Social impact policy analysis of technological innovation challenges (SIMPATIC) - Interim policy messages and relevant figures

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Economic impact of the FP7 2013 budget of €8 billion – NEMESIS model (SEURECO, FPB and ICCS, 2013)

We present here the assessment of the impact of the FP7 2013 budget of ú8 billion realized with the NEMESIS detailed economic model.

The crowding in or leverage effect allows calculating how much R&D expenditures will allow a one euro subsidy. Taking into account recent literature results, we adopted for the present simulation of the 2013 call the following leverage effect: 0.5 for public R&D investments (40% of the ú8 billion funding) and 0.9 for the private sector. In mean terms, these assumptions give a leverage effect of about 0.74, which means that ú1 EU investment from the 2013 FP7 budget generates ú1.74 of research and innovation expenditure.
Hence, the ú8 billion FP 2013funding will generate ú 13.9 billion R&D and innovation expenditure.

Four phases of economic impact are distinguished:

- The first one is the *expenditures phase* when R&D expenditures increase demand for research equipment goods and for researchers. It is only a ñdemand driven phaseò in the sense that the R&D increase has not yet given innovation during the maturation of R&D (no supply effects). The simulation assumes that all the grant of ú8 billion is handed over in the first year in a one-off shock.
  Figure 1 shows that GDP grows from year one on a scale slightly below the shock effect. In fact, R&D investment consists mainly in physical investment (research hardware) and in jobs, which result in higher pay and consumption. During the first three years, there are only demand effects, because the additional R&D has not yet achieved its full impact. This translates into higher prices and imports, which upsets the external balance somewhat and causes the multiplier to ôleakö. If the instant multiplier is smaller than one, the sum of the effects on the first three years is greater than unity, which is consistent with what is expected. 210,000 jobs are created in the first year; the number then falls back almost completely, as does the GDP, since the shock is one-off.
- During the second phase, the innovations are coming progressively: Total factor productivity increases and unitary cost decreases; the quality is also enhanced; these two factors will increase the demand but in a first step, it is not the case because increase in

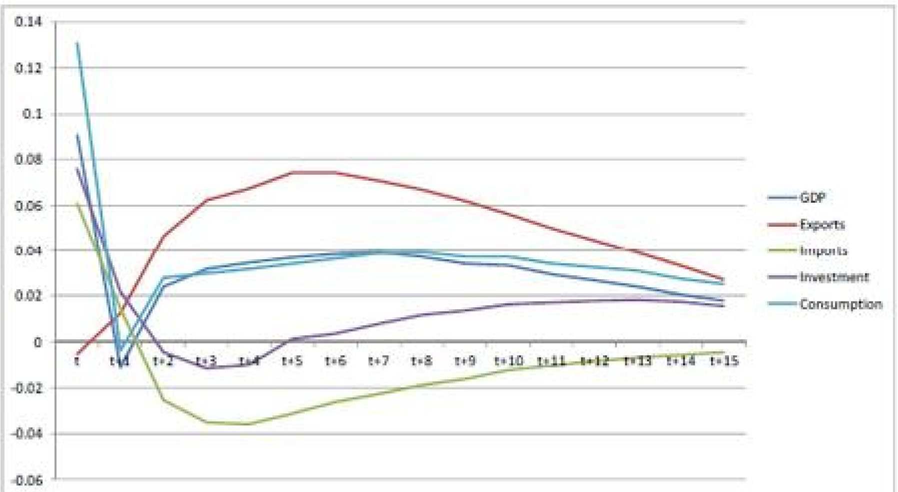
demand takes time: consumers do not immediately react to a lower price and they need time in order to adapt. For equipment goods, it is also the case and we know that the adoption of new technologies pass by a diffusion process that takes time.

The result of an increase in productivity without instantaneous demand expansion is job destruction. During this phase employment will fall below its business as usual level (see Figure 2).

- The third phase is the diffusion of innovation. During this phase, lower prices and improvement in quality will increase domestic demand (consumption and investment) and improve competitiveness and the external balance. The GDP is above its business as usual level and grows up to year t+10 (with t is the year of the shock). It is then about 0.04%. Employment is then around +0.02% which is small compared to GDP growth, but this is explained by an increase in productivity resulting from innovation. Spending on research and innovation results in higher competitiveness that contributes to increase the global surplus of European external balance or to reduce the deficit of some Members States.
- The last phase is the obsolescence of the previous new knowledge induced by new R&D increase and new innovations.

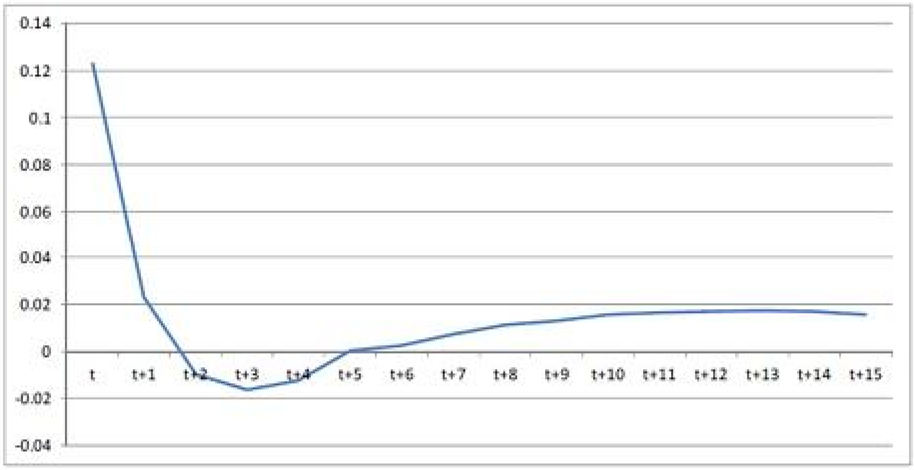
  With the depreciation of knowledge, the effects of given innovations (those which results from the R&D policy analyzed) will decrease over time and so its effect on GDP and its components. In t+5, the level of GDP is only 0,02% above its business as usual level. Nevertheless, the employment is decreasing slower.

Fig. 1 One-off shock across all sectors (% gap from central account).



Source: SEURECO, FPB and ICCS (2013).

Fig. 2 Employment trends (% gap from central account).



Source: SEURECO, FPB and ICCS (2013).

The cumulative jobs created from the policy shock is reflected in the area between the employment curves and the time axis. Cumulative job creation in 2027 (t+15) is 569,000 persons-year. Over the 15 years period, this represents, on average, **38,000 jobs** more than in a situation without the FP7 2013 call.

The cumulative GDP represents all the wealth created by the initial FP funding. It is interesting to calculate the multiplier effect of this expenditure, to see what value ú1 of FP can create. After 15 years, the wealth created amounts ú75 billion; after 20 years this is ú86 billion. This implies that after 20 years, the multiplier effect of R&D expenditures is about 6.2.

Comparing NEMESIS model forecasts with "Europe 2020" targets (SEURECO, FPB and ICCS, 2013)

Comparing model forecasts with "Europe 2020" targets.

	2005	2010	"Europe 2020" target	Nemesis 2020	Nemesis 2030
Employment rate	68.0%	68.6%	**75.0%**	72.3%	79.1%
Gross domestic expenditures on R&D	1.82%	2.01%	**3.00%**	2.01%	2.01%
Greehouse gas emissions (index 100 in 1990)	92	85	**80**	74	68
Share of renewable energy in gross final energy consumption	8.5%	12.5%	**20.0%**	16.0%	19.6%
Primary energy consumption (Gtoe)	1.95	1.89	**1.56**	1.66	1.59

Source: SEURECO, FPB and ICCS (2013).

The table above displays the NEMESIS forecasts for the ñEurope 2020ô.

The first indicator, the European employment rate, is targeted at 75% in 2020. The baseline scenario displays an employment rate of only 72.3 % in 2020, and it is only in 2025 that the 75% objective is reached. The employment rate continues to rise after and reaches 79.1% in 2030.

The second target, the R&D to GDP ratio, is set to 3% for 2020. The NEMESIS forecasts shows a ratio of about 20%, stable over time. This is a conservative assumption, and any policy designed to rise this intensity and stimulate innovation and growth.

The other targets concern energy and environment. The -20% GHG emissions reduction in 2020 compared to 1990 is reached, but the energy efficiency and renewable targets are not. Here again, along with resources efficiency policies (energy-saving investment support, re-enforcement of environmental standards, reduction of emissions caps in ETS), policies aiming to reinforce R&D and innovation may help to improve resource efficiency and accelerate the development of renewable energy sources.

Assessment of the EU first mover advantage in energy technologies: projections from the GEM-E3 model (SEURECO, FPB and ICCS, 2013)

Of particular interest is the analysis of any economic consequences that could accrue to the European Union from the so-called First Mover Advantage in energy technologies. Assuming that the EU adopts early action towards virtual decarbonisation of its energy system without waiting for an overall agreement involving other major polluters in the world, in the eventuality of the latter joining in the effort at a later stage, would the EU have established a lead in key technologies and sectors involved in GHG abatement sufficient to benefit from the rapidly expanding world markets thus offsetting at least in part the economic costs associated with early and drastic decarbonisation? Within the SIMPATIC project, the GEM-E3 team has the specific task of answering this question.

The weak climate policy reference scenario assumes a continuous regional fragmentation of climate policies and a stalling in international climate policy negotiations. This is the baseline scenario of the GEM-E3 model. The EU has established an internal target to reduce total GHG emissions by 20% from their 1990 levels and to increase RES share in gross final energy demand to 20% by 2020. The baseline scenario for the SIMPATIC project reflects these policies up to 2020. Beyond 2020, the reference scenario assumes an annual reduction of the ETS cap (equivalent to an average reduction of 1.74% p.a.), no additional policies for energy efficiency and RES penetration, limited electrification of the transport sector and that non-ETS GHG emissions will remain below the cap specified for 2020.

With these assumptions, GEM-E3 delivers the following projections concerning the energy technologies.

In the market for **wind equipment**, the baseline implies for Europe an increase in the market for wind equipment to the middle of the current decade. The world market for wind turbines is expected to grow vigorously until 2035. The share of the EU in world cumulative sales between 2010 and 2035 is projected to be a substantial 30%, but China will also account for 25% and North America for 17%. In general the baseline implies some erosion of the competitive position of the EU in the wind generator market. This is reflected both in a loss of domestic market share after 2025 and a reduction in the share of EU exports in the Rest of the World market from 2020 onwards with the emergence of new producers in the developing world.

For **photovoltaics**, there is a rapid growth in the EU in the market between 2010 and 2030, a hiatus between 2030 and 2040 and a resumption at the end of the forecast period, albeit at a more modest pace. The baseline projects a dramatic erosion of EU competitive advantage with regard to PV production. EU producers are effectively eliminated from international markets by the end of the forecast period. At the same time, imports of photovoltaics will end up accounting for more than half of domestic demand.

Unlike wind and photovoltaics, **CCS technologies** cannot be considered to be a properly available option for power generation currently. Existing **CCS** plants are effectively demonstration prototypes. The requirements of high carbon values and the fact that the technology is not readily available mean that its prospects before 2030 are almost non-existent. Although given baseline climate policy assumptions the importance of CCS in economic terms is very limited, its potential must not be underestimated. Under different conditions to be examined in alternative scenarios within the SIMPATIC project, CCS can play a major role because it allows the utilization of abundant fossil fuel resources like coal in a carbon constrained world. Under such conditions, an early start by the EU could provide a competitive advantage in a potentially vast market.

The GEM-E3-RD model distinguishes between **plug-in hybrid vehicles** and **pure electric ones**. Both categories depend crucially on the development of cost-effective advanced batteries with a high power density allowing for a reasonable range. The baseline takes an optimistic view that both will start becoming available in the EU and in the Rest of the World already by 2020. Beyond that date, the evolution of the market is projected to be rapid. Apart from the EU, high penetration rates are achieved mostly in highly developed economies, like the USA and Japan. The low penetration rates notwithstanding the potential market for non-conventional vehicles is huge especially if (and this is the case in the table below) the whole cost of the vehicle and not just the parts that render it unconventional are considered. This is clearly another case where an early advantage could confer major benefits that are worth exploring in subsequent scenarios within the SIMPATIC project.

Biofuels constitute another category of alternatives to CO_2emitting conventional liquid fuels in transport. They are already widely use. As the baseline assumes a continuation of this situation and even some further increases in oil prices beyond 2030, the incentive to switch into biofuels is likely to persist. In terms of EU biofuel production, in what concerns ethanol the baseline suggests an increase in penetration of imports. This is not true of biodiesel where the assumption is that promotion of biodiesel production constitutes part of the Common Agricultural Policy. The EU exports no biofuels whatsoever on grounds of lack of competitiveness.

Effect of energy prices on clean and dirty innovation (Dechezleprête and Martin, 2013)

Aghion et al (2012) examine the link between energy prices (i.c. fuel prices) and innovation using firm level data for the global automotive industry. Importantly, price effects on radical clean transport technologies areas ï e.g. electric or hydrogen propulsion ï are distinguished from those from internal combustion engines (ñdirtyò).

The results suggest that there is:

ÅA short run price elasticity of clean innovation of 0.97

ÅA short run price elasticity of dirty innovation of -0.57

Clean innovation increases and dirty innovation reduces in response to a uniform global increase in fuel prices.

When using the tax component of fuel prices as an explanatory variable instead of tax-inclusive fuel prices, slightly smaller values are obtained, consistent with the idea that only part of a cost increase will be imposed on consumers.

ÅA short run tax elasticity of clean innovation of 0.40

ÅA short run tax elasticity of dirty innovation of -0.23

They also find evidence for two different dynamic channels which determine the long run response at the firm level. Firstly there is a strong path dependency whereby firms are more likely to engage in the same type of innovation that they have been conducting in the past.

Similarly we find evidence for stronger innovation spillovers within innovation types. Both these effects give clean innovation a disadvantage when starting from a state of the world where dirty innovation is historically more dominant. However, these feedback effects also create a multiplier effect leading to a stronger long run response of a given policy intervention such as an increase in fuel taxes.

Effect of ETS on clean innovation (Dechezleprête and Martin, 2013)

Policies that primarily target the environmental externality such as carbon emissions pricing ï through carbon taxing or a trading system ï might not only reduce GHG emissions. By putting a price on carbon, they could also provide incentives for companies to direct R&D to clean areas.

The European Emissions Trading System (EUETS) is arguably the largest climate policy initiative to date which has now been operating for 8 years. Calel and Dechezlepretre (2012) examine its impact on innovation. Nearly 3,500 companies are compared that, by virtue of operating at least one sufficiently large installation, came under EU ETS regulations in 2005, with over 4,000 comparable companies that were exempted. Before 2005, these two groups were similar in size, in patenting activities, and operated in the same countries and economic sectors. Both groups would have faced similar macroeconomic conditions but from 2005 they faced different regulatory obligations for their emissions.

The firms look similar over the period 2000-2004, but since the EU ETS launched in 2005, EU ETS regulated firms have started filing more patents to protect low-carbon technologies. The main finding of the research is that EU ETS firms have increased their low-carbon patenting by about 10% compared to a counterfactual scenario without the EU ETS.

Spillovers and clean innovation (Dechezleprête and Martin, 2013)

The existence of knowledge externalities or spillovers is an important reason why carbon pricing is not sufficient to trigger a socially efficient response from clean innovation activities. However, such knowledge externalities are a feature of all types of innovation, not only of clean innovation, and there are a range of policy measures already in place to deal with this such as patent protection and general R&D subsidies. Hence specific policy measures for clean technologies would only be warranted if these spillovers would be higher for clean technologies. Spillovers are also relevant to understand the likely impact of climate policies on short and medium term economic growth. If spillovers in clean technologies are higher there might be positive growth effects.

Dechezleprêtre, Martin and Mohnen (2013) examine the evidence for differences in knowledge spillovers between clean and dirty technologies using patent citation data. Our estimates suggest that spillovers from clean technologies are about 20 to 30 percent higher than spillovers from dirty technologies.

Spillovers for clean technologies are also compared with other emerging technologies such as IT or biotechnology. In this case there is no clear evidence for higher spillovers from clean technologies. Hence, from a normative point of view these results suggest that some extra support for clean technologies is warranted although not more than for other emerging technologies.

R&D subsidy applications: observed patterns (SIMPATIC, 2013)

Firm application behaviour

SIMPATIC research offers the first systematic cross-country view on how firms apply for subsidies in different EU countries. The countries that are studied are Belgium (Flanders), Finland, Germany, The Netherlands, and Spain. Of these countries, Finland and Germany rely ï during the period(s) studied ï only on R&D subsidies, while the other three offer also R&D tax incentives of various forms.

What firm characteristics explain whether a given firm applies for R&D subsidies from the national agency in question? The analysis finds that firm age has a negative impact on the probability of a firm to apply for R&D subsidies in all five countries. Firm size has a negative (nonlinear) impact on the probability of applying in Finland, Germany and Spain, and a positive impact in Flanders and Germany. Exporters are more likely to apply for R&D

subsidies. With respect to SMEs, one could have expected that SMEs are more likely to apply given that they are often given favourable treatment (e.g. by allowing higher maximum subsidies). This turns out not to be universally the case. The only country for which there is any sign of a positive effect of SME status on the probability of application is Belgium, and even there the evidence is weak. For all other countries the effect is either clearly negative (Spain, The Netherlands), or zero or weakly negative (Germany, Finland).

Agency decision-making

SIMPATIC offers the first systematic cross-country view on how government agencies that decide on R&D subsidies, behave. The countries that are studied are Belgium (Flanders), Finland, Germany, The Netherlands, and Spain. The decision variable explained is the subsidy rate, i.e., the percentage of the applicant firmûs R&D cost that the government promises to cover.

The set of explanatory variables is largely the same as in the studies on firmsô application behaviour. In addition to these, we have for some countries information on how the agency graded an application. Projects rated with a high market risk have a lower subsidy rate in both Spain and Finland. The technical challenge of the project has a strong positive impact on the subsidy rate in both Spain and Finland. The only country in which firm age has an impact on the subsidy rate is Finland where the effect is negative. Firm size has no effect on the subsidy rate in any of the five countries. The export status of the firm has no effect in any of the four countries (The Netherlands is the one country where this variable is not used) where it is used to explain the subsidy rate decisions.

SME status: The SME status was expected to have an impact on the subsidy rate as in all countries, SMEs get favourable treatment in the form of a higher maximum subsidy rate. It turned out that this prediction holds in Finland, Germany and The Netherlands, where an SME gets a subsidy rate that is 4-6% higher. SMEs donût get higher subsidies in Belgium and Spain.

Social innovation and economic growth (Konings and Marcolin, 2013)

Konings and Marcolin (2013) define *social innovations* in general terms as new responses to pressing social needs, which affect the process of social interactions (i.e. social capital).
This definition stresses the link between social innovation and changes in social capital.
The advantage of the proposed definition is that it makes it possible to proxy a countryôs level of social innovation exploiting indicators for social capital.
Konings and Marcolin (2013) concentrated on four dimensions of social capital which are stated by the OECD (Healy, 2002):

1) Trust;

2) Community participation through membership and volunteer work in civil society organizations (associations, unions, religious communities, sport clubs etc.);

3) Informal networks (family and friends, neighbors);

4) Political participation (voting, personal involvement in politics, trust in political institutions).

The authors propose 13 proxy measures for social capital which are derived from the European Value Survey. Although the authors used different proxies for social capital, country rankings seem to be mostly coherent with the one derived using TRUST, which has been extensively used in the economic literature so far and therefore is adopted as benchmark. It is hence possible to approximate social innovation with changes in levels of trust in the population.

Innovation and services (Stare, 2013a and 2013b)

Stare (2013a, 2013b) considers ñservice innovationò as any innovation activity with service-like attributes, which can occur in any sector of the economy, apart from the service sector. Innovation in the service sector is being increasingly acknowledged, but the horizontal aspects of service innovation with an impact on other sectors of the economy, most notably manufacturing, is little studied. Service innovation is more than innovation in services and it is not synonymous with non-technological innovation. It is also important to observe that social innovation in businesses and/or by citizens and NGOs is always a service innovation.

Public policy design needs to take account of the peculiar features of service innovation. Service innovation has a lower R&D intensity in the traditional meaning of the term for technological innovation. In addition, it is usually less formalised and rarely carried out in research and development departments; it is incremental rather than radical and consequently less visible. Moreover, service innovation is largely a distributed phenomenon that depends on cooperation and interactions among stakeholders (including the suppliers, research and university, intermediate and final customers) to a greater extent than in technological innovation. Finally, service innovation is mainly demand driven and emerges as a response to user needs (intermediate and final users) that provide critical incentives.

Notwithstanding the fact that knowledge on service innovation has improved significantly in the last two decades, this knowledge has not been adopted more broadly in public policy shaping and integrated into the design of innovation support measures. The attention of policy makers to service innovation and the amount of funds spent for the research of service innovation is utterly disproportionate with the economic importance of services and services related innovations. A number of misunderstandings and myths remain concerning the benefits and impacts of service innovation due to deficiencies in measuring non-technological innovation that is particularly relevant in services. It is of paramount importance to better understand service innovation (in all its varieties) and the ways and means we have of assessing and fostering it. Finally, one cannot ignore the dominant role of services in value added and employment in advanced economies, as well as the facilitating role of service activities in promoting innovation and competitiveness throughout the economy. These facts put innovation in the service sector and in service activities high on the agenda of business strategy and of innovation policy.

Impact of innovation on employment and skills (Damijan et al., 2013)

This SIMPATIC research aims to contribute to still scarce research in the field of effects of innovation on employment and skills composition. The contribution lies in taking into account multidimensional effects of innovation in services. To account for this, a general framework is employed that accounts for the impact of firmsô own innovation as well as innovation spillovers from vertically linked services sector on individual firmôs employment growth and changes in skill composition. The impact of firmsô own technology and non-technology innovations on employment and skills composition is studied in manufacturing and in services firms. In addition, it is studied how innovation in manufacturing and services industries affects employment and skill composition in vertically linked manufacturing and services firms via spillover effects.

The analysis uses unique representative samples of micro data for Spain and Slovenia for the period 1996-2008. Empirical estimations show mixed results. In Spain, there are positive effects of firmsô own innovation both on future employment growth and on the increases of high-skilled labor shares, whereby in Slovenia no such effects were found. In terms of innovation spillover effects on employment, the research finds on the sample of Spanish firms that product innovation in vertically linked industries is positively affecting firmsô future employment growth, while process innovation is shown to have a negative impact. The opposite results were found on the sample of Slovenian firms. In terms of the effects of innovation spillovers on skill composition of labor, in both countries only manufacturing firms experience some significant innovation spillover effects. Positive effects of vertical spillovers are found from product and marketing and organizational innovations and negative spillovers effects from process innovations. The difference is that in Spain these significant innovation spillovers stem from service industries, while in Slovenia they originate in manufacturing industries.

These results hence show a substantial heterogeneity of innovation effects on employment and skill composition of labor. This implies that, first, the effects depend a lot on the specific structure of each economy, whereby results can vary substantially across industries that generate spillovers and across firms that are potential beneficiaries of the spillovers. And second, innovation in service industries do not seem to have a different spillover effect on employment and skill structure when compared to innovation in manufacturing industries.

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