will be sought from the external environment looking for solutions to problems. Through its absorptive capacity the organisation learns from this external information.

To enhance the absorptive capacity of firms it is argued (Innovating Regions of Europe, 2006) that the range of “innovation services” offered to SMEs should be extended to assist them with engaging with innovation support agencies and in developing longer-term relationships with the science base. Such services need to be translated through the work of “non-academic” business support specialists who can work with SMEs on a needs driven basis within the framework of approved projects and programmes integrating with academic staff as appropriate. The current role of many industrial liaison offices and technology transfer offices does not support the development of such activities.

Seeking to address the performance issues of universities in supporting innovation and competitiveness in local economies in 2002 the Industrial Performance Centre of Massachusetts Institute of Technology began a research programme examining the role of universities in supporting industrial development through participation in innovation projects and activities.

Figure 6.0 University Roles in Alternative Regional Innovation Led Growth Pathways (Reproduced from Universities, Innovation and the Competitiveness of Local Economies, Richard K Lester, MIT IPC Working Paper IPC-05-010, and December 2005)



Their research adopted an “outside-in” perspective of the role of the University describing and contextualising the local economy as a set of industries that changes over time (Figure 6.0). Significantly the approach of the MIT research was driven by exploring the role of the local university in supporting local companies to take up technology and new knowledge and apply this profitably.

By adopting an industrial perspective consideration is given to situations in which the University can contribute in additional ways to local economic development, engagement is not limited solely to the creation of spin-out companies or licensing agreements, it addresses situations in which the University may not be a key economic player and takes an external perspective with consideration of the transformation of local economies over time.

This aligns well with European Commission policy that seeks to support the engagement of universities with civil society to support the uptake of innovation (European Commission, 2006) the build up of concrete synergies between universities and surrounding society (European Commission, 2010) and supports the recommendation that exchange of knowledge with industry and within society is not the responsibility of the universities alone and that companies, national, regional and local authorities, business promotion agencies, private and public joint venture investors and other stakeholders must be active in creating the appropriate infrastructure and surrounding environment

A “cultural change” is required to highlight the importance and value of SMEs working with universities and research centres and the impact on long-term company profitability. The focus of university expertise on transfer of research to industry is distinctly different to many of the innovation requirements of SMEs who require basic support in marketing, sales and training. In this field training and mentoring services for companies are critical and existing tools for supporting companies need to be embedded within the offer to companies. At the regional and local level support needs to be co-ordinated and activities clustered to support easier access to companies.

Similarly there is a requirement to “Stimulate SMEs to innovate”. This needs SMEs to be challenged to extend their perspective of innovation and the development of innovation activities within the business. In the scope of science-industry linkages this can be improved through the adoption of business mentoring, continuous education and utilisation of schemes that place experienced academic staff and graduate students in industry.

6.4 European Best Practice in University Business Cooperation

The Science-to-Business Marketing Research Centre in Münster, Germany (S2BMRC) undertook the first major study on University Business Cooperation (UBC) in Europe (Science to Business Marketing Research Centre, 2011). Conducted for the DG Education and Culture at the European Commission (EC) during 2010 and 2011, the study not only provided a benchmark for cooperation, but also to outline potential reasons, influencing factors, drivers and barriers to cooperation as well as offering recommendations for the future. Alongside this the study also produced some 30 case studies of cooperation

approaches from Northern, Eastern, Southern and Western Europe aimed at supporting Collaboration in R&D, Mobility of academics, Mobility of students, Commercialisation of R&D results, Curriculum development and delivery, Lifelong learning, Entrepreneurship and Governance.

There were 6 key insights from the cases studies overall:

1. The Type And Method Of Cooperation Needs To Fit To Regional Characteristics To Maximise Its Success

Fitting to the region's strengths: policy and direction to foster UBC, whether it be in terms of strategies, structures / approaches, activities or framework conditions, needs to fit the unique strengths of the region, the HEIs and the local institutions. Fitting to the region's environmental framework and regional limitations: also to be observed are the obvious barriers that exist in the region, including the legal and funding frameworks

2. Multiple UBC Actors Need To Come Together In Order To Truly Deliver New And Sustainable Value To A Region

There were few cases where the HEI had worked alone to create their area of competence; in general they worked closely with regional development agencies, business, business groups, government organisation and other HEIs.

3. The Extent Of UBC Development Differs Among The Different Regions In Europe

The concept of 'good practice' is relative to the stage of development of UBC in the region (the case studies selected within this document reflect these stages of development). In many cases the UBC is highly developed, with long-term relations and complex interactions whereas other regions are at a much earlier stage in the process of building the right UBC ecosystem. However, they are doing it in their own unique way.

4. Good Practice Can Be Transferred

Principles or elements of the good practice can be successfully transferred to other regions though some adaptation will be required. This is because the case studies chosen offer a high level of adaptability and the manner in which the cases have been written which highlights non-region/institutional-specific characteristics.

5. A Longer-Term Commitment To UBC Is Required

Sustained high-level commitment, funding and patience from all UBC stakeholders are required for successful UBC. These qualities are required to overcome the barriers related to the differing mode of communication, motivations and time horizon among the UBC stakeholders and to forge longer-term partnerships.

6. There is a Movement to Longer-Sustainable Funding Models

In order to ensure the long-term sustainability of some initiatives, some cases demonstrate the move to alternative funding models including private funding and funding from multiple stakeholders involved in UBC.

In a smart specialisation context the linkage between universities and research centres is of fundamental importance. In Romania a major driving force in research is publications and patents. While these are important within the context of the new funding round of the European Structural Funds the focus will be on how limited resources can be focussed to address the activities and areas of the economy that will drive future economic growth. A new perspective that considers alternative project and programme interventions is a necessity.

7 Concluding Remarks

The European Commission Guide to Research and Innovation Strategies for Smart Specialisation (RIS3) (European Commission, 2012) outlines RIS3 as an economic transformation agenda based on four general principles:

5. *(Tough) Choices and Critical mass*: limited number of priorities on the basis of own strengths and international specialisation – avoid duplication and fragmentation in the European Research Area – concentrate funding sources ensuring more effective budgetary management.
6. *Competitive Advantage*: mobilise talent by matching RTD + I capacities and business needs through an entrepreneurial discovery process.
7. *Connectivity and Clusters*: develop world class clusters and provide arenas for related variety/cross-sector links internally in the region and externally, which drive specialised technological diversification – match what you have with what the rest of the world has.
8. *Collaborative Leadership*: efficient innovation systems as a collective endeavour based on public-private partnership (quadruple helix) – experimental platform to give voice to unusual suspects.

This report provides a national view and an analysis of the regional context and potential for innovation, which is the first of six stages in the overall process of establishing a Smart Specialisation Strategy. Such a strategy is not a static document but one that will continue to evolve as new stakeholders become engaged, as additional analysis is undertaken and as projects are developed and delivered.

As highlighted in the European Commission Guide to Research and Innovation Strategies for Smart Specialisation (RIS3) (European Commission, 2012), “Priority setting in the context of RIS3 entails an effective match between a top-down process of identification of broad objectives aligned with EU policies and a bottom-up process of emergence of candidate niches for smart specialisation, areas of experimentation and future development stemming from the discovery activity of entrepreneurial actors. It is of crucial importance that RIS3 governance bodies focus on a limited number of innovation and research priorities in line with the potential for smart specialisation detected in the analysis phase.”

The development of a smart specialisation strategy is being driven predominantly by its status as a pre-condition for the research, technological development and innovation thematic priority of the cohesion and structural funds. The thematic objective has three specific priorities; to increase private research and innovation development; support research and innovation infrastructure and capacity to develop excellence centres and promoting an innovation friendly environment for business. Communication from the European Commission to Romania (European Commission, 2012) has identified specific objectives for this thematic priority which reflect country specific challenges.

Increasing private research and innovation development

- Develop incentives for research collaboration between large domestic or foreign companies and SMEs with an innovative approach, involving where appropriate universities and other resource institutions, encouraging start-ups and spin-offs;

- Increase the research and innovation capacities of firms, including SMEs, supporting technological and applied research and investing in pilot lines and early product validation actions, especially with the aim of creating new products and technologies protected by various forms of IPR (patents, licenses) and boosting high-tech exports;
- Improve the matching of skills produced by universities and higher education institutions with market needs and promote internships based on collaboration between universities and firms.

Supporting research and innovation infrastructure and capacity to develop excellence centres

- Promote the capacity of R&D Romanian institutions to integrate with international networks and the capacity of Romanian R&D institutions to efficiently network with other EU and international partners participating in transnational programmes fostering also Romania's inclusion in the digital European Research Area and science;
- Further strengthening the administrative capacity, streamlining the sectoral governance, including ensuring the role of education for R&I, and concentrating the public resources on the most promising and capable beneficiaries which may include setting competitive working conditions to attract leading scientists.

Promoting an innovation friendly environment for business

- Revise the intellectual property rights framework with the view of increasing commercialisation of research and innovation by public and private stakeholders;
- Promote the transfer of knowledge and innovation in rural economy through the European Innovation Partnership for agriculture and sustainability;
- Foster the development of clusters and cooperation between clusters organisations and knowledge institutions, including in the maritime, agricultural and green growth sectors ;
- Provide high quality shared access facilities and full package of services tailored to match the needs of innovative companies, including promotion of commercialisation.

Considering the principles outlined for smart specialisation and the priorities and objectives outlined for Romania by the European Commission for the RTDI thematic objective reflects the importance of matching RTDI capacity and business need; the development of clusters and cross-cluster linkages; collaboration between large and foreign owned companies and SMEs, the importance of high-tech exports and the role of the rural economy, agriculture and green growth.

The methodology adopted for this report has directly addressed these principles and priorities through a multi-method approach with a specific focus on the competitiveness of sectors at a national level, the capability and competitiveness of clusters at a regional level and the investment in funding for research and development based on established national priorities, engagement in Framework 7, the profile of individual institutions and the outcomes of research based on publications and patents.

Table 7.1: Potential Sector and Research Specialisation focus based on Stakeholder Workshops				
Sector	Sector Specialisation	Research	Research Specialisation	Regional Focus
Food and Agriculture	Agro-Food, Biotechnology, Functional food, wine, bio beekeeping, zootechnics, fisheries	Food and Agriculture	Agronomy, crop science, food science and agricultural and biological science, agricultural biotech. Soil research, nano-materials for protein separation	NE, SE, S, BI, SV, V, C
ICT,	Telecommunications and Software / Computer Programming Mechatronics, security, e-health, ICT for transport, New Media	ICT	Networks of the future, internet of services, software and visualisation, networked media and 3d internet, flexible organic and large area electronics, embedded system design, personal health systems, ICT for energy efficiency and accessible and assistive ICT, Computer science and artificial intelligence,	NE, SE, Bi, V, NV
Motor Vehicle Manufacturing and Other Transport	Materials, Components and Fabrication Ship Building, Aviation, ship design, railway, agricultural equipment	Engineering and Technology Key enabling technologies	Electrical and electronic engineering, nanotechnology, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering, motor vehicle transport and other transport Monitoring systems, charging of electrical vehicles, Joining technologies, mechatronics systems, tribology, micro-nano fabrication Nano composites for textile applications, , anthropometric research for the clothing industry Magnetic nano-fluids Electronics for aviation High power lasers/ x-rays	SE, S, V
Electronics	Computer, Electronics and Optical Products, Medical precision Instruments, Mechatronics. Electronics for automotive, robotics chip design, technological support services, telecomm applications			NV

Machinery and Equipment,	Intelligent Agriculture, Automation Mechatronics			NE, C, NV
Textiles	Technical Textiles, smart textiles, personalised clothing, shoes, leather, fur			NE,
Energy	Renewable Energy, Wind Power, Solar Power, Green construction. Biomass, Ecological Services, geothermal, nuclear energy, oil industry	Energy and Environment, Renewable energy	Pollution, management and monitoring, environmental engineering, ecology and environmental science, network technologies, renewable energy and biofuels, thermo-chemical solar pipe, TiO2 Nano composites for decontamination, high power lasers, solar cells, trigeneration, cogeneration, micro windmills for cities, heat pumps, waste to energy, energy autonomous irrigation systems, energetic building efficiency, molecular structures for photovoltaic panels, intelligent monitoring systems and sensors for energy production, energy production and management (especially in urban areas)	S, BI, V, NV
Pharmacy-Health-Tourism	Wellness tourism, geriatrics, Plant and other natural treatments, derma cosmetics		systems for aged and disabled, antibiotics, cosmetics	NE, SE, SV
Green Housing Construction-wood	Metallic structures, personalised furniture, design		Building materials, conversion of wood waste	C, NV

The aim of this section is not to set the priorities for Smart Specialisation in Romania but to highlight areas of interest that can be analysed and investigated further, supported by the involvement of stakeholders and the development of a vision for innovation at a regional and national level.

Section 3, 4 and 5 of this report have considered the potential areas for specialisation based on the development of medium-high technology and high technology at a national and regional level reflecting business activity and research capacity at a national level. In addition table 7.1 below identifies the linkage between business activity and research capacity from the workshops held in Bucharest on the 13th and 14th February 2013.

The European Commission communication to Romania specifically identifies role of the rural economy, agriculture, agro food, green growth and the transition to a low carbon economy and maritime and marine related industries.

Our analysis has specifically identified the importance of food and agriculture in the Romanian economy and its significance in terms of employment and GVA at both a national and regional level. It is also relatively significant in research in both agriculture overall and biotechnology. This report recognises that agriculture within European Commission documentation is reflected as low technology and low skill, however by considering this within the context of agro food and agricultural biotech as a potential smart specialisation this would reposition this activity as higher-skill and higher-tech.

Table 7.2 Potential for Food and Agriculture Specialisation

Sector	Sector Specialisation
Food and Agriculture	Agro-Food, Biotechnology, Functional Food, Wine, Fisheries
Research Area	Research Specialisation
Food and Agriculture	Agronomy, crop science, food science and agricultural and biological science, agricultural biotech. Soil research, Nano-materials for protein separation
Regional Focus	NE, SE, S, BI, SV, V, C
Key Summary	• Ranked 3rd in Research and Development expenditure by Industry • Highest ranked sector specialisation • Highest number of Romanian businesses in manufacturing (food) • Highest employment in manufacturing • Highest overall level of wages and salaries • Highest value added • Ranked of highest importance for Romanian regions • Ranked 4th in R&D by field of science

The ICT sector overall is well reflected in economic activity in both telecommunications and software at a national and regional level which established clusters across Romania. In addition ICT has a strong research profile at a national and European level in terms of project profile and relatively significantly in terms of publications. Given the fundamental importance of this sector it should be a focus for smart specialisation and a number of research areas are identified in this report and in table 7.3 that could form the basis for this specialisation.

Table 7.3 Potential for ICT Specialisation

Sector	Sector Specialisation
ICT	Telecommunications and Software / Computer Programming, Mechatronics, security, e-health, ICT for transport, New Media.
Research Area	Research Specialisation
ICT	Networks of the future, internet of services, software and visualisation, networked media and 3d internet, flexible organic and large area electronics, embedded system design, personal health systems, ICT for energy efficiency and accessible and assistive ICT, Computer science and artificial intelligence.
Regional Focus	NE, SE, BI, V, NV
Key Summary	• Telecommunications is the 2nd largest service sector by turnover and 1st in value added • Computing ranked 2nd in service sector R&D • Communications ranked 2nd in comparative advantage in the service sector • Computing ranked 3rd in comparative advantage in the service sector • Ranked 2nd most important sector by Romanian regions in workshops • Computer Science ranked 5th for publications in Romania

The field of engineering and technology is the most diverse of all the sector areas incorporating motor vehicles, other transport, electronics, machinery and equipment and technical textiles. At a business level these are the areas in which the largest level of business expenditure in research and development can be seen and in which there are significant foreign owned businesses.

Table 7.3 Potential for Motor Vehicle and Other Transport Specialisation

Sector	Sector Specialisation
Motor Vehicle Manufacturing and Other Transport	Materials, Components and Fabrication. Ship Building, Aviation, Ship Design, railway, Agricultural Equipment
Research Area	Research Specialisation
Engineering and Technology	Electrical and electronic engineering, nanotechnology, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering, motor vehicle transport and other transport. Monitoring systems, charging of electrical vehicles, joining technologies, mechatronics systems, tribology, micro-nano fabrication, Magnetic nano-fluids, electronics for aviation
Regional Focus	SE, S, V
Key Summary	• Ranked 1st for International Trade • Ranked 3rd in Employment • Ranked 2nd in Overall wages and salaries • Ranked 2nd in Value Added • Ranked 1st in Business Expenditure on Research and Development • Ranked 5th in Comparative advantage • Ranked 3rd in importance by Romanian Regions • Engineering and Technology ranked 1st in overall research and development expenditure and number of researchers

It is in this area that the linkage between foreign owned firms and SMEs, increasing high-technology exports and cross-sectoral linkages identified by the European Commission in their briefing to Romania should be focussed. From a research perspective this is also the most diverse area of activity incorporating electrical and electronic engineering, nanotechnology, materials (specifically electronic, optical and magnetic materials, materials chemistry, materials science and metals and alloys) and mechanical engineering, motor vehicle transport and other transport. There is a clear argument for smart specialisation in this field, however further investigation and discussion is needed with research and business stakeholders to highlight specific areas of activity. This may for example lead to a focus on motor vehicles and other transport which would bring in the specialisms of electronic engineering, material, machinery and equipment.

Energy and the Environment are reflected in the European Commission communication which highlights the transition to a low carbon economy and green growth. At an economic level in Romania the potential of this sector can be seen in investment in renewable energy however in research terms while this is a growing area it is one that needs a significant increase in research infrastructure capacity and capability based on the level of publications in this field to date. Environmental research is however a strong area in Romanian research particularly in areas of environmental engineering, pollution and environmental biology. The combination of these research themes is seen as a positive basis for potential specialisation. In addition there are other sectors that are worthy of consideration for a potential focus on smart specialisation including:

- Textiles - ranked strongly in employment, wages and salaries, specialisation and comparative advantage
- Machinery and Equipment – ranked strongly in wages and salaries, value added and employment
- Wood and Furniture – ranked 1st in comparative advantage and high in number of businesses

These sectors of the economy are not as highly ranked as ICT, Agriculture and Food and Motor Vehicles and Other Transport. However Romania does have regional differentiation and it should be considered that such sectors are an appropriate focus at an individual regional rather than national level

In conclusion evaluating these potential areas of smart specialisation in Romania against the criteria of the European Commission RIS3 guide we can see that they meet the requirement for:

(Tough) Choices and Critical mass: Based on the selection of four themes based on current and future business potential and Romanian research specialisations at a national and international level

Competitive Advantage: Based on the matching (see table 6.0) of business sector activity and research undertaken by business, government and enterprise.

Connectivity and Clusters: Based on regional specialisations and existing cluster profiles with a focus on technology which can be deployed across sectors

Collaborative Leadership: Based on priorities which match business activity both in commercial terms and in research and with a linkage to government and higher education research.

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Glossary of Terms

APIMAR	Romanian Association of Producers and Importers of Agricultural Machinery
BERD	Business Enterprise Research & Development - Expenditure on R&D in Businesses
CEE	Central and Eastern Europe
Clusterix	An INTERREG project to help regions to develop clusters
DG	Directorate General – a division of the European Commission
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
EU Innovation Scoreboard:	An analysis of metrics and indicators of the innovation among EU27 Member States and associated countries. http://ec.europa.eu/enterprise/policies/innovation/facts-figures-analysis/innovation-scoreboard/index_en.htm
Eurostat	The statistical office of the European Union http://ec.europa.eu/eurostat
FTE	Full-time Equivalent
GERD	Gross Expenditure on Research and Development
HERD	Higher Education Research and Development. (Expenditure on R&D in Higher Education)
HVAC	Heating, ventilation, and air conditioning
INTERREG	An EU Community Initiative to promote development and cooperation across borders of member states. It is financed under the European Regional Development Fund (ERDF).
GVA.	Gross Value Added
JASPERS.	Joint Assistance to Support Projects in European Regions. A partnership between the European Commission (DG for Regional Policy), EIB, EBRD and Kreditanstalt für Wiederaufbau (KfW) which provides technical assistance to the 12 countries which joined EU in 2004 and 2007. It provides these States with support to prepare major projects co-financed by EU funds.
MPPI	Materials, Innovative Processes and Products (Topic within National Partnership Programme)
NACE	Nomenclature Générale des Activités Économiques dans les Communautés Européennes (EU classification system for economic

	activity)
NPIs	Non-profit institutions
NUTS	Nomenclature of territorial units for statistics. This is a hierarchical system for dividing up the EU for the purpose of economic and statistical analysis.
OECD.	Organisation for Economic Co-operation and Development
R&I.	Research & Innovation
RIS	Regional Innovation Strategy. Smart Specialisation is one such strategy developed by the EU
Scimago.	SCImago Journal & Country Rank is a portal providing journals and country scientific indicators developed from information contained in the Scopus® database developed by Elsevier B.V.
SEE	South East Europe Transnational Cooperation Programme
SEENECO	South-East European Network-of-Excellence of Cluster Organisations
Smart Specialisation.	The process of identifying unique characteristics and assets of a country or region, highlighting its competitive advantages, and rallying regional stakeholders and resources around an excellence-driven vision of their future
SME	Small and medium-sized enterprises (defined by EU in terms of employment and turnover - http://ec.europa.eu/enterprise)
UNIDO	United Nations Industrial Development Organisation
SOP	Sectoral Operational Programme
SOP-IEC	Sectoral Operational Programme in "Increase of Economic Competitiveness"