The Potential Contribution of Innovation Systems to Socio-Ecological Transition

Deliverable No. 4

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Contents

Tables

Figures

Executive Summary

Economic performance in Europe has become rather disappointing since the mid-nineties, specifically in terms of growth of GDP, productivity and unemployment, though large differences across European countries exist and seem to persist. This comes while Europe is facing a multitude of grand challenges. The increased globalization shifts economic power to Asia and breeds additional low-cost competitors. The ageing population in Europe is shifting consumption and work patterns and it will increasingly weigh upon welfare systems in Europe in the next decades. The emergence of new technologies and the post-industrialization create many new opportunities for firms to enhance their competitiveness but they also change existing production modes and consumption patterns. Furthermore, limited natural resources and the increase in greenhouse gas emissions and pollution call for the necessity for ecological and climate change. At the same time high public deficits and increasing debts have put strong pressure on the welfare systems in Europe and limit government interventions.

Though it would have been tempting under these circumstances to opt for a "low road strategy" to stimulate growth, for instance by increasing working hours, limiting social inclusion and postponing climate change goals, European countries have agreed upon a much more ambitious new growth path. Europe's 2020 strategy defines the achievement of smart, sustainable and inclusive growth as its main goal. In a nutshell, the strategy aims at achieving a socio-ecological transition by fostering economic growth but also social development (e.g. with respect to employment, gender or cultural aspects) while actively taking ecological and resource constraints and opportunities simultaneously into account.

Research and innovation are generally seen as a major driver of growth. The term innovation should be understood here in a broader sense. It can be a technological innovation, but also an organizational, marketing or social innovation. An important aspect is also whether innovations improve resource efficiency and/or allow energy savings. Innovation can be pushed by technological progress but it can also follow current and future market forces, for instance an increasing demand that stems from the envisaged shift towards more inclusiveness and sustainability. In order to shift Europe towards a new growth path with greater social inclusiveness and more ecological awareness, it is important that the innovation system itself as well as innovation policy and industrial policy promote this change in paradigm at the EU and national level. That is, governmental interventions should work also in favour of future goals and systemic change. The aim of this report is to summarize and explore how the innovation system and different key actors within the innovation system can contribute to the aspired socio-ecological transition.

Striving for a socio-economic transition, a key question that arises and which has to be answered is to what extent European firms are able to produce and sell goods and services in a socially inclusive and ecologically ambitious environment. Existing concepts of competitiveness, however, that solely focus on price or quality competitiveness do only insufficiently cope with these demands and neglect important aspects. Within the WWWfor Europe project, a new combined measurement of competitiveness was developed that is in line with an economy in transition to a new path of growth with high dynamics, more social inclusion and environmental sustainability.

The new concept defines competitiveness as the "ability of a country to deliver beyond GDP goals for its citizens today and tomorrow”. It consists of three different components: The first component is the traditional cost component as lower costs provide firms with a competitive advantage on international markets. Costs are mainly operationalized using unit labour costs which are affected by the level of wages and productivity. However, labour productivity loses its outstanding relevance if the growth path should become more inclusive and sustainable. Quality competitiveness therefore makes up the second component. It in turn consists of two pillars: the current structural composition of the economy, e.g. measured by the production or export share of education-intensive sectors, innovation-intensive sectors or of industries that produce ecological and renewable goods, and its capabilities. The latter describes factors that allow firms to upgrade and adapt to new opportunities in the future, e.g. R&D spending in relation to GDP, share of population with a university degree, productivity-enhancing functions of the social welfare system, consumers‘ or firms’ ecological ambitions or supportive institutions like clusters. The final piece is outcome competitiveness with respect to beyond-GDP goals for which three important pillars have been identified: The first one is income where a stronger emphasis is put on disposable household income and consumption expenditure instead of GDP per capita. The social pillar accounts for indicators that reflect outcomes of a country’s socio-economic system (poverty risk, inequality, youth unemployment), whereas the ecological pillar summarizes ecological outcomes such as resource productivity, emissions and energy intensity.

The analysis for the EU-27 countries reveals that the new concept paints a more diverse picture, highlighting strengths and weaknesses of different country groups on different components of competitiveness. Scandinavian countries, for instance do particularly well on the social pillar, but are among the top performers in the other dimensions as well. Small countries like the Netherlands and Austria are also highly competitive in terms of income as well as social indicators. Strikingly, new member countries (NMC) from Central and East Europe (CEE) clearly outperform Southern European countries on social indicators like poverty risk and inequality, despite the fact that the latter have a significant income lead over the former. Ecological outcomes, however, are the least favourable in the NMC from CEE. In contrast, southern (Portugal, Spain, Italy), Scandinavian (Sweden) and small (Austria) countries exploit renewable energy sources the most or pursue ambitious environmental policies. Whereas France and Germany are in the top ten with respect to income and ecological outcomes, they only show average performance with respect to social outcomes.

Taking outcome competitiveness into account turns out to be important. For instance, regression results show that Estonia, UK and Bulgaria perform better in terms of outcome than predicted by price and quality competitiveness, whereas countries like Malta, Slovakia and the Czech Republic underperform and Spain, Germany and Denmark have been close to their potential.

Industrial policy had often been criticized for holding back structural change. Provoked by the challenges revealed by the globalization and reinforced by the financial crisis, a change in industrial policy has been observed in Europe since the mid-2000s. In order to promote inclusive and sustainable growth it is characterized by three new elements including the orientation towards competitiveness, employment creation and a more cautious and future-oriented use of natural resources (including the environment). History has shown that successful industrial policies establish national and/or regional effective incentive structures for the private sector and encourage openness to trade and investment by creating an international environment favourable to competition, innovation, education and technology transfer. Therefore industrial policy merges with innovation policy into the Systemic Industrial and Innovation Policy (SIIP) approach. This new approach encompasses both small and large firms and as a key feature it promotes close relations and co-operations between firms and universities (clusters). This new SIIP approach is particularly challenging for the New Member Countries from Central and East Europe (CEEC) which had adopted very diverse approaches to industrial policy since the beginning of the economic transition and which still show quite different economic structures, e.g. with respect to the share of high-technology manufacturing. Yet, all CEEC have adapted this new orientation of industrial policy and implemented various programmes. The evaluation of the impacts of the implementation of the new industrial policies in CEEC, however, is still in its infancy. The most important improvements took place in their innovation systems with major increases of business R&D spending in some "high-tech subcontracting countries" among the CEECs. A further remarkable change is the dynamic re-industrialisation of the Baltic countries, with a marked environmental and resource-saving orientation. Job creation in manufacturing is observable mainly in those cases where effective incentives to the inflow of FDI to labour-intensive sectors have been able to add competitive CEEC locations to the global production networks of leading multinational firms. This development seems to have a quite strong sectoral concentration in automobiles which increase business cycle vulnerability. The Baltic countries are an exception to this trend with their more SME-based, and to a certain extent green oriented job creation processes. Overall, the green orientation of industrial policy in the CEECs still seems to be in its initial phase.

At the regional level, large variations in New Growth Path (NGP)-performance indicators can be found across Europe. In total, six groups of European regions have been identified based on their performance with respect to economic prosperity, social inclusion and environmental sustainability. One group of regions (located in Scandinavia, Central Europe and around the Bay of Biscay), for instance, performs high on all dimensions, while other groups of regions suffer from low social inclusion and/or weak environmental sustainability. Since clusters play an important role in the new SIIP approach in order to achieve a new growth path, chapter 4 analyses the importance of regional clusters in stimulating regional NGP performance indicators. Differences in regional NGP performances have been found to be driven by the regional strength of the cluster portfolio (measured by the share of regional payroll earned in strong clustered) and regional business environment conditions. Differentiating by NGP performance indicators, the econometric analysis reveals that both economic prosperity and environmental sustainability are significantly related to regional cluster portfolio strength with a much stronger link for economic prosperity. Social inclusion, however, is not explained by regional cluster portfolio. Instead social inclusion is very strongly positively related to business environment quality. Interestingly, the latter doesn't matter for environmental sustainability. Given the measures available, this is not entirely surprising: they are likely to be driven much more by a combination of policy choices, inherited endowment effects and overall levels of economic performance. The empirical analysis suggests that clusters might indeed enhance the likelihood of high road equilibria to emerge. But the broader NGP data is not sufficient to test whether a high road equilibrium is also reflected by higher environmental sustainability and more social inclusion.

There are also significant differences in cluster initiatives across European regions. A remarkably high share of cluster initiatives is found in particular with respect to environmental sustainability. Cluster initiatives are more likely in regions with higher levels of social capital and cluster portfolio strength; though policy choices play an important role as well. The presence of cluster initiatives is positively correlated to better NGP-performance at the regional level. It is, however, not significantly correlated with prosperity differences which are driven by business environment quality and cluster portfolio strength. This could indicate that cluster initiatives are a tool to extend performance into non-prosperity related fields. Alternatively, it could also indicate that regions that politically support many cluster initiatives also push harder to achieve NGP-goals.

Another important aspect related to the socio-ecological transition is the question whether a trade-off exists between economic growth and a greening of the economy which takes ecological and resource constraints simultaneously into account. Advocates of the green economy argue that there is no trade-off but that the transition towards a reduction in greenhouse gas emissions and pollution, improvement of energy and resource efficiency and provision of ecosystem services provide a double dividend: In addition to the environmental benefits it will also stimulate growth in income and (net) employment. The rapid growth of the renewable energy industry in recent years, currently offering 1.165 million jobs in Europe (2012), is seen as evidence. These figures, however, relate only to gross employment effects and do not take indirect and induced employment effects in other parts of the economy into account. The WWWforEurope project offers three different approaches to provide a more in-depth analysis.[1] A meta-analysis shows positive net employment effects from deploying renewable energy technologies which play a crucial role in mitigating climate change. First, the analysis shows differences in creating employment across renewable energy technologies. Wind energy for instance has provided a more stable and uniform employment environment than photovoltaic, where learning has occurred much more quickly and has lowered labour intensity substantially in recent years. Second, the majority of model-based analyses derive positive expected gains in net employment from a move towards a stronger deployment of renewable technologies. Third, the magnitude of expected gains in net employment vary substantially across scenario studies and can even be negative depending on the region-specific set of policy assumptions, investment and financing schemes, assessment methodologies and assumptions about export demand, fossil fuel prices or technological learning curves and are thus hardly comparable and generalizable. Studies that incur the

[1] The third approach models employment effects at the macro level using a computational general equilibrium approach. The approach is explained in section 5.3 though results of this task are only due in November 2014.

financial burden on the part of households, either through labour wage tax increases or higher electricity prices, tend to show negative net employment effects.

It is, however, important to note that the new growth agenda of the EU promotes the "greening of all sectors". The Eco-innovation Action Plan for instance understands environmental innovation not just as being crucial for the renewable energy industry but that all firms can and should become environmental innovators by introducing new eco-innovative approaches into their operations and by launching to the market new less environmentally damaging products and services. Therefore a firm-level analysis is conducted for 16 European countries comparing the net employment impact of environmental and non-environmental innovations. Results clearly demonstrate that both environmental and non-environmental product innovations are conducive to net employment growth. Yet, the contribution of non-environmental product innovation to employment growth has been larger. However, this is a result of differences in the average innovation engagement and innovation success across both types of product innovation, but not of differences in the transformation of a given level of innovation success to employment growth. Hence, this should open up similar employment potentials across countries or sectors for policy if they are successful in stimulating environmental innovation. Industrial (environmental) policies which shift the innovation focus towards environmental-friendly innovation will therefore probably not destroy jobs but contribute to job creation at least in some member states even if one assumes limits in the innovation capacity of countries and firms. From a policy perspective it is also important to take into account that both environmental and non-environmental process innovation plays only a little role for stimulating employment growth or releasing labour.

Europe's innovation potential is currently dominated by well-established large companies as the bulk of R&D expenditures is spend by large companies. However, young and small companies are generally said to be the driving force behind radical innovation which will be a source of employment and growth in future. Entrepreneurship is therefore increasingly supported by policy either in specific programmes or by stimulating university spin-offs or knowledge regions. However, there might be significant technology-specific heterogeneity with regard to the contribution of SMEs and young firms to innovation. Investigating the role of small and young firms for competitive green technologies using patent data, results show that this group of firms might not be able to drive the technology development towards a more sophisticated use of energy resources and renewable energies. Like in most other fields of technology the direction of technical change is determined by established large firms. Hence, under the current framework of innovation and industrial policies, the development of the "more entrepreneurial economy" will probably not form forerunners on the ways towards a new growth path. Furthermore, private sector's production of invention activities became not stronger directed towards technologies which aim at production, storage, distribution, and management of new energy technologies compared to other fields of technology. Given the societal need for new energy technologies the paper speaks in favor of government regulation, invention and incentives to stimulate research, development, and implementation new energy technologies though such stimuli should not necessarily favor SMEs or young firms.

According to the new growth path agenda, the diffusion of renewable energy (RE) technologies is desirable. However, the market selection process under-supplies socially desired RE technologies. Hence policies to promote the diffusion of RE technologies are implemented in most European countries. As a result the market undergoes a fundamental change. The supply structures are changing from few large-scale plants to a multitude of distributed RE producers of various scales and parts of the existing capital stock are becoming obsolete. This greatly increases the technical and industrial complexity of the market, and is not Pareto-efficient. A comparison of three countries (Germany, Denmark and Spain) which successfully induced the rapid diffusion of wind and solar power shows that the promotion of 'sustainability' undermined 'competitive' mechanisms, which potentially has adverse effects on the 'security of supply'. This is due to the merit order, which ranks energy sources by their marginal costs. This market design is socially desired, since it keeps prices low. Emerging wind and solar power outperform conventional technologies whose marginal costs are greater than zero. The market selection mechanism thus does not provide a level playing field, and adds to the competitive pressures of the liberalisation that established suppliers face. In extreme cases, conventional power plants are forced to exit the market, which is a desired outcome in the case of 'dirty technologies. Yet, conventional power facilities such as gas or storage plants are still required to provide emergency capacities when RE is not available. This has become an issue especially in Germany. These systemic interdependencies are pivotal to an 'energy transition'. Several remedies have been developed to avoid outages. These range from a grid expansion, additional operative management tools and emergency capacities to more flexibility in the grid access. If markets are seen as one, there seems to be a threshold of wind and solar power that the current back-up system can incorporate without risking the security of supply. Notably, there is no such threshold for the integration of RE from a technical point of view. A full provision with RE is feasible, yet would be very costly. From an economic perspective, the crux lies in the conflicting mechanisms. The top-down promotion and planning policies undermine the bottom-up market selection and put the security of supply at risk. However, without interventions the market does not seem to provide socially desired outcomes. If these tensions aggravate further, the implementation of the new technology base is likely to stall.

Intangible assets like R&D, design, software, advertising, organizational capital are non-monetary assets without physical substance and with low energy consumption and low carbon emission. Investments in such intangible assets, social and organizational innovations are seen as an important element of the new path of economic growth. A natural question is therefore how these investments can be stimulated by policy in order to contribute to new growth performance. Descriptive statistics show that the EU-27 has been one of the most important locations for international greenfield investment in intangible assets during the period 2003-2010 though a decline has been observed after the recent financial and economic crisis. In contrast, FDI inflows in intangible assets increased in the United States, in other non EU OECD countries and in emerging countries. Among the EU countries the UK, Germany, France, Spain and Ireland are the most attractive locations for investment in intangible assets, whereas the Southern and Eastern EU member states are least successful in attracting FDI projects in intangible assets. The empirical evidence further shows that the attractiveness of locations for

FDI in intangible assets depends significantly positively on quantity of human capital, quality of human capital, broadband penetration, strength of investor protection, R&D endowment and direct R&D subsidies. In contrast, wage costs, costs of starting a business and corporate taxes have a significant negative impact on FDI inflows in intangible assets. Other policy factors, such as labour market regulations, product, or FDI regulations do not matter.

Social innovation and social entrepreneurship are concepts that are widely used in the policy discourse of the new growth path agenda. However, despite its wide-spread use both concepts are analytically not well defined and very diffuse, as it is often the case in nascent fields of research and policy design. Using key concepts from institutional economics, evolutionary (game) theory and the capabilities approach to welfare economics, this report proposes a definition of social innovation and social entrepreneurship. Social innovation can be interpreted as the introduction and diffusion of new beliefs and new mental models that lead to the establishment of new institutions and as a consequence to a change in policies. As such it is part of a perpetual cycle of institutional change in which new realities lead to the revision, replacement or demise of established formal or informal normative systems. Social entrepreneurs or change agents are individuals, organizations or special interest groups who are dissatisfied with an established institutional set-up. By altering existing widely shared belief systems and establishing supporting networks they promote alternative arrangements. In doing so they become active in areas where there is partial market failure or where no markets exist at all. These change agents differ considerably in what they do and how they do it. This depends largely on the social context in which they operate, on what they want to change and why. Social innovation is likely to translate into changes of economic performance, welfare or subjective well-being through a number of transmission channels. For instance, social innovation may lead to the provision of customised public goods which may improve social welfare as they target the recipients' needs better. Social innovation may also lead to the establishment of (mostly not for profit) enterprises which may contribute to generate income and employment. However, empirical evidence of how social innovation affects performance is scarce. Based on the proposed definition, it is furthermore generally not possible to say whether institutional change and social innovation have always a beneficial effect on society. Finally, the report assesses to what extent social innovation and social entrepreneurship can be a driver of industrial change, and conclude that there is a scope for policy intervention to foster social innovation in the context of a new industrial policy only under certain circumstances. This is the case when considerable social pressure to conform to existing social norms and formal rules will deter potential change agents from becoming active.

Prior evidence has shown in various facets that science is an important driver of technological change and that it plays an increasing role for firm innovation and thus for industrial competitiveness. However, frontier research in European universities and research institutions is rather weak compared to the US and asymmetric international mobility of highly talented European scientists towards top quality US universities is well documented. These two observations point to a serious issue with respect to the European growth model, in particular given the still strong role of geographic proximity for knowledge flows. An important aspect in order to achieve a new growth path in Europe thus relates to the "competitiveness" of higher education systems. One way of measuring competitiveness of higher education systems is its ability to attract talented scientists in their field. Results of a large scale experiment on the determinants of job choice in academia, show that for both early and later stage researchers the remuneration component of jobs matters (salaries, health care and pension provisions), along with the quality of peers, the availability of grants and the balance between teaching and research tasks. The quality of life in the country of the proposed job must not be worse than in the current country of residence, however higher quality of life does not act as an attractor. As regards early stage researchers, systems of higher education which provide jobs featuring early career perspectives, early research and financial autonomy based on research performance only seem to be particularly attractive. Later stage researchers prefer jobs where their line of inquiry is not bound to the research of previous job- or chair-holders. In addition, they favour jobs providing university internal funding to cover their research needs, supportive administration units and public pay schemes including a performance element. Our results indicate that overall, the US research universities offer the most attractive jobs for early stage researchers, consistent with the asymmetric flow of talented scientists to the US. Behind the US is a group of well performing European countries, the Netherlands, Sweden, Switzerland and the UK. Austria and Germany are next, closely followed by France, which in turn is followed by Italy. Spain and Poland are, according to our results, least able to offer attractive entry positions to an academic career. Basically, the US offers a triplet of advantages which are difficult to emulate in the short term: attractive salaries, attractive working conditions and high quality peers. Especially the latter works as a factor of inertia, as good researchers will attract good researchers. Change will need time and certainly not less attractive working conditions than in the US, accentuating the need for urgent reforms.

The Potential Contribution of Innovation Systems to Socio-Ecological Transition

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Abstract

European countries are currently faced with a variety of challenges, ranging from the new global distribution of economic activity, the diffusion of new, radical technologies to the aging of its population, youth unemployment and the aftermath of the economic and financial crisis. These challenges put the traditional growth model and the policies to foster it under strong pressure. This report summarizes the contributions of the wwwforEurope projects on the definition resp. redefinition of industrial, regional and innovation policy to characterise and stimulate the economies along a new growth path. It is argued that a new growth path needs a new vision on what Europe understands as competitiveness. The report highlights the history and the way forward of European industrial policy. As regional and innovation policy are fully intertwined with industrial policy for a new growth path, it sheds light on these domains as well. For example, the report investigates the role of clusters for the new growth path and the contribution of green innovation, especially in the energy sector, to employment creation. Finally, the report takes a look at the role of SMEs and universities, new players in the new growth model which are normally not included in discussions of competitiveness.

Keywords: Environmental innovation, Social Innovation, Socio-Econological Transition, Europe

JEL-Codes: O33, J23, L80, C21, C23

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1. Motivation and Overview

Economic performance in Europe has become rather disappointing since the mid-nineties, specifically in terms of growth of GDP, productivity and unemployment and although a trend towards cohesion exists for a long time large differences across European countries persist. Recently, the financial and economic crisis generated new challenges towards cohesion as several member states were hurt especially hard and their GDP is still below the pre-crisis level. Other member states were better able to cope with the crisis and have recovered more quickly. What is especially troublesome is that the ability of some countries to invest into future growth shrinks considerably as public and private debts have reached all-time record levels, and the financial crisis limits the ability of the financial sector to finance investments. This comes at a time when Europe is already facing a multitude of grand challenges. The increased globalization shifts economic power to Asia and breeds additional low-cost competitors. The ageing population in Europe is shifting consumption and work patterns and it will increasingly weigh upon welfare systems in Europe in the next decades. The emergence of new technologies and the post-industrialization create many new opportunities for firms to enhance their competitiveness but they also change existing production modes and consumption patterns. Furthermore, limited natural resources and the increase in greenhouse gas emissions and pollution call for the necessity for ecological and climate change. At the same time high public deficits put strong pressure on the welfare systems in Europe and limit government interventions.

Though it would have been tempting under these circumstances to opt for a "low road strategy" to stimulate growth, for instance by cutting labour costs, increasing working hours, limiting social inclusion and postponing climate change goals, European countries have agreed upon a much more ambitious new growth path. Europe's 2020 strategy defines the achievement of smart, sustainable and inclusive growth as its main goal. In a nutshell, the strategy aims at achieving a socio-ecological transition by fostering economic growth but also social development (e.g. with respect to employment, gender or cultural aspects) while actively taking ecological and resource constraints and opportunities simultaneously into account.

The WWWforEurope projects aims at analyzing these challenges and put forward policy options which might help Europe to better cope with these challenges under the restrictions set by the economic, social, and ecological systems. This reports summarizes work done so far with regard to the domains of industrial and regional policies.

Chapter 2 develops a new definition of competitiveness for a new growth path for Europe which explicitly takes into account the ecological and social challenges highlighted in the Europe 2020 growth strategy.

In Chapter 3 we deal with the implications of such a redefinition for industrial policy. Here we highlight the evolution of industrial policy in the EU. A particluar focus is given to the development of industrial policy in the new, central and eastern European member states including the link of industrial policy to regional and innovation policies.

Chapter 4 focuses on a new regional policy especially as the intersection of regional policy and innovation policy is concerned. We implicitly argue that under the perspective of the enlarged definition of competitiveness, industrial, regional, and innovation policy are fully intertwined. First, we present results on cluster and their role for the new growth path. Secondly, we shed some light on the link between key enabling technology adoption and the regional dimension of spillovers.

Chapter 5 highlights the employment consequences of environmental policies. We start by summarising employment implications of the transition of energy production systems towards renewable production. Then we highlight the results of an empirical firm-level analysis linking the introduction of eco-innovation to employment growth and we compare whether employment effects due to green innvations are larger than those due to innovations without ecological benefits. Finally, this chapter gives a short introduction to the ongoing work on the macroeconomic modelling of the link between eco-innovation and employment growth.

The central role of the energy sector for the soci-oeconomic transition is reflected in chapter 6 which introduces several country studies of policies to promote the transition towards renewable energies in Germany, Denmark and Spain. This chapter also deals with the contribution and potential role of SMEs in the generation of new technologies to foster renewable energies.

Chapter 7 looks on the attractiveness of the EU and its member states to attract foreign direct investment. It focuses on intangible investment as this type of investment is said to be of special importance for the new growth path. In addition, the chapter discusses the role of social innovation and social entrepreneurship for the new growth path.

Finally, Chapter 8 looks at the contribution of basic (academic) research to smart, inclusive and sustainable growth. High quality academic research increasingly matters for firm innovation in Europe and thus also for solving societal challenges. One important option to improve research quality is to increase the attractiveness of academic careers in Europe by reforming higher education systems. In particular, the chapter focusses on the ability of universities in Europe to attract and produce highly qualified and internationally mobile researchers. It uses newly available international comparable microdata to look at university research and university organization for the knowledge flow between academia and the private business sector.

2. Competitiveness under a Socio-economic Transition Perspective[2]

2.1 Introduction and Outline

European growth has been disappointing in the past two decades. Europe failed to catch up with the US in productivity since the mid-nineties and growth has been slower than in the US in and after the financial crisis. Output (as measured by GDP) is still lower in the EU-15 in 2013 relative to the pre-crisis peak. Unemployment is above 10%, youth unemployment even higher and disparities across countries in trade and employment are high. On the other hand Europe has a balanced trade, an export surplus versus the US, and relatively stable market shares and is one of the richest regions in the world. This calls – together with the challenges of globalization, new technologies, reforms of the welfare state and ageing – for new approaches to enhance competitiveness in Europe.

This chapter derives a concept of competitiveness that is adequate for the new challenges and for the position of an industrialized high-income region. Furthermore, it provides an overview on the assessment of the competitiveness of Europe and its member states under a transition perspective. This gives some hints on pillars which are crucial for competiveness and also points towards policy actions which might improve the completive position under the "new growth path".

This chapter is structured as follows. Section 2.2 shortly summarizes the origin and the development of the term competitiveness as it evolved from the firm perspective to the industry and macro perspective. It started from the notion of cost resp. price competitiveness, followed by the assessment of (sectorial) structure, technology and abilities (enablers) sometimes called quality or technological competitiveness. More recently, a broader set of goals – in line with "Beyond GDP" discussion and the OECD's "Better Life Indicators" – is used in the discussion on competitiveness. Section 2.3 presents the results on price competitiveness, quality or non-price competitiveness and outcome competitiveness. Section 2.4 summarizes the results of the econometric study which relates the elements of price and quality competitiveness to the outcome indicators and indicators for competiveness under new perspectives indicators. This section also derives some conclusions for policy.

2.2 Developing a Meaningful Concept for the Future

2.2.1 From Crisis Towards a New Growth Path

Competitiveness of nations or regions is an evasive concept, never well defined, seldom derived from theory, but persistently used by politicians, economists, business people and media. It has regained specific and rising attention in the globalizing world and – after the

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2 This chapter draws on *Aiginger et al.* (2013)

financial crisis – in countries struggling to regain growth, and to limit unemployment. This holds specifically for Southern Europe, but also for other European economies as well as the US which try to restructure and stabilize their financial sector and to refocus on their shrinking industrial base. The purpose of the paper by *Aiginger et al.* (2013) is to define competitiveness in line with an economy in transition to a new path of growth with high dynamics, more social inclusion and environmental sustainability. These goals are defined in the EU-2020 strategy. The project WWWforEurope has the mission to scientifically analyse the transition of Europe to a new growth path up to 2020 and beyond. This transition must take place in an environment in which industrialized countries face multiple challenges including globalisation, tense public budgets, costly welfare systems and an ageing population. Persistent disequilibria exist across countries (even within the currency union) and high income differences (often increasing within countries) and global warming are new challenges which have to be taken into account.

2.2.2 The Many Facets of the Term "Competitiveness"

Price competitiveness

The term competitiveness has been used historically primarily to draw attention to the cost position of firms or countries. It is still used today predominantly when drawing attention to rising costs in an economy (or a firm or industry) that is challenged by new low cost competitors. It is this narrow focus on costs which was heavily criticized by *Krugman* (1994) as "elusive and meaningless" on the conceptual level and as "misleading or even dangerous" on the policy level, since the term competitiveness – narrowly defined – suggests cost reduction as the one and only important policy reaction. Complaints about losing competitiveness primarily focus on wages as the main cost component, but today they extend to deplore high energy prices and taxes (and sometimes capital cost inter alia of young firms needing venture capital or being squeezed out in the deleveraging financial sector).

However, absolute cost levels do neither decide about the survival of firms nor the health of an economy; instead they should be set in relation to productivity. The profitability of firms and the ability of an economy to sell internationally are not limited by costs if productivity is also high. Profit margins are positive if the productivity lead of a firm or region is larger than the cost disadvantage. These "relative costs" are summarized in the concept of unit labour costs. On the practical side it is difficult to find data for the absolute productivity level (per capita or per hour) *and* the wage level in a consistent way.[3] Monitoring *changes* in unit labour costs is much more common and easier, even if this involves a lot of statistical issues too.[4] The role of productivity is sometimes emphasized to an extent that authors claim that productivity is the only meaningful

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[3] Additionally the relation between value added "level" per employee and wage "level" per employee degenerates to an inverse "wage ratio" (Y/W), which is traditionally interpreted as result of industrial relations, market structure and capital intensity (and not as an indicator of price competitiveness).

[4] This starts from the question whether to include changes in the currency values or not. Furthermore price indices used to deflate value added or production on the one hand and wages on the other hand can be different, too.

concept of competitiveness (*Porter,* 1990; *Kohler*, 2006) now however deemphasizing costs too much.

Concepts of cost competitiveness in the narrow sense (costs only) or in the more balanced approach (looking at costs and productivity simultaneously) become complicated if all cost components are included (labour, capital, energy, taxes) and if all productivity components (labour productivity, capital productivity, resource productivity, government efficiency) should be addressed. These extensions are usually made in cost benchmark studies (looking at individual cost components sequentially) or in studies on Total Factor Productivity (TFP; using a production function approach).[5]

Quality competitiveness

Competitiveness is not an accounting result generated by comparing costs and revenues at some point of time. Assessing competitiveness of a firm or region needs an evaluation of the sources of competitiveness as well as of the prospects for the future. It should necessarily contain a look at the processes which lead to a favourable cost or productivity position and into the chances to sustain or improve the position. Competitiveness is therefore about abilities and processes. In the literature terms like "quality competitiveness" or "technological competitiveness" are used, even if both terms could be narrowly interpreted to focus on two specific aspects (quality and technology).

Two components for operationalization of "quality" competitiveness are used. The first one looks at the "structure" of an economy while the second focuses on the abilities of an economy, e.g. the innovation and education system:

- The **structural composition** of the manufacturing sector, for example, can be analysed by breaking down value added or exports (i) by the main input used in an industry (differentiating for example between labour-intensive and technology-intensive industries), (ii) by the sophistication of inputs (e.g. low-skilled or high-skilled labour), (iii) by the extent and characteristics of services used/provided (transport services vs. knowledge input), and (iv) according to whether competition takes place mainly along the price or the quality dimension. Other structural features look at the share of education-intensive sectors or innovation-intensive sector in production or in exports. More recently, the (relative) importance of industries producing ecological and renewable goods is seen as another feature of future competitiveness.[6]

- **Capabilities** are the second component of "quality" competitiveness. It focuses on factors which determine future dynamics and the sources of success and failure. Both innovation and education decide about firm growth, market position and the ability to

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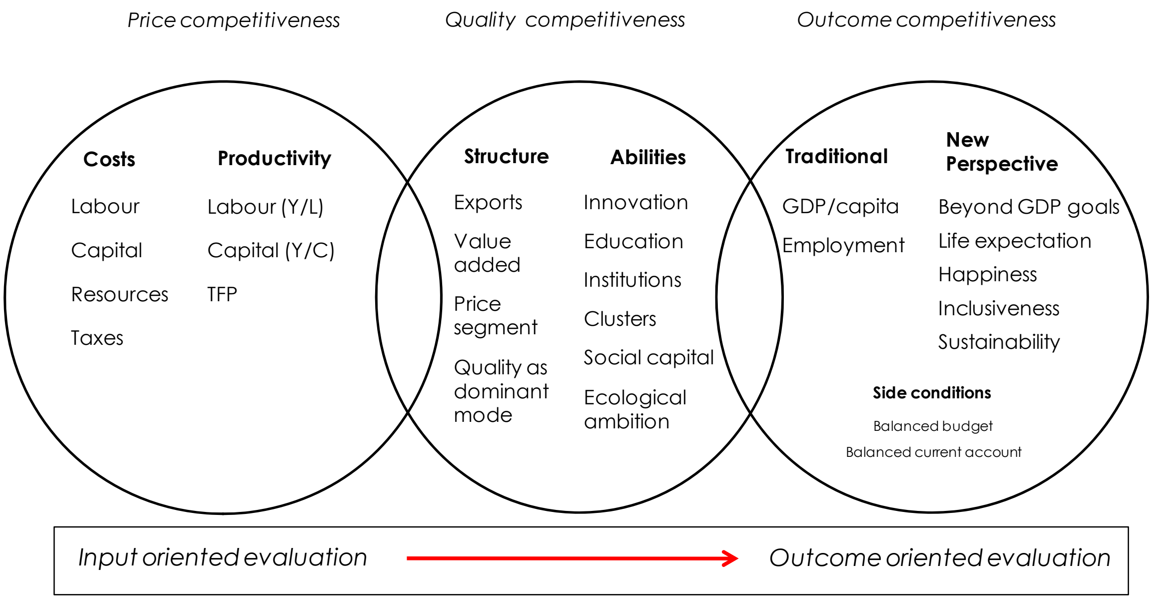
[5] For the second approach Total Factor Productivity data are provided under great efforts (see EU KLEMS database) *for changes over time*, seldom for absolute comparisons of TFP are available, and practically never in a way to compare Total Factor Productivity (TFP) with a comprehensive cost evaluation ("Total Costs").

[6] *Janger* (2012) and *Janger et al.* (2011) are leading studies in analysing structural components of competitiveness at the European level.

increase incomes on the macroeconomic level (GDP growth), specifically in industrialized countries. Indicators on research input, human capital availability and use, retraining or attractiveness for high quality migrants are therefore instrumental. The importance of institutions has got increased attention over the past years (*Acemoglu*, 2003, *Rodrik et al*., 2004, *Bouis et al*., 2011). This includes the role of governance, how fiscal and monetary policy can stabilize economic activity and to which extent the public sector and regulation supports or hinders firms in the long run. The rule of law, absence of corruption and trust in institutions are widely accepted as determinants of efficiency as well as growth of firms and countries. The importance of clusters (cooperation between firms in specific "related industries") for competitiveness has been analysed by *Porter* (1990, 2004) and *Ketels* (2006).

Figure 1 **Competitiveness under New Perspectives**



Source: Aiginger et al. (2013), p.11.

In the specific context of the transition to a new growth path, the ability of the social system to enhance the productive capacity of an economy becomes important, i.e. the ability of the system to retrain people if the old qualification are less needed, to reduce inherited differences in education, to minimise the gender gap, to be open for innovations, to grasp the advantages of globalisation and new technologies, and to include outsiders and migrants. In addition, *Porter* (2004) has stressed the sophistication of consumers as important driver of improved technologies and products as to gain a first mover advantage. The eagerness to look for a better energy mix, higher energy and resource efficiency, to change habits as to become more in line with climate goals, reduces inputs and fosters innovations. Social and ecological activities turn into productive forces which do not limit incomes and production but increase welfare (in other words social and ecological innovation can be drivers of growth and development).

Outcome competitiveness

But competitiveness can never be assessed alone by looking at the inputs proper (costs and productivity) or inputs in a wider view (structure and capabilities) alone. Outcome competitiveness initially was measured by trade or current account balances, with deficit countries assessed as "non-competitive". This benchmark ("external balances") was then downgraded as less important, be it that fast growing countries tend to have trade deficits, be it that current accounts of member countries were seen as meaningless in a currency union, since no currency reserves were necessary to compensate deficits and no national currency had to be devalued. In the wake of the financial crisis the neglect of increasing deficit in the current accounts proved wrong (see *Aiginger*, 2010) since the difference in the depth of the crisis in individual countries was shown to be correlated with the current account position and its change in the upcoming phase. Current account deficits of Greece, Portugal and Spain added to the problems of these southern peripheral countries, since financial markets summed up public and private debt as well as current account deficits in calculating the risk of governments bonds (see *Aiginger, Firgo and Huber*, 2012). But balancing the current accounts is no final goal of a society. The ultimate goal of an economy is to enable high and rising incomes, to provide employment opportunities and to improve living conditions. Current accounts (as well as public deficits) are thus shifted into the position of side conditions, which could destabilise growth but they are no final goals and high surpluses are no proofs of a successful development. Typical for a definition of competitiveness focusing on welfare is that by the *European Commission* (2001) which emphasized "the ability of an economy to provide its population with high and rising standards of living and high rates of employment on a sustainable basis".

Fundamental assessments of outcomes started with the use of GDP per capita (either at currency value or even better at purchasing power parity) as main indicator of outcome competitiveness.[7] Then employment resp. unemployment indicators are added. In the context of the transition to a more socially inclusive and environmentally sustainable path, the goals of social inclusion and sustainability should be included also. The “social pillar” comprises indicators for poverty and poverty reduction through transfers, limiting differences in net incomes by progressive taxation, guaranteeing pensions above poverty level, achieving gender equality, or providing broad access to the health system. In addition, the ecological dimension can be measured by indicators for carbon emissions, for access to clean water, or for the use of and production of energy from renewable sources.

The critique of the GDP as the central measure of economic activity or success and even more as a meaningful indicator of welfare leads to the "Beyond GDP approach" (*Stiglitz, Sen, and Fitoussi*, 2009). This approach measures the achievement of a society by a broader set of goals, and this should lead to the assessment of competitiveness by broader goals, too.

What we have discussed above is an approach using a diverse set of indicators to assess the different dimensions of competitiveness. As an alternative to broad indicator sets to measure

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7 *Aiginger* (2006) calls GDP evaluations as “operationalisation 1” of output competitiveness, employment as “operationalisation 2”.

welfare, several institutions developed "all-in-indicators" which use only one or a few indicators that should summarize many components of competitiveness. More recently such “all-in-indicators” also include well-being: life expectancy is one such quantitative indicator, survey responses to the question of life satisfaction or to assess personal "happiness" are qualitative "all-in-indicators".

2.2.3 Defining Competitiveness

Aiginger et al. (2013) define competitiveness in this project as the "ability of a country (region, location) to deliver beyond GDP goals for its citizens today and tomorrow”. Competitiveness of a country or region needs a set of viable firms and industries which are able to compete internationally building on balanced costs and productivity. They have to be embedded in the structure of an economy and driven by abilities developed privately or by government. Current accounts, public sector revenues and expenditures have to be balanced in the long run, but balanced accounts are not final goals. Given the objective of transition to a more socially inclusive and environmentally sustainable growth path, investments in the social and ecological system which make the economy more productive (in creating incomes and welfare) are an important part of "competitiveness on the new growth path". The social system, the environmental ambition and (public and private) institutions become a "productive force". The outcomes to which firms, countries, locations have to contribute are the Beyond GDP goals. This is an extension of the definition which has been used increasingly in the late literature, defining competitiveness as increasing "living standards" or "value added plus employment".

The definitions chosen involve important intentional choices. The definition of competitiveness as the ability to create welfare in general and to deliver “Beyond GDP goals” in specific, downgrades the focus on costs as main driver of competitiveness and on external balances as main indicator of success. The devaluation of a currency, cost cutting and beggar my neighbour strategies are no meaningful strategies to increase competitiveness of an industrialized country in the long run. Reducing social costs or environmental excellence are counterproductive for the transition to a new growth path.

Productivity is an important part of competitiveness, but a factor to be assessed relative to wages. And labour productivity loses its outstanding relevance if the growth path should become more inclusive and sustainable. Lower labour productivity and higher resource productivity may be better for achieving welfare if employment and sustainability are important goals.

Structure is important for a definition of competitiveness since it offers a glance at the future prospects. Abilities determine today's welfare position and even more the future one. Emphasizing structure and ability (and maybe also strategies) changes the nature of competitiveness from an ex post evaluation to an ex ante concept.

If we try to separate the components of competitiveness into costs, structure and ability and outcomes, we have to admit that they are intrinsically related. Productivity is partly determined by structure and abilities, and labour productivity can be seen as component nested in traditional as well as new outcome perspectives.

Specifically demanding is the allotment of indicators on the social system and on sustainability into costs, abilities and outcomes. In early competitive rankings social expenditures as well as environmental standards were assessed as costs which reduced the price competitiveness of countries and locations. Literature has in the meantime come up with the concepts of the social system as a "productive capacity" or "social capital" and environmental sophistication as creator of first mover advantages, green jobs and export potential.

We have therefore to distinguish between "enablers" and "corrective strategies". Some social measures or costs like education and training, lifelong learning, child care institutions increase the abilities and productivity of an economy. Furthermore incentives preventing health risks and burnout and encouraging rehabilitation increase the "productive capacity" of an economy. Other social expenditures like transfer payments, high replacement rates for unemployed, early pensions change the ex-post distribution or lower poverty.

Similarly some sustainability indicators highlight a productive force (subsidies for renewable energy fostering innovation and technical progress), while others like repair or cleaning expenditures focus on restoring environmental quality. These "corrective measures" restore welfare and improve outcomes.

2.3 Measuring the Dimensions of "Competitiveness"

2.3.1 Price Competitiveness

The current international debate on competitiveness is dominated by concepts of price competitiveness. In the Euro Area, the economic crisis has focused attention on (unit) labour costs: for example, regarding the downward adjustment of wages in Greece or low wage increases relative to productivity in Germany since the early 2000s. In the USA, recent discoveries of large shale gas deposits have highlighted the importance of resource costs for industrial companies.

Overall, viewing competitiveness through the traditional lens of labour costs, the indicators clearly favour the NMS in Central and Eastern Europe: despite some catch-up to the West since 2000, they still registered the lowest unit labour cost levels in 2011. On the other hand, Switzerland and most of the industrial nations from the core and the northern EU have the highest unit labour costs, which have also been increasing since 2000.

Economic policy is often more interested in changes in price competitiveness than in current levels. Both labour costs and productivity increased fastest over the period in the new member countries from Central and Eastern Europe. Overall, unit labour costs also increased in these countries (by about 4 percent per year on average), indicating that productivity rose more slowly than wages. Ireland, the Netherlands and Finland also registered comparatively large wage increases, but considerable productivity gains held unit labour costs in check (they even declined in Finnish manufacturing). In Denmark, productivity could not compensate the wage dynamics, so that unit labour costs increased by more than 2 percent p.a. In the Southern European countries, wages rose faster than productivity until 2008. Since then, wages were cut and productivity improved slightly. Still, between 2000 and 2011, unit labour costs in Italy, Greece, Spain and Portugal increased between 2.5 and 2 percent per year on average. In Italy in particular, wages kept rising despite negative annual average productivity growth rates. In British, Swedish, German and Austrian manufacturing on the other hand, annual wage increases remained below productivity gains, leading to declining unit labour costs. In the UK, this was the case also for the total economy.

Total factor productivity (TFP) growth is an indicator of improvements in the productivity of all production factors combined. Calculated using the growth accounting approach, based on a standard neoclassical production function, TFP growth is that part of productivity growth that cannot be explained by the growth of capital and labour. The figures for TFP are similar to those for labour productivity: high growth rates in the new member states, Finland, Sweden and the US; intermediate growth rates in the Netherlands, Germany and France; and lower or even negative growth in Belgium, Denmark and Italy. More surprising is Ireland's negative performance, which supports a cautious approach towards Irish productivity figures. Spanish TFP also declined until 2007, indicating that the country's wage increases up to the crisis may have been unsustainable. TFP growth in the manufacturing sector considerably exceeded that in the economy as a whole in most countries, and even Belgium and Denmark, with negative average annual TFP growth on aggregate, registered positive growth in manufacturing.

2.3.2 Quality Competitiveness

When measuring the quality dimension of competitiveness it is useful to distinguish between the indicators which captures the structural features of the economic and indicators which assess capabilities of an economy which are linked to forward-looking investments into the capabilities of the population and the quality of institutions.

- **Structural composition of an economy:** The structure of an economy allows an assessment of quality competitiveness today as well as likely future opportunities. Firm-specific competitive advantage is crucial for individual firms' long-term survival, and these can be created and sustained by innovation and skills. Particularly advanced industrial countries with higher incomes are more likely to be able to compete in the long run in industries where profitability is higher due to some vertical heterogeneity, such as heterogeneous products and competition in quality instead of prices. Thus, firms in high-income countries are better positioned in the long term if their selling position is derived from a lead in technology or employee skills. The literature on competitiveness captures the structural composition by looking at main factor input and distinguishes **labour-intensive vs. capital-intensive vs. marketing vs. *technology-driven*** industries. A second breakdown looks at types of skills used **(low-, medium- and *high-skill intensive* industries**. A third breakdown focuses on the type of service inputs used **and defines the following inputs: transport services, retail and advertising services and *knowledge-based services***. Other breakdowns classify industries according to the **intensity of R&D or education of the workforce.** Finally, directly linked to sustainability one can distinguish industries by their share of **ecological and renewable resource consumption**. Such types of structural breakdowns might use production-, value added or export-based indicators.

The look at structural indicators reveals that large countries and those in the Northern periphery tend to be in the top league more often than small countries. Belgium, the Netherlands, Denmark and Austria have a successful manufacturing sector despite mostly average or below-average ranks in terms of industrial structure. The bottom group consists of new member countries and those from the Southern member states.

- **Capabilities:** The dimension of quality competitiveness consists of factors that allow firms to upgrade and adapt to new opportunities, thus facilitating structural change. Five different capabilities are used. (1) **capacity for innovation** (e.g. R&D spending in relation to GDP, (2) **the education system** (e.g. share of population with university degrees), (3) **the social welfare system** in its productivity-enhancing function (e.g. active labour market programmes which seek to increase the ability of unemployed persons or female labour force participation rate) (4) **consumers' and firms' ecological ambition** (e.g. lead users with a taste for environmental safe products or investments in renewable energy or share of ecological patents in total patenting), and (5) **supportive institutions** (e.g. like clusters, level of trust or levels of bureaucracy). When selecting indicators for each of the categories, it is important to focus on reflecting processes and capabilities rather than outcomes.

  Summarizing all five components of capabilities the Scandinavian countries Denmark and Sweden clearly come out on top. Germany and France achieve top-five positions on innovation and the social system but show less impressive figures on education, ecological ambition and institutions. Romania, Bulgaria and Greece consistently underperform across indicators.

  However, we have to admit that the ranking of countries is quite different if you only look at one specific indicator. Hence, in order to arrive at a meaningful assessment of capabilities as driving forces of competitiveness a wide variety of indicators should be used.

2.3.3 Outcome Competitiveness under New Perspectives

Traditionally, analyses of outcome competitiveness examine GDP per capita as well as employment and unemployment rates. The traditional indicators for outcome competitiveness are widely used in economic policy discussion and hence we need no reflection here. The top group of countries regularly comprise Luxembourg, Sweden, the Netherlands, Denmark, Germany and Austria. At the other end the new member states and – as far as labour market outcome affected by the crisis is concerned - the Southern European countries (Greece, Spain, Italy and Portugal) perform badly.

However, defining competitiveness as the "ability of a country, region or location to deliver the beyond- GDP goals" requires indicators on the beyond-GDP goals and indicators that are useful for evaluating the progress on the socio-ecological transformation. While the beyond-GDP goals are numerous, *Aiginger et al.* (2013) focus on three pillars. The income pillar starts with GDP per capita but moves towards disposable household income and consumption expenditure. The social pillar summarizes indicators that reflect outcomes of a country's socio-economic system (poverty risk, inequality, youth unemployment). The ecological pillar reports ecological outcomes such as resource productivity, emissions and energy intensity.

- **Income pillar:** This pillar comprises indicators like **GDP per capita** and the modified GDP concept called **net national income (NNI)** which excludes depreciations normally contained in GDP. A second approach uses household level income and examines **net disposable household income after taxes and social transfers** (NDHI). And finally, **household final consumption expenditure** (HFCE) is used which comes closest to a welfare consideration.

  Rankings of countries are quite similar for all three indicators. There exists a high correlation between the simple GDP per head to the more refined household consumption per head. Of course, national tax and social security policy has some influence on the ranking but Luxembourg is still on top, followed by the UK, Austria and Germany. Notably, when looking at the NHDI indicator Greece jumps from rank 14 to rank 7.

- **Social pillar:** The social pillar contains indicators that characterize outcomes of countries' socio-economic systems in terms of poverty risk, income distribution and unemployment. Indicators includes **At-risk-of-poverty rates after social transfers** in the total and the elderly populations, the **amount of social transfers**, computed as the difference between at-risk-of-poverty rates before and after transfers, **income inequality** measured by the Gini coefficient of disposable income and the ratio of the shares of income received by the top and the bottom quintiles of the income distribution. Widely available indicators are the **youth unemployment rate** and the **long-term unemployment rate**, and the **employment gender gap**, measured as the difference between male and female employment rates.

  Evaluating countries' performance across these indicators, the Netherlands, Austria and Scandinavian countries regularly lead the European ranking. However, when it comes to risk-of-poverty indicators and equality indicators several new member states belong to the top group. Germany and France do only average overall. At the other end, Spain and Greece come last; Spain has the highest youth unemployment rate, while in Greece, social transfers have the smallest impact in reducing poverty across all EU-27 countries. Other weak performers are Italy (large employment gender gap and second-smallest impact of social transfers), Latvia (highest poverty risk) and Bulgaria (second-highest old-age poverty risk). On average, the Southern European countries (Greece, Spain, Portugal and Italy) lag behind the new member countries from Central and Eastern Europe on the social indicators considered here.

- **Ecological pillar:** Regarding ecological outcomes, we consider resource productivity (i.e. output produced per unit of materials input), the intensity of greenhouse gas emissions (i.e. tons of carbon dioxide (CO2) and nitrogen oxide (NOx) emitted per GDP or inhabitant), the energy intensity of production, and the share of electricity produced from renewable energy sources.

  While resource productivity is high in small countries (Luxemburg) and in large countries with a relatively small manufacturing base (UK, France and Italy), it is low in the new member countries. CO2 intensity is low in countries heavily using nuclear power (France, Sweden), hydropower (Austria, Sweden) or solar and wind energy (Spain and Portugal). The share of electricity generated from renewable sources is highest in Austria, Sweden, and Portugal. In Sweden, this results from the country's sustained policy efforts towards sustainability, and it is among the best performers across all indicators in this pillar. On the other hand, several new member countries (the Czech Republic, Poland and Estonia) take the last places. While France, Germany and the UK are in the top ten, Belgium and Finland do not do well overall. In general, the indicators considered here are not highly correlated with each other as they reflect a broad range of determinants ranging from industry structure to ecological environment and path-dependent trajectories of energy production.

Comparing country groups across the three pillars of outcomes under new perspectives, it is striking that the new member countries from Central and Eastern Europe dramatically outperform the Southern European countries on social indicators like poverty risk and inequality, despite the fact that the latter have a significant lead over the former on the income indicators. The Scandinavian countries do well on all dimensions of outcome competitiveness under consideration, particularly on the social pillar. Small countries like the Netherlands and Austria also score highly on income as well as social indicators. Ecological outcomes in the new member countries from CEE are the least favourable, while some Southern (Portugal, Spain, Italy), Scandinavian (Sweden) and small (Austria) countries exploit renewable energy sources or pursue ambitious environmental policies. **Overall, broadening the concept of outcome competitiveness clearly paints a more diverse picture of the EU-27, highlighting strengths and weaknesses of different country groups on different pillars**.

2.4 Determinants of Competitiveness under New Perspectives

In order to gain further insights the study relates the new dimensions of competitiveness to potential drivers. The large number of indicators used and their correlation with each other suggests extracting information using principal components factor analysis. This is done for the outcome indicators – the traditional GDP based and the new perspectives indicators - and for the groups of determinants - price competitiveness, the two dimensions of qualitative competitiveness (economic structure and capabilities) – to construct composite indicators for each group.

Regressing outcomes on its determinants indicates that not only price competitiveness (labour costs), but also quality competitiveness (economic structure as well as capability indicators) are significantly related to outcomes under new perspectives and to traditional outcomes. One difference in the results for the two outcome measures is the importance of ecological capabilities for achieving new perspectives outcomes. In contrast, institutions dominate for traditional outcomes.

The conclusion is that a narrow focus on the price component of competitiveness neglects other important aspects of the concept. For high-income economies like the EU-27, a purely cost-based strategy for improving outcomes is therefore unlikely to be as successful as one that also leverages the positive effects of a favourable economic structure and strong capabilities. Hence, quality resp. non-price competitiveness is more important than the pure price competitiveness.

Based on the regression outcomes, the study concludes Estonia, the UK and Bulgaria. They have, on average over the period from 2001 to 2010, not achieved the level of "new perspectives" outcome that the model would predict given their price competitiveness and non-price competitiveness. Their outcome in terms of competitiveness under new perspective is larger that the one expected by looking at price and non-price competitiveness indicators. Spain, Germany and Denmark appear to be close to potential. On the other hand Malta, Slovakia and the Czech Republic do not reach a position in new competitiveness indicators projected by the model. Hence reforms in the areas of price competitiveness, non-price competitiveness (economic structure and capabilities) seems to be needed in order to maintain current levels of outcome competitiveness.

3. Industrial Policy

3.1 Industrial Policies in Europe in Historical Perspective[8]

What role was played by industrial policies for the spectacular economic growth and industrial development in Western Europe after 1945? Such a question is impossible to answer precisely, because the rapid industrial growth performance after WWII was surely the result of a broad variety of influences, national and international conditional factors. However, it is a matter of fact, that since the early 1950s, the state itself became again increasingly involved within the economy in all Western European countries.

3.1.1 National Industrial Policies

Compared with the pre-war period, the state experienced a much larger share in economic activities after 1945, not like before during wartimes for military mobilization, but for the

[8] This section is based on *Grabas and Nützenadel* (2013).

achievement of national security, equity, and stability objectives and to promote industrial and economic development in general. State intervention was essentially important and became particularly apparent within the field of industrial policies. Nevertheless, there was no specific pattern or an overall strategy adopted in the same way by all countries. Rather, industrial policy was based on variety of mechanisms and directed towards different fields ranging from the promotion of specific technologies, the creation of infrastructures, energy policies or a distinctive protection of certain branches. Instruments ranged from state enterprises, tax incentives, direct subsidies, or financial credits conceded by public developmental banks. While in some countries (like France and Italy, for example) powerful and centralized agencies were created, in other countries (like West Germany, for example) regional or local initiatives were far more important. National traditions, historical legacies and path-dependencies did play an important role and may explain the enormous differences between nations and regions in Europe, even when they had to face similar challenges.

The period of strong industrial policy interventionism, initiated by post-war reconstruction and the reorganization of the European economies was terminated with the end of the Bretton Woods system, the oil crises of the 1970s, rising unemployment and accelerating inflation. From the late 1970s and early 1980s on, industrial policy and economic interventionism in general in most European countries came under severe attack and were stigmatized posterior as important hindrances of economic development and growth. Indeed, for a long time industrial policy appeared old-fashioned: something that belonged to a distant past when mercantilism ruled economic philosophy in Europe. The industrial sector seemed to fade away, marginalized by the Internet boom, the financial sector and other expanding branches of the knowledge economy. Moreover, the liberal reforms implemented in many countries since the 1980s strongly limited state interventions. According to this view, the market is more efficient to decide which sector should succeed. Industrial policy, in this view, was mainly an instrument to protect the old manufacturing sectors, which under market conditions were unable to survive. However, it is important to stress, that on a national level in most Western European countries strong interventionist industrial policies still prevailed. Despite all official proclamation for the free market, for gradual deregulation and re-privatization, the paradigm shift towards the free market approach in the field of industrial policies was anything but dramatic. In fact, even from the mid-1970s onwards up to the early 1990s, national industrial policies remained strongly interventionist and rather reactive in order to protect home industries.

For the period from 1945 to 1990, there are some overall results that can be drawn: the paradigm shift towards an interventionist industrial policy approach implemented in most European countries after 1945, which persistently prevailed until the 1990s, fostered economic structural change and was partially very effective in supporting the high economic growth rates during the prosperity years, but had often led to an inefficient allocation of national economic resources in many countries in the longer run. The more important and effective factors that enhanced industrial productivity in the long run, were, firstly, industrial policies establishing national and/or regional promising effective incentive structures for the private sector, and secondly, industrial policies encouraging openness to trade and investment, by creating an international environment favourable to competition, innovation and technology transfer. For

Western Europe, it was increasing trade and investment openness, largely, but not exclusively, under the heading of European integration.

3.1.2 EU Industrial Policy

On the supranational level, the earliest industrial policy initiatives in Western Europe after WWII had been implemented within the institutional framework of the European Coal and Steel Community, so their legal basis was the Treaty of Paris (1951). The Treaty of Rome (1957) included only a very few elements of industrial policy at all. It was not until the Maastricht Treaty, signed in February 1992, that an actual title concerning industrial policy appeared in the Treaty of the European Union. From the early 1990s onwards, the EU had increasingly intensified its efforts to support and coordinate industrial development and structural adjustments in member states, and recently made new rapid progress since the beginning of the new millennium. Nevertheless, industrial policy at the Community level is still playing a rather subsidiary and coordinating role compared to national policies as EU industrial intervention had largely been carried out only by competition policy. However, the European Union already favoured the strategical shift towards a promising integrated industrial policy approach that on the one hand emphasizes the need for cooperation and coordination of efforts between the European Commission and the Member States and on the other hand encompasses a full range of EU policies such as competition, trade, innovation or energy since they all have an impact on the competitiveness of industry.

3.1.3 Historical Lessons

The present crisis provides evidence that economies based mainly upon services – such as those of Great Britain, Ireland or the United States – are more heavily under pressure than countries with a sound industrial foundation, such as Germany or France. Even for the progress of knowledge-based economies, a complimentary industrial development seems to be crucial. Not only in Europe, but also in other parts of the world, there is a true renaissance of industrial policy. Nearly all of the new economic powerhouses of the past decade – Brazil, China, South Korea or India – implemented comprehensive strategies to promote the growth of the domestic manufacturing sector. Even countries such as Great Britain or the United States, which in the past sturdily rejected any form of state involvement in industrial development, are beginning to reconsider their economic philosophy. However, the belief in the overall efficiency of market allocation has been shattered. The collapse of the financial sector has fairly demonstrated that market economies require a more rigorous level of regulation and coordination. Finally, the economic problems of Southern Europe have brought industrial policy back to the fore. There are reasons to assume that the foreign debt crisis is also the consequence of more severe and structural deficiencies of the real economy in these countries, such as weak infrastructures, backward technologies and an underdeveloped manufacturing sector.

Historical lessons on achievements and failures of industrial policies in Western Europe after WWII need to be made fruitful for any current or future effective political action. As economic crises and slumps were always reasons for state intervention in Western Europe after 1945, at the same time these economic crises always provoked a "rethinking" in terms of the suitability of industrial policy approaches, measures and instruments. The integrated and future oriented industrial policy approach of the "Systemic Industrial and Innovation Policy" (SIIP) can be considered as a perspicacious and profound outcome of this theoretical correlation, which fairly demonstrates that future effective industrial policy has to start from the challenges revealed by globalisation and those in the financial crisis. In a free and open market, further national and/or regional promising effective incentive structures for the private and the public sector has to be established and industrial policies have to be based on research and education, and industrial policy merges with innovation policy. It has to encompass small as well as large firms, and promotes close relations between firms and universities and cooperation between firms and universities (clusters). This integrated industrial policy approach, based on strong cooperation and coordination between the European Commission and the Member States and which encompasses competition, trade, innovation, education or energy policies, needs to be translated and implemented in concrete political measures and instruments both at national and EU level for stimulating industrial productivity and modernization, economic development and social and ecological sustainability.

3.2 The „Resurrection" of Industrial Policy in the European Union and its Impact on Industrial Policy in the New Member Countries[9]

The ten transition member countries of the EU (Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Romania and Bulgaria) form three groups.

- The first group includes the CEECs with trade specialization in technologically progressive sectors and with close intra-firm connections with German, Austrian and partly North Italian industry ("*high-tech subcontracting countries*"): the Czech Republic, Hungary, Poland, Slovak Republic and Slovenia.
- The second group is the *Baltic countries*, Estonia, Latvia and Lithuania. These countries have economies with marked potentials of catching up, boasting quite strong service sectors but having, for the time being, weaker patterns of manufacturing specialization.
- The third group includes Bulgaria and Romania. These are the *emerging countries* of the region with still quite considerable capacities in agriculture, and a relatively strong role of low-value added industries in manufacturing.

For the ten countries considered, the terms "catching up" or "convergence" impliy the objective of attaining the average of the EU-27 in the socio-economic sense. The main research question is about the kind of **industrial policy** the CEECs need **for successful catching up**. Each of the transition economies had suffered from centralized and inefficient industrial policies prior to

[9] This section is based on Török, Csuka, Kovács and Veres (2013).

1990. “Transitional recession” called for completely new approaches to economic policy in general and industrial policy in particular. Most CEECs have made significant policy efforts to put their industrial policies on new paths based on more or less new concepts of industrial development. The first phase of the transformation of their industrial policies was a shift from crisis management to horizontal industrial policy until the mid-2000s. Our interest concerned the second phase reflecting the changes in the conceptual background of industrial policy thinking and practice in Europe.

This change in concepts and approaches has put competitiveness in the focus of industrial policy. We define competitiveness as the ability of a country (region, location) to deliver GDP-based and more broadly formulated welfare goals for its citizens. The new understanding of industrial policy embraces a more sophisticated approach to job creation and a more future-conscious treatment of natural resources including the environment.

The renewed interest in active industrial policy originated first from the apparent inability of the EU to close the productivity gap relative to the United States and to counter the increasing competitive pressure from emerging economies in the globalizing world. “Systemic Industrial and Innovation Policy” (SIIP) is pulled by the vision of a new growth path of social development and higher emphasis on sustainability.

The link between **environmental performance** and job creation is positive. European companies perform well on the global market in ecological products, e.g. in photovoltaics, air pollution control and waste disposal. In 2011, the export share of products from eco-industries (in percentage of total exports) was under 1 per cent in Estonia, Latvia, Lithuania, Poland, Romania, Bulgaria and Slovakia. In the Czech Republic, exports of eco-industries were 1.44 per cent of total exports, 1.19 per cent in Hungary and 1.37 per cent in Slovenia.

Average annual growth of output of high-technology manufacturing was 3.3 per cent in the EU-27 and 3.8 per cent in the Euro area between 2005 and 2011. Total industrial production of the EU at the end of June 2012 was still 10 per cent lower than pre-crisis. Since the onset of the crisis, over 3 million industrial jobs were lost, approximately 10 per cent of the sector’s employment in the EU. Total investment in the EU economy fell from 21.25 per cent of GDP before the crisis (2007) to 18.6 per cent in 2011.

3.2.1 Green Industrial Policy in CEECs

The priority goal would be to deliver sustainable growth, create high-value jobs and solve the societal challenges related to European industry. A “Stronger European Industry for Growth and Economic Recovery” point towards the crucial importance of strengthening industrial competitiveness in order to underpin growth and jobs and to facilitate **transition to a low emission and resource-efficient economy**.

Between 2004 and 2008, the total amount of waste generated by industry in the EU fell by 8.6 per cent, whereas for the whole EU economy this decline was 8.1 per cent, indicating that industry reduced its waste somewhat faster than the wider economy. The global market for eco-industries is estimated at EUR 1.15 trillion per year, and the EU captured approximately one third of it. In the future, this global market could almost double, with an average estimate of EUR 2 trillion a year for 2020.

The preconditions for green economic development exist only to a limited extent in the CEECs. This means, in the first place, the existence of relevant policy documents requested by the European Commission, but an appropriate restructuring of industry is only at an initial phase. Such policy documents include one of the seven focus areas of the New Széchenyi Plan in Hungary, Poland’s National Reform Programme, and Slovakia’s National Action Plan for Green Public Procurement.

The Ministry of Environment of the Czech Republic updated the Programme of Support of Environmental Technologies originally approved by the government in July 2009. The update aims to increase energy efficiency and stresses the importance of renewables and eco-innovation. Slovenia’s action plan for the implementation of cradle-to-cradle principles is based on the concepts of eco-effectiveness, eco-efficiency and closed-loop economy

The main funding instrument for environmental policy in Romania is the operational programme Environment. The development of eco-efficient production, the increasing of energy efficiency and the promoting of renewable energy sources are supported by the OP Increase of Economic Competitiveness. Bulgaria’s national plan for green public procurement sets binding objectives for the government on green procurement of six product groups, for example, Information Technology (IT) equipment, air-conditioning, and lighting. A System for Certification of Green Jobs has generated 786 new green jobs since January 2011.

To tackle the challenges posed by environmental constraints and to ensure sustainable production, Member Countries are using demand-side and supply-side policies. The effects of these policies have not always been fully positive, and synergies between them are promising. Demand-side policy tools such as green public procurement and labeling, taxation and subsidies seem to have solidly taken root. Supply-side policies, such as better access to finance for environmentally viable solutions, education and information services directed at enterprises, are still bottlenecks.

3.2.2 Cluster Policies

National **cluster policy** in Hungary has existed since 2007, after several misplaced efforts in the nineties. It has a horizontal character with a focus on innovation, competitiveness and employment. The Pole Programme supports clusters of firms with export potential in the main urban concentrations. Cluster policy in Poland is part of the National Reform Programme 2020.

The Czech Republic’s Co-operation Programme (2007-13) promotes clusters, poles of excellence and co-operative projects. In 2010 alone, USD 42 million was invested in cluster collaboration platforms. On the contrary, there is no explicit cluster policy in Slovakia. However, there are references to cluster formation in other types of policies.

Slovenia began with its national cluster policy in 2001. More than thirty cluster initiatives came to the fore in Slovenia before the year 2005, but explicit support to the cluster development programme stopped thereafter. National platforms are in place to serve specific cluster categories. These platforms, largely financed by the government, provide companies with information on how to access project funding.

Cluster policy in Lithuania is integrated in innovation policy and industrial policy. Currently, the government regards cluster policy as one of the key components in the policy mix expected to make the economy competitive. The Clusters of Excellence Network (KCT) is a public body aiming to coordinate networking actions and support the promotion of cluster organizations and activities.

Romanian cluster policy is also part of industrial policy. The first cluster organization came into existence in 2010. The fundamental aim of Romanian cluster policy is to develop specific regional clusters while establishing a national network of clusters as well.

A wide range of industrial policies exists in the CEEC region, with more or less interventionist policies along with very liberal ones. Common features of these very diverse approaches to industrial policy have included, for example, a focus on incentives to foreign direct investment (FDI) and a more or less strong emphasis on R&D and innovation.

3.2.3 Link between Industrial and Innovation Policy

The role of **innovation and R&D** in industrial policy is still rather controversial in the region. In 2012, Poland became a modest innovator and Lithuania advanced to the moderate performance group level of innovators according to the Innovation Union Scoreboard 2013. Their shifts between performance groups were due to marginal changes of the innovation performance in both countries. The performance of modest innovators (Bulgaria, Latvia, Poland and Romania) is below the EU-27 average. Among the “economies with marked potentials of catching up”, each country is a moderate or a modest innovator, except two “follower” countries, Slovenia and Estonia with innovation performances close to the EU-27 average.

In order to enhance growth based on research and innovation, Member Countries should increase the availability of **venture capital**. Hungarian venture capital investment per capita ranked fourth among the Member Countries of the EU in 2011. In Slovenia, innovation vouchers for enterprises to buy services from R&D providers remain a popular policy measure. Estonia, Latvia and Lithuania all have such schemes and Slovakia is considering a similar system.

In 2011, for the very first time since the beginning of the crisis, the total public R&D budget of the EU-27 Member Countries decreased slightly. Since 2011, through FP7, the EU has supported about 30 million € worth of research projects on social innovation and it is funding two networks of incubators to nurture and scale up successful social innovation. The pilot European Public Sector Innovation Scoreboard is the first EU-wide attempt to better understand and analyse innovation in the public sector.

The **catching-up group** within the EU as we see it consists of Bulgaria, Romania, the Czech Republic, Poland, Hungary, Slovakia, Latvia and Lithuania. These countries face significant challenges as they move towards more knowledge- and skills-oriented industries, in spite of their weaknesses in innovation capacity and knowledge transfer. Resource efficiency is still low, in particular in the case of Bulgaria and Romania.

Hungarian industrial policy of the 1990s was relatively successful in introducing a number of tools for promoting innovation, supporting small and medium-sized enterprise development and attracting FDI, but a marked industrial policy profile was missing most of the time. A spectacular turn towards active industrial policy occurred in 2000 under the “Széchenyi Plan”. The focus of Hungarian industrial policy has been increasingly on innovation, mainly with respect to new elements of industrial policy. The government's technology policy agency introduced a series of innovative tools of innovation promotion increasing BERD, and also with quite significant network-building effects.

Activation of Hungarian industrial policy after 1998 included a shift towards such a horizontal approach, which involved less direct expenditure by the government but made life considerably easier for SMEs. In the transition process, the countries examined opened their markets for **foreign direct investment** (FDI) in the late 1980s. The Czech Republic, Hungary and Poland were the most attractive investment destinations during the transition process. In 2000, these three countries received 76.36 per cent of the total FDI that went to the region, while in 2011 this was 70.21 per cent.

The policy background of competitiveness increase has existed in most CEECs since 2008. The Czech Republic adopted the International Competitiveness Strategy for 2012-2020 and the National Innovation Strategy (NIS) in 2011. Public R&D expenditure remained reached 0.58 per cent of GDP in 2010, with business expenditure on R&D (BERD) at 0.97 per cent of GDP. The majority of Czech companies performing R&D are foreign owned. The Czech Republic has to solve some difficulties in the R&D sector, in order to increase its competitiveness in research and innovation. There is a certain lack of co-operation between the research and the business sector in the Czech Republic.

The industrialization of Slovakia figured high on the policy agenda of most post-war governments of Czechoslovakia. This idea became a priority again for the Dzurinda government in office from 1998. Automotive industry played a key role in the Slovak industrial policy program launched in the same year, but this industry alone has not been able to make Slovakia more than a moderate innovator. Automotive industry provided 32 per cent of total exports already in 2003. Total R&D expenditure in Slovakia is one of the lowest in the EU (in 2010, 0.63 per cent of GDP).

Slovenia is the best performer within its reference group (CZ, IT, HU, SI, SK) for several innovation indicators such as “patent applications per GDP”, “share of the employment in knowledge-intensive activities” and “contribution of medium and high-tech product exports to the trade balance”. The share of high-tech products in Slovenia’s exports is not necessarily associated with indigenous technological capabilities. The country needs a new industrial policy including a strategy for attracting foreign capital linked to R&D.

Romania’s economy has a prevalence of low-and-medium-technology sectors, with a weak demand for knowledge and an underdeveloped innovation culture, and a low innovation level. The Global Competitiveness Report 2011 classifies the country as efficiency-driven (together with Bulgaria), all the rest of the EU economies being either in transition to, or already in the innovation-driven stage. The R&D intensity of Romania increased from 0.37 per cent in 2000 to

0.58 per cent in 2008, and dropped back to 0.48 per cent in 2011, but all these data are massively below Hungarian, Czech or Polish levels. The Romanian R&I system is primarily public-based, with only 38.3 per cent of research performed by the business sector (the EU average is 61.5 per cent).

Latvia is a modest innovator, Lithuania is a moderate innovator and Estonia belongs to the group of innovation followers. The Baltics (Estonia, Lithuania and Latvia) are at the top of the scale within their own respective innovation performance groups. Estonia experienced the highest growth rate (7.1 per cent) in innovation performance of all Member Countries, between 2008 and 2012. Lithuania was the growth leader (5.0 per cent) among the moderate innovators. Latvia was the growth leader among the modest innovators (4.4 per cent).

3.2.4 Industry Structure and Industrial Policy in CEECs

For a **comparison of the various industrial policy regimes applied in the CEECs** it is essential to gauge the role of industry within GDP along with growth performance. In addition to growth, an analysis of competitiveness is inevitable in order to obtain a reliable policy assessment.

All the Baltic countries have had growth in GDP after 2010, which shows their success in combating the crisis. FDI played an important role in their business development. Inward FDI increased in all three Baltic countries after they joined the EU.

Manufacturing in Hungary is concentrated in low-skill sectors. Almost all medium-high-tech and high-tech sectors, especially motor vehicles, electrical machinery and apparatus, and radio, TV and communication equipment have increased their weights in the economy after 1995, as well as their R&D intensities. There is a growing trend of specialization in high-tech sectors in Hungary, but they are regionally strongly concentrated and still unable to generate all-out significant new employment in the economy.

Business R&D intensity in Poland declined between 2000-2011, due to a stagnation of relative research intensity in high technology sectors and the export-based shift of the economic structure towards less research-intensive activities. Only the motor vehicles sector has gained ground within total Polish manufacturing production. Office equipment, accounting and computing machinery, medical, precision and optical instruments, showed an increase in their R&D intensities.

The sectoral structure of manufacturing industry in the Czech Republic is gradually approaching the average structure in the EU. The most significant changes took place especially in traditional Czech export sectors, including the iron and steel industry, electrical equipment production, transport, engineering and textile industries. A large array of production capacities have been created owing to FDI. The relative share of BERD based on inward FDI doubled over the period 1999-2009. Around 40 per cent of this segment of BERD comes from German-owned firms. With a relative share of FDI-related BERD in total BERD of more than 85 per cent, pharmaceuticals and motor vehicles are the manufacturing sectors that show the highest degree of internationalisation. The dominance of foreign affiliates in high-tech and medium-high-tech sectors is reflected by the fact that Czech firms are completely absent from the EU top 1000 R&D investing firms.

Marked structural change took place in the Slovak manufacturing sector during the period of 1995-2009. After 2010, the share of medium-high and high-tech manufacturing exports within the GDP has been above the level of the average EU-27. Several medium- or low-tech sectors (fabricated metal products and food and beverages) have increased their knowledge-intensity between 1995 and 2009. Both GDP and export growth originated mainly from the communications equipment sector, electrical machinery, motor vehicles sector, and the fabrication of metal products.

Latvia has been moving from traditional industrial activities to more knowledge-intensive industries. The contribution of manufacturing to Latvia's total gross value added (14.12 per cent in 2011) is still lower than the EU average (15.5 per cent). Latvia's traditional specialization pattern is based on sectors with low and medium-low research intensity such as metal processing and machinery, wood and wood products, and food processing. Latvia's economic structure is highly biased towards small enterprises in traditional sectors such as sawmilling and wood planning as well as fish processing.

Lithuania's manufacturing industry is dominated by traditional low-tech sectors such as food and beverage, and chemicals in the medium-low tech sector. RCA indices of the Lithuanian manufacturing industry sector, show that the manufacturing of products of wood, furniture, rubber and plastic products, food, textiles and apparel is comparatively more important that in the rest of the EU.

Estonia is one of the countries that are catching up fast in terms of manufacturing: in 2011, manufacturing production represented 17.3 per cent of total value added (compared to the EU average of 15.6 per cent). Estonia focused on labour-intensive industries and specialized in manufacturing of electronic products, fabricated metal products, motor vehicles, electrical equipment, and machinery and equipment. There was marked structural change in the Estonian manufacturing sector over the period 2005-2009, and also an increase in R&I investment in several industrial sectors of the Estonian economy, both in low-tech and traditional sectors.

Romania is specialized in less technologically advanced sectors. Romania, similarly to the traditional specialization pattern of Estonia, is highly specialized in labour-intensive industries (preparation and spinning of textile fibers, sawmilling, wearing apparel and accessories), in capital-driven industries (cement), and marketing-driven ones (footwear). Dynamic structural change generated fast increasing value added in Romania's still scattered technology-driven and innovation sectors (office and computing machinery and motor vehicles, and to a lesser extent electrical machinery and apparatus).

Bulgaria has not managed to accelerate the much needed structural transformation and technological upgrading of its economy. In 2011, the highest shares in Bulgaria's manufacturing exports belonged to the labour-intensive and resource-based products: 31.1 per cent while the corresponding share in the EU is about 2.5 times lower (12.6 per cent). These are all products that need unskilled, low-paid labour and generate little Bulgarian added value. Overall, Bulgaria still differs substantially in structural and technological aspects from its European partners, and some claim it has fallen in the “low-tech sectors trap”. The manufacturing sector plays a slightly bigger role in Bulgaria than in the EU as a whole, owing to its specialization in labour-intensive industries (e.g. textiles and clothing, leather and footwear), and in capital-intensive industries (e.g. cement, refined petroleum and non-metallic mineral products).

In most CEE countries, **defence industry** has been a critical element of structural change in industry since 1990. The reason was the problem of conversion of the defence industry, since the collapse of the Warsaw Pact deprived most of such CEEC firms from their traditional markets, but their competitiveness on world markets was limited. Furthermore, military spending dramatically decreased after 1990 in Hungary, Poland, Bulgaria and Romania. After NATO accession, there was growth (or at least stagnation) in military spending. From 2004 through 2008, Polish military spending grew at more than 6 per cent when, for example, defence spending shrank in France, Germany, Italy, Sweden, Belgium and Japan.

Factories face similar problems when trying to overcome barriers in switching from military to civilian production. As the scale of industrial potential is different however, the scale of the problem varies from country to country, being greater in Poland or Slovakia and less acute in Hungary or the Czech Republic. Sectoral differences also matter. Electronics firms supplying the defence sector before 1990 (e.g. parts of Videoton and Telefongyár in Hungary or Tesla in the Czech Republic) had to scratch off most of their former equipment in order to make a successful conversion to non-military production. Vehicle producers (e.g. Rába in Hungary, Škoda Plzen in the Czech Republic or Nysa in Poland) could make it without major losses of capacity.

Reorientation of military R&D generated “costs” as underemployment of R&D facilities, “brain-drain” and job losses. In addition to this, several direct successors of pre-1990 military industry firms in the CEECs remained state-owned and they are competitive only on the public procurement based domestic market of defence equipment. They could be made internationally competitive only if their continuous access to world-standard technologies could be ensured. This, however, is not a challenge for industrial policy, and it has considerable security implications which are beyond the scope of the present study.

3.2.5 Bridging Innovation Policy, Industrial Policy, and Environmental Policy in CEECs

The New Member Countries of the EU have adopted **very diverse approaches to industrial policy** since the beginning of economic transition. Most of them adjusted to the industrial policy stance of the EU (and of its leading countries) which underwent at least two major changes since the eighties. The “hands-off” industrial policy approach dominant between about the mid-1980s and the mid-2000s in Europe was also prevalent in most CEECs after 1990. On the other hand, some quite original local clones of this industrial policy line emerged, to name just a few cases, in the Czech Republic, Hungary or Romania.

These local clones or mutations reflected, in the first place, the fast growing need for industrial restructuring and crisis management in most CEECs during the first half of the nineties. The apparent inactivity of industrial policy in the CEECs slowly gave way to an increasingly active promotion of FDI, which gradually became the key element of an officially still "market-oriented" (i. e. passive) industrial policy line.

The EU's main think tanks, and not much later the European Commission gave up their reluctance to industrial policy around the mid-2000s, partly owing to the conclusions of the 2005 Competitiveness Report. This turn, however, did not mean the re-emergence of old "*dirigiste*" industrial policy thinking. It was characterized by three new elements including competitiveness orientation, employment creation and a more cautious and future-oriented use of natural resources (including the environment). The global economic crisis starting in the year 2008 gave additional leverage to competitiveness-enhancing industrial policies in Europe, including, of course, the New Member Countries (NMCs).

Most if not all NMCs have followed this change of industrial policy thinking in the EU. This policy adaptation could be identified based on the analysis of a string of relevant policy documents produced by CEEC governments since the late 2000s. Most of these documents speak of a good ability of the NMCs to adjust to the policy requirements set by the transformation of the global economic environment. On the other hand, the impacts of the implementation of their new industrial policies could be demonstrated by available statistics only to a quite limited extent.

The most important improvements took place in their R&D and innovation systems with major increases of business R&D spending in some "high-tech subcontracting countries" among the CEECs. A further remarkable change is the dynamic re-industrialisation of the Baltic countries, with a marked environmental and resource-saving orientation.

Job creation in manufacturing is observable mainly in those cases where effective incentives to the inflow of FDI to labour-intensive sectors have been able to add competitive CEEC locations to the global production networks of leading multinational firms. This development seems to have a quite strong sectoral concentration, with car assembly dominating the creation of manufacturing jobs in Hungary, Slovakia, Romania, Poland and the Czech Republic. This strong sectoral concentration also means increased vulnerability given the fact that the car industry is one of the most business cycle dependent sectors of manufacturing. The Baltic countries are an exception to this trend with their more SME-based, and to a certain extent green oriented job creation processes.

The green orientation of industrial policy in the CEECs seems to be in its initial phase. Policy documents underline the strong commitment of most NMC governments to this industrial policy stance. Therefore, and of course conditional upon the availability of adequate financing, the years 2014-2020 can be expected to give rise to a widespread trend of green job creation in several CEECs, mainly of course the ones with more environment-conscious political elites (the Baltic republics, Slovenia, the Czech Republic, potentially Slovakia and Hungary).

3.3 Industrial Policy for a Sustainable Growth Path[10]

3.3.1 The Revival of Industrial Policy

Recently, renewed interest in industrial policy has emerged due to the idea that government intervention might contribute to growth and employment. In this section we shortly highlight to what extent the *new* industrial policy differs from the old and discredited policy which decelerates structural change instead of opening up new opportunities. Academic scholars (*Rodrik*, 2004, *Aghion et al.*, 2011, *Aiginger*, 2007, 2012) argue that the *new* industrial policy focuses on the generation of new opportunities and supports society's long-term targets. The U.S. government, the European Commission and the OECD have advocated reindustrialization and industry-oriented 'integrated' policies, since at least the recent financial crisis.[11]

An important question is whether industrial policy and climate policy reinforce or interfere with each other. The European Commission favours the first view by moving 'sustainability' (together with 'competitiveness') to the 'centre stage' of industrial policy (*European Commission*, 2010b). Renewable energy was declared to be one of the 'key enabling technologies'. However, the US seems to adhere to the second view by lowering environmental standards to facilitate newly available energy resources. If the second line of arguments wins, Europe will lose the first-mover advantage of becoming a test-bed for clean technologies.

The WWWforEurope project explores the ambitious strategy and asks for growth opportunities of pursuing an industrial policy which links the fostering of innovation in its broadest sense with climate policy.

3.3.2 Globalisation and the Financial Crisis as Promotors

The revival of industrial policy is linked to two recent incidences: (1) The integration of emerging countries into international production networks led two an increasing decline of the manufacturing share in most industrialized countries. (2) The financial crisis destroyed millions of jobs in Europe - inside and outside of manufacturing. In some countries, GDP per capita has still not reached the pre-crisis level. In addition, the recovery from the crisis was especially disappointing in those countries with a low share in manufacturing and with an above average share of current account deficits (*Aiginger*, 2011). Looking for indicators to explain differences in national performance during the financial crisis has shown that the current account balance is the most important determinant of the depth of the crisis across countries. Countries with high current account deficits and a small manufacturing base at the beginning of the crisis endured a particularly long crisis and output is often still lower than in 2007 (see Figure 2).

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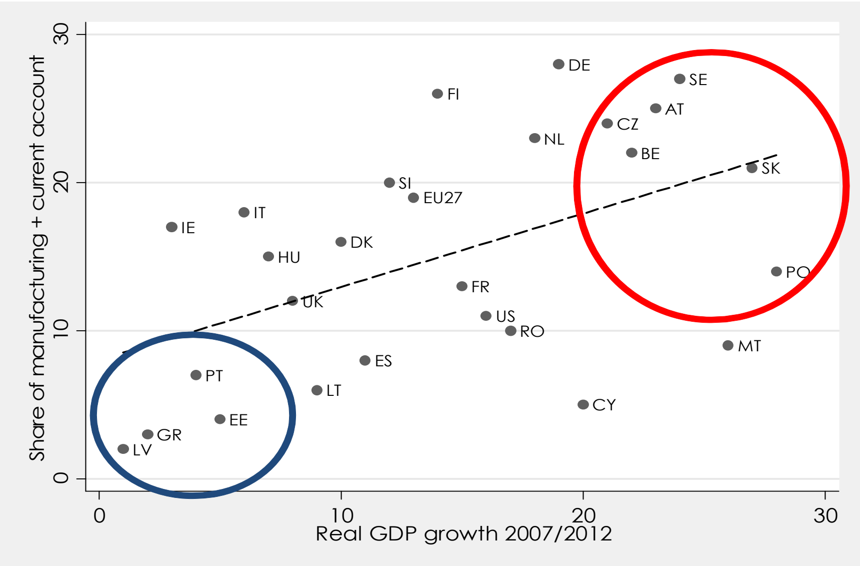
[10] This section is based on *Aiginger* (2014).

[11] See *European Commission* (2010b, 2011, 2012) and *OECD* (2012).

Figure 2 **Depth of the Crisis vs. 'Industrial Base'**



Remark: industrial base = share of manufacturing/GDP 2007 plus share of current account; the sum is ranked (lowest rank = 1); output performance = change in real GDP growth (lowest rank = 1).

Source: Aiginger (2014).

3.3.3 Elements of the 'New Industrial Policy'

These observations have led to calls for a new industrial policy in academic papers and policy documents. The academic literature stresses the difference of the new industrial policy from the old one: *Rodrik* (2004) first offered the perspective of a new industrial policy for developing countries, whereas *Aghion et al. (*2011) present a pro-market approach for an industrial policy in frontier economies. In addition, *Aiginger* (2012) presents the concept of a systemic industrial policy: The following elements seem to be common to these 'new approaches':

- Industrial policy should be a state of mind … create a climate of cooperation between government and the private sector … a discovery process … generate positive spillovers to other sectors and not be based on purely financial incentives … not picking winners (*Rodrik*, 2011). It should target activities and broad sectors, never firms; it should promote new activities not prevent exit … follow markets instead of leading them (*Aghion et al.*, 2011).
- Industrial policy is necessary to prevent 'lock-in' situations of investing in old technologies. Producers of 'dirty products' tend to innovate in 'dirty programs'. The task of industrial policy is to prevent conservative path-dependent decisions.
- Industrial policy should create new comparative advantages and help developing countries to diversify; it should stimulate exports, not prevent imports. Industrial policy should not protect non-viable domestic firms (*Aghion et al.*, 2011).

- Governments should only intervene where they have a long-term interest. Industrial policy should benefit society not just individual companies (*Aghion et al*., 2011; *Rodrik*, 2008, 2011).
- Industrial policy should no longer be an isolated policy. Industrial policy should start from the vision for the economy's future based on a vision which capabilities will provide competitiveness and a sustainable growth path (see Chapter 2).

3.3.4 A New Industrial Policy for Europe

The European Commission's new industrial policy developed in steps and become visible through several documents (*European Commission*, 2005, 2009, 2010a, 2010b, 2011, 2012, 2013b, 2014a, 2014b).

- Before the financial crisis the EU focuses on the impact of globalisation. Industrial policy maintains both horizontal and vertical approaches. The horizontal approach continued to dominate, while sectorial ideas enter through an emphasis of sector-specific effects of horizontal policies. Elements like 'key enabling technologies', 'flagship initiatives' and 'priority lines' can be seen as a manifestation of vertical elements.
- Industrial policy of the Commission was then seen as instrument of implementing the Europe 2020 strategy to contribute to smart, sustainable and inclusive growth. The trade-off between competition policy and industrial policy should be overcome by a "wider, integrated industrial policy" which tries to take into account simultaneously competition, trade, single market, regional, innovation, resources and energy policies.
- Finally, industrial policy takes up the challenges arising from the 20/20/20 energy goals and the roadmap for reducing greenhouse gases by 80-95 % by 2050. However, the non-neutrality of industrial policy led to repeated assertion that this might harm competitiveness and induce the threat that energy-intensive industries could relocate to regions with lower energy prices and lower environmental standards. This results in documents where different goals for industrial (and energy) policy are merely enumerated without addressing the trade-offs and priorities. Setting 'competitiveness' *and* 'sustainability' at the centre stage is one such compromise (*European Commission*, 2010b).

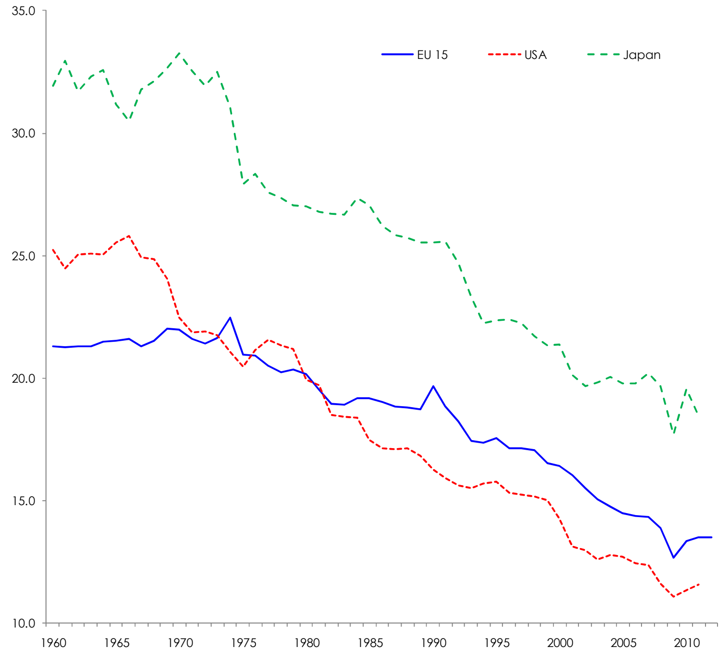
Manufacturing - a key target of industrial policy?

Recently, the importance of manufacturing for jobs has been highlighted since one in four private sector jobs is created in manufacturing (and a further job in associated services, see *European Commission,* 2010b). Furthermore, 75% of exports and 80% of private R&D originates in manufacturing. The EU Commission further states that Europe is a world leader in many strategic sectors such as car-making, aeronautics, engineering, aerospace, chemicals and pharmaceuticals (*European Commission*, 2012). Given the tremendous job lost caused by the crisis, the Commission calls for a 'reverse the declining role of industry in Europe from its current level of around 16% of GDP to as much as 20% by 2020'. This ambitious statement is complemented by calls for higher levels of investment, greater intra-European trade and a significant increase in the number of SMEs (small- and medium-sized enterprises) exporting to third (non-EU) countries.

However, these goals are quite unrealistic along the current growth path. Only if one considers new combinations of core manufacturing products with production-related and value-adding services this might be a realistic target. However, this is unlikely counted statistically as manufacturing. What the European Commission means by its goal - if taken literally - is to dampen the decline of the share of industry and to limit other regions' inroads into European domestic markets.

Figure 3 **Share of Manufacturing 1960 to 2012 for EU-15, USA, and Japan**

Share of Manufacturing (Nominal values) in % of GDP



Source: Aiginger (2014).

New Targets

Much analysis of Europe's low dynamics over the past decade forgets that the European Union has been a tremendously successful integration experiment. It started with only 6 members 50 years ago. It now has 28 members with 10 more countries applying for membership or neighbourhood contracts. Europe has integrated former communist countries at such a high speed that the World Bank labelled it an 'integration machine' (*Gill and Raiser*, 2012). The current EU-28 is the largest economic region in the world, as measured by Gross National Product. Its share of world trade is more stable than the U.S.'s, albeit falling slightly due to the impact of the newly-industrialised countries. Europe takes the lead in pushing for environmental goals (Kyoto protocol, EU-2020 energy goals) and has promoted a system of carbon emissions trading.[12] Europe has lower shares of poverty and less income inequality than other economic areas.

Nevertheless there are also indications of weaknesses. Economic output in the Eurozone in 2014 is still lower than it was in 2008.[13] Europe has a double-digit unemployment rate, its banks are undercapitalised and its member states pay higher interest rates for their sovereign debt (despite lower debt/GDP ratios) than the U.S. and Japan. There are internal trade disequilibria with large surpluses in Germany, the Netherlands and Austria, and deficits in others (e.g. U.K., France, Italy, Greece, or Portugal). In addition, Europe will miss its employment, R&D, poverty reduction, energy efficiency and CO_2-goals set out in the Europe 2020 strategy. Lower dynamics and large disequilibria are partly mirrors that the European institutions are no longer adequate for 28 countries.

The new industrial policy needs (i) a new yardstick for performance, (ii) a new definition of competitiveness, (iii) a more ambitious strategy for competitiveness and (iv) an industrial policy aiming at a broader set of harmonised policies. Such an ambitious policy will encounter hurdles and resistance. Some resistance comes from the traditional inefficiency of governments in reaching their goals, some from the fact that voters tend to vote for their short-term interests, and lobbying groups that benefit from the status quo.

3.3.5 Energy Policy and New Industrial Policy

The need for and the success of a new industrial policy, which promotes quality competitiveness and explicitly takes societal goals into account, can be illustrated for the case of climate policy. Global warming, its threat and the need to limit temperature change are now well understood (*Stern*, 2007, *IPCC*, 2014). Europe has established a roadmap to reduce greenhouse gas emissions between 80% and 95% by 2050 and 20% by 2020. There are encouraging signs that policy is on a new path:

- The EU-27's greenhouse gas emissions for 2010 are 10% below their 1990-levels.
- Material consumption was 14% lower in 2000 than in 1970, and further declined by 13% between 2000 and 2010 (*Fischer-Kowalski and Hausknost*, 2014).
- Nearly all industrialised countries show signs of relative decoupling of GDP growth and energy consumption. And the share of energy derived from renewables is increasing.

However, there are also backlashes and rebound effects:

- The European CO_2 emission trading system collapsed and there is little political will to re-establish it.

[12] The system broke down since too many energy-intensive sectors were exempted, and other energy-intensive companies were able to buy extremely cheap permits from ailing eastern European companies or from companies severely hit by the financial crisis.

[13] In contrast to the U.S. where it is 9% higher; world output exceeds its pre-crisis level by 20% compared to 2008.

- In energy policy, the focus is shifting away from supporting energy efficiency and renewable energy, and towards the old strategy of emphasising 'affordable' prices and security of supply. Germany's *Energiewende* – the plan to phase-out nuclear energy often seen as a forerunner - is under pressure.
- In Europe coal use has increased after the collapse of CO_2 emission trading, when coal became cheaper than gas. It is also used to complement renewable energy at times of low supply. Nuclear energy is returning via the so-called 'neutrality approach' and some countries argue in favour of additional subsidies for this industry.
- Energy prices in US drop due to liquefied gas and gas extracted via new technologies such as fracking. This puts EU energy policies under pressure as energy-intensive industry argue in favour of moving to the US and also US coal exports to EU becomes a cheap source of energy.

European industrial policy faces two options to meet the challenge of lower U.S. energy costs: (1) lowering its own energy costs or (2) boosting energy efficiency and supporting future competitiveness of energy-consuming industries. Option (1) follows the logic of the 'old' industrial policy. If input costs are too high, try to get cheaper inputs too or subsidise industries. Option (2) demands the increase in energy productivity and fosters factors which increase tomorrow's competitive advantages.

In line with option (1) energy-intensive industries are exempted from ambitious standards or from carbon taxes. Industrial policy along this line leads higher greenhouse gas emissions but preserves competitiveness of energy-intensive industries at least in the short run. However, this avoids long-run competitiveness as this limits the incentives for investment in energy-saving innovations which might overcompensate. In addition, industrial policy might use R&D incentives to develop or employ new technologies e.g. via research sponsored by Horizon 2020. Finally, industrial policy might use dynamic standards employing the best available technology for energy-production. Thus, a combination of research incentives and standards will contribute to reach long-term competitiveness of energy-intensive production in the EU.

3.3.6 Industrial Policy Aligned with Beyond-GDP Goals

Industrial policy is back on the political agenda. Recent academic studies claim that new industrial policy should promote competition and should be designed as cooperative game between government and companies. It has to be driven by a wider vision, instead of a standalone policy in conflict with other strands of government policy. The new industrial policy requires three new yardsticks:

- Economic performance should be measured by a broader set of goals instead of GDP growth.
- Industrial policy should downgrade or abandon the concept of price competitiveness with its emphasis on low costs.
- Industrial policy should focus on R&D, skills, ecological ambition, an empowering employment policy and excellent institutions.

The new intentions of industrial policy are still on trial. Europe's fear of losing cost competitiveness relative to the U.S. is reducing its determination to put sustainability at the 'centre stage'. On the positive side the share of renewable energy has increased strongly. But new energy sources need complementary fossil fuels and investment in the power-grid infrastructure. Europe has in principle two choices to cope with high energy prices: to go for lower energy prices itself (by exploiting shale gas or by reducing taxes on energy) or to further its lead in energy efficiency *plus* to increase investment in innovation. Given a vision of a system encompassing social and ecological goals, the only viable choice is to pursue an industrial policy to encourage energy efficiency, social and ecological innovation.

4. Regional Policy

4.1 Clusters and the New Growth Path[14]

4.1.1 Introduction and Motivation

As explained in the last chapter, clusters play an important role in the new SIIP approach in order to achieve a new growth path. The traditional analysis of clusters is concerned with the questions of why these particular types of agglomerations occur in equilibrium, and what their presence implies for economic performance, in particular for prosperity differences across locations. This chapter wants to understand whether the presence of clusters makes it more likely that the broader welfare objectives of the New Growth Path (NGP) are going to be achieved. Large parts of the paper by *Ketels and Protsiv* (2013) have an empirical focus, looking at cluster presence, cluster initiative activity, and the broader set of NGP-relevant outcomes.

Conceptually, the paper focuses on the systemic interactions between the behaviour of individual firms, driven by externalities and linkages between firms. The question is whether the presence of clusters and of cluster initiatives as a platform for collective action makes it more likely that outcomes consistent with the New Growth Path objectives are achieved. The general policy environment and the patterns of individual behaviour by companies that also drive NGP outcomes are assumed to be given.

Clusters and cluster initiatives will have an impact on New Growth Path-consistent outcomes, if they increase the likelihood that the systemic interaction between firms leads to equilibria where such behaviour is individually optimal. The key underlying hypothesis is that companies face a choice on how to compete in the market place - there are different ‘paths’ that companies and regional economic systems can take as they compete (*Aiginger*, 2012). And choosing the ‘high

[14] This section is based on *Ketels and Protsiv* (2013).

road' might be more likely if clusters provide the necessary cluster-specific common assets (public infrastructure, knowledge pools, deep and specialized input markets).

The main focus of this paper is on exploring the empirical evidence related to these ideas, and the emergence of a number of new datasets over the last few years on regional business environment conditions, cluster presence, and cluster initiative presence is exploited.

The paper is organized by three key research questions. First, it is analysed whether clusters contribute to higher productivity and wages. The correlation between agglomeration at the cluster and industry level as well as locational factors on key economic outcome factors is tested. The hypothesis is that the presence of clusters contributes positively to higher industry-level wages. The role of other location-specific factors that might influence industry-level wages is examined and the relative role of these two sets of drivers is assessed.

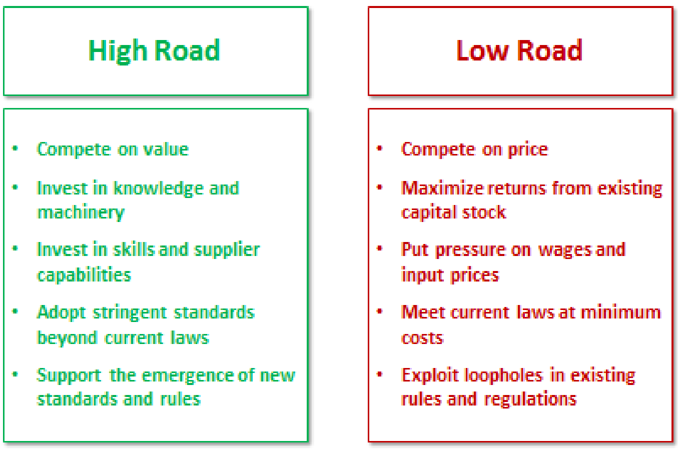
4.1.2 Empirical Findings

The paper draws on the detailed dataset from the European Cluster Observatory. The data covers all NUTS 2 regions in EU-27 countries and at its base level covers all 4-digit NACE 2.0 industries. The two key indicators are the number of employees and the average wage in each region-industry pair. A regression model using the (log of) average wage as the outcome variable and controlling for regional and sectoral fixed effects is defined. Predictor variables are narrow specialization within an industry and broader specialization within a cluster of related industries. The results show that regional and industry properties are extremely important in explaining the differences in wages in Europe. However, the coefficient for employment specialization is highly significant and suggests that the elasticity of wages with respect to employment localization in an industry is approximately 2.9% and almost twice as high for cluster specialization. These results indicate a clear relationship between wages (reflecting higher labour productivity) and the presence of strong local agglomerations in sets of related industries. Then a composite indicator for regional business environment quality (*Franco et al.*, 2011) is used to look at the effects of employment specialization at different levels of business environment quality. The cluster effects are considerably larger in the regions with top business environment; clusters enhance a region's ability to translate business environment qualities into economic performance.

The paper reveals that specialization is significantly correlated with wages. It shows that both the agglomeration in narrow industries and the agglomeration in clusters of related industries matter which is consistent with both economics of scale and scope and which is also compatible with the presence of clusters. For the New Growth Path analysis, these findings establish the importance of clusters for narrow economic performance. The conceptual framework suggests that clusters make it more likely that a high road equilibrium emerges in which companies achieve higher productivity and pay higher wages. Clusters are shown to be correlated with higher wages than specialization in narrow industries alone. This is consistent with clusters supporting a high path-equilibrium, but not conclusive: these results could also reflect standard cluster dynamics that occur in all scenarios.

To provide more clarity on this relationship, the paper adopts a regional perspective with respect to the second research question and asks what role clusters play in regions with stronger New Growth Path performance. A range of indicators widely based on economic performance, social inclusion, and environmental sustainability is deployed to profile European regions. Aggregates within each of the three categories and for the overall New Growth Path performance are created based on simple averages of the normalized values. Finally, these indicators are used to group European regions by the specific profile of New Growth Path performance across the three performance categories. The second analysis then relates these groups of regions with the presence of specific categories of clusters as well as the overall strength of their cluster portfolios. A measure of business environment quality as a driver of new growth path outcomes is included, looking at both its direct effect and its interaction with cluster presence.

Figure 4 **Cluster Characteristics and Transition**



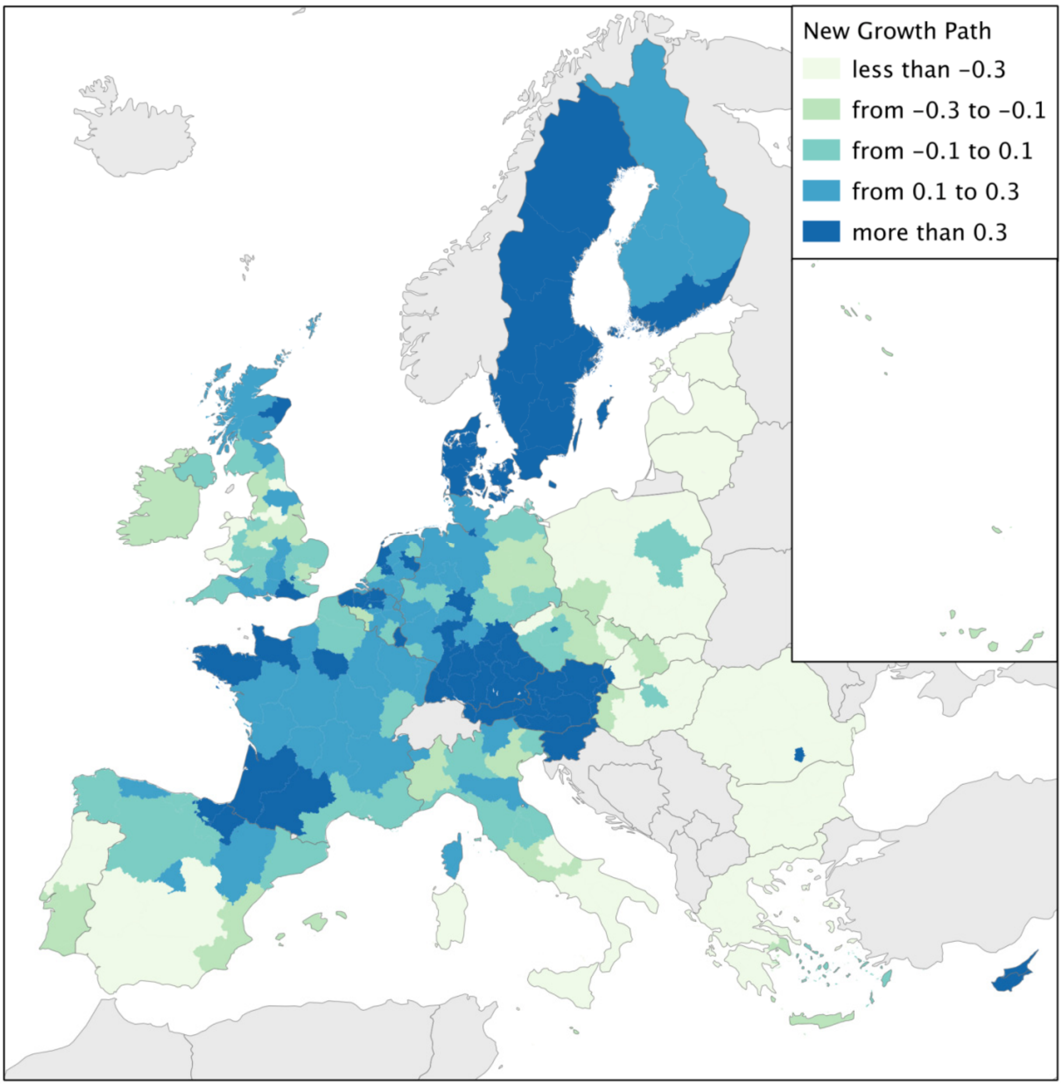
Source: Ketels and Protsiv (2013).

The New Growth Path ultimately has to affect the reality of entire locations, not just of individual clusters. The paper aims to classify subnational regions by their performance relative to the objectives outlined by the New Growth Path, and then look at the role that clusters play in relation to these different outcome patterns.

Assessing the New Growth Path performance of European regions requires quantification of each of the main pillars: economic prosperity, social inclusion and environmental sustainability. As there was no readily available regional indicator for these concepts, own definitions are constructed based loosely on the way Eurostat defines them. The three pillars are combined to obtain the overall New Growth Path indicator. The resulting pattern highlights that the strongest performers are located in Scandinavia, Central Europe and the regions around the Bay of Biscay. Perhaps the most surprising feature is the relatively poor performance of the United

Kingdom with only London, Brighton and Aberdeen in Europe's strongest quintile. Among the medium-size countries, only Sweden and Austria show consistently good performance (while Greece and Bulgaria are consistently poor). Capital regions perform much better in Central and Eastern Europe (Romania, Slovakia, Poland, Czech Republic and Hungary) but not in decentralized countries of Western Europe (Germany, Italy and the Netherlands). There is clearly meaningful correlation between the aggregate New Growth Path score per region against average GDP per Capita (PPP) per region. But there are also clear differences, especially among regions with higher levels of both GDP per capita and New Growth Path performance. This is consistent with a no road/low road/high road perspective: poor performance affects all dimensions of outcomes but good performance can be achieved through different paths that can be ranked from a New Growth Path perspective.

Figure 5 **New Growth Path Performance in EU-27**



Original Data Source: Eurostat. The values represent the deviations from the mean and the cutoff points roughly correspond to the quintiles of the distribution.

Source: Ketels and Protsiv (2013)

In the final step of the analysis, the paper explores whether there are any systematic groupings of regions based on their profile of New Growth Path-performance. A simple k-means cluster analysis of the regions according to their performance on the three dimensions is conducted.

Group 1 regions score high on all indicators. This is a relatively small group of advanced regions in Austria, Denmark and Sweden that have both reached a high level of economic performance and show New Growth path performance consistent with a 'high road' strategy. Group 2 includes a somewhat larger group of regions from the Netherlands, Belgium, Western Germany, Southern Finland, selected parts of the UK and France, and a small number of regions in Italy and Spain as well as the Bucharest region in Romania. They all also achieve high economic performance and register strong social inclusion, but fall behind on the environmental indicators. This is more consistent with a 'low road' strategy, despite the high levels of economic performance. Group 3 includes 40% of all European regions, covering most of the remaining parts of Western Europe. They perform solid and balanced across all dimensions, but seem to be more 'stuck in the middle' without clear patterns of differentiation. Group 4 regions are those in Southern Europe hit hardest by the economic crisis. They rank high on environmental sustainability but worst of all groups on social inclusion. Group 5 includes regions in Eastern Europe most clearly on a healthy catch-up path. Their economic performance is still relatively low, but social inclusion is better than in groups 3 and 4, suggesting that growth is reaching most parts of society. Economic sustainability is higher than in groups 2 and 3, most likely because of the still lower level of economic activity. Group 6 includes those regions in Eastern Europe were the catch-up dynamics have not developed in the same way. Economic performance is lower than in all other groups and social inclusion even worse. Environmental sustainability is more positive, but also just a reflection of low economic activity.

With regions profiled by their New Growth Path-performance, the impact of cluster strength and other factors on these outcomes is analysed. As a regional cluster strength indicator, the share of regional payroll earned in strong clusters is calculated. The authors also include a measure of business environment quality, and indicator of urbanization, and a dummy for the EU-12 countries as a proxy for the overall level of institutional and economic development that countries have reached.

The measure of cluster portfolio strength is in all specifications of the models significantly related to the NGP indicators, with the exception of social inclusion. The effect is predictably strongest for GDP where doubling cluster portfolio strength is associated with a 21% increase in GDP per capita. Nevertheless, this strong effect persists when other prosperity measures are taken into account, suggesting that cluster performance and economic prosperity are related. This is not the case for social inclusion, even though social inclusion is rather strongly related to the prosperity indicator. This suggests that the variation in social inclusion is mostly explained by other factors rather than cluster portfolio strength. A more careful examination reveals that indeed social inclusion is very strongly positively related to business environment quality. Interestingly, the situation is reverse with the sustainability indicator: cluster portfolio strength is very strongly related to sustainability (positively) as is urbanization (negatively), while business environment has no role. Finally, the relationship between the strength of the cluster portfolio and the overall New Growth Path composite is positive and significant.

The paper shows large performance variations across European regions. Even among the more prosperous regions of Western Europe there are clear differences in New Growth Path-performance. One group of regions performs high on all dimensions of the New Growth Path, while another group of regions suffers from low social inclusion and/or weak environmental sustainability. In the catch-up regions of Eastern Europe, one group of regions combines growth with solid social inclusion but often lower environmental performance. The other group of regions shows the opposite pattern. Business environment conditions and cluster presence as possible drivers of New Growth Path performance are found to have an impact on New Growth Path performance, with the strongest direct link to the narrow economic performance indicators.

For the New Growth Path analysis, these findings are at the regional level consistent with the notion of multiple equilibria as the High Road/Low Road-framework proposes: For the same level of economic performance, regions register different levels of broader New Growth Path outcomes. These findings also suggest that cluster presence, as well as business environment quality, is positively associated with higher economic performance and stronger New Growth Path performance. The effect is largely driven by the impact on economic performance, not on environmental sustainability or social inclusion. Given the measures available, this is not entirely surprising: they are likely to be driven much more by a combination of policy choices, inherited endowment effects, overall levels of economic performance. The economic performance analysis suggests that clusters might indeed enhance the likelihood of high road equilibria to emerge. But the broader New Growth Path data is not sufficient to test whether a high road equilibrium is also reflected by higher environmental sustainability and more social inclusion.

4.1.3 The Role of Cluster Initiative for a New Growth Path

The third research question is whether cluster initiatives contribute to New Growth Path performance. Each cluster initiative is described by its region, the cluster category in which it operates, and whether or not its activities are related to environmental sustainability or social inclusion. Possible drivers of the presence of cluster initiatives in particular regions are explored, particularly existing ‘social capital’. The second analysis tests the impact of cluster initiative presence alongside business environment quality and cluster portfolio strength on NGP-goals.

Cluster initiatives are a platform for the type of collective action within clusters that the papers framework suggests might support the emergence of high road equilibria. The key source of cluster initiative data is the European Cluster Observatory. It covers more than 2000 organizations overall, with the vast majority of them within Europe.

Norra Mellansverige (Sweden), Namur (Belgium) and Luxembourg are the top performers by the number of cluster initiatives per million inhabitants. Cluster efforts are most common in Information Technology, followed by biotechnology and automotive. Cluster categories with the most cluster effort include a number of relatively small sectors, such as biotechnology, aerospace and medical devices. Normalizing the number of cluster initiatives by the number of employees in Europe in a sector yields a staggering number of 718 initiatives per million employees in biotechnology (or one initiative per 1400 employees), and this number is likely biased downward as the database of initiatives the authors used is incomplete. Other top sectors include aerospace, energy and IT, where there is approximately one organization per 10 thousand employees.

Both business environment quality and cluster portfolio strength are strongly positively related to the presence of cluster efforts. Including social capital as the only business environment related predictor in the model reinforces the idea that it is a significant predictor of the presence of cluster efforts. However, these measures only explain 18% of variation in the presence of cluster efforts suggesting that there are other variables missing from the model. The strongest candidate is the extent to which government is focusing on cluster development in a particular region.

As part of the systematic review of cluster organization websites, the information they report about their activities and classified them with respect to their relatedness to environmental sustainability and social inclusion are analysed, namely having each as (i) their primary activity, (ii) side activity or having a related project participation and (iii) not related to environmental sustainability and social inclusion at all. About 40% of all cluster initiatives have environmental sustainability as their primary or side activity. Only in Cyprus, Greece and Lithuania there were no organizations operating in environmental sustainability in the database. This brings the average per country ratio to 30%, and, excluding Malta’s only cluster, to about 25%. On the opposite side of the spectrum, top performers with both the average amount of clusters concerned with environmental sustainability and the average share of those clusters above the mean, are Denmark, France, Germany, Spain and Sweden.

Subsequently, the relationship between the measures of business environment, cluster portfolio strength and cluster effort with regional outcomes is examined. As the authors move from GDP per capita to broader measures that encompass sustainable development, business environment quality becomes less important as a driver, while the presence of cluster efforts becomes relatively more meaningful.

More detailed analysis at the cluster level suggests that once the strength of cluster effort is included in the model together with cluster specialization, it appears to have a weak negative influence, while its interaction with specialization has a strong positive impact. These results suggest that the presence of cluster initiatives only has positive impact on wages when the underlying agglomeration is strong. In weak clusters, cluster efforts are more a sign of government action, and this the data suggests is biased towards regions where wages are systematically lower.

Hence the paper finds clear differences in cluster initiative intensity across regions and cluster categories. At the regional level, differences in social capital but also cluster portfolio strength have an impact on the likelihood to find cluster initiatives. However, other factors – presumably often related to government policy- explain a much larger share of cross-regional variation in cluster initiative presence. About 40% of all cluster initiatives report significant activities related to New Growth Path-objectives, in particular environmental sustainability. Finally, when including cluster initiative presence in the empirical framework for explaining New Growth Path-performance at the regional level, a significant correlation for the broader New Growth Path measure but not for narrow economic performance is found. For the New Growth Path analysis, these findings have two core implications. First, cluster initiatives are a platform for collective action that is widely used to pursue goals in line with the New Growth Path, in particular environmental sustainability. This suggests that as a policy tool at least cluster initiatives have potential. It is also consistent with the conceptual framework that suggests clusters to provide an environment where the collective action needed to purse High Road strategies is more likely to emerge. Second, cluster initiatives are across all regions not significantly correlated with prosperity but with the other aspects of the New Growth Path. There are two possible explanations: Either cluster initiatives do indeed lead to collective action that enhances environmental sustainability and social inclusion. Or cluster initiatives are more likely to be initiated in regions that also more aggressively push for these New Growth Path objectives through other means.

4.1.4 Summary and Conclusions

The paper finds that average wages are positively and statistically significantly affected by the presence of clusters. This suggests that specialization does indeed play a role in driving economic performance. Also three other factors, i.e. industry concentration, location-specific fixed effects, and industry-specific fixed effects have an impact as well. Industry fixed effects are a reflection of differences in industry features like capital- and knowledge intensity. Location-specific effects point towards the importance of business environment conditions that vary more by the overall stage of development of the location than the specific cluster or industry within the location. Industry concentration effects can be a reflection of the narrow economies-of-scale specialization that the hypothesis suggests is more likely to drive low path-behavior. The fact that wages benefit from industry-level specialization but benefit even more from strong clusters is consistent with this view.

Moreover, there are significant differences in New Growth Path performance across European regions. More specifically for regions of comparable levels of prosperity the paper shows significant variations in both social inclusion and environmental sustainability. This suggests that there are indeed different paths of competing, and that these paths are relevant at different levels of economic development. For prosperous regions, there are three subgroups: High performance on all categories; high performance with the exception of environmental sustainability, and overall weaker performance on all indicators. This is consistent with a High Road strategy in the first group, a Low Road strategy in the second group, and weaker performance in the third. For less developed regions, the key differentiator is social inclusion. Regions on a robust catch-up path generate opportunities to ensure social inclusion but often at a cost to environmental sustainability. Regions struggling to catch-up also suffer from social challenges; their better environmental performance seems due to a lack of economic activity. While the gap between high and low prosperity largely separates western and eastern Europe, the gap between high and low path strategies largely separates northern and southern Europe. Within large countries, there are significant differences that do not follow these broad geographical trends. The paper shows that economic performance is driven by both business environment quality and the strength of the regional cluster portfolio. The impact on other aspects of New Growth Path performance is visible, even if it is less pronounced. This could as well be an artefact of the limited data available than of a genuinely lower impact of cluster presence on these performance dimensions.

There are also significant differences in cluster initiative presence across regions and cluster categories. A remarkably high share of cluster initiatives to be engaged with New Growth Path-consistent activities is found, in particular with respect to environmental sustainability. Cluster initiative presence is more likely for higher levels of regional social capital and cluster portfolio strength; other factors, in particular policy choices, are relevant as well. The presence of cluster initiatives is positively correlated to better New Growth Performance-performance at the regional level. It is, however, not significantly correlated to prosperity differences which are driven by business environment quality and cluster portfolio strength. This could indicate that cluster initiatives are a tool to extend performance into non-prosperity related fields. Alternatively, it could also indicate that regions that politically support many cluster initiatives also push harder to achieve NGP-goals.

4.2 Technology Platforms in Europe[15]

4.2.1 The Role of Technology Platforms for Innovation Policy

This section reviews the policy and scholarly literature on general purpose technologies (GPTs), key enabling technologies (KETs) and technology platforms. Drawing on this it introduces and discusses the main elements characterising technology platforms and the specific qualities of the underlying technology which are subsequently empirically tested.

Technological integration and synthesis has held a most important place within the literature on innovation and technological change. The paper by de *Propris and Corradini* (2013) identifies two main processes through which technological integration and synthesis may take place. The

[15] This section is based on *De Propris and Corradini* (2013).

first is related to the expansion of firms' absorptive capacities through technological diversification, whereas the second is related to the presence of enabling technologies. Broad-based knowledge capabilities act as a platform enabling the expansion and the diversification of firms' technological trajectory in derived technologies along a wide range of new opportunities. Hence, they increase the level of potential exploration and reconfiguration of existing knowledge into new fields of research, allowing for a more fruitful exploitation of firms' combinative capabilities. Although technological diversification represents an important strategy for the horizontal exploitation of technological opportunities across the innovation environment, it requires resources and competencies that are often scattered across heterogeneous and dissimilar companies. In this sense, the creation of new technological paradigms resulting from the integration of 'distant' innovative capabilities requires a wider set of different actors to trigger the positive feedbacks that generate technological progress and economic growth. These may encompass public research institutions undertaking basic research, large incumbent firms and new technology-based companies, communicating together through a common, coherent knowledge base.

The paper argues that the key feature of technology platforms is a broad technological base characterized by high technological dynamism generating positive technological externalities across a wide range of sectors, thus yielding increasing returns to scale in the output of the innovation system. In other words, those key enabling technologies that underpin technology platforms can also generate increasing returns to R&D and a 'cascade' effect on all technologies pegged to the platform - similarly to the disruptive effect of the adoption of GPTs as technological applications across the wider economy.

Technology platforms increase the opportunities that companies might have to learn from distant technologies, and to exploit complementarities across a wide range of technological fields that are connected through a common enabling technology. Similarly, they increase the likelihood of inter-sectoral cross fertilisation to take place, thus generating new possible directions for current technological trajectories. In other words, technology platforms developed around KETs may play a fundamental role in sustaining communication across diverse technological fields, generating high levels of dynamism and pervasiveness through processes of 'innovational complementarity' and innovation synthesis.

The discourse associated with technological platforms is clearly associated with another level of analysis rooted in a spatial perspective. Therefore technology platforms are comparable to clusters but not to the same extent, as high-tech clusters and districts might be argued to comprise an external technological platform defining the contours of the cluster's technological proximity. With respect to technology platforms, one important difference is identifiable: while high-technology clusters are usually defined in terms of sectoral proximity, the distinctive element in the agglomeration effect defined by the presence of a technological platform is the underlying core technology, around which spillovers arise and are exchanged. As *Maurseth and Verspagen* (2002) have shown, knowledge spillovers in Europe are often confined within a national dimension. Thus, innovations that are based on 'distant' technologies may have a higher likelihood of success if the knowledge required for their development is characterized by a geographical proximity.

4.2.2 Empirical Results

Building on that theoretical foundation the paper develops two hypotheses, which are empirically tested. First, KETs exert a positive effect on the likelihood to develop more original technologies and second, innovations which are spatially related are more likely to foster the development of original technologies.

The empirical analysis is based on patent data from the EP-CRIOS1 database covering all patent applications made at the European Patent Office (EPO), whose priority date is comprised in the period between the year 1996 and 2006 included. Focusing on all patent applications for all 27 member countries of the European Union, the sample obtained accounts for 490,444 patent applications.

The IPC classes with the highest percentage of patenting across the EU are class 3 (Telecommunications) and class 7 (Technologies for Control/Measures/Analysis), followed by class 1 and class 27 (respectively Electrical engineering and Transport technology). Conversely, lower values are presented by class 9 (Nuclear technology), class 8 (Space technology) and 21 (Environmental Technologies).

Interestingly, the authors observe significant differences across the selected countries. For example, Germany presents higher specialization in sectors such as Transport technology and Technologies for Control/Measures/Analysis, while France is stronger in Telecommunications and Electrical engineering. The UK is also strong in Technologies for Control/Measures/Analysis, but it also shows strong specialization in Biotechnologies and Pharmaceuticals. Quite different is the case of Italy, whose higher values are associated with Handling and Printing technologies, Consumer goods and Civil engineering. Other countries are even more specialized. Sweden, for example, holds almost a quarter of all its patent in the Telecommunications class, while for Finland this value goes up to around 40%. For the Netherlands, more than a third of all patents are in classes 2, 3 and 4.

The empirical model to test the hypotheses deploys as dependent variable a well-established measure of the sector dispersion of a patent's backward citations following *Trajtenberg et al*. (1997). This measure represents patents escaping the path dependency inherent to the cumulative nature of technological change as dependent variable and can be seen to capture 'shifting technologies' that broaden the spectrum of the technological frontier. Such patents can also be related to original and more radical innovations.

The dependent variable is explained by the presence of key enabling technologies, the degree of internationalization of technology flows in the development of technology platforms, the number of inventors that registered the patent, the coherence between the patents, the technological diversification among applicants and their R&D intensity (measured by an applicant's patent stock), whether the patent is owned by an university or a not for profit Government organizations (GNP) and further control variables capturing the quality of a patent by using information on the backward citations included in the application.

The descriptive analysis reveals that there is a medium-high negative correlation between technological coherence across backward citations and the level of generality among these, indicating that patents that are based on distant technologies tend to rely on technologies that are characterized by a broad technological applicability. As expected, there is a positive correlation between knowledge stock and the level of technological diversification, while a negative correlation is present between coherence and originality.

The regression analysis, which applies a fractional response model suggested by *Papke and Wooldridge* (1996), is carried out for all available EU countries and for single countries respectively. The estimates for KET are in line with the first hypothesis that key enabling technologies are positively related to the development of more original patent applications, with the relative coefficients being positive and statistically significant across all countries and also in single country estimations. In other words, even after controlling for patents' technological class and coherence across backward citations, patents based on general technologies - or KETs - are significantly more likely to be original and to integrate components from a wider range of different technologies. Such technologies can be regarded as exerting a binding effect that may ultimately lead to technological shifts or innovation cascades.

The role of the internationalization, that is, the proportion of citations from countries other than the one of the citing patent, presents a mixed picture with different coefficients across the countries analyzed. In particular, for Germany and Italy is positive and significant, while for Sweden is significant but negative. Such results are likely to be related to both the characteristics of the specific national systems of innovation and to the sector specialization or diversification of the technological base in such countries. Overall, the paper does not find convincing evidence of a European innovation system.

The remaining control variables behave as expected. The authors find a general positive effect in the presence of a larger team of inventors, a negative sign for the coherence between the patents and a positive one for the technological diversification among applicants. With respect to these variables, the findings confirm that patent applications which are based on innovations characterized by a closer technological base are less likely to be more original in nature. Conversely, companies that are able to engage in different technological avenues present a higher likelihood of being able to benefit from and integrate distant technologies, thus developing more original innovations.

The role of university and GNP patents is less clear cut. While for the EU overall the coefficient is statistically significant for both categories, Germany and France are the only countries where these variables present a positive and significant effect, GNP patents for the former and university's patents for the latter. Again, such differences might be explained in terms of different national systems of innovation. At the same time, these findings may also suggest that the level of originality usually associated with universities' patents depend more on their ability to use general technologies, or KETs, in their innovation processes. In other words, the function of public research in developing more original technologies lies in its ability to use and integrate enabling technologies within its innovation activity. This is supported by the findings on the mean value of KET across different types of applicants and the estimates from the multivariate analysis where universities and GNP organizations are found to show a much higher coefficient for KET than private companies.

The paper extends the analysis to the role of a technology platform that may be one of the most interesting technologies in terms of both sustainability and long-term innovation impact that is environmental technologies. The dependent variable is substituted with a dichotomous variable representing whether the patent cited is a green technology. In other words, the paper studies whether the use of KETs may increase the likelihood of integrating green technologies in the development of innovation in other sectors.

The descriptive statistics show that the development of environmental technologies is characterized by a strong regional dimension, with four macro regions accounting for the majority of applications in this IPC class. These include the southern regions of Finland and the area around Helsinki, south-western Sweden, the district of Paris in France, the region between the Netherlands and the western part of Germany as well as Bavaria.

With respect to inter-technology knowledge flows, environmental technologies are characterized by a wide web of linkages with all other ICP classes. However, as for all technologies, some sectors are more important than others. Two classes are particularly important. These are Technical processes (chemical, physical, mechanical) – IPC class 18 – and Engines/Pumps/Turbines –IPC class 24. Materials/Metallurgy (IPC 14) and Basic Chemistry (IPC 12) are relevant also.

The regression results again show the coefficient for the KET variable to be positive and statistically significant across all specifications, representing respectively estimates for the EU as a whole and for the selected countries. This provides evidence in favour of the hypothesis that KETs enhance ‘shifting technologies’ and resilience. The other estimated coefficients are similar to those observed in the previous model.

4.2.3 Summary and Policy Implications

This paper addresses the central question of how technological innovations can be supported to contribute to EU competitiveness – socio-economic sustainability. This relates to what policy can be designed and what actors can be mobilized to support such technological shifts so as to reset and sustainably foster EU growth. To this end, the paper has addresses related issues such as: what innovation process generates more original technological innovations? How technological innovations can generate shifts in the technological trends? What integrated policy can drive the anchoring of the anchoring of technology platforms in Europe and how these can propel the technological upgrading of EU firms? The paper investigates the role played by technology platforms in enhancing cross-fertilisation across different technological domains, thus fostering the development of more original and radical inventions that combining a number of different but related technologies enables inter-sectoral cross-fertilisation or technological trajectory leapfrogging.

The results have relevant policy implications. In particular, they suggest that technology platforms play an important role in fostering technology flows across sectors, ultimately leading to the emergence of innovation that are more radical in nature and that may lead to technological breaks and leapfrogging on new technological trajectory.

Concrete policy recommendations can be formulated on three levels. Firstly, universities and governmental not-for-profit organizations play a crucial role in integrating a wide range of technological patents and by using them to produce also more radical innovations. The results confirm findings of previous studies, that is, the higher level of originality and generality of patents developed by universities and governmental not-for-profit organizations. More interestingly, the crucial role public research institutions play in terms of technological synthesis and radical innovation lies in their higher propensity to effectively adopt and use KETs within their innovation activity. For this reason, the results seem to suggest that public funded research may play a key role in driving radical innovation, acting as a boundary-spanner in connecting, translating and integrating different technological knowledge. This would seem to suggest that the Europe 2020 commitment to pushing R&D investment to 3% of GDP is crucially important to enable the EU to either maintain or gain a leading position in new technologies. Related to that, public government spending in R&D may be important for two additional reasons: firstly, to signal companies the direction of their private R&D investment in a sort of risk-sharing bonding, and secondly, to inject original innovations in the wider innovation system from which firms can cherry-pick technologies they need to be competitive in the market.

In addition, from the EU-wide patent database the paper derives which technologies can be intrinsically defined as enabling technologies. These are those with higher level of generality (e.g.: > 0.5), including Organic chemistry (10), Macromolecular Chemistry (11), Surface technology (13), Biotechnology (15), Technical processes (18) and environmental technologies (21). These technologies are able to generate a spawning of patents spreading across different technological fields and for this reason they are enabling technology with the potentials to enhance the innovative capacity of other sectors. These technologies can be considered the root of a number of derivatives and applications that trickling down the innovation process will in the end produce products and services that will satisfy the changing needs of our society from aging to pollution. It is desirable for Europe to have a grip on such enabling technologies and to embed the latter in technology platforms that are located in European regions. Regional spillovers will work to diffuse such innovations across embedded regional innovation systems.

Finally, the paper has singled out patents related to green technologies and found that these have a stronger impact on sectors such as Technical processes (chemical, physical, mechanical), Engines/Pumps/Turbines, Materials/Metallurgy and Basic Chemistry. Hence, the paper offers empirical evidence that the use of KETs may enhance the integration of green technologies within innovations across related and unrelated technological classes.

5. Employment Effects of Ecological Innovations

5.1 Green Employment Creation Resulting from Transition to Renewable Energy Supply – A Meta-Analysis of Existing Literature[16]

5.1.1 Introduction

With respect to the labour market, Europe and the world are facing stagnating economies accompanied by high and rising unemployment rates, particularly among young people. Youth unemployment rates in Europe reached 23.5% in the first quarter of 2013, more than twice the rate for the overall population. In some countries, more than half of young people under the age of 25 are unemployed (*European Commission*, 2013a).

These socio-ecological developments suggest a mismatch with the objectives of a sustainable economy that would be characterized by environmentally benign and socially inclusive production and consumption patterns securing long-term progress of societies. Given the requirement to de-carbonize the current energy system and given the challenges of overcoming the economic downturn and increasing employment shares, the concept of a "green economy" was laid down by the United Nations Environment Programme (UNEP) in late 2008 and has become a topic of international institutions and research agendas.[17] It is defined as low in carbon, resource-efficient and socially inclusive. The transition towards a green economy requires private and public investments to reduce GHG emissions and pollution, enhance energy and resource efficiency, prevent the biodiversity loss and to provide ecosystem services that generate growth in income and employment (*UNEP*, 2011). Advocates argue that transitioning to a green economy will also have positive economic impacts. The expected economic benefits are important additional arguments for public engagement in long-term climate mitigation policies; though they should be considered as co-benefits of environmental policies and not as their mayor target.

Meyer and Sommer (2014) summarized the economic impacts from transitioning to a low-carbon economy by focusing on (net) employment effects from renewable energy deployment using a meta-analysis. The paper concentrates on renewable energy technologies and thus on mitigating climate change. All remaining environmental challenges of transitioning to a green economy such as material consumption and waste deposition, however, are not considered.

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[16] This section is based on *Meyer and Sommer* (2014)

[17] The OECD embarked on a "Green Growth Strategy". According to the OECD, green growth means "…fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies" (*OECD*, 2011). The OECD approach also relates to the term "planetary boundaries" in order to refer to the space in which growth must take place (*Rockström et al.*, 2009). The Europe 2020 strategy, in turn, addresses smart, sustainable and inclusive growth (*European Commission*, 2010a). The Asian strategy on green transition and innovation (*AASA*, 2011) shall be mentioned as well. All of these approaches are similar in their future strategic realignment of economic policy towards sustainability. The green economy was a focal point of the UN conference on sustainable development in Rio 2012 (Rio+20).

Renewable energy as a core strategy for mitigating climate change

Renewable energy sources (RES) and technologies play a crucial role in mitigating climate change and providing energy services such as light, space heating, mobility, communication and production processes (IPCC, 2011). Multiple technologies and types of renewable energy from solar, geophysical (wind, water) or biological (biomass) sources are becoming increasingly cost-effective. They can supply electricity, thermal energy and mechanical energy as well as liquid fuels, while lowering greenhouse gas (GHG) emissions from the energy systems. RES release little or no additional direct CO_2 emissions.[18] The combustion of fossil fuels, in contrast, was responsible for 56.6% of all anthropogenic GHG emissions (CO_{2eq}) in 2004 (*Rogner et al.*, 2007). On a global basis, RES accounts for 13% of total primary energy supply but this share varies substantially by country and region (2010, IEA data base). While the contribution of RES to the primary energy supply is still rather small, it has increased rapidly in recent years[19]; a development that is also due to the fact that residential, industrial and commercial energy consumers are increasingly becoming producers of renewable power in a growing number of countries (*REN21*, 2013). The global potential of RES greatly exceeds both current energy use and the projected future global energy demand. Among RES the technical potential of solar energy is highest (*Moomaw et al.*, 2011). Thus, there is no limit to the continued market growth of RES technologies. However, due to the public good character of climate protection and due to the fact that RES technologies are competing with low cost fossil fuels such as coal and natural gas, and in particular unconventional oil and gas, the transition to a low-carbon energy system requires strong government initiative, a stable political framework for investments and private engagement.

Green Employment: A Concept in Transition

Green employment represents a keystone of transitioning to a green economy. In particular, green jobs are "...positions in agriculture, manufacturing, construction, installation, and maintenance, as well as scientific and technical, administrative and service-related activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect and restore ecosystems and biodiversity, reduce energy, materials and water consumption through high-efficiency and avoidance strategies, de-carbonize the economy and minimize or altogether avoid generation of all forms of waste and pollution" (*UNEP et al.*, 2008).

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[18] This refers to the operation of renewable energy technologies. For evaluating the production process of RES it is, however, important to consider emissions and energy consumption during the entire life cycle. For instance, in photovoltaic panel production the transformation of metallic silicon into solar silicon is highly energy consuming and the panel assembling is characterized by the use of aluminium frame and glass roofing which are very energy-intensive materials. However, the energy pay back time is estimated to be shorter than the panel operation life time, so that photovoltaic electric production is advantageous for the environment (*Stoppato*, 2006).

[19] In 2012, the worldwide renewable power capacity grew by 8.5%, exceeding 1,470 GW in 2012 (*REN21*, 2013). Hydropower accounted for 990GW (+ 3%), while other renewables account for 480 GW (+21.5%). Globally, wind power accounted for about 39% of renewable power capacity added in 2012, followed by hydropower and solar PV (26% each) (*REN21*, 2013). Renewables made up just over half of total net additions to electric generating capacity from all sources in 2012.

This qualitative description delivered by UNEP allows for a broad range of green employment, but it does not give a clear and precise definition. A coherent systematic approach for different categories of green jobs that could be commonly applied and statistically measured is still missing. Gathering information on green jobs though is essential for enabling informed policy choices and monitoring policy effectiveness. It also helps with communicating the benefits of greening the economy to a wider public.

One problem why green jobs are not well-captured in statistics is because they cut across different sectors of the economy. Examples for such cross-sectoral industries are the environmental goods and services industry (*Eurostat*, 2009) or the tourism industry (*Eurostat et al.*, 2001). Generally, data on green employment are available for certain segments, such as specific industries or countries, but they tend to be a snapshot rather than representing consistent time-series and to be estimates more than firm figures (*Eurostat*, 2009, *IRENA* 2013). One of the challenges is thus to characterize and typify green jobs in order to develop a meaningful statistical concept. Some examples may illustrate the endeavor to find coherent measures on green employment that are universally applicable (following *UNEP et al.*, 2008):

- Efficiency improvements are a core requirement for a transition to a low-carbon economy. However, employment in new technologies, business practices or shifts in professions that yield improved energy efficiency are difficult to separate from regular employment, as they occur in existing industries and achieve the same economic output and level of well-being but with less energy. In addition, efficiency is a relative and dynamic concept. Today's efficiency can become marginal tomorrow as technology and efficiency standards advance.

- The production of environment-related technologies often labeled "environmental industries" or "green tech" is considered to contribute to a low-carbon and green economy. These technologies span a broad spectrum of products and services that use new, innovative technologies to create products and services with less of a detrimental impact on the environment. Pollution control and end-of-pipe technologies constitute a substantial part of this concept. However, it is not clear whether employment related to pollution control technologies shall be considered "green" because these technologies remain part of a resource- and waste-intensive economy. The transition toward a low-carbon, green economy requires a more fundamental shift away from energy and material consumption. The importance of downstream environmental clean-up and protection technologies is in fact decreasing in developed countries, while at the same time the importance of resource-saving technologies like renewable energy, energy efficiency and recycling is growing (*Jänicke*, 2012).

- Newly emerging sectors such as renewable energy production lack long-track empirical data. Relevant employment data is either derived from industry surveys or from macro-economic/econometric modeling, based on input-output (I-O) tables that capture direct and indirect employment, in order to estimate net employment effects.

The green employment concept thus remains fuzzy. As technology progresses different standards of what is "green" and what is defined as "low-carbon" will apply. A realistic and pragmatic approach is therefore process-oriented and remains open for new technologies in different sectors of the economy. As a guiding principle to quantify green jobs, the transition towards a low-carbon, green economy would involve the following employment shifts:

- additional jobs being created,
- some employment being substituted,
- some jobs being eliminated without replacement, and
- many existing jobs being redefined as greened skills, methods and profiles.

In order to evaluate the quantity of green jobs reported it should be indicated whether these relate to gross or net employment effects. Other categorizations of green jobs refer to direct, indirect and induced employment effects. Investments in environmentally-friendly economic activities generate a certain number of direct and indirect jobs from intermediate supply, while induced jobs are created through additional consumer spending from direct and indirect job earnings. However, it remains an open question whether induced jobs shall be considered "green". If the additional income is spent on energy- and material-intensive goods and services, the induced employment effect compensates environmental gains derived from direct and indirect green employment and therefore should, in principle, not be considered green ("employment-income rebound"). However, such qualitative distinctions have not yet been made in modeling green employment effects from renewable energy deployment. But induced income effects play a critical role in the literature with respect to re-spending money savings from energy efficiency gains and are known as energy rebound (*Antal and van den Bergh*, 2014). In this case, re-spending from money savings may stimulate new energy uses that partly offset the original savings. Another useful distinction of job categories is the stage of job creation within the life-cycle of the resource or energy saving technology. Whether jobs are created in R&D, production, construction and installation or in operation and management (O&M) is relevant because production may take place abroad while O&M stays within a country.

Finally, a central guiding question in defining green jobs is whether investment in environmentally benign technologies is more/less labour intensive and results in more/less pollution per unit of spending than investment in alternatives. The reduction in GHG emissions from investment in low-carbon technologies should be substantial and not merely marginal in order to be deemed "green". Therefore, one approach towards establishing a "green economy" is to place a stronger emphasis on improving resource productivity rather than labour productivity.

5.1.2 Renewable energy deployment and job creation

The renewable energy industry has grown rapidly in recent years. It addresses solar power, solar thermal energy (water heating), wind, small scale hydro power, geothermal energy (heat and power applications) and bioenergy (biomass for heat and power generation as well as transportation). According to the IRENA 2013 report, the majority of renewable energy employment is concentrated in China, Brazil, the EU, the US and India (see Table 1).[20] These countries are the biggest manufacturers of renewable energy equipment, producers of bioenergy feedstock and installers of production capacity. However, other countries are following by boosting their investments and policies in support of renewable energy deployment, thereby creating jobs, mostly in O&M activities.

Employment trends vary across renewable energy technologies. The increase in biofuel capacity leads to employment creation, in particular with respect to biomass feedstock production. Cultivation and harvesting of biomass feedstock is more labour-intensive than other technologies, however, mechanization of feedstock operations reduces labour needs. Jobs in solar photovoltaic energy have surpassed those in wind in the last three to four years, with about 1.36 million direct and indirect jobs created worldwide. A key driver for this dynamic uptake has been the substantially lower costs of solar panels, which triggered a boom in installations and consequently in O&M. Chinese companies have become the world's largest PV manufacturers, with 300,000 people employed in this sector. Solar heating and cooling account for about 800,000 jobs, and China is by far the world leader in solar hot water with more than 80% of global installations. With 37.000 jobs concentrated solar power (CSP) is still in its infancy compared to solar PV and solar water heating. Spain and the US currently lead the market for CSP with 76% and 20% of global installed capacity, respectively. The Middle East and North Africa region is emerging as an attractive market for CSP deployment driven *inter alia* by the motivation to create local employment opportunities. Employment driven by growing wind energy capacity has more than doubled between 2007 and 2012. Europe has long been the leader in wind energy, both in the manufacturing of wind turbines and parts and the development and operation of wind energy in the region. Yet the industry has quickly been expanded to other parts of the world. In 2012, China and the US installed the majority of added wind energy capacity, surpassing Germany and India. Other countries such as Japan, Australia, Brazil and Mexico are steadily increasing their wind energy capacity as well, creating employment in this area.

[20] The IRENA 2013 report assembles information from a wide variety of publicly available reports, studies and databases originating from literature by government ministries, international agencies, industry associations, non-governmental organizations, consultancies and academic institutions.

Table 1 **Employment in Renewable Energy for Selected Countries/Regions**

	EUROPEAN UNION (EU)							
	GERMANY	SPAIN	OTHER EU	UNITED STATES	CHINA	INDIA	BRAZIL	WORLD
	1,000 jobs							
Biomass	57	39	178	152	266	58	.	753
Biofuels	23	4	82	217	24	35	804	1,379
Biogas	50	1	20	.	90	85	.	266
Geothermal	14	0	37	35	.	.	.	180
Small Hydropower	7	2	18	8	.	12	.	109
Solar PV	88	12	212	90	300	112	.	1,360
CSP	2	18	.	17	.	.	.	37
Solar Heating/Cooling	11	1	20	12	800	41	.	892
Wind Power	118	28	124	81	267	48	29	753
Total	370	105	691	612	1,747	391	833	5,729
	Percentage of World							
Biomass	7.6	5.2	23.6	20.2	35.3	7.7	.	100
Biofuels	1.7	0.3	5.9	15.7	1.7	2.5	58.3	100
Biogas	18.8	0.4	7.5	.	33.8	32.0	.	100
Geothermal	7.8	0.2	20.6	19.4	.	.	.	100
Small Hydropower	6.4	1.8	16.5	7.3	.	11.0	.	100
Solar PV	6.5	0.9	15.6	6.6	22.1	8.2	.	100
CSP	5.4	48.6	.	45.9	.	.	.	100
Solar Heating/Cooling	1.2	0.1	2.2	1.3	89.7	4.6	.	100
Wind Power	15.7	3.7	16.5	10.8	35.5	6.4	3.9	100
Total	6.5	1.8	12.1	10.7	30.5	6.8	14.5	100

Data: IRENA (2013); Data are mostly from 2009-2012, the last column is derived from the world totals of employment. CSP: concentrated solar power.

Source: Mayer and Sommer (2014).

For most countries data on renewable energy employment are only available for a single year or for scattered periods of time, limiting the conclusions that can be drawn about trends and dynamics in renewable energy technology deployment and their respective regional applications. However, Germany, Spain and the US have been the global renewable energy pioneers from whom lessons can be learned in several respects. Until recently, renewable energy supply and installed capacity were expected to continue to grow, fostered by a constant flow of investments and policy support. However, their recent performance has been mixed due to reduced public financial support as a result of the financial and economic crisis and due to declining costs of renewable energy technologies that undermine the rationale for financial support (*IRENA*, 2013). Changes in the global PV market, e.g., have lowered module and cell production in European countries, resulting in a loss of 23.000 jobs in Germany and 20.000 in Spain. The US also saw a decline in the share of total solar employment in manufacturing from 36% to 25% between 2011 and 2012. Meanwhile, manufacturing shifted towards Asia (China, India) where almost 86% of global solar module production took place in 2012. Thus, pioneering countries are confronted with rising international competition in production and trade. In contrast to employment in manufacturing, employment in installation and O&M is localized and less sensitive to shifts. In total, the renewable energy sector withstood the latest financial and economic crisis more successfully than other industries (*IRENA*, 2013). Renewable energy has become a relatively mature economic sector with steady technological progress, falling production costs and rising labour productivity.

What are the prospects for future employment in the renewable energy sector? *Greenpeace et al.* (2013) offer global “Energy [R]evolution” scenario projections for renewable energy employment in 2015, 2020 and 2030. Global employment in renewable energy, including direct jobs in manufacturing, construction and installation, O&M, and domestic fuel supply, will evolve from 7.9 million jobs in 2010 to 12.2 million in 2015 and, 13 million in 2020. It is therefore expected to grow by 65% between 2010 and 2020. At the end of the projection period, increased labour productivity is expected to outweigh additional growth in renewable energy, reducing the number of jobs to 11.9 million in 2030. It is still not clear to which extent renewable energy and low-carbon employment can go beyond fossil and nuclear fuel based energy production, since low-carbon technologies are essentially substitutes for traditional technologies. *Greenpeace et al.* (2013) project employment in fossil fuels and nuclear energy to drop from 14.7 million in 2010 to 11.2 million in 2015, 9.7 million in 2020 and 6.3 million in 2030. Thus, the losses in fossil fuels and nuclear energies (–8.4 million jobs 2010/2030) by far outweigh the gains in direct jobs from renewable energy production (+4.1 million jobs 2010/2030). *IRENA* (2013) calculates a well-performing renewable energy employment policy scenario, estimating the effects of a doubling of the share of renewable energy in the global energy mix, reaching 16.7 million renewable direct and indirect jobs in 2030. It therefore derives substantial growth potential for renewable energy employment within the coming decades.

5.1.3 Methodologies for Forecasting Employment Effects

Models for forecasting employment creation are necessarily based on various assumptions, e.g. about energy price developments, technological developments and country- or region-specific policy goals. Projections may be assessed based on different policy measures that provide incentives for renewable energy deployment (e.g. carbon pricing by taxes or certificates, feed-in tariffs) and apply different financing and investment schemes. In addition, projections are derived from different methodologies and are based on different data sets. This results in a lack of comparability of forecast studies.

Gross employment studies only focus on the economic relevance of the particular renewable energy sector. They neglect any potential negative job effects that may occur in alternative sectors, e.g. by substituting jobs in fossil fuel and nuclear energy or via reduced consumption activities due to increased electricity prices. Employment effects may be smaller or greater if indirect and induced employment effects are taken into consideration.

To include the effects on upstream industries and thereby consider employment from intermediate inputs, the assessment requires a multiplier analysis based on an I-O table approach or a supply chain analysis. Some studies suggest that the number of indirect jobs is generally larger than the number of direct jobs for all renewable energy technologies (*Lehr et* *al.*, 2011, 2012). However, both approaches do not capture economy-wide effects in terms of net employment. Net employment studies are conducted by comprehensive economic models (e.g. computable equilibrium models (CGE) or macro-econometric models) and relate to all employment impacts including those which occur beyond the renewable energy industry. In particular, economy-wide price, income and substitution effects are taken into account. These may affect the consumption of households or the production of intermediate products and services, as well as the competitiveness of entire industries as a result of altered energy prices. Net employment may be negative depending on which repercussions are taken into account.

Employment factor approach

The easiest method of assessing direct jobs from renewables is the employment factor approach. Employment factors indicate the number of jobs (in full-time equivalents) created per physical unit, e.g. installed peak capacity or produced energy expressed as megawatts (MW) or megawatt-hours (MWh) for electricity generation, heat production or fuel supply (*IRENA*, 2013). To estimate the total number of direct jobs, employment factors are multiplied by a certain renewable energy capacity. The approach applies different employment factors to different phases of the life cycle. For bioenergy, the fuel supply phase is considered an additional activity (growing, harvesting and transportation of feedstock). Even within the same life cycle of a particular technology, different employment factors may be used in order to account for regional differences in the labour intensity of the life cycle stage. As the manufacturing of renewable energy technologies may occur abroad, the application of employment factors must take into account the import structure of manufacturing as well. Countries exporting renewable technologies and components generate employment in addition to their domestic renewable energy capacity and that installed renewable capacity may not be misinterpreted as an indicator for renewable employment (IRENA, 2013). Denmark is often cited as an example, as it has a large wind turbine manufacturing sector (high employment rate) with most of the components exported. This situation significantly inflates the jobs-per-MW ratio (*Lambert and Silva*, 2012).

In general, the number of jobs per unit of capacity is considerably lower for O&M than for manufacturing, construction and installation (MCI), but O&M generates employment over the lifetime of the respective technologies, while MCI may require several months to a few years only. O&M employment factors are applied to the total installed capacity, whereas MCI employment factors only refer to newly added capacities. Furthermore, employment factors tend to decline with technology maturity and labour productivity. Many renewable technologies are still in an early stage of development, and therefore cost degressions and economies of scale are expected to occur in the future, resulting in lower employment factors.

Table 2 provides an overview of employment factors from OECD countries applied in the Energy [R]evolution scenario (*Greenpeace et al.*, 2013). In emerging and developing countries, labour productivities remain considerably lower, thus showing much higher per-MW job figures. For instance, studies estimated a range of 30 to 46.6 jobs per MW for MCI in wind energy in China and 37.5 jobs per MW for MCI in India (*IRENA*, 2013). As the renewable energy industry exhibits rapidly evolving labour productivity, estimates of employment factors need to be continuously revised.

Table 2 **Employment Factors Used in Global Analysis**

FUEL	MANUFACTURING	CONSTRUCTION & INSTALLATION	OPERATION & MAINTENANCE	FUEL – PRIMARY ENERGY DEMAND
	Jobs/MW	Job-years/MW	Jobs/MW	Jobs/PJ
Biomass	2.9	14	1.5	32
Hydro – large	1.5	6	0.3	
Hydro – small	5.5	15	2.4	
Wind onshore	6.1	2.5	0.2	
Wind offshore	11	7.1	0.2	
PV	6.9	11	0.3	
Geothermal	3.9	6.8	0.4	
Solar thermal	4	8.9	0.5	
Geothermal – heat	3.0 jobs/MW (construction & manufacturing)			
Solar – heat	7.4 jobs/MW (construction & manufacturing)			

Source: Meyer and Sommer (2014) based on Greenpeace et al. (2013).

Supply chain analysis

Supply chain and I-O analysis are used to calculate both direct and indirect employment effects, thus covering intermediary inputs and related services throughout all stages of the life cycle. Supply chain analysis generates figures on direct and partly indirect jobs (first-round indirect effects) by mapping the specific supply hierarchy and relationships among companies of a specific renewable technology. Within this approach stages of production and services ranging from the provision of raw materials to renewable energy production itself are determined by defining hierarchical tiers. Companies in the various tiers are then identified and data on capacity, project costs, labour and other inputs, turnover and production values are gathered for each tier in the supply chain. Finally, labour inputs are related to the respective output capacity. This method is, however, rarely applied compared to the employment factor approach and the I-O analysis. In fact, it is a bottom-up microeconomic approach based on business surveys and statistical data analysis and is thus less suited for macro-economic modelling and assessment.

Input-output (I-O) analysis

I-O analysis offers an analytical framework for assessing direct and indirect or direct, indirect and induced employment creation from renewable energy deployment. I-O tables provide detailed information on the flows of intermediary goods and services among all sectors of the economy, as well as on the interdependencies of a country's economy with the rest of the world. Total production of an industry derives as the sum of all inputs to other industries plus final demand, plus exports minus imports. However, as renewable deployment represents a cross-sectoral activity, developing new technology-specific I-O tables for different renewables would be very helpful. *Lehr et al.* (2008) integrated 10 renewable energy technologies as production vectors to the German I-O table.

The question of whether the deployment of renewable energy is beneficial from an economy-wide perspective must be assessed within a framework that captures all induced employment effects. In order to assess the net employment effects, complex economic models such as the computable general equilibrium (CGE) model are used. CGE models draw on social accounting matrixes (extended version of I-O models) as data bases. In this approach generally, two future scenarios are compared with each other: a business-as-usual scenario and a scenario with an ambitious renewable energy policy.

Major points of criticism of I-O-based approaches concern the high aggregation of I-O tables, which can prevent the adequately capturing of specific renewable technologies and their employment effects (e.g. PV or wind), as well as the fact that I-O modeling implicitly assumes a constant structure of the economy. In light of large economic transformations such as the energy transition, these approaches can significantly depart from reality, and therefore all quantitative results on employment figures must be interpreted with caution.

5.1.4 Overview of International Peer-Reviewed Studies on Renewable Energy Employment

This section analyses 23 economic impact studies on the employment effects from renewable energy deployment published in peer-reviewed journals. A summary of the employment factors estimated in the literature is displayed in Table 3 and 10.2 in the Appendix summarizes the studies using the employment factor approach. It shows a range of employment factors which is higher than the one applied in *Greenpeace et al.* (2013, see Table 2). For instance, PV employment factors range from 28 jobs/MW to 55 jobs/MW depending on the geographical area, while the latest Energy [R]evolution assessment uses a much lower average employment factor of about 18 jobs/MW (*Greenpeace et al.*, 2013).

With respect to wind energy the array of employment factors ranges from 8 jobs/MW to 13 jobs/MW, which is closer to the factor applied in the Energy [R]evolution study (8.8 jobs/MW).

The analysis confirms a much more stable and uniform employment environment for wind energy than for PV, where learning has occurred much more quickly, lowering labour intensity substantially in recent years. Recently, *Cameron and van der Zwaan* (2013) report a lower bound for employment factors for PV of 7 jobs/MW.

Table 12 and Table 13 in the Appendix summarize studies that deal with renewable scenarios based on national or regional policy targets, investment and financing schemes. The primary focus of these studies is electricity and heat production. Most studies do not consider the transport sector and thus exclude biofuels and fuels produced from renewable energy sources such as electricity, biogas or hydrogen from their analysis, with the exception of *Neuwahl et al.* (2008) who assess the effects of biofuels from 1st and 2nd generation fuels on the job market. However, there are no systemic approaches to renewable energy supply that integrate different energy sectors of the economy, including transportation. These may yet reveal economic or environmental synergies and should therefore be considered for future research. The selection of studies focuses on renewable energy deployment and in the majority of cases disregards any analysis of energy efficiency. Beyond these features, few common characteristics can be found. Each study develops its region-specific set of policy assumptions, using different assessment methodologies and deployment paths such that employment effects are difficult to compare. In addition, assumptions about key data such as export demand, fossil fuel prices and technological learning curves differ substantially. In general, the majority of model-based analyses derive positive net employment effects from renewables. Study 9, for instance, calculates a net additional employment of between +23,000 and +180,000 for Germany in 2030 depending on assumptions about the export share. The higher the export share, the higher is the resulting employment effect. Results also vary according to different oil price scenarios, with a higher oil price accompanied by higher employment results from renewable deployment. However, the results strongly depend on the way in which renewable energy deployment is financed. Studies that, for example, assume increasing electricity prices to be mainly incurred by households may derive negative employment effects due to income losses. Negative impacts on employment also result from increased labour taxes to subsidize RES deployment.

Table 3 **Employment Factors of PV and Wind from Reviewed Studies**

		REGION	YEAR OF PUBLICATION	NO. OF STUDY
PV				
jobs/GWh				
	1.03	USA & Europe	2012	1
	1.09	GRE	2011	2
	0.87	USA	2010	14
jobs/MW				
	38	Aragon (ESP)	2010	4
	29	ESP	2013	7
	37.3	ESP	2008	16
	54.8	GRE	2013	18
	37-46	TUR	2011	21
	28.3	Middle East	2013	22
WIND				
jobs/GWh				
	0.2	USA & Europe	2012	1
	0.33	GRE	2011	2
	0.17	USA	2010	14
jobs/MW				
	13	IRE	2007	3
	10.74	BRA	2013	6
	13.2	ESP	2008	16
	8.3	Middle East	2013	22

Source: Meyer and Sommer (2014).

5.1.5 Conclusions

To conclude, the majority of policy scenarios show beneficial effects with respect to the labour market. In addition to the GHG mitigating effect from switching to renewable energy production, positive economic effects in terms of net employment (and income growth) may also occur if subsidy and investment policies are carefully chosen. Studies that incur the financial burden on the part of households, either through labour wage tax increases or higher electricity prices, tend to show negative net employment effects. In general, however, a detailed comparison of model results is not feasible due to the large variety of scenario approaches. As a general rule, greater harmonization of the methods used to estimate renewable energy jobs would enable more accurate comparisons across different technologies and countries.

5.2 Environmental Innovation and Firm-Level Employment Growth in Europe[21]

5.2.1 Introduction and Background

The Europe 2020 strategy aims for smart, sustainable and inclusive growth and job creation. Environmental innovations have been placed at the heart of this strategy as they are seen as key for Europe's economy to adjust to environmental and resource constraints. In addition to its environmental benefits, policy hopes that green innovations could provide an important contribution to strengthen the competitiveness of firms and, consequently, to the preservation or creation of *new* jobs. That is why the EU launched its Eco-innovation Action Plan as part of its EU2020 strategy in 2011. It complements the ambitions of the EU2020 Innovation Union and Resource Efficiency Flagship initiatives. The Eco-innovation Action Plan aims at boosting eco innovation[22] by different instruments such as implementing new environmental policy legislations, developing new standards, subsidies for research in eco innovation, mobilizing financial instruments for eco innovation, fostering international cooperation or promoting European innovation partnerships. Recent years have already seen a growth of eco industries as explained in the previous section.[23] However, it is important to note that the EU understands environmental innovation not just as being crucial for a special industry but that all firms can and should become environmental innovators by introducing new eco-innovative approaches into their operations and by launching to the market new less environmentally damaging products and services. The Eco-innovation Action Plan thus promotes the "greening of all of the sectors" and recommends the use of a broad spectrum of instruments to foster the change.

Back in 1991 Porter argued that environmental policy should not only be viewed as a restriction to a more efficient use of resources but that environmental policy might drive the long-run efficiency and induce early adjustments to upcoming price effects and hence open up opportunities to gain market shares in the future. Since then a wide variety of studies has looked at the impact of environmental policies on the adjustments of economies, industries, or firms, in particular whether it stimulates innovation. Environmental product and process innovation are supposed to be associated with positive effects by capturing two external effects.

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[21] This section is based on *Licht and Peters* (2013, 2014).

[22] The terms environmental innovation, eco innovation and green innovation are used interchangeably.

[23] The EU estimates a €319 billion turnover of eco industries and an employment of 3.4 million people in 2008 which has increased by 0.6 million jobs between 2004 and 2008; see EU (2011), http://ec.europa.eu/environment/ecoap/about-eco-innovation/policies-matters/eu/772_en.htm.

On the one hand they are supposed to reduce the negative externalities by lowering the environmental damage of production and consumption and thus contribute to climate policy goals. On the other hand, they are supposed to induce positive externalities associated with the generation and diffusion of new technologies, for instance the creation of new jobs. The possibility that environmental policy yields a "double dividend" can be seen as an important motivation also for the Eco-Innovation Action Plan. Hence, the Porter Hypothesis attracted the attention of a vast number of theoretical and empirical studies.[24] The literature put forward a weak version of the Porter Hypothesis which states that government regulations and interventions utilizing the price mechanism affect the innovation and R&D decision of firms by putting more resources to the development and/or adoption of cleaner production and/or cleaner products. The strong version of the Porter Hypothesis postulates that effective governmental inventions will have a positive impact on the economic performance of firms, e.g. in form of a positive effect on the productivity of firms. The majority of studies finds empirical evidence in favor of the weak version of the Porter Hypothesis. The strong version, however, could not be confirmed by the majority of studies (see *Leeuwen and Mohnen*, 2013, for a short review). In addition, *Marin* (2014) finds the returns to eco-innovation to be substantially lower than those of non-environmental innovations. This might give rise to a crowding out of more profitable innovation by eco-innovations if firms innovation potential is limited due to the availability of financial resources or innovation capabilities.[25]

Licht and Peters (2013, 2014) take employment growth as an indicator for economic performance of firms. In order to focus on the strong version of the Porter-Hypothesis they take the innovation decision as given and ask whether eco-innovation and non-eco-innovation differ in their impact on firm's employment growth. Thus, both papers contribute to the discussion of the impact of green innovation on employment growth. In particular, they compare the employment impact of environmental and non-environmental patents as well as those of product and process innovations using data for manufacturing and service firms in Europe and in more detail in Germany.

5.2.2 Theoretical Background

The question how innovation affects firm-level employment is non-trivial since various channels exist through which different kinds of innovation may destroy existing jobs (displacement effects) or may create new jobs (compensation effects). In addition, different types of innovation such as product and process innovation influence employment via different channels. Table 4 summarizes how different kinds of innovation might affect employment. Employment effects of process innovation are closely related to productivity changes. New production processes most often lead to labour productivity improvements since they allow firms to produce the same amount of output with less labour input and, ceteris paribus, lower unit costs. The size of this effect depends on the current production technology and direction of the technological change.

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24 See *Licht and Peters* (2014) and the references cited therein.

25 The possibility of a crowding-out is also present in the public discussion on environmental regulation. With respect to the proposal of the EU commission on new emission goals for cars, the Wallstreet Journal comments on Chancellor Merkel's opposition to the new rule by referring to the opportunity cost of technological adjustments induced by substantially tighter standards of car emissions (see WSJ "Green Regulation and Jobs" July 1, 2013).

A key open question is here whether environmental process innovations are associated with the same increase in labour productivity and thus reduction in unit costs as non-environmental process innovations. At the same time, firms can pass on lower unit costs to their product prices. In a dynamic perspective, lower prices can lead to a higher product demand, thus increasing output and employment. The magnitude of this price effect depends on the price reduction, the price elasticity of demand, the degree of competition as well as on the behavior and relative strength of different agents such as managers and unions within the firm. Product innovation boosts employment growth mainly via demand. Demand for the new product can either be the result of an overall market expansion, or it may come at the expense of the firm's competitors. And therefore, the size of this effect depends on the demand elasticity, the existence of substitutes and the reactions of competitors. A priori it is unclear whether and to what extent demand effects might differ for new products with and without environmental benefits for the consumer. Firm-level demand for environmental product innovations might be higher if there is less competition in the market for environmental products and services. On the other hand, eco innovations might be sold at higher prices if demand elasticity is relatively low and this might lead to less output and thus employment. In addition, indirect demand effects on the innovative firm's existing products have to be taken into account as the new products might (partially or totally) replace the old ones. However, in the case of complementary demand relationships, the new product will cause demand for existing products to rise as well, and employment will increase further. Finally, the same amount of output of the new product may be produced at higher or lower productivity levels compared to the old product. That is, the new product may imply a change in production methods and input mix, which could either reduce or increase labour input. This effect is called productivity effect of product innovation (*Harrison et al.,* 2014).[26]

Table 4 **Effects of Product and Process Innovation on Employment at the Firm Level**

	Employment-reducing effects (displacement effects)	**Employment-creating effects (compensation effects)**
Product innovation	*Productivity effect of product innovation*: New products require less (or more) labour input (-) *Indirect demand effect*: Decrease in demand of existing substitutes (-)	*Direct demand effect*: New products increase overall demand (+) *Indirect demand effect*: Increase in demand of existing complementary products (+)
Process innovation	*Productivity effect of process innovation*: Less labour input for a given output (-)	*Price effect*: Cost reduction passed on to price expands demand (+)

Source: Dachs und Peters (2014).

The majority of empirical studies have found an employment-stimulating effect of product innovation whereas the effect of process innovation is ambiguous, ranging from significantly negative to positive (see *Licht and Peters,* 2014, for a short survey). However, up to now empirical evidence on the employment effect of environmental innovation is scarce and mainly

[26] Additional employment effects of innovations exist at a sector or macro level, see section 5.3.

focused on Germany (see *Pfeifer and Rennings*, 2001, *Rennings and Zwick*, 2002, *Rennings et al.*, 2004, *Horbach*, 2010 and *Horbach and Rennings*, 2013). Most of these studies find evidence for a positive impact of green innovation on employment. With respect to green product innovation, results are mixed. On the one hand, *Horbach* (2010) demonstrates that German firms belonging to the environmental sector are more likely to increase employment after they have launched new environmental products. *Horbach and Rennings* (2013), however, could not corroborate that environmental product innovators grow faster than non-environmental (product and process) innovators in Germany. Concerning environmental process innovations, they find a slightly positive impact on labour demand and they emphasize that this result is driven by material and energy saving process innovations. However, process innovations aimed at reducing air and water pollution, where end-of-pipe technologies dominate, lead to labour destruction. These results corroborate prior findings of *Rennings and Zwick* (2002) who find that end-of-pipe technologies are associated with a decrease in employment for five European countries.

5.2.3 Employment Impact of Environmental Innovation Based on a Structural Approach

In contrast to prior research, *Licht and Peters* (2013, 2014) used a structural approach, developed by *Harrison et al.* (2014) to estimate employment effects of environmental innovations. For estimation they use Community Innovation Survey (CIS) data related to the period 2006-2008 for 16 European countries. In the CIS, environmental process innovation is defined as the implementation of a new or significantly improved production process, distribution method, or support activity for firm’s goods or services which has had any of the following environmental benefits: reduced material or energy use per unit of output, reduced CO2 footprint, reduced air, soil, water pollution or noise production, replaced dangerous materials and recycled waste, water or materials. An environmental product innovation is defined as new or significantly improved products or services with any of the following three environmental benefits through the use of these products/services: reduced energy use, reduced air, water, soil or noise pollution, and improved recycling of product after use.

Based on their econometric analysis, they are able to decompose employment growth into the contribution of the following sources: (1) country-industry specific general (i.e. not related to process innovation) productivity trends in the production of existing products; (2) displacement effects of environmental process innovation; (3) displacement effects of process innovation without any environmental benefits; (4) the growth in output of existing products for non-product innovators (i.e. non-innovators or pure process innovators); (5) the net contribution of product innovation to employment growth for environmental and non-environmental product innovators, respectively.

In manufacturing, average employment growth amounted to 4.5% (see Table 5). General improvements in productivity would have led to a decline in employment of 6.1%. The contribution of both environmental and non-environmental process innovations to employment growth is negative but of secondary importance when observed quantitatively (-0.04% and -0.2%). These negative impacts on employment have been more than offset by the growth in output (demand) of existing and new products. It turns out that the growth in existing products was the main contributor to employment growth fostering it by 7.6%. An additional 3.4% growth originates from the output growth in new products for product innovators. When they disentangle the sources of the latter effect, they find that environmental and non-environmental product innovators have contributed to a similar extent to employment growth via an increase in output for their new products (+4.5% vs. +4.8%). At the same time, product innovators have been faced with a decline in the output of their existing products which weakened the positive employment effect by about 6%.

Table 5 **Decomposition of Employment Growth in European Firms 2006-2008**

	Manuf.	Services
Employment growth	**4.5**	**9.6**
Decomposed into contribution of		
General productivity trend in production of existing products	**-6.1**	**-5.5**
Displacement effect of process innovations related to existing products	**-0.2**	**0.0**
Thereof environmental process innovations	0.0	0.0
Thereof non-environmental process innovations	-0.2	0.0
Output growth of existing products for non-product innovators	**7.6**	**11.8**
Thereof for non-innovators	6.1	10.4
Thereof for environmental process innovators only	0.7	0.6
Thereof for non-environmental process innovators only	0.7	0.8
Product innovation	**3.4**	**3.3**
Thereof output reduction in existing products	-6.0	-3.9
Thereof output increase in new products for environ. product innovators	4.5	2.7
Thereof output increase in new products for non-environ. product innovators	4.8	4.5

Source: Licht and Peters (2013), CIS 2008, Eurostat

In services, the broad picture looks similar to manufacturing with some interesting distinctive features. Average employment growth was more than twice as large as in manufacturing (9.6%). However, the contribution of the general productivity trend, process innovation and product innovation was of similar magnitude in this period (-5.5%, 0% and +3.3%). The larger employment growth mainly stems from larger sales growth of existing products for non-product innovators. The latter effect stimulated employment growth by nearly 12%. A second difference between manufacturing and services relates to the contribution of product innovations for environmental and non-environmental product innovators. In contrast to manufacturing, the authors record a much smaller contribution via an output increase in product innovations for environmental (+2.7%) than for non-environmental product innovators (+4.5%).

5.2.4 Summary and Conclusions

The study demonstrates that both environmental and non-environmental product innovations are conducive to employment growth in European firms. It finds impressive evidence for this growth stimulus in nearly all 16 European countries and across all sectors. In most countries, a one-percent increase in the sales due to new products for environmental product innovators also increases *gross* employment by one percent. This implies that there is no evidence that environmentally-friendly new products are produced with higher or lower efficiency than existing products. Furthermore, results show no substantial differences how product innovation success translates into employment growth between environmental and non-environmental product innovators.

Another interesting result of the study is the fact that the estimated gross employment effect of environmental and non-environmental product innovation is very similar in nearly all countries and sectors. Observed differences in the contribution of environmental and non-environmental product innovation to employment growth across countries or sectors are thus a result of differences in the average innovation engagement and innovation success across countries or sectors, but not of differences in the transformation of a given level of innovation success to employment growth. Under the assumption that there will be no structural breaks in this relationship, this should open up similar employment potentials across countries or sectors for policy if they are successful in stimulating environmental innovation.

From a policy perspective it is also important to take into account that the type of innovation matters for employment. When designing their innovation policies, governments should take into account that process innovation plays only a little role for stimulating employment growth or releasing labour. This holds for both environmental and non-environmental process innovation and the result turns out to be quite robust across different countries and sectors.

The study has demonstrated that on average product innovation is conducive to employment growth with only small differences between environmental and non-environmental product innovators. Future research should dig deeper whether the employment effects of environmental product innovations are heterogeneous across certain firm characteristics. For instance, it would be interesting to know whether fast growing firms benefit more from environmental product innovation that the least performing firms. This should also help policy to design innovation policies more effectively.

5.3 Macro-economic Modelling of Employment Effects Using a CGE-Approach[27]

As previously explained, the EU has adopted a set of comprehensive and integrated policies to achieve smart, sustainable and inclusive growth by 2020. Investment in education and the support of innovation are central to the broad strategy and considered a pillar of growth policies together with climate policies. The “20-20-20” targets are the cornerstone of the EU climate policy up to 2020. Policymakers realised that environmental taxes and regulation alone are not sufficient to achieve such ambitious targets without the burden of excessive costs. One main pillar of the European climate strategy is innovation, which has the potential to lower the long-run costs of emission reduction policies. This is a well-established result in the economic literature about environmental policy (*Nordhaus*, 2002, *Smulders and de Nooij*, 2003, *Acemoglu*

[27] This section draws on *Baccianti and Löschel* (2014a)

et al., 2012) and several studies advocate research subsidies as necessary in the policymaker's toolkit.

The "20-20-20" targets are designed to be integrated in the more general framework, the "Europe 2020 Strategy", and policies are intended to exploit synergies between the greening of the economy and the achievement of higher well-being, low unemployment and social inclusion. The EU programme aims at re-orientating Europe's industrial sector towards novel and environmentally sustainable production processes but, at the same time, exploiting the potential economic benefits of leading the green transition at the world level. By supporting the early development of environmental friendly technologies and creating first-mover advantages, European and National governments expect to create new job opportunities and boost economic growth in the next decades.

5.3.1 Innovation, Environmental Policy and Employment

Most of the literature analysing the employment effects of environmental policies and innovation is based on micro-data, see section 5.2. In contrast, this section takes a macroeconomic perspective. Among the few available studies with an aggregate focus are *Neuwahl et al.* (2008), *Chateau et al.* (2011) and *Otto et al.* (2008). *Neuwahl et al.* (2008) provides an assessment of policies to support biofuels in the EU using an input-output model in which the energy and biofuel-related sectors (transportation, capital goods and agriculture) are modelled in details. Under different policy assumptions, the results indicate that the more extensive use of biofuels would not trigger employment losses. Inefficiencies due to the use of a relatively more expensive energy source are compensated by the general equilibrium feedbacks like the expansion of biofuel-related sectors and the tempering of oil price.

Chateau et al. (2011) is a more general analysis regarding environmental policies. The study is based on the OECD ENV-Linkage CGE model and it focuses on Europe and OECD countries. Results point out the importance of tax-revenue recycling to reduce distortionary taxes (i.e. labour), the idea of double-dividend. Outcomes for alternative policy and tax-recycling scenarios show that mitigation policies (e.g. Cap and trade system) do not lead to significant losses in real gross value added and employment, even in the worst-case scenario. In general, the use of carbon permit revenues to reduce labour taxes has a strong potential to boost economic growth compared to the case of no mitigation.

Technological change in the previous two models is not endogenous and innovation does not improve factors' efficiency over time. *Otto et al.* (2008) have instead fully-fledged endogenous innovation in a dynamic multi-sector model for the Netherlands. They assess how carbon constraints and R&D subsidies impact economic growth when they are differentiated CO2-intensive and less CO2-intensive sectors. In their model, R&D is used to increase total factor productivity and if research policy favours the less polluting sectors, the target on emission reductions can be achieved with higher production and welfare compared to the case of no policy. Instead, not differentiated mitigation policy would rely mostly on structural change and reduce carbon emission by shrinking the polluting sectors, bringing about heavy output losses at the aggregate.

5.3.2 Modelling Growth and Employment Effects of Environmental Innovation

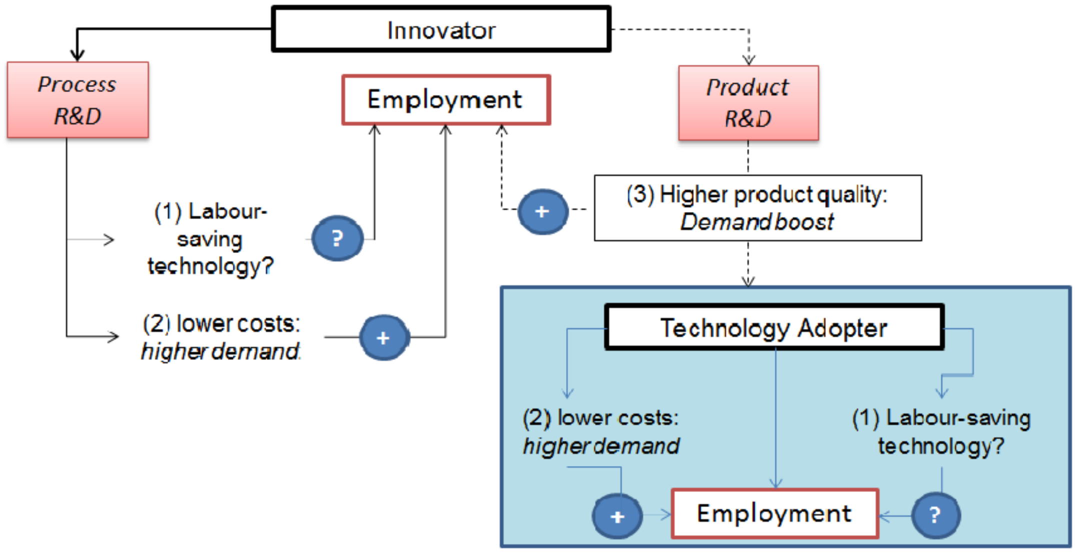
The inclusion of endogenous technological change in CGE models is a relatively recent achievement and it is still a challenging task. Innovation types are treated differently when the interest focuses on the aggregate level. For microeconomic analysis, process and organizational innovation are clearly distinct concepts. However, they can hardly be distinguished when sectors or economies are considered as a whole, because both types of innovation increase aggregate factor productivity.

Similar to Table 4 at the micro-level, Figure 6 shows the general relationship between innovation, technology adoption and employment under a macroeconomic perspective. Successful R&D activity directed towards process innovation has the final result to reduce costs in production. Lower prices trigger higher demand and innovative firms expand their market share at the expenses of less efficient firms. However, it does not necessarily induce higher employment because firms would achieve cost cuts by laying off workers or not hiring more if the nature of the innovation is labour-saving.

When R&D expenditures are instead targeting improvements in product’s quality, namely product innovation, implications for employment are substantially different. From a microeconomic perspective, innovative firms could be able to gain additional market shares or even to get a monopolist position. Demand is in any case boosted and there are no effects on factor shares in production (unless the new product is produced with a radically different input mix), so that employment would definitively benefit from the new product’s success. At the aggregate, regardless of the market structure, product innovation leads to an increase in employment if the closure of failing competitors’ production does not offset the first-order beneficial effect.

On the other side of the market, the new product may be used for production and have additional employment effects. This is the case of capital goods (i.e. machinery, equipment and vehicles), which are adopted as new technologies and lead to changes in production efficiency very similarly to process R&D. Firms without internal R&D in general improve their productivity by purchasing new process technologies. Regarding employment effects for the technology adopters, the case resembles process innovation described above and the net final outcome depends on the characteristics of technological change.

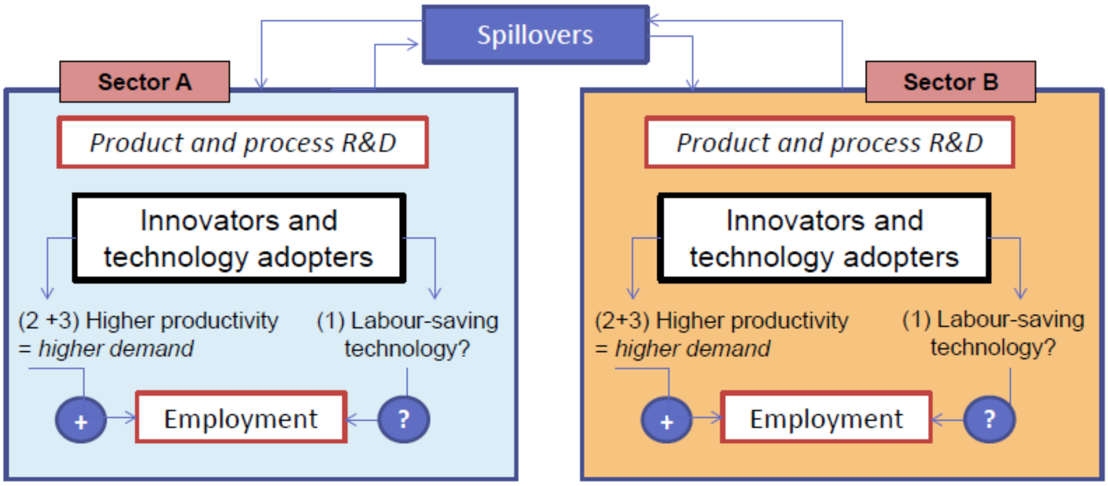
Figure 6 **Innovation, Technology Adoption and Employment**



From a modelling perspective, when output is composed of homogeneous goods the effect of technological change is limited to productivity improvements and it mostly represents process and organizational innovation. Accounting for quality in a quantitative model needs further details about which specific type of quality we are interested in. Among environmental innovations, there is one large class of technologies that aim to lower the energy or pollution intensity in product use. Electrical and electronic equipment is a clear example: more efficient vintages consume less electricity to provide the same amount of services. In this case higher quality means higher energy efficiency in product use.

The state of the art in multi-sector general equilibrium modelling with endogenous technological change has so far relied on a very specific assumption about innovation and technology use. Different sectors are independent in carrying out their own research activities, apart from some spillovers that may arise at the national level (Figure 7). That is, R&D in sector A leads to production efficiency improvements only within the same sector because of the assumption of sector-specific technology, implying that innovation cannot be adopted by firms in other sectors because of technical incompatibility. This assumption is quite restrictive. The business model of firms in the machinery and equipment sectors is to sell capital goods to the rest of the economy and provide other firms technologies that are able to boost their factor productivity. Therefore, it is quite misleading to assume that each sector is able to carry out independently all the R&D necessary to make productivity improvements. Instead, inter-sector technology flows are very important, as first remarked by *Scherer* (1982) and *Griliches and Lichtenberg* (1984).

Figure 7 **Multi-sector Framework: Sector-specific Technology**



In standard I-O modelling à la Walras, only prices can transfer productivity improvements between firms. When goods are homogeneous and technological progress makes sector A's product cheaper, another sector using sector A's goods as intermediate inputs would benefit from the productivity shift. However, it excludes the case of product-embodied technological change as remarked above. Higher quality products, e.g. a more energy efficient refrigerator, may be more expensive and the Walrasian mechanism does not hold. Back to Figure 7, if sector B is the Banking and Finance sector, the standard setting assumes that internal R&D activities are able to bring about improvements in energy efficiency of buildings and IT-facilities and to make labour more productive. Even if partially valid, productivity increase is largely due to the purchase of new equipment and IT-structures manufactured by firms in the Equipment sector. The crucial difference between the two assumptions stands on the demand boost that the Equipment sector would experience in the latter case.

The CGE model that has been developed within this task of the wwwForEurope project is based on *Otto, Löschel and Reilly* (2008) and it embeds the inter-sectoral effects of product innovation. The original version is a multi-sector model with R&D-driven technological change, in which the level of technology is accounted as total factor productivity stocks in each sector. Energy-related product innovation is mostly concentrated in the production of building materials, used to set-up the building's level of energy efficiency, and the manufacturing of machinery, electronic and electric equipment, together with the production of vehicles. All products in these sectors have embodied energy intensity in use that determines the energy consumption on the adopter's side.[28]

[28] This task of Workpackage 303 is still ongoing and results are due by November of 2014.

6. The Role of the Energy Sector

6.1 Innovation in the Energy Sector[29]

This paper departs from the Europe 2020 goals, and concurs that the current energy mix exposes the EU to severe long-term risks which forward-looking policy makers should strive to minimise. The broadening of the energy mix is desirable from an environmental, geopolitical and economic perspective.

The starting point of the policy design debate is the market selection process which under-supplies socially desired renewable energy (RE) technologies. Hence policy makers intervene and promote the diffusion of existing technologies with the aim to alter the capital stock. As a result, the sector is undergoing a fundamental change as it incorporates an increasing proportion of RE.

The paper analyses the market dynamics that technology policy in the energy supply sector caused and elaborates on two guiding questions. First, what are the social and industrial dynamics that are relevant to the adoption of new technologies? The impact of RE on the use, generation and distribution of renewable energy production is studied, thereby sketching the main dynamics that the policy-induced diffusion of RE causes. Methodologically, social constructivism is drawn on. Second, some of the socio-economic effects of the adoption of RE innovations themselves are explored. It is analysed how the general findings apply to three countries and their specific implementation models.

The data used are derived from a variety of sources including the relevant academic literature, official statistics, policy documents, programme descriptions and evaluations, industry and market studies, as well as interviews with technology experts, industry representatives and public sector officials.

The paper studies supply-side technology policy and explores the dynamics behind a Europe-wide 'energy transition'. In particular it discusses the increase of the proportion of renewable energy (RE) to 20%, which is assumed to require 'radical' innovation to achieve the goals. The targets themselves rest on a broad justification.

The discussion is embedded into the concept of industrial policy. 'Old industrial policy' promoted specific firms, and was undermined as firms' competitiveness faded due to inefficiencies; market mechanisms were largely lacking, and policy makers persistently intervened in decision processes. Then 'new industrial policy' emerged, where horizontal innovation promotion and human capital formation asymmetrically affect firms and industries. The promotion strategies rest on 'systemic industrial and innovation policy'. This constitutes a recent development in industrial policy concepts that proclaims the promotion of industrial competitiveness beyond the intervention in the presence market failures. This systemic approach seems to rest on the new industrial policy concept, but societal, not purely economic needs justify the intervention. The

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29 This section provides a summary of *Friesenbichler* (2013).

approach assumes that a mix of industrial and technology policies will be sufficient. Many policies that seek to promote RE implicitly follow this assumption. The present findings cast doubt on whether a mix of subsidies, taxes and regulations alone are sufficient.

The implementation of the RE targets is not a straightforward exercise from a technical point of view. The supply structures are changing from few large-scale plants to a multitude of distributed RE producers of various scales. The grid greatly gained complexity, and the pattern in which production followed consumption is partly being reversed. The shift in supply structures will fundamentally transform the existing market. Feeding more RE into the grid pushes the market mechanisms to their boundaries. Parts of the existing capital stock will become obsolete; this is desired by policies. The arrival of new technologies will greatly increase both the industrial and technical complexity. Investments into new facilities, the underlying infrastructure and in on-call capacities are necessary. Altogether, the 'transition' assumes that the shift towards more RE will be as smooth as the shift from wood to coal.

6.1.1 Renewable Energy Policies in Germany, Denmark and Spain

In the paper Germany, Denmark and Spain served as comparison countries. The selection was the result of a stepwise procedure, which considered dimensions such as the different starting points of the energy mix (path dependency), the electricity market framework (Nordic, Central European and Iberian market), the increases of RE in the energy mix or the respective technological capabilities of the national innovation system.

The focus in the selection was on countries that pursued a RE strategy. Notably, the RE targets of "Europe 2020" are not implemented in all member states. Many NMS opt for low-cost, conventional power; countries that face budgetary crisis tend to halt their promotion as part of ongoing austerity programmes. Even though the targets are EU-wide and country specific goals may differ, this suggests a lack of country ownership of Europe 2020 which puts the target achievement as a whole at risk.

The present case study is intriguing from a policy design perspective. The energy policies rest on the principles sustainability, security of supply and competitiveness, i.e. market outcomes. However, policies would have to bias the technological trajectory in an economic planning fashion to effectively achieve the targets. Since the market selection process under-supplies socially desired eco-friendly technologies, public policies subsidise the diffusion of RE technologies. These increasingly displace the current technology stock. RE receives preferential grid access due to the merit order effect, which prefers energy sources with the lowest marginal costs. Hence, RE with quasi no marginal costs compete in a supposedly free market with technologies whose marginal costs are greater than zero. The market selection mechanism does not provide a level playing field.

The merit order itself is a desired component of the market design. It is the key instrument to achieve static price efficiency. The arrival of RE in the merit order, however, adds to the competitive pressures of the liberalisation, which already reduced conventional suppliers' profitability, investment incentives and economies of scale. However, given the current technology base, a full supply of RE is not feasible. RE rely on factor endowments which lack consistency of provision. Conventional power facilities such as gas or storage plants are still required to provide emergency capacities when RE is not available. In Germany for instance, this led to calls to subsidise conventional capacities in addition to RE. This is insofar paradoxical that the same instrument that sought to phase-out non-renewable energy is now in a different application supposed to be used to preserve them.

There are various remedies that cope with the emerging issues, which again are at least partly in conflict with one another. For instance, the provision of emergency capacity may undermine the incentives to optimise the operational management of the national grid, which again may stand against the international 'target market' that is promoted by the EU. Correspondingly, the international target market hampers the establishment of a spatially split market, because additional layers complicate the integration efforts.

The debate whether market outcomes should be planned or market driven also stretches to the geographic dispersion of production and consumption. The local distribution grid needs to change to accommodate a plethora of distributed power producers that feed electricity into the grid at various nodes. It is unclear how a grid can be set up that sufficiently flexible in order to incorporate emerging producers. The long-distance transmission grid faces similar issues. These are planned in a top down manner, by central authorities after a consultation process, and not the result of a competitive bottom-up selection process. This raises the question about how to connect emerging suppliers to a grid which is planned? An electricity grid is not a 'web' that constantly re-emerges, which causes a discrepancy between centrally planned grids at the national level, the increasingly internationally interwoven markets and not systemically designed distributed generation.

The arising issues imply that if markets are seen as one, there is an intrinsic threshold of wind and solar power that can be managed by the currently installed emergency capacities without losing security of supply. This threshold exists, even if it depends on the degree of internationalisation of the market, characteristics of the available grids, the respective technology mix and other idiosyncratic elements such as the regulatory framework. Hence, this critical point can be shifted to higher levels by a flexible grid management that alleviates the priority access for RE, and international markets that compensate for a supply surplus or shortages.

Notably, there is no threshold for the integration of RE from a mere technical point of view. With the help of batteries, power to gas and back-up gas turbines (driven by renewable gas) a full provision with RE is feasible. Yet, the cost might increase dramatically.

Policy makers across the EU member states chose to promote the diffusion of existing RE technologies. Technology push measures such as mission oriented R&D programmes are in place, but implemented to a lesser extent. The diffusion fostering instruments directly intervened with the market selection process. Such measures would have been more neutral, and probably been equally effective in the longer term. The direct interventions led to the abovementioned discrepancies and raise the question between outcomes from a market selection process and industrial planning.

In 2012, grid parity of PV has been achieved, or will be achieved shortly. In Germany and Italy, for instance, the optimisation of self-consumption allows for cost efficiency of larger systems without subsidised feed-in tariffs. Also wind turbines are expected to break even in the near future. This is agreeable with the promotion objectives, and has important implications on the design of future policies; subsidies should get reduced where grid parity is in sight.

Furthermore, countries such as Denmark or Spain managed to overcome issues as they occurred in Germany by flexibly adjusting their promotion and grid-management strategies. In Spain, the preferential grid access was weakened by the grid operator that balances the supply and demand structures. In Denmark, promotion policies were adjusted over time to avoid the complications that later emerged in Germany. Hence, policy makers should consider a great degree of flexibility. From a systemic perspective, also the regulatory regime, the underlying market mechanisms and the requirements to the grid need to find consideration in the design of technology policy instruments. This is hitherto not everywhere the case.

The policies successfully accelerated the diffusion time. Evidence on past diffusion processes finds that it takes between 15 and 30 years for a technology to reach a saturation point. RE has hitherto been diffusing very fast, which indicates that these estimates are rather conservative when they are applied to RE. Yet, the time span is based on free market economies, i.e. in a different setting. The fast deployment of RE technologies may have shortened the ‘formative phase’ of the diffusion process, which is necessary to generate learning effects and allow for incremental technological improvements. Compressing the timescales further may lead to the deployment of premature technologies.

More generally, the design of the promotion instruments seems suboptimal; country characteristics are hardly reflected by promotion policies. For instance, both Germany and Spain subsidise photovoltaic systems and their operations to a large extent and with similar instruments, regardless of their natural factor endowments.

Promotion policies should get modified so that they shift parts of the risk to operators, i.e. that a risk sharing between the co-funding agency and the beneficiary is in place. Price pegs should get alleviated in favour of auctioned promotions for newly established systems. Self-consumption should get favoured over feed-in solutions to avoid distorting effects of promotions, prices and minimise investment requirements to grids.

Albeit the net benefits from more RE are assumed positive, the shift itself is not pareto-efficient. Parts of the currently installed machinery and equipment will have to be written down if the book value is positive; TSOs and distribution grid operators will have to finance the grid expansion, and consumers may face higher electricity prices. There is substantial cross country variance in the cost allocation mechanisms. A three country case study reveals that in Spain and in Denmark, the promotion is quintessentially financed by the general budget.

In Germany, additional costs are allocated by a levy system to electricity consumers; large industrial consumers are exempt not to harm their competitiveness. This promotion design asymmetrically affects poorer households that spend more of their household income on the consumption of electricity. A price increase allocates a relatively larger share to the least wealthy. If a green energy provision is seen as a public good, a public funding mechanism that allocates additional costs to the general budget is to be preferred. Society as a whole then finances it.

The entry of distributed producers induced a substantial shift in the industry's ownership structures. Utilities used to be dominated by a few large firms which were often subject to antitrust litigation. The deployment of RE led to the emergence of a large number of actors; private households are now acting as producers and consumers at the same time (pro-sumers), citizens invest into RE plants, or as in the Danish case hold shares of municipal utilities that are set up as co-operatives. It seems that the broad involvement has substantially contributed to the social acceptance of RE, which one could describe as the 'democratisation' of power provision. Also, the Danish system demonstrates how policies can shape ownership structures and public acceptance.

The new capital stock comprises a series of technologies that potentially provide linkages to other fields. In this regard the paper uses smart meters as a showcase. They constitute one component in an ongoing trend of the deployment of ICT products that a 'smart home' involves. These products can increase citizens' convenience and safety, while at the same time they can reduce the cost of living. Their functionality affects both the environment – e.g., through energy costs, and social aspects, for instance through applications in fields like healthcare or the aging society. Hence, it is argued that the plethora of still emerging applications bears potential to contribute to solutions for environmental and societal challenges.

6.1.2 Summary

The innovations described in the paper are provided by private firms that face to expand a market that is still in its infancy. It is uncertain which technologies will eventually prevail. In many cases it is a product bundle whose implementation hinges on technical developments, user acceptance, and a policy mix that provides infrastructure, adequate regulation or skills.

This implies that public policies are restricted; actions by the private sectors eventually shape outcomes. Hence the paper distinguishes between the technology formation processes that are purely private on the one hand and the public sector on the other hand.

The objective for public policies should be to support the private sector in a non-discriminatory way. The (non-exhaustive) range of policy options comprises fields such as infrastructure, standardisation or regulation:

- Many of the desired applications draw on infrastructure such as access to broadband lines that currently are only insufficiently installed. The public sector should provide investment incentives to sufficiently stimulate the deployment of a high-speed data grid.
- A great challenge is to interconnect the various electronic devices that emerge, which requires standardised protocols. Due to incomplete information and the risk of adverse selection, standardisation processes should be rather market driven. Policy makers should provide a discussion platform where required.

- It is unclear whether the current regulatory framework – in both the utility and the health sector – is adequate to facilitate the roll-out of ICT solutions with socio-environmental benefits. Studies should provide relevant evidence.
- Policies should be evidence-based. Before mandatory regulations shape market outcomes, a sufficient amount of knowledge on the socio-economic and environmental effects of the respective policy should be gathered. This might seem straightforward, but is not always adhered. For instance, smart metering is a novel technology whose roll-out has been prescribed in a compulsory fashion, even though only few pilot studies are currently available and concerns about privacy issues and the cost-effectiveness of smart meters remain. The European Commission's recommendation for smart meters foresees a cost-benefit assessment whose result seems predetermined.

The technologies that the 'greening' of the energy mix requires are largely available, even though they do not seem to be fully matured; a full provision with RE is not feasible at socially acceptable costs with the current technology base. Further technology-push efforts are required. In addition, the demand-pull measures, the promotion of diffusion triggers a series of socio-economic questions. How can policies arrange the allocation mechanisms so that security of supply is guaranteed despite unsteady supply? Green energy has a public good character – how can it be provided at an affordable price level? What will be the role for market selection mechanisms in a sector in which any player is heavily subsidised? Will the public accept the new technology base? What institutional adjustments are required?

There is no doubt that these are urging questions. Some possible answers were provided in the present contribution; questions, however, remain. Nonetheless, the long-run prospects are bright. The energy mix has been constantly changing in the past. Also the utility sector has undergone periods of comparably fundamental shifts. There is no reason why this should not happen again.

6.2 The Contribution of Small and Young Firms to Inventions in Sustainable Technologies[30]

6.2.1 Introduction and Motivation

Europe's innovation potential is currently dominated by well-established large companies. In most member countries the bulk of R&D expenditures is spent by large companies. Following OECD data, SME's share in total R&D spending amount to 8% in Germany or Japan, around 15% in US, France, Korea or Italy, about 20% in Sweden, Finland or Switzerland, about 30% in Netherlands, Austria or Poland, and about 50% in Poland, Ireland, Slovakia or Greece. First of

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[30] This section is based on *Aschhoff, Licht, and Schliessler* (2013).

all, these figures point to a considerable heterogeneity with regard to the importance of SMEs in national R&D activities.

However, young companies are said to be the driving force behind radical innovation which will be a source of employment and growth in future. In addition, the weakness of Europe is not only the small number of hightech startups but more specifically the number of hightech startups which accomplish continuing, rapid growth. However, there might be significant technology-specific heterogeneity with regard to the contribution of SMEs and young firms to innovation.

Aschoff, Licht and Schliessler (2013) deal with two questions: (1) How Europe is placed in the global production of sustainable papers and especially of energy-related patents. (2) What is the role of SME and young firms in the production of new, sustainable technologies?

6.2.2 Patent Applications at the EPO

Data Sources and Definitions

In order to identify inventions this project relies on the concept of patent applications. The authors use all patent applications at the European Patent Office from 1990 to 2007, which they have retrieved from the patent database PATSTAT, Version Spring 2013. Patent applications at the EPO are often used in international comparisons as relevant patents are generally filed at the EPO and as the maintenance of the data by the European Patent Office ensures a high quality. The focus is on patent applications – not on granted patents – since the interest is in the entire research effort put into sustainable technologies and not the number of patent rights eventually granted.

The classification of inventions as sustainable and smart is based on the WIPO Green Inventory. In 2010 the World Intellectual Property Office (WIPO) has released this tool for searching and retrieving patent documents related to green technologies, i.e. the development and transfer of so-called Environmentally Sound Technologies (ESTs) for adaptation to climate change as outlined by the United Nations Framework Convention on Climate Change (UNFCCC). Patent applications are counted in the year in which the application was filed at the EPO. The regional classification is based on the country of the patent applicant. In case of more than one applicant, a fractional counting has been applied.[31] The following countries and country groups have been studied: EU-27 – divided into Germany, France, UK/Ireland, Rest Western Europe, Southern Europe, Northern Europe, New Member States –, Japan, South Korea, China, US, World. Besides the simple count of patent application, they also count triadic patents which are patents that have been applied for at the European Patent Office, the US Patent Office and the Japanese Patent Office since they are often considered to capture the more valuable set of patents; see *Grupp and Schmoch* (1999) for more details.

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[31] Fractional counting means that a patent applied for one applicant from Spain and one from Italy is assigned to both countries as ½ patent.

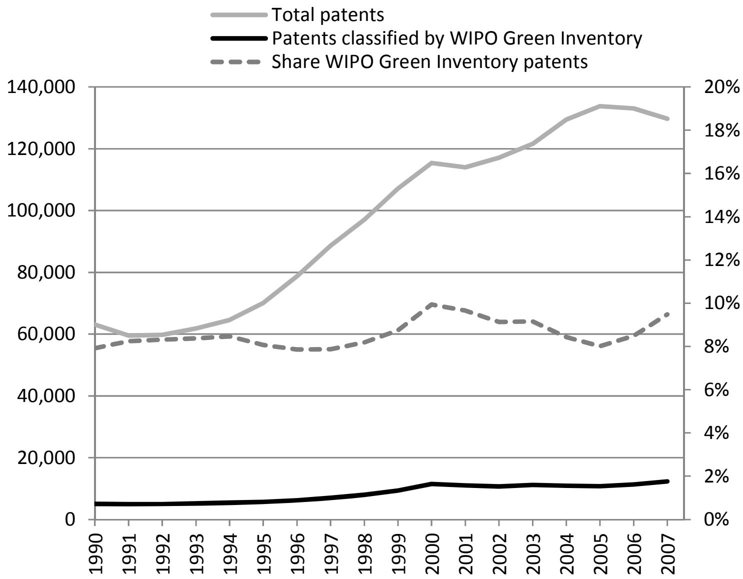
Table 6 **WIPO Green Inventory Classification**

WIPO Green Inventory Technology Class	Contents
Alternative Energy Production	▪ Bio-fuels ▪ Integrated gasification combined cycle (IGCC) ▪ Fuel cells ▪ Pyrolysis or gasification of biomass ▪ Harnessing energy from manmade waste ▪ Hydro energy ▪ Ocean thermal energy conversion (OTEC) ▪ Wind energy ▪ Solar energy ▪ Geothermal energy ▪ Other production or use of heat, not derived from combustion, e.g. natural heat ▪ Using waste heat ▪ Devices for producing mechanical power from muscle energy
Transportation	▪ Vehicles in general ▪ Vehicles other than rail vehicles ▪ Rail vehicles ▪ Marine vessel propulsion ▪ Cosmonautic vehicles using solar energy
Energy Storage	▪ Storage of electrical energy ▪ Power supply circuitry ▪ Measurement of electricity consumption ▪ Storage of thermal energy ▪ Low energy lighting ▪ Thermal building insulation, in general ▪ Recovering mechanical energy
Waste Management	▪ Waste disposal ▪ Treatment of waste ▪ Consuming waste by combustion ▪ Reuse of waste materials ▪ Pollution control
Agriculture/Forestry	▪ Forestry techniques ▪ Alternative irrigation techniques ▪ Pesticide alternatives ▪ Soil improvement
Administrative, Regulatory and Design Aspects	▪ Commuting, e.g., HOV, teleworking, etc. ▪ Carbon/emissions trading, e.g. pollution credits ▪ Static structure design
Nuclear Power Generation	▪ Nuclear engineering ▪ Gas turbine power plants using heat source of nuclear origin

Source: WIPO, see http://www.wipo.int/classifications/ipc/en/est/.

The number of green patent applications at the EPO, i.e. WIPO Green Inventory classified patent applications, increased by the factor 2.5 between 1990 and 2007, from almost 5,000 in 1990 to 12,300 in 2007. The number of all patent applications more than doubled during the same time period. Correspondingly, the share of green patent applications in all patent applications at the EPO is rather constant and varies between 8 and 10 percent during this time period. One in ten patent applications at the EPO is "green" in 2007.

Figure 8 **All Patent Applications and WIPO Green Inventory Classified Patent Applications at the EPO, 1990-2007**



Source: Aschhoff, Licht, and Schliessler (2013). Data Source: EPO Worldwide Patent Statistical Database (PATSTAT).

Triadic patent applications grow less than overall patent applications between 1990 and 2007. In 2007, the number of triadic patent applications is 1.4 times higher than in 1990; the number of triadic patent applications in green technologies is almost 1.6 times higher.

The importance of the individual technology classes for WIPO Green Inventory classified patent applications

The WIPO Green Inventory differentiates between seven technology classes. In 2007, the most active areas are alternative energy production with 26% of all green patent applications, energy storage (21%), and waste management (19%). Administration, agriculture/forestry and transportation contribute between 8 and 14 percent to green patent applications at the EPO. Patent applications within the area of nuclear power generation are negligible (1%). The number of patent applications in 2007 outnumbers the patent applications in 1990 in all green technology classes except in nuclear power generation. Administration, transportation and alternative energy production exhibit the highest growth. Thus, the relative importance of waste management decreased during the period 1990-2007, while the importance of alternative energy production increased.

The EU-27 was responsible for 44 percent of all "green" patent applications at the EPO between 1990 and 1999. The share reduced to 39 percent between 2000 and 2007. Within Europe Germany was the major contributor to the "green" patenting activity with a share of 17 percent of all "green" patent applications at the EPO. The reduction of the share of Europe in the global production of green patents came along with an increase of the contribution by Japan (from 18 percent to 21 percent), Korea (from 1 to 2 percent) and China (from 0 to 1 percent). The average annual growth rates in "green patenting" was 7 percent between 1990 and 1999 and has reduced to 4 percent between 2000 and 2007. The strongest growth can be found for the new EU member states, China and South Korea.

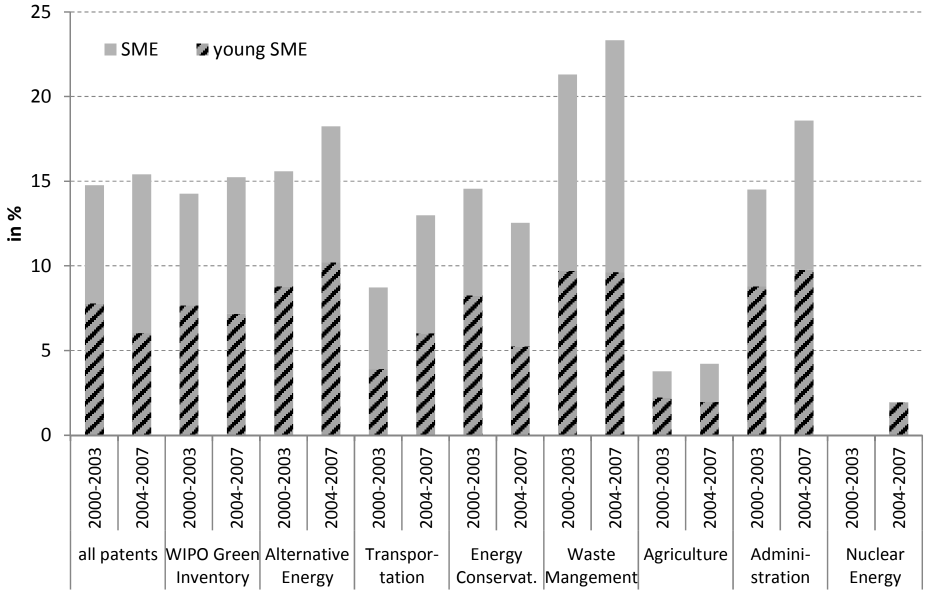
“Alternative Energy” patent applications at the EPO

Turning to the green patents classified as alternative energy patents by the WIPO we find slightly higher growth than for the overall green patents with a 9 percent average growth rate for 1990-1999 and a seven percent average growth rate for 2000-2007. With respect to specialization we find EU-27 to be slightly below average in 1990-1999 and exactly at the average in 2000-2007. Germany moves from a specialization below the average to +2 in 2000-2007. The countries least specialized in alternative energy patenting are the United States and the rest of Western Europe.

6.2.3 SME and Young Firms Contribution to Patenting in Sustainable Energy Fields - The Case of Germany

SMEs are responsible for about 15% of all patent applications. This is the same for the WIPO Green Inventory classified patents (green patents). Micro firms, i.e. firms with less than 10 employees, play an important role. About one half of all patent applications by SMEs are filed by micro firms. The share of patents applications of SMEs varies with technology class. While in waste management the share of SMEs is relatively high, SMEs are less active in transportation, agriculture and particularly nuclear power generation. The share of young SMEs in all SMEs patent applications is 53 for all patent applications between 2000 and 2003 and reduces to 39 percent in 2004 to 2007. In the green patenting area the share of young SMEs in all SMEs patent applications is also 53 in 2000-2003, but reduces less strongly to 46% in 2004 to 2007.

Figure 9 **Share of Patents Applied by SMEs and Young Firms in all Patent Applications of German Firms at the EPO, by Field and Time Period**



Source: Aschhoff, Licht, and Schliessler (2013). Data Source: EPO Worldwide Patent Statistical Database (PATSTAT).

To summarize, the study finds the relative contribution of SMEs to green patenting to be similar to their overall contribution to patenting. When controlling for the value of the patents, the contribution of SMEs to green patents even decreases below their contribution across all technology areas.

Based on the link of German firm data to patent applications at the European Patent Office, they analyzed at the firm level whether small and young firms are more or less likely to file sustainable patents than other firms. The results show that large firms are significantly more likely to file both patents in general and green patents. They do find that, for micro, small and medium size firms, the negative effect on patenting compared to the reference category of a large firm is less strong for the younger firms. This effect exists both for the generation of patents in general and the generation of green patents. Therefore there does not seem to be a particular advantage for small or young firms in producing sustainable, green patents. Our study also finds that the green patenting at the firm level is driven mainly by firm size and prior experience in patenting and particularly green patenting. This indicates that green innovations are the result of an experienced innovation regime rather than being driven by young entrepreneurs.

6.2.4 Summary and Conclusion

This study contributes to the ongoing innovation policy discussion on how to best promote smart and sustainable growth. It provides policymakers with the insight that neither small nor young firms are at an advantage in the production of sustainable green innovation, such that policies aimed at the promotion of these innovations should best target the broad population of firms.

Future studies may want to take a closer look at the particular characteristics of "green" patents in order to classify them along the notions of an incremental or radical innovation.

7. Intangible Investment and Social Innovation

7.1 Intangible Investment and Innovation Types: Findings from International Investment in Intangible Assets[32]

In advanced economies, knowledge is the main factor influencing growth and competitiveness. Intangible assets (or intangible capital) can be characterized as "knowledge capital." In the last decades, investment has shifted from tangibles to intangibles. This development is often described as the evolution of the knowledge economy.

Intangible assets can be defined in various ways. In economic literature, investment in intangible assets comprises computerized information (i.e. software), innovative property (scientific and non scientific R&D) and economic competencies, such as organizational capital and firm-specific human capital (*Corrado, Hulten and Sichel* [CHS], 2005). In the accounting literature, intangible assets include computer software, patents, copyrights, motion picture films, licenses, franchises, models, design, prototypes, etc., but exclude firm-specific human capital (see Eckstein, 2004).

Previous studies using aggregate and firm-level data find that intangible assets are an important determinant of productivity growth (see *Corrado et al.*, 2012; *Marrocu et al.*, 2012; *Van Ark et al.*, 2009 for the EU countries). In particular, it has been found that the contribution of intangibles to productivity growth is larger or only slightly lower than that of tangibles. However, unlike for the contribution of intangible assets to growth and productivity at the macroeconomic level, little is known about the drivers of international investment in intangible assets.

This study contributes to the emerging literature on the drivers and impacts of intangible assets by investigating the determinants of international investment in intangibles. The main contribution of this study is that it provides one of the first empirical investigations of the location factors in intangible assets. It focuses on the internationalisation of intangible assets as measured by greenfield investments. In particular, we investigate the main factors determining the choice of international locations for intangible assets in developed (including the EU countries) and emerging countries (including the BRICs). Intangible assets are defined as software, except video games, (ii) advertising, public relations and related activities (iii) headquarters, (iv) research & development and (v) design and development & testing. The

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[32] This section is based on *Falk* (2013) .

empirical model is based on a FDI gravity model augmented by cost-based factors (e.g. corporate taxes and labour costs), product market regulations and institutional factors (e.g. FDI regulation and entry regulation costs) as well as factor endowments (e.g. quantity and quality of skills, R&D expenditures and broadband penetration).

7.1.1 Empirical Analysis

Intangible assets are difficult to observe and to measure (*Hunter, Webster and Wyatt*, 2012). Intangible assets, intellectual capital and knowledge capital are often used interchangeably. Definitions and measures of intangible assets are available at the microeconomic (firm) level and the macroeconomic level. *Zambon* (2003), in a study prepared on behalf of the European Commission, defines intangible assets as non-physical sources of expected future benefits.

In the economic literature, *Corrado et al.* (2005, 2009, 2012) have introduced a broad measure of intangible assets consisting of computerized information (including software), innovative property and economic competences. The authors construct measures of investment in intangible assets for all EU countries. According to the estimates by *Corrado et al.* (2012), the most important subcategory of investment in intangible assets is organizational capital ranging between 12 and 36 per cent across the EU countries with unweighted average of 24 per cent, followed by software and R&D each having a share of 16 and 17 per cent respectively (unweighted across EU countries).

The measure of investment in intangible assets consists of greenfield investment in intangible assets. These data are derived from the FDI Markets database, which contains a register of some 110,000 greenfield investment projects around the world from 2003 onwards. The FDI Markets database is used by UNCTAD in its World Investment Report. In particular, the FDI Markets database includes data on all new foreign establishments and expansions in existing foreign investments. The greenfield FDI project information is derived from media sources and can be interpreted as investment commitments.

The FDI Markets database contains information on the types of greenfield FDI projects categorised by function, cluster, name and national origin of the parent company, destination country, number of jobs generated by greenfield investment, and amount of capital flow. The availability of FDI project data by function makes it possible to analyse greenfield FDI activities in intangible assets defined as FDI projects in (i) software (except video games), (ii) advertising, public relations and related activities, (iii) headquarters, (iv) research & development and (v) design, development & testing. The data covers greenfield FDI projects and investment flows in intangible assets for 26 major home countries, 40 host countries, namely the EU-27 member states and 15 OECD and emerging countries. The data refers to the period 2003-2011 for the descriptive statistics and the period 2003-2010 for the regression model. The FDI projects are aggregated across source destination pairs.

Table 7 shows the structure of intangible assets by subgroups. Software accounts for the major bulk with more than one third of all projects followed by headquarter services and design, and development & testing.

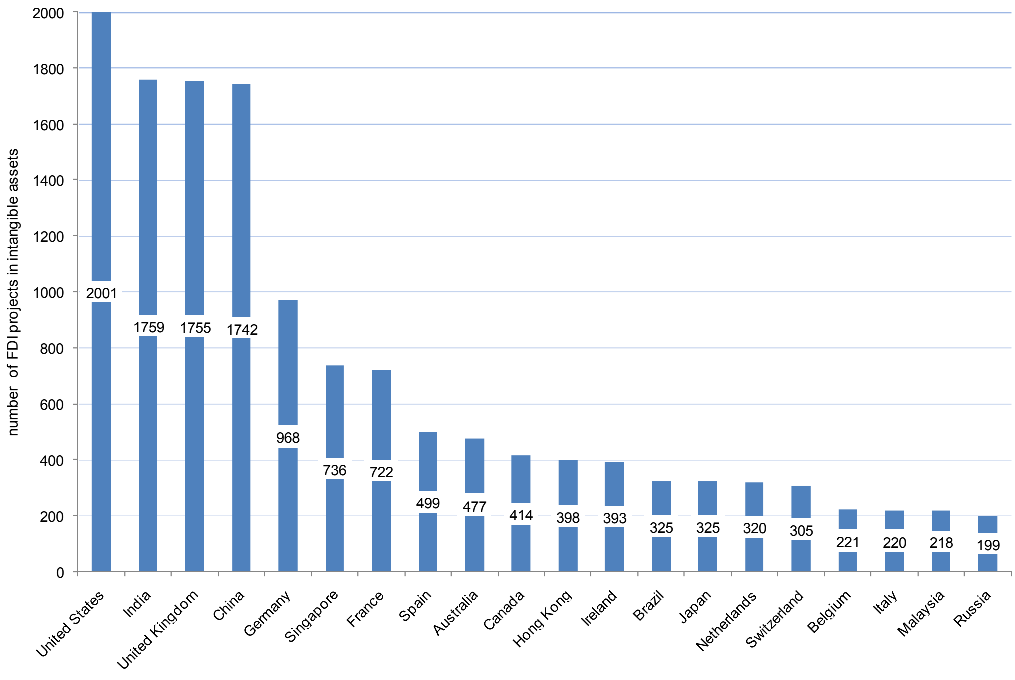
Table 7 **Structure of Greenfield FDI Projects in Intangible Assets by Subgroups**

	EU-27	40 Host Countries
software except video games	40	36
advertising, public relations and related activities	9	7
headquarter services	24	22
research & development	10	12
design, development & testing	17	22

Source: Falk (2013). Data source: FDI markets database.

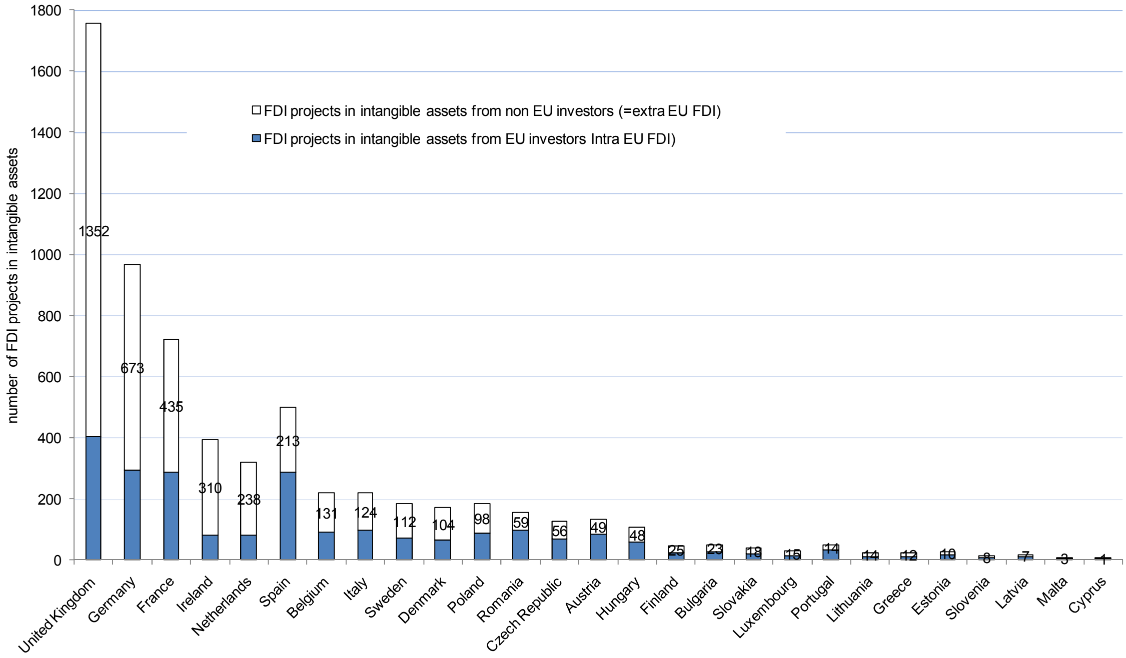
Figure 10 shows the distribution of the number of greenfield investment projects in intangible assets by country for the Top 20 destinations. Among the EU countries, Germany is second after the United Kingdom and then followed by France, Spain and Ireland. When distinguishing between investors from EU and non EU countries, *Falk* (2013) finds that for non EU investors, United Kingdom, Germany, France, Ireland and the Netherlands are the most attractive locations for international investment in greenfield investment (see Figure 11).

Figure 10 **Number of Greenfield FDI Projects in Intangible Assets by Host Country (cumulated 2003-2011)**



Source: Falk (2013). Data source: FDI markets database.

Figure 11 **Number of Greenfield FDI Projects in Intangible Assets in the EU Countries Disaggregated by Intra- and Extra-EU FDI Projects (cumulated 2003-2011)**



Source: Falk (2013). Data source: FDI markets database.

Table 8 shows the distribution of greenfield FDI projects in intangible assets by host region. It is interesting to note that the EUs share of greenfield FDI projects in these activities decreased after the economic and financial crises of 2009 (from 36 in 2008 to 32 per cent in 2011). Distinguishing between intra- and extra-EU activities shows that the decline in the EU-27's share was mainly due to the decline in the share of intra-EU FDI projects, while the extra-EU FDI projects share is relatively stable. In 2011, however, the extra-EU share declined for the first year since the data has been available. Turning to the distribution of source countries, one can see that the United States is the largest investor with about 40 per cent of all FDI projects in intangible assets followed by United Kingdom and Germany.

Table 8 **Percentages of Greenfield FDI Projects in Intangible Assets by Host Country and Year**

	2003	2004	2005	2006	2007	2008	2009	2010	2011	mean
Extra EU-27	21	22	26	23	22	22	22	22	21	22
Intra EU-27	11	10	13	13	15	14	12	13	11	13
Other OECD (non EU)	10	10	10	10	10	10	11	11	12	10
United States	9	6	7	9	11	10	12	14	15	11
Japan	2	2	2	2	2	1	2	2	1	2
China + Hong Kong SAR	14	15	13	11	11	11	10	10	10	11
India	12	15	11	13	9	8	7	6	8	9
Brazil	1	1	1	1	2	1	2	2	3	2
Russia	1	2	2	1	1	1	1	1	1	1
Other emerging countries	13	11	9	9	9	12	12	11	11	11
Other countries	6	6	7	8	8	8	9	8	7	8
Total	100	100	100	100	100	100	100	100	100	100

Source: Falk (2013).

7.1.2 Determinants of FDI in Intangibles

The OLI *paradigm* serves as the theoretical background for understanding the motivations and determinants for the international investment decision. The OLI theory states that a firm decides to invest abroad because of ownership-specific advantages, location-specific advantages and internationalisation advantages (*Dunning*, 2000). Ownership-specific advantages arise from firm-specific knowledge-based assets, such as human capital, R&D expenditures and intangible assets. Hence, countries that are relatively abundant with highly educated workers and with a high level of R&D expenditures relative to GDP show higher levels of FDI outflows. Location-specific advantages refer to the conditions in the host country. These factors can be classified into four groups: (i) demand side factors, (ii) knowledge-based factors, (iii) factor costs and (iv) product market regulations and institutional characteristics.

Previous studies on the determinants of cross-border activities in knowledge-based activities primarily deal with foreign investment in R&D and/or software. Studies on international R&D activities by multinational firms have identified two main motivations for cross-border investments in R&D: (i) "asset-exploiting" strategy and (ii) "asset-augmenting" attitude (von *Zedtwitz and Gassmann*, 2002; *Narula and Zanfei*, 2005; *Nachum and Zaheer*, 2005). *Dunning and Lundan* (2009) distinguish between three main motivations for international investment in R&D (see also *Hollenstein* 2013):

- market seeking strategy (e.g. market size, market growth, proximity to suppliers) ("asset exploiting strategy")
- knowledge and resource seeking strategies (e.g. presence of good universities, availability of skilled workers) ("asset augmenting strategy")
- efficiency seeking strategy (low wage costs, tax advantages).

The so-called asset-exploiting strategy means that multinational firms undertake foreign R&D in order to adapt their products to local market conditions. Thus, size of the market, market growth and proximity to potential suppliers are the main factor for this type of motivation. The second major motivation for cross-border investments in R&D and related knowledge-based activities is to obtain access to local scientific and technological resources and skilled labour. This is referred to as the “asset- or knowledge-seeking/augmenting” attitude (*Narula and Zanfei*, 2005; *Dunning and Lundan*, 2009). In summarizing the literature on the determinants of FDI in knowledge-intensive industries *Hollenstein* (2013) suggests that asset-exploiting is more important than asset-seeking as a motive of FDI in these activities although the relevance of asset-seeking motivation strongly increased in the last years.

The choice of investing abroad in knowledge-based activities is also likely to be influenced by institutional factors. These factors include the strength of protection for IPR in the host country and FDI regulatory regime. *Branstetter et al.* (2006) find empirical evidence that a strong IPR regime in the host country has a positive impact on local R&D expenditure of US foreign affiliates. However, the relationship between IPR protection and FDI in knowledge-based activities is not clear-cut (*Javorcik*, 2004).

The empirical specification of the FDI gravity equation takes into consideration a wide range of potentially relevant determinants of FDI (see *Zwinkels and Beugelsdijk*, 2010; *Chakrabarti*, 2001). As outlined above, these variables include market size, skills, R&D endowment, ICT infrastructure and cost-based factors. The gravity model predicts: the larger the economies, the larger FDI activities or the greater the geographical distance, the lower the FDI activities, respectively.

Estimates using the random-and fixed effects negative binomial model based on the sample of 40 host countries show that both quantity of education measured as the tertiary graduates share and quality of education measured as the PISA index have a positive and significant impact on the number of greenfield investment in intangible assets. Hourly wage costs have a significant and negative impact on greenfield investment in intangible assets while corporate taxes do not play a significant role. The results for host country and home country GDP are not clear-cut.

When the sample is restricted to the EU host countries, we find significant differences in the FDI determinants between the total. In particular, corporate taxes in the host country are now significantly negative, while the coefficient of wages is much lower in absolute terms than for the total sample including 40 emerging and industrialized countries.

When the human capital variables are replaced by the R&D to GDP ratio of the host and parent country it turns out that R&D endowment of the host country is a significant factor influencing greenfield FDI inflows into intangible assets (based on the sample of 40 host countries). When R&D is divided into public sector and private sector, the results indicate that public sector R&D is more important than private sector R&D in determining the number of greenfield investment projects in intangible assets.

Product market regulation and investor protection also matter for greenfield investment in intangible investments. The results based on the random effects specification show that the costs associated with starting a business and strength of investor protection are significant factors influencing greenfield FDI inflows into intangible assets. Broadband penetration also has a significant and positive influence on greenfield investments in intangible assets. This clearly shows that a high level of broadband penetration is a prerequisite of knowledge interactions, such as the transfer of codified knowledge between a parent company and its affiliates.

7.1.3 Summary and Conclusions

Higher investments in knowledge-intensive activities, such as intangible assets, are essential for making progress in the implementation of Europe's 2020 strategy for smart, sustainable and inclusive growth. Hence, knowledge about the factors influencing the level of international investments in intangible assets is important for policy makers. This study has investigated the policy and non-policy determinants of bilateral greenfield investments in intangible assets. For the EU countries, the share of tertiary education, R&D intensity, market size, strength of investor protection and corporate taxes are significant determinants of greenfield FDI in intangible assets, while for the total sample, the presence of skilled workers, quality of education, direct R&D subsidies, entry regulation costs, broadband penetration and strength of investor protection and Internet infrastructure are significant factors.

This study empirically analyses the determinants of greenfield investment in intangible assets in emerging and industrialized countries. Data consists of host parent country pairs of greenfield FDI projects in (i) software (except video games), (ii) advertising, public relations and related activities, (iii) headquarters, (iv) research & development and (v) design, development & testing. With a world market share of 33 per cent in 2011 in terms of the number of projects, descriptive statistics show that the EU-27 is one of the most important locations for international greenfield investment in intangible assets. However, there was a decline in the EU-27's share of such projects after the recent financial and economic crisis, which is mainly due to the decrease in intra-EU greenfield FDI activities. In contrast, FDI inflows in intangible assets increased in the United States, in other non-EU OECD countries and in emerging countries. Among the EU countries United Kingdom, Germany, France, Spain and Ireland are the most attractive locations for investment in intangible assets, whereas the Southern and Eastern EU member states are least successful in attracting FDI projects in intangible assets. For investors from non-EU countries the ranking is quite similar with United Kingdom receiving the largest number of FDI projects followed by Germany, France, Ireland and the Netherlands.

The results of this study have important policy implications, and not only in direct relation to FDI. Reducing the regulatory burden on new businesses should be a key goal of policy makers. Second, additional investments in tertiary education and Internet infrastructure should thus be the main objective of policy makers.

The results show that FDI in intangible assets depends significantly positively on quantity of human capital, quality of human capital measured as the PISA score in maths and reading, broadband penetration, strength of investor protection, R&D endowment and direct R&D subsidies. Wage costs (or unit labour costs) and costs of starting a business have a significant negative impact on FDI inflows in intangible assets. Other policy factors, such as labour market regulations, product, or FDI regulations, do not have a significant impact. Separate estimates for the EU-27 countries show that corporate taxes matter for the international location decision for intangible assets. The empirical results presented may help to develop a proactive action plan to attract international investments in intangible assets in Europe.

7.2 Social Innovation and Industrial Performance[33]

Social innovation and social entrepreneurship are concepts that are widely used in the policy discourse. Despite this they are analytically not well defined and very diffuse. The aim of the paper by *Reinstaller* (2013) is to clarify these concepts and to work out how social innovation is likely to contribute to social and economic progress in general, and to industrial change more specifically.

The paper provides a brief review of the use of the concept of social innovation in recent years both in the academic and the policy oriented literature. It shows that while the different notions seem to lack a common epistemological basis at first, most definitions relate to some form of autonomous or induced institutional change. These changes then either affect (and possibly improve) the welfare of some specific social groups or of society at large, or lead to the rearrangement of existing or the establishment of entirely new social relationships.

The paper links the concepts of social innovation and social entrepreneurship to prior work on institutions, institutional change and economic performance pioneered by *North* (1990) and others. Using this theoretical framework social innovation can be interpreted as the introduction and diffusion of new beliefs and new mental models that lead to the establishment of new institutions and as a consequence a change in policies. As such it is part of a perpetual cycle of institutional change in which new realities lead to the revision, replacement or demise of established formal or informal normative systems. These changes can take place at different scales in hierarchically related elements of social systems.

7.2.1 Defining Social Innovation

Social entrepreneurs are often viewed as the drivers of social innovation. However, the concept of “social entrepreneurship” is as diffuse as the term social innovation. The paper argues that actors with entrepreneurial traits can be observed in many different policy arenas and not just in the provision of social services, as is done in some important parts of the literature on social innovation. These change agents are individuals, organizations or special interest groups who are dissatisfied with an established institutional set-up. By altering existing widely shared belief systems and establishing supporting networks they promote alternative arrangements. In doing so they become active in areas where there is partial market failure or where no markets exist at all. These change agents differ considerably in what they do and how they do it. This depends largely on the social context in which they operate, on what they want to change and why. This explains the wide variety of definitions in the literature.

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[33] This section is based on *Reinstaller* (2013).

Entrepreneurial change agents are antagonists to stabilising forces in a society that try to enforce conformity and compliance with the established institutional set up. As a consequence, they often encounter considerable resistance either through informal normative systems such as social norms and people supporting these norms or through formal rules and law enforcing agents. The strengths of these normative systems will therefore affect the diffusion of social innovations. Social environments in which there is a strong pressure for conformity it is less likely that social innovations will diffuse. This is typicall the case in very homogeneous populations or populations where the individuals are either few or closely related individuals. In such populations change agents face high social costs and "underinvest" in social innovation. The antagonistic interaction between change agents and stabilising forces leads to patterns of institutional change and socio-economic development that are characterised by punctuated equilibria in which short periods of change induced by change agents are followed by longer periods of stabilisation of the new institutional set up.

7.2.2 Social Innovation and Economic Performance

There is relatively little literature that has investigated the effect of social innovation at the micro-economic level on economic performance, welfare or subjective well-being. A closer scrutiny of the literature on social innovation reveals a number of transmission channels through which social innovation is likely to translate into changes of economic performance, welfare or subjective well-being. For instance, the provision of customised public goods that part of the literature relates to social innovation may improve social welfare as they target the recipients' needs better. As a consequence the tax spending efficiency increases as does the tax loyalty of tax payers. Some types of social innovation that are more closely associated with the empowerment of people to improve the quality of life in their communities may have a direct impact on their income as well as on their subjective well being. Other types of social innovation that lead to the establishment of (mostly not for profit) enterprises may contribute again to generate income and employment.

From the perspective proposed in this paper it is generally not possible to say whether institutional change and social innovation have always a beneficial effect on society. On the one hand social innovation may also lead to the diffusion norms that from a social, humanitarian or economic point of view may be considered to be inferior and therefore negatively affect the well-being or economic performance of a country. Indeed, the literature suggests that the institutional set-ups of an economy are related to its economic performance (even though the causality is not so clear). On the other hand the process of change increases the uncertainty in society by destabilising existing normative systems and this increases transaction costs. Indeed, recent research shows that there is a positive relationship between institutional stability and economic growth. Finally, as institutional change and social innovation displace existing institutional set-ups the net-effect on economic or social performance may be negative. Given the lack of data a general evaluation of the potential impact of social innovation on the performance of an economy is not possible. A recent micro-level randomised evaluation study assessing the impact of micro-finance in rural India has however shown that there is no significant impact on development outcomes. While this evidence is very limited it suggests that the impact of social innovation and social entrepreneurship may not generally be assumed to have a positive impact on economic or social outcomes.

In its final part the paper then assesses to what extent social innovation and social entrepreneurship can be a driver of industrial change, and whether there is a scope for policy intervention to foster social innovation in the context of a new industrial policy. A central proposition of what nowadays is conceived as “new” industrial policy is that industrial policy should provide adequate framework conditions to ensure that companies are able to generate new sources of value, and that this creation of new sources of value should ensure that all participants in an enterprise (employees, creditors, shareholders, government, firm, consumers) gain. Hence, industrial policy is viewed as a means to achieve equitable and sustainable growth.

A central part of this creation of new sources of value is industrial innovation. To assess the potential impact social innovation can have on the innovation performance of firms it is important to conceive of industrial innovation as process, in which strategic choices on the allocation of resources have to be made under conditions of uncertainty (and thus beliefs and mental models of managers play an important role in decision making). Innovation is also a collective, social process in which it is necessary to integrate people with different functional specialities and hierarchical responsibilities into a process of organizational learning. Finally, it is a process in which financial models have to be developed and deployed to sustain innovation from the time research and development investments are made until higher quality products yield financial returns. Thus, the failure of companies to generate innovations and being competitive is an institutional and organizational and not so much a market failure (see *Lazonick* 2012). These failures arise as the management, the organizational memory of companies, financing institutions rely on inadequate beliefs and mental models in their decision making.

Social innovation can play four roles in overcoming such failures. The first role can be conceived as the inside-out function of social innovation: As innovation is a social and organizational process, organizational mechanisms that support experimentation, the development of new interpretations of reality (aka new mental models and belief systems) and their integration into the organizational set up are crucial to escape organizational myopia. The second role may be conceived as an outside-in function of social innovation. Strategic choices about resource allocation are based on beliefs (“gut feelings”, see *Gigerenzer* 2007) about how markets and competitors and relevant institutions work, and what consumers need. Often these beliefs turn out to be wrong, as the management is not aware of significant changes in consumer preferences or other relevant institutional factors. The monitoring and close interaction and exchange of companies with change agents can break this type of institutional myopia. A final role for social innovation is that companies turn themselves into change agents in order to change institutional framework conditions that are unfavourable for their activities. Recent attempts to bypass traditional banking finance and engage into crowd funding schemes are an example of the third role social innovation can play in overcoming institutional failures in the context of industrial innovation. The final role is that specific types of social entrepreneurship involve the creation of new businesses and hence the development of new markets.

7.2.3 Social Innovation and Policy Policy

For the first two roles of social innovation in the context of a "new industrial policy" there is little scope for public policy intervention as the minimisation of institutional and organizational failures inside a company falls into the realm of entrepreneurial risk taking. The third role is one in which companies turning into change agents may face considerable resistance both from inside the business sector, e.g. by competitors or chambers of commerce, as well as from the public sector, e.g. by the institutions they try to change. Hence, there may be some "underinvestment" in such change activities, and, as a consequence, public action may be required that balances the need for institutional stability and certainty and the need for change in the existing institutional set up. Measures that increase the public awareness and mechanisms that ensure a certain degree of leniency and that balance potentially strong suppressive public sector reaction could ensure that the novel ideas get a better chance for being carefully assessed with regard to their potential effects on different parts of society. For the final role social innovation can play in the context of industrial policy the literature shows that the problems social entrepreneurs that engage into the creation of businesses face are rather similar to business entrepreneurs engaging into industrial innovation activities. Hence, existing mechanisms to minimise the risk for underinvestment in industrial innovation should be adapted to take into account some peculiar needs of social entrepreneurs.

The principal findings of the paper show that there is scope for public intervention to support different types of change agents as considerable social pressure to conform to existing social norms and formal rules will deter potential change agents from becoming active. This problem is likely to be more accentuated in more conservative, conformist societies.

The findings also show that social innovation and social entrepreneurship may not generally be thought of as being a "positive" force for change. On the one hand, social innovation may lead to the diffusion of norms and behaviours that are inferior from a social or economic point of view. On the other hand, social innovation may also increase transaction costs in an economy.

The public sector faces generally a trade-off in supporting social innovation: on the one hand it has to act as a structurally conservative force to ensure social and economic stability. On the other hand, it should allow for enough social variety in order to ensure social and economic progress.

With regard to a potential role social innovation can play in the context of a new industrial policy the paper shows that while social innovation may play an important role to foster the competitiveness of companies there is a limited role for public intervention.

Regarding the question how institutions of modern market economies can be changed so as to internalise the current social and ecological externalities and to decrease volatility and divergence in Europe it has to be kept in mind that these changes are often conflicting with established institutions and are therefore difficult to achieve. Established institutions are structurally conservative forces as they enforce established informal and formal rules. However, the decentralised identification of problems and development of potential solutions is an important activity for social and economic progress.

Change agents such as policy entrepreneurs can play and have played a significant role in the change of market economies and the internalisation of social and ecological externalities in the past. Change agents often encounter much resistance from inside the established system. Sound democratic institutions (that allow for variety of views and their competition on the ballot box) and a strong civil society are key to ensure that there is enough social experimentation in society.

However, such changes imply always a phase of high(er) institutional, social and sometimes economic volatility. The paper highlights that (significant) institutional change progresses always through alternating phases of short periods where new ideas punctuate existing social equilibria where volatility is high and longer periods of stabilisation where volatility is low.

How the general public, third sector actors and vested interests can be motivated to support reforms towards a new growth path is to some extent a normative question as the notion of a "new growth path" exactly needs to be filled with meaning by politicians and civil society, not so much by researchers. Normative questions are not addressed in this paper. The paper provides however an overview on the mechanics of institutional change and social, i.e. how altered perceived reality by some change agents, may induce changes in beliefs that in turn may induce institutional changes that finally can lead to new or altered policies.

8. The Role of Universities[34]

Frontier research in European research institutions is weak compared with the US. At the same time, studies point to an increasing role of science for firm innovation, not only in a few sectors close to science such as pharma, but across the board. Together, these two observations point to a serious issue of the European growth model, in particular given the still strong role of geographic proximity for knowledge flows. When academic research quality matters for firm innovation, the "competitiveness" of the European model is under strain. This chapter contributes to the question how basic (academic) research can contribute to smart, inclusive and sustainable growth.

8.1 Does the Quality of Academic Research Matter for Business-Science Links?

So far, there are no results for the original research question, however the literature survey confirms the relevance of the quality of academic research for innovative activity:

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[34] This chapter is based on *Janger, Strauss and Campbell* (2013) and *Janger and Nowotny* (2013).

- Academic contribution to firm innovation: usually, firms name top scientists as sources for their innovative activity (see firm surveys like *Mansfield*, 1995)
- Firm location and university research quality: firms locate their R&D headquarters/labs close to high quality universities (see firm R&D statistics and university data, e.g. *Abramovsky, Harrison and Simpson*, 2007, *Belderbos, Leten, and Suzuki*, 2009)
- Investigations of technology transfer activity confirm more intense business science links for high research quality universities (see *Conti and Gaule*, 2011, and *Di Gregorio and Shane*, 2003, more specifically for start-ups)
- Star scientists and firm entry are linked. Based on bibliometrics data, *Zucker and Darby* (2007) show that the „geographic distribution of new science-based industry can be mostly derived from geographic distribution of intellectual human capital embodying the breakthrough discovery upon which it is based.

8.2 New University Research Organization Model

There is sound evidence on the international mobility of highly talented researchers as well as on asymmetric mobility towards prestigious US universities from many regions of the world, not only developing countries but also Europe. At the same time, there has been little systematic research on the academic labour market and on what makes researchers choose one job over another in cross-country settings, leading to any asymmetric job flows. The papers by *Janger and Novotny* (2013) and *Janger, Strauss and Campbell* (2013) contribute to the literature by using a unique international survey of more than 15.000 early and later stage researchers for an experimental stated choice approach. Based on previous evidence, the authors build a range of typical jobs in academia and let respondents choose among randomly allocated job offers. From the chosen jobs, they estimate probabilities of job choice given specific job characteristics and hence draw conclusions on which job feature sets researchers deem to be particularly attractive.

The results support earlier evidence and add a variety of explanations for career choices in academia. Among attractive job features for both early and later stage researchers the authors found salaries to matter, in particular for male, later stage and mobile researchers as well as researchers from disciplines where private sector involvement is likely (medicine, engineering). This confirms evidence that academic researchers do react to relative earnings, not just as a factor for the choice between two jobs in academic research, but also between a job in academic research and in (research) private sector jobs. Health and pension characteristics of jobs also exert significant influences on job choice, in particular for female researchers as regards health care and later stage researchers (LSR) concerning the pension arrangement. Part of the remuneration package that was designed for the choice experiment, were also fringe benefits mostly related to facilitating taking up jobs which involve a change of country. Academics who already have been internationally mobile value these fringe benefits most; child-related benefits add to job attractiveness from the perspective of early stage researchers (ESR).

Table 9 **Factors Affecting Mobility of Scientists**

Early stage	Later stage
Remuneration	
Net salary p.a. (incl. bonuses): the more the better	
Health care: the higher patient contributions, the less attractive the job	
Retirement pension: the higher net expected replacement, the better	
Fringe benefits covered: depends on individual characteristics (schooling for children, job offer for partner…)	
Country characteristics	
Quality of life: must not be worse in country of new job	
Working Conditions	
Career perspectives I: Length of initial contract: the longer, the better (up to 6 years)	Ease of starting new lines of research: the more research has to be in line of previous chair-holder, the less attractive
Career perspectives II: Extension of initial contract: tenure track contingent only on research performance very attractive	Quality of administrative support: the less time for administration required, the better
Research autonomy: Time for own research (independence) - the more, the better	Salary advancement scheme: Public scheme including a performance bonus
University-internal funds for research (accessibility - financial autonomy): funds provided by university without strings attached very attractive	University-internal funds for research (how much of research can they fund): the more research can be funded via university-internal funds, the better
University-external funds for research - good availability of short-term and long-term basic research grants important feature of attractive jobs	
Quality of peers (research reputation): the better, the more attractive a job	
Split between teaching and research tasks: a fruitful balance including approx. 10h of weekly total teaching load in a 40h week	

Source: Janger and Nowotny (2013).

The quality of life in the country of the job to be chosen can be seen as a necessary, but not sufficient characteristic: it must not be worse than in the current country, but a better quality of life does not add much to job attractiveness so that quality of life is not an attractor.

The job attributes contained a number of features framing the working conditions of academics. For both ESR and LSR, in line with the previous literature, the authors find highly significant effects of the quality of peers in the job and of the availability of external research funding grants, in particular for equipment-intensive fields of science such as the medical sciences. These are important elements which usually are more likely to be found in prestigious research universities which either can draw on endowments or on generous funding by national higher education systems. Attractive jobs feature moreover a balance between teaching and research. Jobs with some teaching - a bit less than a third of combined teaching and research time - are favoured over jobs with no teaching and jobs with too much teaching. While a too high teaching load restricts research and hence the possibilities for establishing priority as the major determinant of a successful academic career, some teaching can be beneficial because it allows researchers to make contact with promising students and potential young researchers, and can contribute to a deeper understanding of their field. Teaching may also be intrinsically motivated by the desire to impart knowledge.

Concerning working conditions specific to early stage researchers, the paper finds a very strong role of career perspectives, i.e. the length of the initial contract and its extension possibilities in the form of tenure contingent only on research performance; and of organizational factors (research and financial autonomy). Early stage researchers seem to be particularly attracted to job environments where they can enjoy early independence and where this independence leads to own research results which support the claim to a tenured position. Early stage researchers want to take their career in their own hands. This is in line with accounts of researchers' intrinsic and extrinsic motivations which may be closely connected: The possibility of early freedom to do own science may confer an early start to attempts at establishing priority, in turn triggering processes of cumulative advantage, related inter alia to advantages in applying for external funding (the so-called Matthew effect in science).

These results are stronger specifically for PhD-holders and post-docs, where processes of career choice involving a change of country are most likely according to empirical evidence. When levels of confidence in future career prospects as a proxy for quality are interpreted the results are even stronger for highly talented PhD-holders and post-docs, providing some clues to the observation of asymmetric mobility of talented scientists in the direction of the US.

LSR-specific job attributes describing the working environment of researchers included the amount of research which can be funded from university internal sources. LSR favour jobs where these funds can cover a high share of research needs. Further attractive job characteristics are administrative support for researchers which minimises the time spent on administrative tasks and a salary scheme which is based on a public scheme but involves an element of performance pay. Researchers were sceptical towards individual research evaluation as a means to determine salary hikes. Moreover, later stage researchers, and in particular highly confident ones, dislike jobs where it is less easy to take up new lines of research or where they have to continue lines of research by the researcher they are replacing. This speaks in favour of university recruitment based on quality, rather than fit with narrow discipline needs.

The way ESR and LSR view organizational job attributes (research autonomy, career perspectives, research continuity), they give support to departmental organization at the working unit level of universities, as compared with a more chair-based organizational structure. In the latter, having only one researcher at the top necessarily limits career perspectives and research as well as financial autonomy, while the replacement of the chair is going to face stricter demands on the contents of his or her research and teaching. In a more team-based department structure, several researchers of similar rank can work together, allowing for more career options, research autonomy and ease of taking up new lines of research. Again, these organizational features are commonplace in US research universities, so that these universities do not only enjoy advantages as regards the quality of their peers and funding/salaries, but also with respect to their working environments for researchers.

Insofar as talented researchers attract talented researchers, turning a situation of asymmetric into one of symmetric mobility (or a brain drain into brain circulation) faces the challenge of considerable inertia and persistence. However, as stated, high quality peers are not the only job attractor. European universities can offer attractive career perspectives and working environments, while the career model of US universities in the form of the tenure track has come under a lot of strain recently, in addition to problems of funding. An evolution of European career systems towards more similar structures characterised by the findings above would also lead to deeper integration of academic labour markets in Europe, boosting the efficiency of job matching, increasing competition and hence undoubtedly raising the profile of European science. For this to happen, there is of course the condition of letting non-native researchers teach in English so as to open up insider systems. Furthermore, research-only basic research institutions such as the Max Planck institutes in Germany or the CNRS institutes in France are also at a disadvantage concerning the attractiveness of jobs they are able to offer. Last, but not least, attractive academic career structures could also lead to increased immigration of highly qualified scientists, as witnessed in the USA; at the very least, it could turn a situation of brain drain from Europe to the US in a situation of mutually beneficial brain circulation.

Based on the findings from above, the paper classifies 10 selected national higher education systems according to their capability to offer attractive jobs for university researchers. Components of the summary index are as follows:

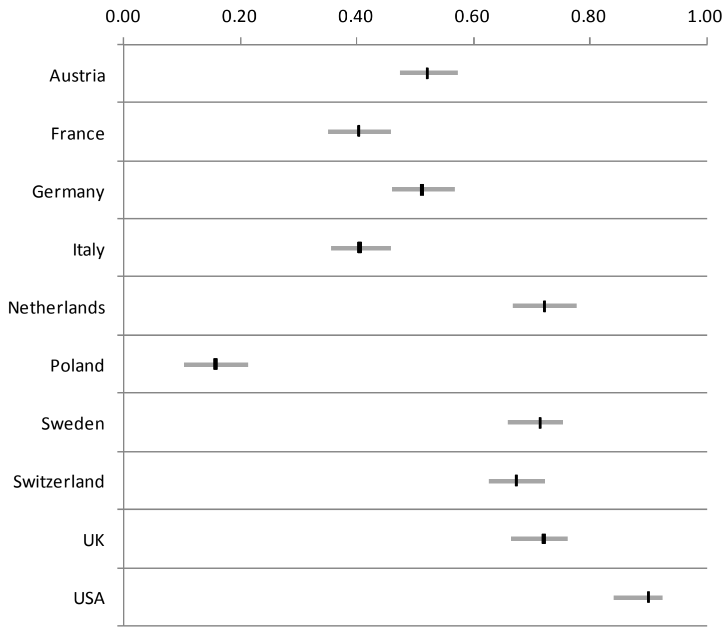
Table 10 **Determinants of Mobility – Measurement Concepts**

Area	**Components**	**Source**
Salary	Net salary p.a., in USD PPP	Statistical
Quality of life	Quality of life Index	Statistical
PhD-studies	• Recruitment of PhD-students • Structure of PhD-studies: Supervision • Structure of PhD-studies: Coursework • Research career orientation of Phd-studies	Qualitative
Career Perspectives	• Share of tenured researchers below full professor • Ability to teach in English • Existence of tenure track model • Characteristics of tenure track model • Recruitment for tenure track positions	Statistical/Qualitative Qualitative
Research Organization at working unit level	• Research autonomy of assistant professor/first position of academic career • Accessibility of university internal funding for ESR (financial autonomy of ESR) • Organization of working units (departmental vs. Chair-based) • Recruitment of assistant prof./entry position in academic career vs. recruitment full professor	Qualitative
Balance teaching research	• Average teaching load in hours per week • Mechanism to adjust student numbers to teaching capacity • ESR vs. LSR teaching load	Statistical/qualitative Qualitative
Funding	• Higher education funding per student in US PPP • Perception of availability of basic research grants • Funding mode of ESR (internal or external funding)	Statistical Statistical/qualitative
Quality of peers	• Probability of working with high quality peers – aggregation of Leiden university ranking to national level	Statistical

Source: Janger and Nowotny (2013).

Figure 12 presents the summary index, showing the mean of the scores as well as the minimum and the maximum.

Figure 12 **Summary Index of Job Attractiveness (1 = most attractive)**

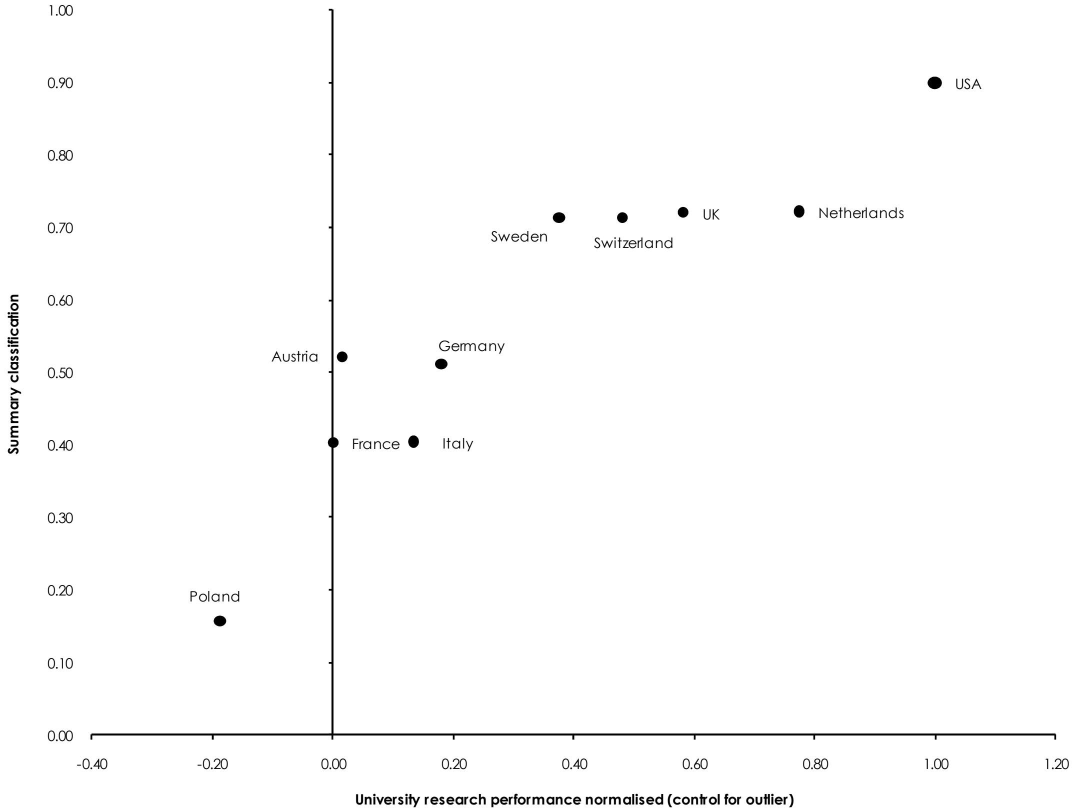


Source: Janger and Nowotny (2013).

The US seems to be most able to offer attractive jobs, followed by a group of four well performing European countries: the Netherlands, Sweden, the UK and Switzerland. Around the average of the summary index are Germany and Austria, followed by France and Italy which are clearly below average. Poland comes last in the exercise. Basically, the US offers a triplet of advantages which are difficult to emulate in the short term: attractive salaries, attractive working conditions and high quality peers. Especially the latter works as a factor of inertia, as good researchers will attract good researchers. Change will need time and certainly not less attractive working conditions than in the US, accentuating the need for urgent reforms.

The comparison should not be seen as comparing all the relevant aspects of a higher education system which may impact on university research quality, but rather those aspects which are directly relevant for the attractiveness of jobs. In particular, the authors do not look at issues of university governance such as the autonomy they have got. As such, they complement earlier literature on comparative higher education which focuses on the competition between autonomous universities as a determinant of university research performance (*Aghion et al* 2007, 2008, 20010). While this literature could be interpreted as “getting the best out of the researchers a university has got” the authors’ endeavour is more oriented towards “getting the best in the first place”. Nevertheless, they find a very high correlation of 0.9 of the summary index with the measure of research quality (an aggregation of the Leiden Ranking). Of course, this does not imply causality.

Figure 13 **Correlation of Summary Index with Quality of Peers**



Source: Janger and Nowotny (2013).

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10. Annex

10.1 Annex: WWW-Contributions Summarized in this Report

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These papers can be downloaded from www.foreurope.eu. Baccianti and Löschel (2014a,b) are not yet available in the internet.

10.2 Supplementary Figures and Tables

Table 11 **Studies Using the Employment Factor Approach**

Author and Title	Region	Time period	Methodology	Data Source	Trigger/ Policy Scenarios	Employment factors			Employment scope				
									Gross	Net	Direct	Indirect	Induced
1* Lambert (2012)	USA & Europe	1998-2004	Review	13 reports & studies listed in Kammen et al. (2004)	-	PV Wind Biomass	1.03 jobs/GWh 0.2 jobs/GWh 0.21 jobs/GWh	4.13 jobs/$ 2.81 jobs/$ 2.75 jobs/$	x		x		
2 Tourkolias (2011)	GRE	present	IO-model	-	National target for RES deployment into power sector: 40% in 2020. 4 different scenarios w.r.t. import share, unemployment rate, decreasing investment costs for RES, and public expenditure.	Hydro PV Wind Biomass Geotherm	0.33 jobs/GWh 1.09 jobs/GWh 0.49 jobs/GWh 0.80 jobs/GWh 0.24 jobs/GWh		x		x	x	x
3* Dalton, Lewis (2011)	IRE	2007	Comparison of installed wind capacity and jobs in wind industry in Europe & Ireland	Approx. 20-25 reports of NGO's and EU/international organisations (EU & UNEP)	Job Creation by historic development of wind power installations	Wind	Onshore wind 10-16 job-years/MW (construction)	0.44-2.4 job-years/MW cumulative (O&M over lifetime)	x		x		
4* Sastresa et al. (2010)	Aragon (ESP)	2007	Review	Papers	-	PV Wind Solar Heat	38 jobs/MW 0.86 jobs/MW 43 jobs/MW (due to high rate of expansion)	R&D: 10.25 Inst.: 8.12 O&M: - R&D: 0.8 Inst.: 0.02 O&M: 0.05 R&D: 1.6 Inst.: 40.41 O&M: -	x		x		
5 Thornley et al. (2008)	UK	-	Survey of existing plants	CHP and electricity plants	-	Biomass	1.27 job-years/GWh		x		x	x	x
6 Simas, Pacca (2013)	BRA	2010-2017	Analytical method & IO-model multiplicators for indirect employment	Personal interviews & review of onshore wind turbines life cycle assessments	Realisation of wind energy projects expected to begin operation by 2017	Wind	person-year-equivalents/MW Manufacture (direct / indirect): Nacelle 0.85 / 0.34 Rotor 1.75 / 0.99 Tower 0.81 / 0.87 Construction Steel Tower 6.73 / 0.59 O&M 0.59 Total 10.74 / 3.4		x		x	x	
7* Llera et al. (2013)	ESP	2001-2010	Supply chain analysis	- Analysis of reports on activity of business associations - Trade information of companies - Surveys	No Scenarios. Comparison of real observed jobs and model results for the historic period of 2001-2010	PV	Jobs/MWp Projects/studies 0.33 Silicon 0.98 Cells 2.41 Module assembly 9.05 Solar tracker 6.37 Electr. components 2.60 Installation 6.06 Operation 1.65 Total 29.46		x		x		

Source: Mayer and Sommer (2014).

Table 12 **Studies on Employment Effects – Germany**

	Author and Title	Region	Time period	Methodology	Data Source	Trigger/Policy Scenarios	Employment Effects			Employment scope: Gross	Net	Direct	Indirect	Induced
8	Böhringer et al. (2013)	GER	Static year 2004	CGE	Mainly: GTAP7 2004	Policy scenarios: Implementation of renewable electricity (RES-E) Subsidies financed by 1) lump-sum tax 2) labor tax 3) electricity tax 4) coal subsidy abolishment: revenue-neutral replacement of existing coal subsidies	Hydro other RES		Results for RES-E being subsidised 100% - Lump-sum: positive employment effect, i.e. decline of unemployment rate from 10% to 9.86% - Labour tax, negative, increase to 10.28% - Electricity tax, negative for high subsidy (positive for small subsidy rate) - Coal subsidy abolishment, positive, decrease to 9.87% (negative for small subsidy rate)		x	x	x	x
9	Lehr et al. (2012)	GER	2009-2030	IO-model PANTA RHEI	PANTA RHEI Model Nitsch, Wenzel (2009)	Scenarios: - Internat. fossil fuel prices (path A, path B) - Export of PV (optimistic, moderate, max) - Investement in domestic RES according to Nitsch, Wenzel (2009): Leitszenario 2009 - Additional investment in PV (PV1 , PV2)	Hydro PV Wind Biomass Geotherm Biogas Solar Heat pumps	onshore & offshore electricity & heat electricity	Net employment of between +25,000 and +180,000 (optimistic export) in 2030		x	x	x	x
10	Bach et al. (2002)	GER	1999-2010	PANTA RHEI (IO) LEAN (CGE)	-	Environmental tax reform Increased fossil fuel tax, revenues are used to lower non-wage-labour costs 4 scenarios: low and high crude oil prices, model comparison	RES as in 9 plus CSP		40,000-250,000 additional jobs in 2010 due to lower non-wage-labour costs		x	x	x	x
11	Hillebrand et al. (2006)	GER	2004-2010	Econometric model	-	Scenarios: REF: Freezes the RE status quo of 2003 S1) Expansion of RE share to 12.5% in 2010 Investment in power plants (focus on windpower) Investment in power grid, modification of power plant fleet (natural gas) Investment volume 2.6 Bn € (2004)-1.5 Bn € (2010) --> increasing electricity costs --> induced negative income effects	 Hydro PV Wind Biomass Geotherm Biogas	Investment (Bn €): 2004 2006 2008 2010 0.208 0.208 0.208 0.208 0.375 0.443 0.511 0.579 1,668 1,078 0.608 0.608 0.280 0.044 0 0 0.016 0.028 0.021 0.020 0.056 0.055 0.063 0.050	Investment induced increase in jobs and induced job losses due to higher energy prices (in 1,000 jobs) 2004 2006 2008 2010 Investment induced 35.66 25.35 19.77 19.37 Price induced –2.3 –7.7 –15.46 –23.31 Total 32.3 17.6 4.3 –5.0		x	x	x	x
12*	Lehr et al. (2008)	GER	2004-2030	PANTA RHEI (IO) Data on RES	Central model data: - Survey of 1,100 interviews - PANTA RHEI Model Central Scenario Data: IEA, European Renewable Energy Council	Scenario pool: 1) Four export scenarios.: Diff. export shares of RES technology (Cautious, cautious optimistic...) 2) Two internat. scenarios w.r.t energy prices: - REF: Reference Scenario in prices (IEA) - DCP: Dynamic and current policy (European Renewable Energy Council) 3) Two German scenarios: - REF: economic reference forecast by EWI/Prognos –30% (–44%) CO_2 achieved in 2030 (2050) - TOS: Target-oriented Scenario: reach national target of –40% (–80%) CO_2 in 2030 (2050)	Hydro PV Wind Biomass Geotherm Biogas CSP		4 Gross employment results, employment in RES Sectors (in 1,000) Export Scen. / Internat. Scen./ German Scen. 2004 2010 2020 2030 Cautious/DCP/TOS 157 244 306 333 Cautious/REF/REF 157 161 170 180 Caut. optimistic/REF/REF 157 170 181 197 One Net Employment Result 2010 2015 2020 2030 difference between cautious/REF/REF and Cautious/REF/TOS 55 64 74 84	x	x	x	x	x
13*	Kuckshinrichs et. al. (2010)	GER	2005-2007	Extended IO-model	Clausnitzer (2008)	German CO_2 refurbishment programme for the years 2005-2007	Energy efficiency	Building Refurbishment programme 2005-2007	Direct Empl./€ invested (job-years/Mio. €) 2005 2006 2007 18.3 18.4 16.4	x		x	x	

Source: Mayer and Sommer (2014).

Table 13 **Studies on Employment Effects – Other Countries (1)**

	Author and Title	Region	Time period	Methodology	Data Source	Trigger/Policy Scenarios	Employment Effects		Employment scope: Gross	Net	Direct	Indirect	In-duced
14*	Wei et al. (2010)	USA	2009-2030	Employment factor approach combined with scenarios	15 Reports & studies listed in the paper	3 energy demand scenarios: BAU (+24% energy demand), Medium-EE (+12% energy demand) and "flat energy" (+6% energy demand) 2 energy production scenarios: BAU with 7.4% RES-E in 2020 and 9.1% in 2030 Policy scenario: 20% RES-E in 2020 and 30% RES-E in 2030	job-years/GWh (direct) Hydro 0.27 PV 0.87 Wind 0.17 Waste 0.72 Biomass 0.21 Geotherm 0.25 Solar 0.23 CCs 0.18 Energy Efficiency 0.38 Insulation of buildings	2009-2030 Medium-EE: +1.9 Mio. job-years Flat-Energy: +4 Mio. job-years	x	x	x		
16	Moreno, López (2008)	ESP	2005-2010	Employment factor approach in combination with scenarios	Spanish Renewable Energy Development plan 2005-2010 (2005) Partly based on forecasts from 1996 (TERES II)	Scenarios (baseline-optimistic-pessimistic): Investment in RES according to Spanish Renewable Energy Development plan 2005-2010	5-year-period Hydro: 18.6 (constr.), 1.4 (O&M) jobs/MW PV: 34.6 (constr.), 2.7 (O&M) jobs/MWp Wind: 13 (constr.), 0.2 (O&M) jobs/MW Biomass: thermal: 0.12 (constr.), 0.01 (O&M); electricity: 4 (constr.), 0.14 (O&M) jobs/toe Biogas: 25 (constr.), 6 (O&M) jobs/MW Solar: 2.5 (constr.), 5 (O&M) jobs/1,000m^2 Biofuels: 5 (constr.), 1.5 (O&M) jobs/1000t/y	+9,996-10,700 +274-587 professional jobs (high skill)		x	x		
17	Cai et al. (2011)	CHN	2006-2009	Employment factor approach (direct), IO-model (indirect employment) combined with scenarios	Governmental publications: 11th 5-year plan of developing RES in CHN, 2008, and official statistics	Policy Scenarios: Power generation 2006-2009 with different power plant fleets, or "What if the same amount of electricity was generated by large (efficient) coal power plants (LCPP) or by renewables"? Reference – Additional capacities inst.: Large Coal Power Plants (LCPP); Replacements: - Policy 1 "replace" – Additional capacities inst.: LCPP; Replacements: Small CPP are replaced by LCPP Policy 2 "mitigation" – Additional capacities inst.: Renewables; Replacements: Small CPP are replaced by LCPP	2006-2009 (Direct / Indirect) Hydro: 1.95 jobs/MW (inst.) / 6.1 jobs/GWh PV: 0.5 jobs/MW (inst.) / 150 jobs/GWh Wind: 0.38 jobs/MW (inst.) / 21.7 jobs/GWh Biomass: 0.32 jobs/MW (inst.) / 51.7 jobs/GWh	in 1000 Policy 1: Direct: –559; Indirect: +~1,000; Total: +479 Policy 2: Direct: +76; Indirect: –599; Total: –523 Policy 3: Policy 1&2 combined, prolongation to 2010; Total: +472		x	x	x	
18	Markaki et al. (2013)	GRE	2010-2020	IO-model	Eurostat IO-tables of 2010	Implementation of the National Renewable Energy Action Plan of Greece: - investments of 47.9 bn € - 18% renewable energy share of final energy demand - minus 5% CO2 w.r.t 2005 - 10% biofuel share - increase of energy efficiency	jobs/MW installed; Jobs(FTE)/Mio. € investm. Hydro: Small hydro (pumped-storage) 34 (40) of which… Direct 16.2 (18.7), Indirect 11.6 (14.4), Induced 6.2 (7.1); 22.7 (21.1) PV: 54.8 of which… Direct 25, Indirect 19, Induced 11; 20.7 Wind: onshore (offshore) 19.8 (21.3) of which… Direct 12 (9), Indirect 9 (23), Induced 5 (13); 19.8 (21.3) Biomass: 109.2 of which… direct 59.2, indirect 31.4, induced 18.7; 23.3 Geotherm: 44 of which… Direct 19.4, Indirect 15.3, Induced 9.3; 20 Solar: 18.8	108,000 average full time equivalents (FTE) over 2010-2020, of which 47.8% direct, 28.2% indirect, 24.1% induced	x		x	x	x

Table 14 **Studies on Employment Effects – Other Countries (2)**

	Author and Title	Region	Time period	Methodology	Data Source	Trigger/Policy Scenarios	Employment Effects				Employment scope				
											Gross	Net	Direct	Indirect	In-duced
19*	Lund, Hvelplund (2012)	DEN	2010-2020	IO-model	-	24% of building stock integrated in district heat grid and equipped with heat pump. G22 Net investment of 9 bn €. Scenarios: different combinations of technologies 1) 80% (out of the 24%) district heat, 20% heat pump 2) S1 + district heat by large scale heat pumps (300-400 Mwe input) 3) S2 + 40% solar thermal energy in 90% of district heating 4) S3 + geothermal energy in comb. with waste-CHP plants 5) S4 + natural gas single boiler replaced by biomass boiler				7,000-8,000 jobs/year Positive public revenues over whole period		x	x	x	x
20*	Graham et al. (2013)	AUS	2010-2060	Process based model CSIRO	Australian National Accounts – Australian Bureau of Statistics	100% renewable electricity scenario: Transition to - Zero-emission eletricity plants (domestically manufactured) - Electric cars - Increased energy efficiency - Increased biomass use	Hydro PV Wind Biomass			Positive until 2030 (peak at +40,000), flattens out to zero until 2060 (positive in manufacturing)		x	x	x	
21	Cetin, Egrican (2011)	TUR	2010-2030	Spread-sheet model	Coefficients taken from non-peer-reviewed studies and workshops	PV roadmap for Turkey Objectives: - Solar energy plants 20 MWp/a - Installation of 4 GWp by 2020 - 50% of panels, cells and inverters produced locally	PV	37-46 jobs/MWp	In detail: - Installation (34.6) - O&M (2.7) - Panel production (10) - Additional: wholesale, retail, installation (36)	Direct gross employment in Turkey in 2020 due to PV Roadmap: 177,000-220,800	x		x		
22*	van der Zwaan et al. (2013)	Middle East	2010-2050	Technology Model		Installation of renewable electricity technologies until 2050 to reach a capacity of 210 GW and generate 60% of total electricity demand	PV Wind CSP	min/median/max Person years/MW in - Manufacturing 3.2 / 12.6 / 19.4 - Installation 3.9 / 15.4 / 23.6 Jobs/MW in O&M 0.1 / 0.3 / 0.7 Person years/MW in - Manufacturing 2.1 / 6.6 / 12.2 - Installation 0.5 / 1.5 / 2.8 Jobs/MW in O&M 0.1 / 0.2 / 0.6 Person years/MW in - Manufacturing 2.3 / 5.1 / 18 - Installation 2.3 / 5.1 / 18 Jobs/MW in O&M 0.2 / 0.5 / 1.0		Gross employment in 2050 (median coefficients applied) 270,000 Jobs of which... 155,000 direct 115,000 indirect	x		x	x	
23*	Neuwahl (2008)	EU	2020	Dynamic econometric IO- model	GTAP6 EUROSTAT agricultural statistics	Scenarios (in 2020, in %): BAU / PRIMES_G1 / PRIMES_G2 / GRX-LC (least cost) Biofuel share: 6.9 / 15.2 / 15.2 / 12.3 Share 1st generation fuel: 80 / 33 / 33 / 54 Share 2nd generation fuel: 20 / 33 / 66 / 0 Share Biofuel imports 0 / 33 / 0 / 46	Biofuels: 1st generation: Bioethanol (cereals) Biodiesel (rapeseed) 2nd generation: (lignocellulose feedstock) Biodiesel (from biomass gasification)	Job Effects in 2020 (in 1,000 jobs): Variant A : Subsidized Biofuel blending financed by additional taxing: BAU / PRIMES_G1 / PRIMES_G2 / GRX-LC +100 / +70 / –40 / –38 Variant B: No Subsidy. Mandatory blending BAU / PRIMES_G1 / PRIMES_G2 / GRX-LC +73 / +182 / +20 / +38				x	x	x	x

Source: Mayer and Sommer (2014).

Project Information

Welfare, Wealth and Work for Europe

A European research consortium is working on the analytical foundations for a socio-ecological transition

Abstract

Europe needs change. The financial crisis has exposed long-neglected deficiencies in the present growth path, most visibly in the areas of unemployment and public debt. At the same time, Europe has to cope with new challenges, ranging from globalisation and demographic shifts to new technologies and ecological challenges. Under the title of Welfare, Wealth and Work for Europe – WWWforEurope – a European research consortium is laying the analytical foundation for a new development strategy that will enable a socio-ecological transition to high levels of employment, social inclusion, gender equity and environmental sustainability. The four-year research project within the 7th Framework Programme funded by the European Commission was launched in April 2012. The consortium brings together researchers from 34 scientific institutions in 12 European countries and is coordinated by the Austrian Institute of Economic Research (WIFO). The project coordinator is Karl Aiginger, director of WIFO.

For details on WWWforEurope see: www.foreurope.eu

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