Industrial and innovation policy as drivers of change

Deliverable No. 9

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August 2015

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 290647.

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Work Package 306

D306.1 "Policy report: Industrial and innovation policy as drivers of change"

Deliverable No. 9

This paper can be downloaded from www.foreurope.eu
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THEME SSH.2011.1.2-1

Socio-economic Sciences and Humanities Europe moving towards a new path of economic growth and social development - Collaborative project

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 290647.

Contents

1. Introduction: Europe's challenges with growth and prosperity 2

1.1 Macro economy and the euro 2

1.2 The technological change 3

1.3 The global shift 5

1.4 The green targets 6

1.5 Social inclusion 7

1.6 Key questions 8

2. A vision and a trajectory 8

2.1 Beyond GDP 8

2.2 A New Definition: Outcome Competitiveness 9

2.3 The three pillars 11

3. From trade-offs to synergies: how to reconcile economic growth, social cohesion and the green shift 15

3.1 Game changer 1: the green shift 15

3.2 Game changer 2: the technological shift 19

3.3 Game changer 3: social enhancement through education and training 23

4. Beyond 2020: 20 Recommendations for A New Industrial Policy for Europe 25

References 34

1. Introduction: Europe's challenges with growth and prosperity

Europe faces a number of challenges in this post-recession period that need to be addressed in a concerted and collaborative manner since individual member states appear powerless to overcome them successfully. In this part of the WWWforEurope project in particular, the core of the research and findings has focused on the vision, trajectory and priorities of *A New Industrial Policy for Europe*. Embarking on a growth path that leverages current technological chances, that is ecologically compatible and that delivers greater and more shared prosperity requires a vision that is able to set long term, clear and transparent targets and to draw pathways to reach them. Businesses require certainty to take risks and create the jobs that societies and communities need to flourish and prosper.

In this context, the theoretical and empirical contributions of WWWforEurope Area 3 have been distilled to draw *A New Industrial Policy for Europe*. Before unpacking the details of our policy recommendations it is important to remind ourselves of the challenges Europe is currently facing and where Europe stands with respect to major world competitors in this respect.

1.1 Macro economy and the euro

The 2008 financial and economic crisis left European governments with higher than desirable public debts, negative growth and high levels of joblessness. Concerns over the markets' reaction to the public debts especially of (but not only) eurozone economies has induced a long and painful period of austerity. The shrinking size of government spending in most European economies was not however compensated by private investment; the latter has been sluggish and in responsive mode. As growth has flat lined across most of Europe, jobs were not created to take people's standard of leaving to pre-recession levels. Some member states outside the Eurozone and with a sizable tradeable sector have come out of recession more quickly; however, in the Eurozone most economies have stagnated, except for Germany which has exploited a favourable (effective) exchange rate to boost its exports.

Against this macro-economic backdrop, Europe finds itself facing this century's most important opportunities – some challenges risk however turning them into possible threats.

Though it would be tempting under these circumstances to opt for a "low road strategy" to stimulate growth, for instance by increasing working hours, limiting social inclusion or postponing climate change goals, European countries agreed an ambitious new growth path around five priorities employment; research and development; climate/energy; education; social inclusion and poverty reduction. Europe's 2020 Strategy defined 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.

Our research shows that economic growth, social inclusion and ecological ambitions are not necessarily mutually exclusive, but neither mutually supportive. In the *New Industrial Policy* that this report is presenting, we see a real opportunity for developing a policy agenda that is capable of transforming some of the trade-offs into potential synergies, problems into solutions and constraints into advantages.

1.2 The technological change

The emergence of new technologies is creating many new opportunities for firms to enhance their competitiveness; but they also change existing production modes and consumption patterns, that require investment and risk-taking. This technological shift also poses a significant threat as firms might resist change or delay change due for instance to technological uncertainty or credit constraints.

The EU continues to lag behind the US in terms of innovation performance. On the input side, the EU's R&D goals in the Lisbon and Europe 2020 strategies have been set against the background of higher US R&D intensity (2.8% of GDP in 2012, compared with 2% of GDP in the EU-28); further frequently discussed EU-US gaps are in university rankings and venture capital financing of start-ups. At the level of outcomes or industrial performance, the main EU deficit versus the US consist of the

lack of so-called “Yollies”, or young leading innovators in knowledge-intensive sectors which grow to be large, R&D intensive firms (Cincera and Veugelers, 2014; Veugelers and Cincera, 2010). There are few firms in the EU which can be compared with the likes of Apple, Google, Facebook, Tesla, etc.

Critically, both research and innovation are generally seen as major drivers of growth. This is even more the case for the stream of innovations that are expected to emerge from the current technological shift. Here, the change in the current techno-economic paradigm through key enabling technologies is redrawing the scientific knowledge and the possible applications across a broad spectrum of sectors. Indeed, it is the cross fertilisation across unrelated technologies that is found to generate the most radical innovations (Corradini and De Propris, 2013). The term ‘innovation’ is here understood in a broad sense to include technological innovation, but also an organisational, marketing or social innovation.

An important aspect is also whether and to what extent innovations can improve resource efficiency and/or allow energy savings, as well as address major societal needs such as aging. Innovation can be pushed by technological progress but can also respond to current markets needs as well as expectations of emerging market forces.

In order to shift Europe towards a new growth path with greater social inclusiveness and more ecological sustainability, it is important to recognise that the innovation systems at the EU, national and regional levels must align the priorities and incentives of businesses, governments, and societies. As innovation and industrial policies are intertwined, governmental interventions should work not only in favour of increased economic dynamism, but also simultaneously in favour of future mission-oriented goals and systemic change.

As we are at the beginning of a new wave of technological transformations, investment and stewardship is necessary to explore the scientific potentials at hand and the derived tributaries of applications. Europe needs to gain centre stage and strategically drive the pace and direction of such technological change. However, this technological shift is unwinding as other conflicting challenges are troubling firms and society: globalization has shifted economic power to Asia with its low-cost competitors and

reduced the ability of European regions to have strong tradable sectors; an ageing population is shifting consumption and work patterns whilst also increasingly weighing upon member states' welfare systems. Finally and most importantly, limited natural resources and the increase in greenhouse gas emissions and pollution are calling for immediate changes so as to tackle ecological and climate challenges.

1.3 The global shift

The emergence of multi-national corporations (MNCs) since the 1990s has changed the geographical organisation of production with the manufacturing production process being segmented and located where economic conditions were more appropriate. This led to low labour cost 'places' becoming the destination for MNCs' more labour intensive functions as against high cost and high competence places being targeted for high value added functions such as head-quarters. The impact of manufacturing offshoring has caused - especially in advanced economies - job losses and skills hollowing out. This is true for most EU15 member states. Such manufacturing hollowing-out has had deep repercussions in terms of the erosion of the skills based related to those activities more radically relocated, the parcelling and fracturing of the supply chain and the separation of innovation/R&D activities from manufacturing. A service based economy was accused, however, of showing weaker signs of resilience in the wake of the 2008 financial crisis; countries with current account deficits at the start of the crisis together with a small manufacturing base endured a particularly long crisis, and output is often still lower than in 2007 (Aiginger, 2015). Besides, important technological shifts have been crucially changing the manufacturing sector, offering viable options for high cost economies to be competitive (Merlin-Jones, 2012). The commitment to reindustrialise Europe became a call for action with DG Enterprise and Industry launching the 'Mission Growth: Europe at the Lead of the New Industrial Revolution'[1] and with reports such as 'Manufacturing Europe's future' (Veugelers, 2013).

[1] http://ec.europa.eu/enterprise/initiatives/mission-growth/index_en.htm

Comparing the US and Europe, US manufacturing today generates only 12% of GDP, less than half its share in 1960 (Aiginger, 2015).[2] In Western Europe (EU-15) the decline in manufacturing's share of GDP, down from 21% (1960) to 14% (2012), is less dramatic. But Europe is unable to eliminate the gap in per-capita income and labour productivity compared to the US (which is larger in per-capita terms and smaller per hour; see Aiginger et al, 2013). R&D expenditure particularly by companies is lower in Europe, and Europe lacks top universities. Overall, it appears that in the U.S. spending on innovation – and resulting productivity – is high, although this is not used to produce enough goods or services to balance trade. In contrast, Europe has a balanced trade position, with low dynamics and a persistent productivity deficit compared to the frontier economy. At the same time, emerging-market countries are gaining market share in both regions. These trends have led to calls for a new industrial policy.

1.4 The green targets

The EU climate and energy package managed by the newly set up DG Climate Action shows the commitment of EU member states to reach certain climate and energy targets by 2020. These are the so-called "20-20-20" targets: a) a 20% reduction in EU greenhouse gas emissions from 1990 levels; (b) raising the share of renewable resources to 20%; and (c) energy efficiency to increase by 20%. These may well not be ambitious enough.

While these targets show an ambition *to green* the European economy, what will give EU firms a long-term competitive advantage necessitates inevitably significant investment and a fundamental adjustment. In the short term, EU firms are competing with US firms where economic recovery has been driven by -on the one hand- a low-road to growth with lower labour costs and cheap energy, and on the other by pockets of excellence regularly populating headlines with news such as the development of a prototype nuclear fusion reactor by Lockheed or Apple's plans to perhaps produce an electric car on its own. On the other side, Asian economies are not advanced enough

[2] A new argument for the declining manufacturing base in the US is offered by Berger (2013); although new products' invention phase still starts in the US, the offshoring of production to low-cost countries occurs earlier. As a consequence, the learning process from new products in the late innovation and early production phases, is transferred to other countries, reducing positive spillover effects to other companies and subsequent innovations. Cooperation in US manufacturing is less developed than in Europe, it is argued; US companies are 'home alone', instead of being part of a cluster of related companies or embedded in industrial ecosystems (Aiginger, 2015).

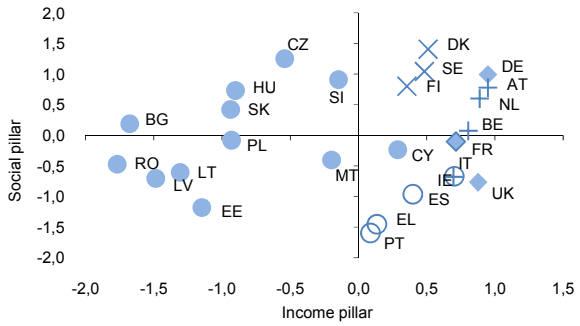
as yet to pursue clean growth and regulations are still relaxed, although China is rapidly increasing its efforts in fighting climate change, with significant increases in scientific knowledge production relevant for green technologies recently (Veugelers, 2015).

The challenge is both to remain committed to the climate and energy targets and to put in place an implementation program. However, due to the lack of a global consensus, and a number of other EU internal concerns, EU green policy is in reality quite patchy. On the one hand, technology is moving fast and often in many directions (see, for instance, hybrid, electric, or hydrogen technologies for cars), and on the other hand, markets are sometimes ready but other times yet to be created. In the middle, there are businesses which need to be able to connect the two with risk-taking and entrepreneurial spirit.

1.5 Social inclusion

There seems to be evidence that despite the long period of economic growth before the 2008 crisis, income inequalities have widened. EU statistics point to Gini coefficients on annual earnings rising between 2006 and 2011 (EC, 2015), just to mention one. This has been confirmed in the measurement of Outcome Competitiveness: here we find that there is no correlation between the income pillar and the social pillar. In other words, economic growth does not automatically delivers greater and more distributed prosperity.

Social pillar vs. income pillar



Our research finds that on the social inclusion front, here narrowly defined as employment, technological progress in the EU over the past 20 years was labour-saving and energy-using, the opposite of what we ideally want in terms of simultaneously reaching climate, economic and social goals (Vogel et al.,

2015). However, although technological change and the pursuit of green targets are expected to cause some job savings, in reality they will both require a very different set of competences. Along this transition, unemployment and mis-employment (the mis-match between demand and supply of skills so people do jobs they are not trained for) are likely to rise with the undesirable impact on income and social welfare.

The misalignment between the existing skills and the required competences is occurring at a time when training and education are hit by significant cuts to public spending and when businesses are seeking efficiencies and cost-saving rather than undertaking investment.

1.6 Key questions

Against this backdrop, this policy report addresses five key questions: (a) How can we redefine competitiveness so as to encompass social and ecological objectives and to motivate a new industrial policy needed for technology shifts and inclusive, sustainable growth? (b) How do we realign innovation and industrial performance towards social and ecological objectives? (c) What is the impact of green innovation on growth, employment and social cohesion? (d) How can entrepreneurial dynamics drive smart and sustainable growth? (e) How can intangible assets and the quality of academic research act as drivers of change? The research findings converge to design a New Industrial Policy for Europe.

This policy report is structured as follows. Section 2 presents a new definition of competitiveness. Section 3 addresses more specifically the issue of how compatible priorities are, namely economic growth, social cohesion and the ecological shift. Section 4 will present the 'New Industrial Policy for Europe'.

2. A vision and a trajectory

2.1 Beyond GDP

Economists have always understood that GDP is not a welfare indicator, yet GDP and its growth have dominated the discussion of economic policy and are seen as the single overarching measures of success of an economy or region. The criticism of this

indicator and its alternatives was summarized by the Stiglitz–Sen–Fitoussi Commission, leading to the conceptualisation instead referring to 'beyond-GDP goals'. The OECD has also published a corresponding set of 'Better Life Indicators' (http://www.oecdbetterlifeindex.org) which several countries have started to use as a measure of performance. Income per capita and income growth will remain important goals particularly for low-income individuals, regions, and countries. Nevertheless, other goals receive greater priority as the marginal utility of income declines. Indeed, GDP dynamics stop being important *per se,* but become instrumental to reach other ultimate goals, such as full employment, social security, health, consumer choice, and so on. In other words, GDP should be considered as a means to an end. The European Commission also embraces this shift away from GDP by suggesting a 'beyond GDP' concept that includes also the ecological concern: indeed the 'beyond GDP' is pushed within the Environment DG in particular.

Our research findings are that a key step towards a new growth path for Europe is to acknowledge the vision of new way of understanding and therefore designing competitiveness. Therefore, due to the new consensus that GDP is not a good welfare indicator, the WWWforEurope project is conceptualising a new definition of competitiveness that we call "Outcome Competitiveness" that measures 'beyond GDP goals'.

2.2 A New Definition: Outcome Competitiveness

We suggest a new definition of Outcome Competitiveness as the "*ability of a country (region, location) to deliver the beyond- GDP goals for its citizens*" (Aiginger et al., 2013). So defined, Outcome Competitiveness combines an evaluation of inputs or processes on the one hand with an assessment of output and goals on the other. This approach has the advantage over welfare functions derived in social welfare theory in that it connects outcomes with measures that can be influenced by economic policy. Our new definition should help to avoid the misuse of the term by media and politicians in the narrow sense of price (cost) competitiveness, which has led to the foregone conclusion that wages, taxes or energy costs should be reduced. This is often referred to as the "low road" to competitiveness. Pursuing such a low-road for high-income countries would be highly damaging in the longer term. Rather, it is productivity and

capabilities that determine long-term economic success. We define the "high road" to competitiveness as one that is characterised by a productivity-enhancing social system and a technology-based ecological ambition able to support a dynamic transition to a new growth path.

Our new definition of Outcome Competitiveness links inputs and processes to outcomes that are broad enough to encompass 'beyond-GDP targets': in particular, they also include ecological and social outcomes.

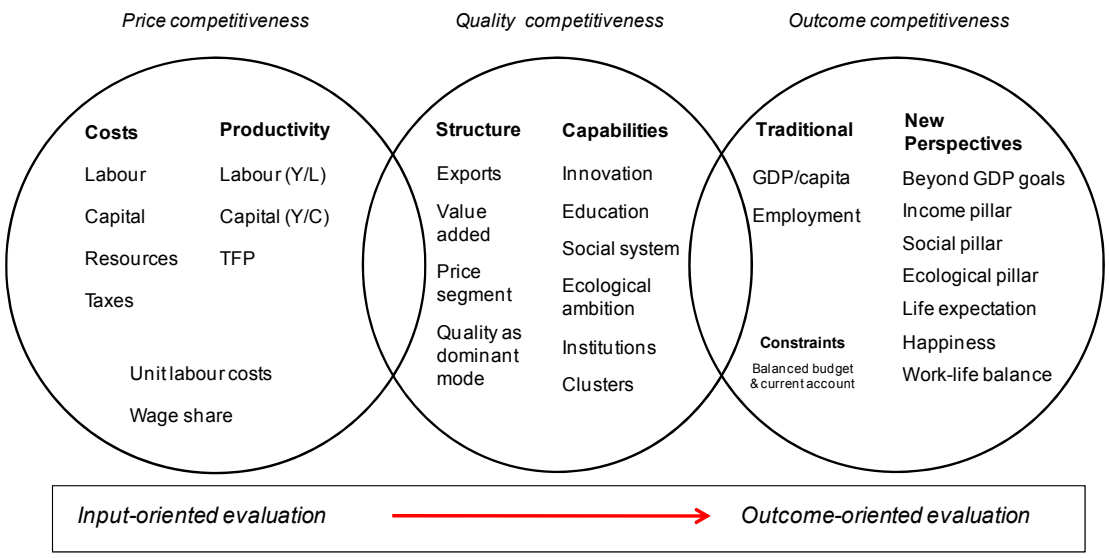
In the past, the term 'competitiveness' has been used predominantly in the narrow sense of cost competitiveness, calling for lower wages and other production costs as policy instruments to 'stay' competitive or 'regain' competitiveness. Here productivity is acknowledged in relation to labour and capital as cost competitiveness. However, this cost focus has been criticised for a long time, as it captures only technological or qualitative competitiveness, and is measured by GDP and employment. Delgado et al (2012) define competitiveness in a more holistic way by using a modified concept of labour productivity as the outcome goal, while the new Outcome Competitiveness is motivated by a focus on the transition of the current economic system to a more inclusive and sustainable one (measured by beyond-GDP indicators). Delgado et al (2012) consider macroeconomic performance, microeconomic performance and institutions as drivers of competitiveness; whereas we investigate costs (relative to productivity), economic structure and capabilities as driving forces.

The new definition of Outcome Competitiveness is based on capabilities like skills, innovation, institutions, an empowering social system, and ecological ambitions and it is measured with outcomes that include ecological-socio-economic indicators. These are divided into three pillars: an economic, a social and an ecological one.

The high-road to growth marks a transition from seeking a competitiveness reliant on lower costs (low wages, low taxes, low oil prices), to one driven by higher productivity - boosted by dynamic capabilities such as education, innovation- renewable energy and

social inclusion. It is economically difficult and socially undesirable for high cost economies such as those in Europe to seek to increase per capita GDP by undercutting wages, because low-income countries would still have that as a competitive advantage. Advanced and high cost economies must rather endeavour to raise quality, innovation, and develop new services (Aiginger, 2015). This definition could end the preoccupation of economic policy with costs instead of capabilities (Aiginger, 2015). The current austerity discourse and preoccupations with the size of governments must not distract from this fundamental priority and the fundamental role that policy must play in projecting a vision and setting a trajectory for growth and prosperity for all.

Figure 1 **Towards a concept of competitiveness under new perspectives**



Source: Own conceptualisation for WWWforEurope.

2.3 The three pillars

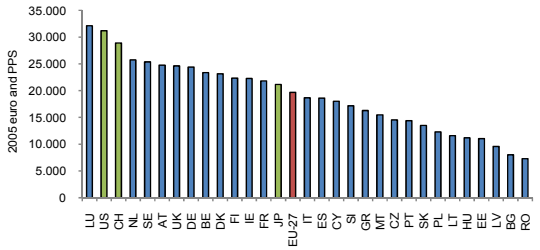
Outcome Competitiveness rests on three pillars. The income pillar considers per-capita measures of net national income, disposable household income and household final consumption expenditure. The social pillar comprises indicators on poverty risk and the impact of social transfers, income distribution and unemployment. Finally, the ecological pillar captures resource productivity, greenhouse gas emissions intensity, energy intensity and the share of electricity produced from renewable energy sources.

A composite indicator that synthetises the New Outcome Competitiveness is calculated based on the income, social and ecological pillars.

As expected, European countries perform very differently against individual indicators that mirror the three pillars as well as against the composite indicator. The main findings are that Scandinavian countries - and Denmark in particular - score highly on this new definition of competitiveness thanks to a strong performance on outcome indicators such as social inclusion (poverty and employment rates) as well as economic performance (per-capita incomes, public debt).

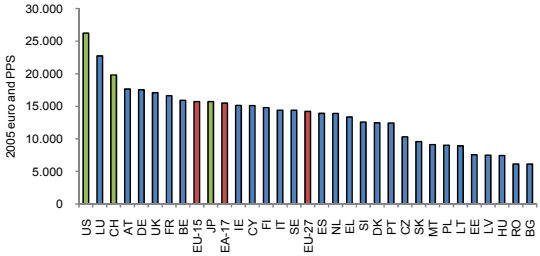
Figure 12 **New perspectives outcomes: Income pillar**

Net national income (NNI) per capita, 2010



Notes: Data in thousands of 2005 euros, adjusted for differences in purchasing power using the PPS exchange rate for 2005.

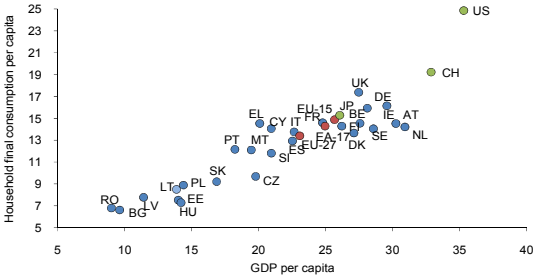
Net disposable household income (NDHI) per capita, 2010



Notes: Data refer to net disposable income of households and non-profit institutions serving households per head of population. Data in 1,000s of 2005 euros, adjusted for differences in purchasing power using the PPS exchange rate for 2005. Data for Romania cover 2009.

Source: Eurostat (AMECO), WIFO calculations.

Household final consumption expenditure (HFCE) vs. GDP per capita, 2010

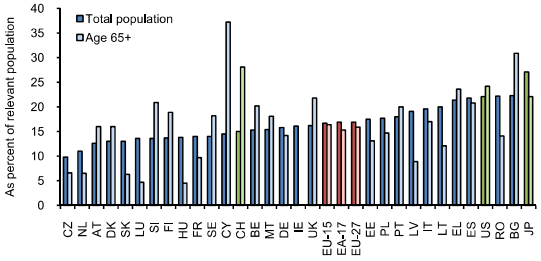


Notes: GDP per capita and HFCE per capita in 1,000s of 2005 euro in PPS. Excluding Luxembourg.

The income pillar shows that there is a clear and enduring north-south divide across EU member states. Besides, US, China and Japan have greater NNI rates than the EU27 average and NDHI greater than EU17 average.

Figure 13 **New perspectives outcomes: Social pillar**

At-risk-of-poverty rates after social transfers, 2011

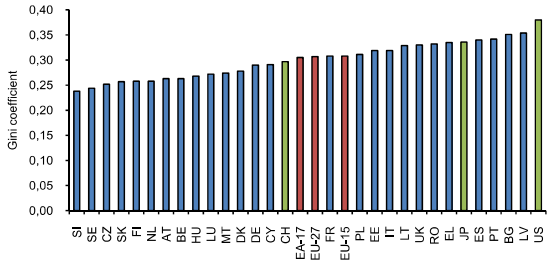


Notes: Countries ranked by values for at-risk-of-poverty rates after social transfers in the total population. For both series, the poverty threshold is defined as 60 percent of median equivalised income after social transfers. The series "Age 65+" describes old-age poverty. Data for the USA and Japan cover 2010 and 2009 respectively.

Source: Eurostat, OECD.

In relation to the social pillar, the Netherlands come first, followed by the Scandinavian countries and Austria. Some new member countries also score highly, such as the Czech Republic, which has the lowest risk of poverty in the total population of all EU-27 countries. Slovenia and Hungary are also in the top 10 due to low poverty risk and income inequality. Germany and France do only average overall. However, Spain and Greece come last with the highest youth unemployment rates and high poverty rates. Other weak performers are Italy (large employment gender gap and the 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.

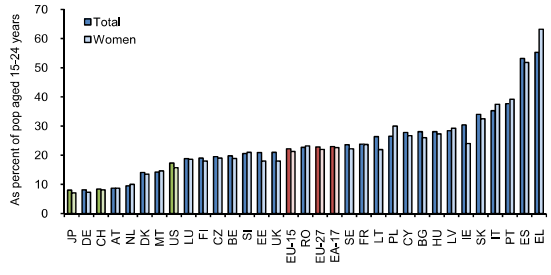
Gini coefficient of disposable income, 2011



Notes: The Gini coefficient relates cumulative proportions against the cumulative proportions of income. It ranges between 0 in the case of perfect equality and 1 in the case of perfect inequality; data for Japan 2009, for the US 2010.

Source: Eurostat, OECD.

Youth unemployment rate, 2012



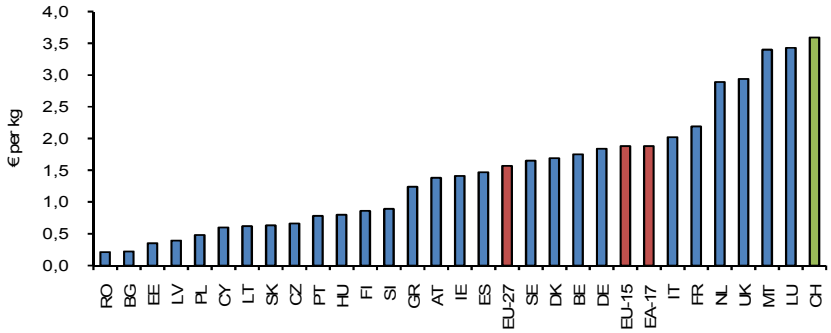
Notes: Countries ranked by percentage of unemployed persons in the total active population aged 15-24 years. Data for the USA and Japan cover 2011.

Source: Eurostat, OECD.

The indicators for the ecological pillar again show an uneven picture across member states: Sweden is the best performing one across all indicators, thanks to the country's sustained policy efforts towards sustainability. CO2 intensity is low in countries using nuclear power (France, Sweden), hydropower (Austria) or solar and wind energy (Spain and Portugal). The share of electricity generated from renewable sources is highest in Austria, Sweden, and Portugal.

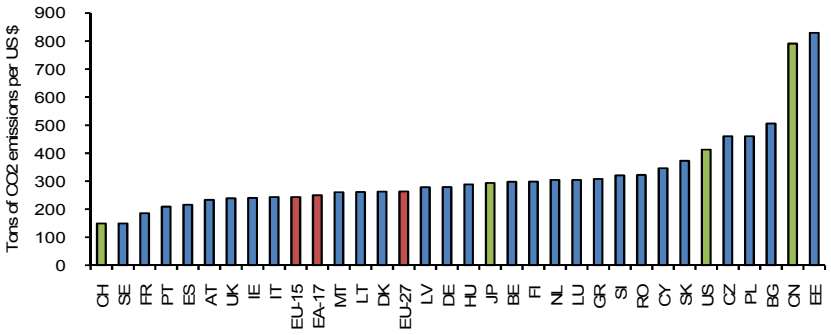
Figure 14 **New perspectives outcomes: Ecological pillar**

Resource productivity, 2010



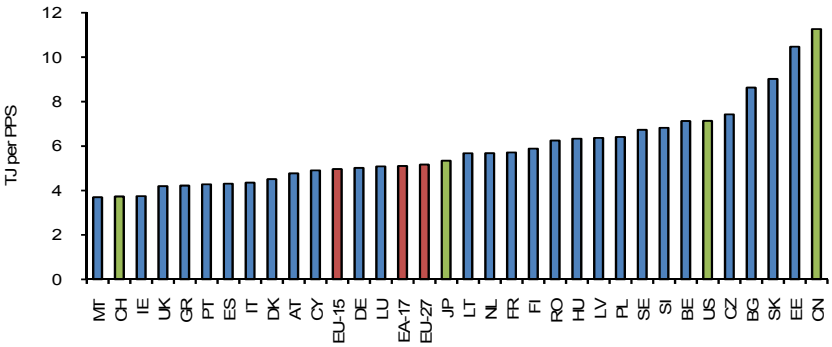
Notes: GDP per kg of domestic material consumption; euro in current prices.
Source: Eurostat.

CO2 intensity, 2010



Notes: Tons of CO2 emissions from fuel combustion relative to GDP at PPS.
Source: IEA, Energy Balances.

Energy intensity, 2010



Notes: Terajoule of total primary energy supply relative to GDP at PPS.
Source: IEA, Energy Balances.

Resource productivity is high in small countries (Luxemburg and Malta) and in large countries with a small manufacturing base (UK, France and Italy), but low in the new member counties (the Czech Republic, Poland and Estonia).

The new Outcome Competitiveness provides not only the vision of a goal to aim to, but more crucially it suggests the three coordinates of the trajectory to engage to achieve it: these are the three pillars. A competitive Europe is therefore a more prosperous, sustainable and equitable Europe.

3. From trade-offs to synergies: how to reconcile economic growth, social cohesion and the green shift

The literature has discussed these effects of innovation under the term the rate and direction of inventive activity, with the rate of inventive activity supposed to spur economic dynamism and the direction potentially affecting issues such as environmental sustainability and social inclusiveness (see, e.g., Lerner and Stern, 2012). The rate of inventive activity within green technologies can however be very important for environmental sustainability, and shifting the direction of inventive activity towards green technologies is sometimes seen under an economic double dividend reflecting increased “green” growth opportunities. Clearly, the challenge today is to simultaneously influence both the rate and the direction of inventive activity, or the rate of invention in a certain direction (Foray and Phelps, 2011).

Our tentative results indicate that several important changes have to be made, if Europe wishes to develop its socio-economic model into a compelling vision. We start by noting some of the overarching changes needed in terms of three ‘game changers’.

3.1 Game changer 1: the green shift

Environmental issues have come to the fore in recent years as the risks of climate change are increasingly known. However, policy makers and business often see implementing the green agenda as a burden or as an added cost. Yet our research

shows that investing in capabilities that can truly push for a green shift can create jobs, economic opportunities and social enhancement.

In order to explore the impact of green innovation on growth, employment and social cohesion, we trace the social and environmental implications of innovation and technological change in terms of employment effects. Vogel et al (2015) explore to what extent technological change has engendered labour and/or energy saving. They find that technological change has produced substantial job losses especially for low and medium-skilled workers, where modest energy saving has been registered. However, also ICT and advanced manufacturing technologies have been found to produce job losses in medium to high skilled labour. This means that highly skilled labour is not insulated from substitution effects induced by digital technologies.

Perhaps more positively, Licht and Peters (2014a) define the scope of ecological innovations and their employment effects by exploiting data from the Community Innovation Surveys for different EU member states. This is critical, as various channels exist through which different kinds of innovation may destroy existing jobs (displacement effects) or may create new jobs (compensation effects). In general, the majority of empirical studies find an employment-stimulating effect of product innovation whereas the effect of process innovation is ambiguous ranging from significantly negative to positive. Overall, results show that the general productivity trend had a strong negative impact on employment growth. More surprisingly, specific process innovations both with and without environmental-friendly characteristics only have a minor impact beyond the general productivity trend. The general growth in output (e.g. linked to the business cycle) had the biggest impact on employment growth. Their work notes that *environmental process innovations, such as those caused by country-specific environmental regulation policies, in all countries have little or no impact on employment beyond the general country-specific productivity trends.*

Thus, Licht and Peters (2014a) do not point towards the often feared negative employment consequences of environmental policies affecting production processes. In addition, they found that *product innovations were a significant driver of employment growth in all countries and that this is also related to environmental-friendly product innovations*. In fact, in manufacturing in some countries (e.g. Germany, Slovakia, and

Czech Republic) the employment impact of new products with environmental-friendly characteristics even outperforms the employment impact of new products without environmental-friendly characteristics. In addition, this work suggests that *ecologically-friendly industrial policies which shift the innovation focus towards environmental-friendly innovation will probably not destroy jobs but contribute to job creation at least in some member states* (Licht and Peters, 2014a and b). Industrial policy might therefore be used in addition to, or in combination with, horizontal policies to stimulate eco-innovation and new eco-friendly production processes without severely endangering employment.

Overall, what this suggests is that environmental innovation (e.g. induced by industrial policies to reduce the environmental impact of production and consumption) might not create trade-offs with regard to the competitiveness of firms in terms of their ability to generate jobs (Licht and Peters, 2014a).[3] Especially for countries close to the productivity frontier, employment growth increasingly might depend on the ability of firms to develop and introduce new eco-friendly products. Hence, there might be room for a growth path which combines both employment growth and lower environmental burden. In the next sections, we will look at policies which may enable such a growth path.

The green shift can also take the form of a wave of new businesses seeking to create new markets and new needs as well as to fill market gaps. Differently from the US, entrepreneurial dynamism is a key problem in the EU, potentially slowing down the creation of new industries and the diversification of existing knowledge bases and as a result efforts to shift innovative efforts towards activities compatible with a new growth path. Extensive research on the role of entrepreneurship in green technologies and green sectors has unveiled a number of opportunities. Firstly, we looked at the characteristics and dynamics of '**green gazelles',** these are high-growth firms specialised in eco-innovations (Colombelli *et al*, 2015). Based on a multi-country study spanning 400,000 firms, they investigate the impact of eco-innovation on firms' growth processes and found that on average firms producing eco-innovations display higher

[3] It should be noted that in case of skill-biased technical change (if there is a skill-bias of eco-innovations), technological upgrading would have negative distributional effects (what is not in line with social inclusion).

growth rates than those generating generic innovations. Moreover when they focus on high-growth firms only, they find that green gazelles, i.e. gazelles generating environmental innovations, actually grow faster than the other gazelles. One reason this happens is because of environmental regulations having an impact on downstream firms' demand for green technologies, leading to sales growth at the suppliers of such green technologies: the effects of environmental policies pushing firms to adopt green technologies engender a bandwagon effect in the economy, which spreads along the value chain. At the same time, technology policies promoting the development of specific technological areas should be coordinated with environmental policies in such a way that firms producing new technologies are given the necessary incentives to produce 'green technologies' to anticipate the increasing demand from downstream firms, possibly inter alia through public procurement.

The trade-off between sustainability and social inclusion translate into energy saving innovations being at the same time also labour saving. However, Vogel et al., 2015 suggest lowering the employers' social security contributions in exchange for an energy tax, which should favour energy-saving technical progress over labour-saving technical progress. More precisely, the rate of energy-saving technological change can be spurred by raising energy taxes, while the rate of technological change in labour-saving fields could be dampened by reducing the compensation of low-skilled workers, thus making them more attractive to hire. This could be achieved in a way that maintains their wage income by lowering the social security contributions paid for them by employers.

Furthermore, green policies should be designed to ensure that demand side and supply side converge in incentives and objectives. There is empirical evidence that government intervention can contribute to starting the 'private green innovation machine', as surveyed by Veugelers (2014a). Technological progress responds to government policy, and also to private-sector initiatives such as voluntary agreements. A green policy can reach its objectives by means of an effective strategy that includes three key elements. Firstly, a priority is to set a higher price on carbon. Indeed, for the EU – and probably worldwide – the biggest hindrance for more effective shifting of firms efforts are higher carbon prices which even in the EU are too low to incentivise behavioural changes, therefore the development of an efficient carbon market or of an

energy tax is essential for low-carbon investments. Secondly, R&D support is crucial to address the knowledge externality associated with the creation of new clean knowledge. Public R&D support is especially crucial for clean technologies which are still in the early stages of research and development, helping to neutralize the installed base advantage of the older, dirtier technologies; however, the share of environmental R&D support within Horizon 2020 has remained at 9%, unchanged from previous framework programmes (Veugelers, 2014a), while “dirty” technologies such as fossil fuels continue to receive subsidies. And as green R&D is now global, so some level of international coordination would be beneficial to pool resources, avoid excessive duplication and accelerate diffusion. So far, there is very little international coordination on these issues on behalf of the EU (Veugelers, 2014a). Thirdly, government regulation, when properly designed, can both create demand for clean products and stimulate the creation of clean knowledge. Lower cost clean processes can be an important, if not more important lever for the development and adoption of green innovations by the private sector – which might follow. Government regulation can, among others foster the growth of ‘green gazelles’ (Colombelli et al., 2015) and innovation in general; but it needs to be stringent, as shown by Ghisetti and Quatraro, 2015, and Arfaoui et al., 2015, using the example of the EU’s chemical regulation initiative REACh: there, a too large time window before the regulation finally becomes binding induced firms to adopt a “wait and see” attitude, with the initiative thus far having no palpable impact on innovation performance (even though this was its stated goal). Higher stringency would have led to faster technological transition.

3.2 Game changer 2: the technological shift

The EU has to seize in full the opportunity of the radical technological transformations that amount to a unique technological shift. Across a number of contributions, our evidence suggests that economic growth and jobs will depend on the extent and pace of such a technological jump penetrating the current industrial base as well as triggering new sector formation. The pervasiveness of these radical innovations across sectors is what underpins the real technological shift that through a trickle-down effect that upgrades and renews existing industrial capabilities. We find that radical innovation is often the outcome of cross-technology inter-sectoral technology spillovers. We find that there are some key enabling technologies that are also able to

connect “distant” technologies and -through such bridging role- they are able to generate highly disruptive innovations (De Propris and Corradini (2013). Indeed, they find that such bridging technologies ‘clot’ around bridging platforms that are able to then spawn patents spreading across different technological fields and for this reason they can enhance the innovative capacity of other sectors. Crucially, these bridging technologies are found in patents developed by universities and governmental not-for-profit organisations. The latter play a critical role in terms of technological synthesis and radical innovation given their higher propensity to effectively adopt and use enabling technologies within their innovation activities. For this reason, we suggest that publicly funded research is crucial in driving radical innovation, acting as a boundary-spanner in connecting, translating and integrating different technological knowledge. The well-known triple helix model seems to be relevant and to reinforce the argument put forward by Mazzucato (2013) that the role of university and public funded research programmes is crucial for marshalling truly disruptive innovations.

National and regional innovation systems are found to be reliant on a triple helix approach where businesses, universities and public research organisations are linked to one another and collaborate over research projects. However, Janger (2015) argues that university entrepreneurship can only be as strong as the quality of its research and teaching. A narrow focus on linking universities with firms and society without making sure that universities’ first two missions work well is an ineffective approach towards increasing the contribution of universities to innovative activity, and hence to a new growth path. Indeed, without universities which are able to operate at the frontier and on a level par with the US, it is difficult to imagine a sustainable European growth and competitiveness model. Shifting R&D and innovative activity to new aims such as climate change can only be promising when the underlying quality of research efforts is as good as it can be, reducing the cost of shifting and increasing the return on R&D efforts (Janger, 2015).

On this potential contribution of universities to innovation based growth, Veugelers (2014b) suggests that policy should take a long-term perspective for developing an industry-science eco-system, and avoid short term ‘quick-fixes’ that fail to enhance the systemic nature of industry-university collaborations. A particularly dangerous policy practice, she argues, is a target focusing only on the commercialization of university

technologies through academic patenting and spin-offs, ignoring the broader contribution to economic development with other pathways, most notably the research based training and mobility of human capital from universities: university graduates are probably the most important contribution of universities towards a new growth path, rather than commercialisation of university discoveries. In this regard, policy makers should be more 'innovative' in their search for effective policy interventions, venturing beyond the classic spin-off and incubator programs.

Technical change is conditioned by firms' accumulated capabilities and knowledge bases (Reinstaller, 2015). At the firm level, innovation, especially in the short run, tends to be much more incremental as firms' search for new ideas and efforts to master new technologies usually happens in close proximity to what firms already know. Technological complementarities and cumulated capabilities crucially affect the direction of technical change and innovation, or put differently, firms usually diversify into new technological areas based on their existing capabilities. "Smart diversification" policies hence should aim both at making sure that policies aimed at redirecting innovative activity take into account existing capabilities, and at the diversification of these capabilities through R&D and adoption of new technologies. In relation to ecologically related innovations, R&D subsidies and price signals are not sufficient in themselves to shift productive systems to new ecologically sustainable trajectories. On this, Reinstaller (2015) makes three recommendations relevant for directing innovative activities: (a) Mission-oriented policies must strike a balance between trying to foster technological capabilities which are very far from the capabilities the targeted firms currently master, and between avoiding technological lock-in by focusing too narrowly on a small set of ideas: (b) Smart diversification policies – namely policies aimed at directing firms' innovative activities towards new directions – should support entrepreneurship and entrepreneurial discovery as this fosters recombining competencies across technological fields and sectors: and (c) Policymakers should favour R&D projects which aim at diversifying existing capabilities (and are more uncertain as a result) rather than expanding them.

Equally, at the regional level, the renewal of existing industrial clusters is found to hinge on the breadth of regional technological competences that can cross-fertilise sectors, technologically upgrade them and therefore trigger industrial renewal. We refer

to these as ‘phoenix industries’ and point to the possibilities of building smart specialisation strategies and industrial policies driving innovations which are aligned with high-road strategies (Amison and Bailey (2014). We highlight three major factors in driving the development of such ‘phoenix’, “new-growth-path” industry at a regional level, using the automotive example. Firstly, ‘open innovation’ is found to be driving the sector, for example noting that smaller firms can sometimes innovate more quickly/more cheaply than the major auto firms; the increased interaction across technologies, up and down supply chains and between larger and smaller firms. It also notes the role of hybrid firms providing services, plus prototyping/low volume manufacturing (largely in niche vehicles) and the transferability of these competences across industrial sectors. Secondly, our research points to the role of historic (and relatively immobile) private investments in the region, for example the past/ongoing importance of established mass producers, the depth of skills and experience in suppliers and in the local workforce; and cross-overs with the overlapping motorsport cluster. Finally, we stress the role of public-private sector cooperation, such as: the establishment of the Automotive Council UK and its work in developing technology roadmaps, informing regulation, and supporting development of the UK supply chain (a type of industrial policy as a discovery process and in line with ‘smart specialisation’ principles); the R&D funding programmes developed with industry input; and the earlier role of the Regional Development Agency. Overall, it points to the possibilities of building smart specialisation strategies and industrial policies driving innovations which are aligned with high-road strategies.

As the competitive advantage in advanced countries is more and more determined by innovation, we also find that investment in intangible assets become crucial. The OECD has defined intangible assets – what it calls “knowledge-based capital” in a recent report (OECD, 2013) as referring to computerized information (software and databases); innovative property (patents, copyrights, designs, trademarks); and economic competencies (including brand equity, firm-specific human capital, networks of people and institutions, and organisational know-how that increases enterprise efficiency). Falk (2013) argues that higher investments in knowledge intensive activities, such as intangible assets, are essential for making progress in the implementation of Europe’s 2020 strategy. He finds that improving the quality and quantity of skilled labour, decreasing firm entry regulation costs (in particular in

Southern European countries), further investment in broadband infrastructure and better investment protection systems are the main factors in driving investment in intangible assets. In this regard, the empirical results on the determinants of international investment in intangible assets may help to develop a proactive action plan to increase the attractiveness of the EU countries for future international investments in intangible assets.

3.3 Game changer 3: social enhancement through education and training

Against the common belief that technological change erodes only low skilled jobs, we find confirmed that technology adoption has produced substantial job losses especially for low and medium-skilled workers, where modest energy saving has been registered. However, ICT and advanced manufacturing technologies have been found to produce job losses in medium to high skilled labour. This means that highly skilled labour is not insulated from substitution effects induced by digital technologies in particular. In order to engineer job survival for low and medium-skilled workers and some success in energy saving, this work suggests cutting social security contributions for low skilled workers compensated by an energy tax that would induce energy saving strategies (Vogel et al, 2015). Productivity growth trends also negatively impact on employment (Licht and Peters, 2013).

However, ecologically-friendly industrial policies which shift the innovation focus towards environmental-friendly innovation will probably not destroy jobs but contribute to job creation at least in some member states. Industrial policy might be used in addition to, or in combination with, horizontal policies that stimulate eco-innovation and new eco-friendly production processes without severely endangering employment (Licht and Peters (2013). Equally, we find that environmental innovation (e.g. induced by industrial policies to reduce environmental impact of production and consumption) might not create trade-offs with regard to the competitiveness of firms in terms of their ability to generate jobs. Especially for countries close to the productivity frontier, employment growth increasingly might depend on the ability of firms to develop and introduce new eco-friendly products. Hence, there might be room for a growth path that combines both employment growth and lower environmental burden (Licht and Peters, 2013).

We also looked at aspects of social innovation and social entrepreneurship outlining what social innovation can do in principle; however, in terms of policy, it remains unclear how to foster social innovation and entrepreneurship and here further work is needed. Reinstaller (2013) argues that the failure of companies to generate innovations and be competitive can be seen as an institutional and organisational and not so much a market failure. On this, 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 organisational process organisational mechanisms that support experimentation, the development of new interpretations of reality (i.e. new mental models and belief systems) and their integration into the organisational set up are crucial to escape organisational myopia. The second role may be conceived as an outside-in function of social innovation. Strategic choices about resource allocation are based on beliefs about how markets and competitors and relevant institutions work, and what consumers need. Often these beliefs turn out to be wrong, as 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. Another 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.

As noted earlier, Aiginger et al. (2015) look at countries which manage to perform well in all three dimensions of the new growth path, i.e. the Scandinavian countries. They also score highly on a variety of input indicators, including those concerning an “enabling” social system (on active labour market policy, social expenditures for the disabled and other disadvantaged groups). Scandinavian social policy could therefore

serve as something of a model of how to achieve social inclusion while minimising negative incentive risks.[4]

In this context, the role of knowledge-creating and -transmitting institutions such as universities and public research organisations play an ever increasing role in educating and skilling people (Falk, 2013). Against this background, governments should aim at increasing the potential contribution of universities to economic growth and tackling societal challenges, both elements of a new growth path which combines economic dynamism with respect of environmental boundaries.

A key finding for the project overall is that higher social and environmental sustainability can be reconciled with higher economic performance, but only when there is a clear policy commitment to actively design and implement a green agenda and an enabling social system. In other words, the possibility for Europe to pursue a high road to growth and become competitive (in line with the new Outcome Competitiveness) is not only desirable, but more crucially possible.

4. Beyond 2020: 20 Recommendations for A New Industrial Policy for Europe

Industrial policy is in back in vogue. A resurgence of very recent contributions converge to stress that in a post-crisis world ‘an industrial policy’ is a necessity and that -despite the familiar terminology- it must promote a very different approach to economic growth to what it stood for in the past. It should promote competition and enable a discovery process in a cooperative climate between government and business (Rodrik, 2008; Bailey and De Propris, 2014, Bailey et al, 2015). Bianchi and Labory (2011a,b) suggest an ‘industrial policy beyond growth’ that identifies a development path and a set of actors mobilised around a ‘sundial’ of four policies, innovation, structural, social and human capital. Cimoli et al (2009) put forward a definition of industrial policies that they see as being associated with “processes of institutional engineering” (Ibid p.2) that involves all economic actors across public and private actors as well as their relations.

[4] These would arguably manifest themselves in low employment rates, low productivity, and eventually high public debt ratios.

Policy documents developed by the EU Commission, international organisations, and a number of national governments are starting to accept the need to defined new goals for industrial policy where the latter term is enjoying a renewed interest and enthusiasm (Aiginger, 2014). All proposals directly or indirectly focus on the fundamental changes in the structure of the economy as a whole, not only on a narrowly defined manufacturing sector, since the borders between manufacturing and services are ever more blurred. The European Commission puts sustainability 'at the core' of industrial policy (unfortunately, jointly with a rather conventionally defined view of competitiveness); however, Europe's fear of losing cost competitiveness relative to the US is reducing its determination to press ahead with the implementation of ground-breaking changes that would cut across most sectors. EU's commitment to pursue an ecologically and socially centred industrial policy is still in progress. Its Energy Roadmap 2050 sets the goal to reduce greenhouse gas emissions by as much as '80 to 95%'. Radical innovation projects, such as the ultra-low carbon steel, are already on-going. On the positive side, the share of renewable energy has increased strongly, with some countries producing 50 per cent of electric energy from 'green' sources. But new energy sources need complementary fossil fuels and investment in the power-grid infrastructure. Coal use in Europe increased after the collapse of the European emissions trading scheme. Increasing US coal exports made coal cheaper in Europe than gas. At the same time, China is undertaking a deep transformation, trying to increase resource and energy efficiency—albeit from a very low initial level. It has set goals to increase R&D investment to 2 per cent of GDP (the current EU share) and is making advances in electric vehicles and alternative energies.

Aiginger (2015) proposes a definition of a 'New Industrial Policy for Europe' as a complex of economic policies designed and implemented -in line with the subsidiarity principle- to promote the competitiveness of a country or region, where competitiveness is defined as the ability to deliver the beyond-GDP goals. For Europe, with high per capita incomes, industrial policy should therefore explicitly be a high-road strategy of building competitiveness based on capabilities, good institutions, and high ambitions for social and ecological behaviour. For Europe and its vision of a socio-economic system with a strong emphasis on inclusion and sustainability, this high-road strategy explicitly includes equity and green goals.

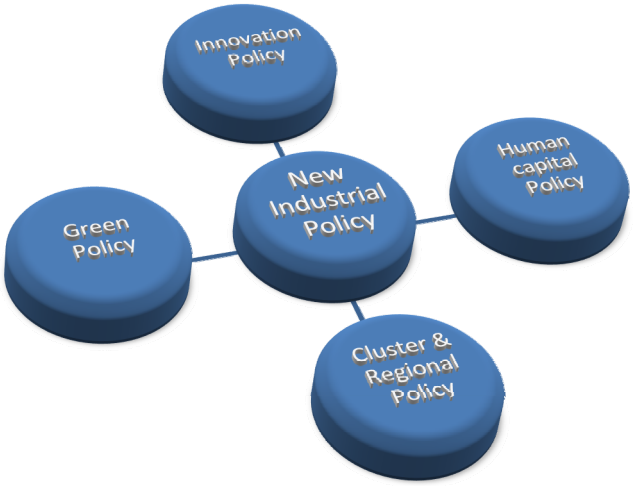
Given the need to reconcile social and ecological goals, the only viable choice is to pursue an industrial policy to encourage energy efficiency and social and ecological innovation. Industrial policy should foster the long-run transition, not decelerate structural change. This is a demanding challenge, given vested interests and the traditional role of governments to preserve the status quo and national champions. Refocusing on the economy's industrial base is a necessity to anchor long-term socio-economic prosperity, particularly after the experience of bubbles in financial and real estate markets. A new industrial policy should therefore pursue a balanced economy whose resilience rests on a balance between both services and manufacturing sectors securing economic diversity; as well as it should support the transition of traditional, narrowly defined manufacturing sectors to an advanced and distributed manufacturing sector able of greater value creation, innovation and creativity.

We therefore define an industrial policy for high-wage countries as a strategy to promote high-road competitiveness where competitiveness is defined as the ability of an economy to provide 'beyond-GDP goals'. It should also mitigate the conflict between industrial policy calling for low energy prices and environmental policy aimed at significantly reducing carbon emissions. Society's ultimate goals determine the direction in which it should move, and the weighting of these goals will differ according to income levels, preferences, and cultural attitudes. Also, it should align industrial policy with the long-term interests of society.[5] These ultimate goals should set the direction of policy interventions and the instruments of industrial policy.

A new industrial policy for Europe should be delivered by means of a portfolio of instruments that simultaneously steer demand and supply sides to move in the same direction creating and additive effect as against a cancelling-out effect. Such a portfolio needs to avoid trade-offs between technological change and growth/employment priorities. Policy changes need to provide long-run and consistent signals, which provide certainty for businesses in making long term investments and short term adjustment. Technological upgrading instruments needs to be mission-oriented programmes, compatible with existing capabilities but enabling capabilities to

[5] Grabas and Nützenadel (2013) suggest that the green orientation of industrial policy in the new member states of Europe is in its initial phase. Conditional upon the availability of adequate financing, the years up to may see a widespread trend of green job creation in several central and East European countries.

be diversified. Universities, investment in intangible assets, new technologies and key enabling technologies, and entrepreneurship will be crucial to secure Europe on a growth path compatible with a beyond GDP competitive agenda.



The New Industrial Policy (NIP) for Europe can be articulated in 20 key recommendations that can be implemented more specifically by means of initiatives and actions that are likely to marry with EU regional policy. These can be summarised as follows:

1. Separate industrial policies, green policies, regional policies, cluster policies, innovation policies, education policies and social policies need to be aligned as a strategy for real change. Ecology and social inclusiveness should be cross cutting themes embedded in all other policies. The NIP should be a complex of systemic solutions that transform the trade-offs between the three pillars into possible synergies by converting shocks and pressures into opportunities and choices. Long term, transparent and integrated policies are preferred to short-term quick fixes and silos of policies in order to simultaneously target economic, environmental and social goals. To avoid trade-offs between technological change and growth/employment, policy should compensate green policy related costs for manufacturing by making innovation and training cheaper and more efficient; for

example so as to engineer job survival for low and medium-skilled workers and some success in energy saving, cut social security contributions for low skilled workers compensated by an energy tax that would induce energy saving strategies.[6]

2. The NIP should translate narrow competitiveness policies focused on costs into industrial policies that aim to promote the competitiveness of EU member states and regions, where competitiveness is defined as the ability to deliver the beyond-GDP goals in line with the new definition of Outcome Competitiveness. A high road to growth should be embraced: one that focuses on rising productivity, boosting capabilities (education, innovation), and shows global stewardship in energy efficiency and renewable energy. For industrialized countries with high per capita incomes, industrial policy should therefore explicitly be a high-road strategy of competitiveness based on capabilities, good institutions, and high ambitions for social and ecological behaviour. For Europe and its vision of a socio-economic system with a strong emphasis on inclusion and sustainability, this high-road strategy explicitly includes equity and green goals.
3. The NIP can have a long lasting impact on EU growth. Its complex of policies must shift the innovation focus towards environmental-friendly innovations that will not destroy jobs but contribute to new functions and therefore new jobs. In combination with horizontal policies to stimulate eco-innovation and new eco-friendly production processes, the NIP can create business and job opportunities
4. The NIP needs to provide long-run and consistent signals, which provide certainty for businesses in making long term investments in green innovations and short term adjustment.
5. It should support and encourage bottom-up and local initiatives looking for new models of business clustering to foster high-road growth. Firm clusters and cluster initiatives are crucial for regional resilience: they can achieve greater innovation and adoption, as well as technology cross-fertilisation thanks to related and unrelated varieties (smart specialisation and smart diversification). 'Place-based' competitiveness is more likely to combine social inclusion with economic prosperity

[6] See Vogel et al. (2015) on "biasing" technology progress.

whilst leveraging the opportunities of more distributed alternative energies – clusters can be tools for achieving high-road strategies.[7]

6. The NIP should rely on a portfolio of green instruments that simultaneously comprises higher carbon prices, R&D subsidies and regulation. A combination of green technology policy instruments that support innovations in green technologies and an environmental policy that creates a demand for eco-friendly technology together enables the achievement of higher economic performance at the firm level and greater ecological impact at the systemic level. Failure to acknowledge the complementarity between policies will lead to inefficient policies, something the EU cannot afford in times of great strain on public budgets. Currently, the biggest issue is the low price of carbon.
7. In regulation, stringency matters. 'Soft' approaches with long time horizons lead to 'wait and see' approaches by firms, slowing down technological transition. The NIP needs to make credible and stringent policy signals now through carbon prices and regulation, while helping firms to adapt through R&D policy.
8. Within R&D subsidies, subsidies for product innovation are most effective (as compared with process innovation and demand-pull incentives).
9. The NIP should be implemented through mission-oriented programmes that targets existing capabilities (overstretching can lead to very inefficient policies) as well as diversifying capabilities (shifting innovative activity). This is facilitated by researcher mobility, R&D cooperation, entrepreneurship and FDI connected to the local innovation system, as well as by R&D project funding selection criteria favouring a diversification of the knowledge base, rather than an incremental specialisation within the existing knowledge base of firms.
10. The NIP should support entrepreneurial dynamism and social entrepreneurship. Fast growing, young innovative firms are a major deficit of the EU, potentially slowing down a transition to a new growth path. R&D policy and regulation as well as market making mechanisms such as public procurement can foster the emergence of "green gazelles", high-growth firms active in green technologies.

[7] In particular, cluster policy should focus cluster efforts on organizing value chains from existing players, informing companies about rules and opportunities, and coordinating collective research on ecological concerns shared across the cluster (Ketels, 2014).

Social entrepreneurship is potentially promising, but it remains unclear how to foster it effectively.

11. Investment in capabilities is crucial to ensure that green innovation is shadowed by skills upgrading: this includes investment in intangible assets. Currently, the US features much higher shares of investment in intangible assets than the EU. Policies to foster greenfield investment include the quality and quantity of skilled labour, decreasing firm entry regulation costs (in particular in Southern European countries), further investment in broadband infrastructure and better investment protection systems.
12. To increase the contribution of universities and academic research/teaching to a new growth path, a narrow focus on commercialisation of academic research results is misguided. Key drivers of the potential contribution of universities are their research and teaching quality, as evidenced by the top ranking US universities. Europe should put more focus on making EU universities as attractive for the best researchers and students from all over the world as US universities, to foster research and teaching quality. Key ingredients are not only both increased and more competitively allocated research funding, but a proper tenure-track system which provides attractive career perspectives and early research independence to young researchers, which currently lure them to US universities.
13. Green policies should be mission-oriented. Mission-oriented programmes may also benefit from complementary market making measures, e.g. through public procurement.
14. Industrial upgrading should be realised through technology cross-fertilisation at the regional level. Smart diversification policies – namely policies aimed at directing firms' innovative activities towards new directions – should support entrepreneurship and entrepreneurial discovery as this fosters recombining competencies across technological fields and sectors – this would also apply for phoenix industries. Here, knowledge transfer mechanisms are of great importance: e.g. labour mobility (of researchers, e.g., between industries, or between industry and academia), R&D cooperation schemes (such as COMET in Austria), fostering employee start-ups and FDI (if well embedded in the local innovation system).
15. Effective green policies needs to include a combination of tools rather than relying on individual instruments; indeed Veugelers (2014a) and Crespi et al. (2015) present the compelling argument that it is desirable for green policies to comprise a

portfolio of instruments that simultaneously includes carbon prices, R&D subsidies and regulation. The complementarity between policies is shown by Aghion, Hemous and Veugelers (2009), who find that the carbon price would have to be about 15 times larger during the first 5 years, while subsidies would have to be on average 115% higher in the first 10 years, to achieve the same effect of climate mitigation. Especially in times of budget consolidation, this is a crucial argument for an efficient and effective public policy. This need for a combination of innovation and technology-specific policy instruments so as to stimulate ecological innovation is also emphasised by Crespi et al (2015), who see an optimal mix covering the entire innovation life-cycle as "smart regulation". Drawing on a taxonomy of environmental policies, they argue that environmental regulation and innovation policy are in fact complementary, since the first is designed to reduce negative, environmental externalities, while the second addresses positive externalities, mainly knowledge-related externalities, deriving from a problem in the appropriability of the benefits of innovation investments. Not combining environmental and innovation policies can lead to unintended and undesirable outcomes such as the 'green paradox' or a technological lock-in, with a well-known example being the subsidization of renewables without a sufficiently high carbon tax, hence leading to overall lower energy prices and a rebound in the use of 'dirty' energy.

16. Effective green policies need to be long-term and time consistent in order to enable the public sector to stimulate the private sector to engage in long-term green innovation investments – this is specifically relevant for green innovations where bigger infrastructure investments are required. The predictability of green policies is crucial for the private sector – to change behaviour, firms must know that changed policies are here to stay.

17. In green policies, evidence shows that higher carbon price through R&D subsidies may also be necessary because an energy tax could reduce overall innovation activity or R&D expenditures. Indeed an energy tax should be combined with subsidies to product innovation as the most favourable combination, leading to positive economic and environmental dynamics in the long run.

18. Green policies should be designed to ensure that demand side and supply side converge in incentives and objectives. A green policy can reach its objectives by means of an effective strategy that includes three key elements. *Firstly,* a higher price on carbon. *Secondly,* R&D support is crucial to address the knowledge

externality associated with the creation of new clean knowledge. *Thirdly,* government regulation, when properly designed, can both create demand for clean products and stimulate the creation of clean knowledge. Lower cost clean processes can be an important, if not more important lever for the development and adoption of green innovations by the private sector – which might follow. Government regulation can, among others foster the growth of "green gazelles" (Colombelli et al., 2015) and innovation in general; but it needs to be stringent, as shown by Ghisetti and Quatraro, 2015, and Arfaoui et al., 2015.

19. The NIP should not be space-blind. Cluster policy should be reconciled with innovation and green policies: on environmental sustainability, policy should consider identifying a market demand for firms, set clear regulations and steer cluster policy to focus cluster efforts in organizing value chains from existing players, inform companies about rules and opportunities, and coordinate collective research on ecological concerns shared across the cluster. On social inclusion, cluster policy cannot directly act to achieve soft welfare impact.

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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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