The costs of a non-innovative Europe: What can we learn and what can we expect from the simulation works

Paul ZAGAMÉ

September 27th 2010

Content

This note follows the August 30, 2010 note of Luc Soete. *The Cost of a non innovative Europe: the challenges ahead.* It aims at summarizing the achievements of all the simulation work carried out with NEMESIS and to present the work in progress or to be done to quantify and associate figures to the questions raised by the reflections related to research policies and innovation. Therefore, it builds on Luc Soete's proposals, but it also incorporates many ideas that were suggested during meetings with European Commission officials Pierre Valette, Domenico Rossetti, Marion Dewar, Ugur Muldur, Cyril Robin-Champigneul, Patrick Brenier, and obviously the whole Erasme team and many other contributions of the DEMETER network and particularly Dominique Foray.
It is organized as follows: after a brief presentation of the instruments used to perform simulations, it lays out results that may be considered as robust because neither time nor the confrontation with other work called into question most of their teachings. We then present more recent results, some in the wake of earlier studies, are just simple transpositions, and can therefore be considered as robust; on the other hand, others may still raise questions both about the model's operation but also about new economic policies implementation tracks. Finally we will present the perspectives suggested by L. Soete's note.

1- The NEMESIS model: contributions and limits.

NEMESIS[1] is a detailed macro-sectoral econometric model (30 sectors) and the operation of the latter might be described as "hybrid" as its trajectory is the result of purely macroeconomic forces, but also of strong interactions between very heterogeneous sectors, some traditional, such as agriculture and some service sectors but also other very progressive sectors with a very high R&D component. The interactions involve the exchange of goods and services but also knowledge transfer (knowledge spillovers), which is unique for a model of this size.
The model is designed so that it can easily incorporate recent advances in theory; its production block, which distinguishes skilled and unskilled labour, can also endogenise technical progress on R&D spending, taking into account knowledge spillovers from other sectors, other countries and public laboratories.
The model system consists of 27 European countries models, models for the U.S. and Japan and an extremely simplified model for the rest of the world. The economic core of the model is connected to "specialized" modules: Energy-Environment, Agriculture, land use, regions.
The advantage of this model is to provide within a formalised coherent framework, and foremost an accounting framework, quantification of effects of a broad spectrum of economic policies including so-called "structural" policies, and policies relative to R&D, energy, environment, taxation, agriculture, land use, etc.
But there is only so much that models can say and in any case their results can not be regarded as undisputable, but only as elements of discussion aimed at shedding light on economic policies or raising new interrogations on these policies. It also happens that these results are used to improve the mechanisms of the model. Moreover, due to a number of phenomena often insufficiently taken into account, they require a modification prior to the evaluation of economic policies. Besides, the

[1] Financed mostly by the Commission's Research D.G.

impact of a number of institutional or more qualitative phenomena must be accounted for exogenously. This is the case for a number of proposals included in Soete's note: the case of demand driven R & D in services, which should make us reformulate the R&D decision, or the rise of research in Asia and particularly China, which requires us to integrate more accurately that geographic area.
In addition, some other phenomena related to the "Innovation Union", will need to be quantified exogenously.

Some simple results that stand the test of time and of competing assessments

The model has already been used to quantify various research policies: the Barcelona 3% (Brécart & alii 2004, 2006), the National Action Plans (Chevallier & alii, 2006), the FP7. (Delanghe & Muldur, 2007). Without going into the detail off all these assessments, we recall that at a 5 to 10 years horizon after the end of the policy's implementation, multipliers range from 6 to 7. Spending one Euro generates total 6 to 7 € of GDP **and for 10 million euros, roughly 300 jobs are created, with** variations taking into account the implemented policies. Note here that these figures depend on the projection horizon for some policies aiming at stabilising R&D intensity, since R&D spending at this rate will grow continuously with the GDP. These figures also may appear differently in the study carried out during the first evaluation of the 3% policy (2002) because at that time, a relative convergence hypothesis regarding intensities of R&D led us to increase the average intensity after 2010 and up until 2040. We will not present the results here as they have been the subject of several reports and publications and have therefore been much discussed.
The mechanism called upon in these assessments starts from an increase in R & D of one or more sectors that has the effect of increasing knowledge in these sectors and other sectors in the country or abroad via knowledge spillovers, which lead to productivity and product innovation that increase domestic and external demand in Europe and hence growth and employment.

However, a more accurate temporal analysis shows that in general two phases should be distinguished in the dynamic evolution. The first one of capital expenditures in R&D is a phase of investment and employment (particularly researchers' employment) boosting, which has no counterpart in terms of supply improvement, as innovation requires time before taking place. Also this phase is generating inflationary imbalances: increasing wages for a job category where supply is inelastic, increased costs due to R&D spending, loss of competitiveness and increasing imports. The innovation phase then allows an increase in competitiveness and domestic demand, but one should keep in mind that the initial cost of those policies is not negligible.
The research policies assessments that followed other models more or less confirm the order of magnitudes that we have presented. Indeed, the Dutch Central Planning Bureau has assessed the consequences of the Barcelona 3% using the SCAN WORLD general equilibrium model (Gelauff and Lejour, 2006) and provided results comparable in terms of GDP and employment for the most favourable case.
The 7th Framework Program evaluations confirm these results with variations which again depend on implementation choices, particularly regarding the funding allocation method.

Since the realisation of these assessments, the crisis came. How did it change our perception of the short and long term and of the role of research policies and their assessments? This is what we should consider now.

2- A lasting crisis due to the drop in R&D spending it causes?

First, we mention that theorists and practitioners have now agreed on an issue that once made debate: the crisis tends to decrease R&D spending, which is pro-cyclical for several reasons, mainly because it reduces demand-driven innovation. Also, since it is an uncertainty crisis, it discourages investment. But it is a liquidity crisis as well, which constrains firms.

Clearly a model such as NEMESIS is not able to describe accurately and spontaneously cyclical sequences. It is rather a structural medium-long term model in which the only variable affecting financial investment is the interest rate and not financial constraints.

To describe the cyclical sequences, we used GDP and its components forecasts produced by DG ECFIN[(2)] and used calibration variables, releasing then econometric functions.

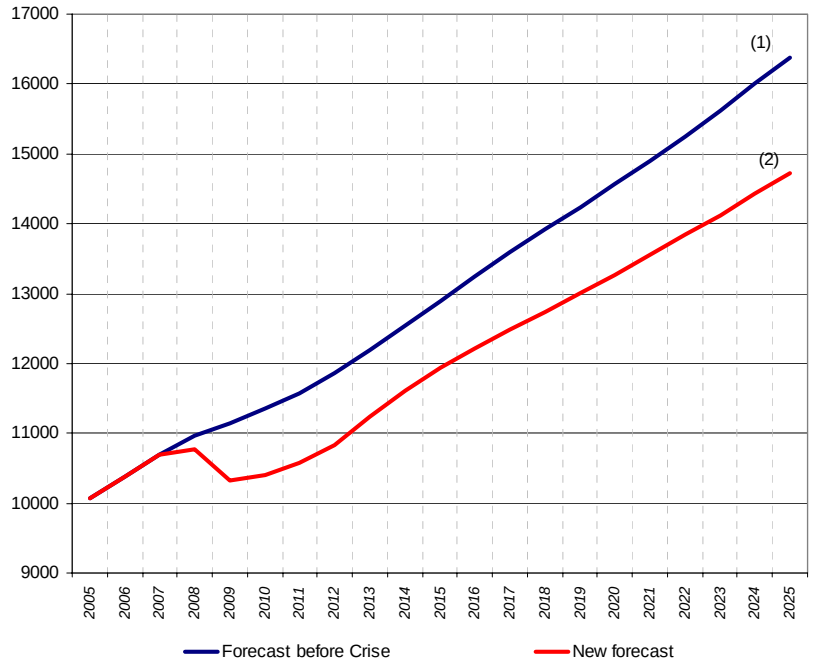
What appears is that the cumulative GDP gap by the end of 2010 is close to 9% and the employment deficit is 3%

Table 1 : Short term effect of the crisis

	2008		2009		2010	
	GDP	*Employment*	*GDP*	*Employment*	*GDP*	*Employment*
Trend (growth rate)	2.7%	1.4%	1.6%	-0.4%	1.8%	-0.3%
Crisis (growth rate)	0.8%	1.2%	-4.1%	-2.3%	0.7%	-1.2%
Cumulartive GAP (%)	*1.9%*	*0.2%*	*7.6%*	*2.1%*	*8.7%*	*3.0%*

After 2010 the model is "released" but it still takes into account the available information on the long-term trend.

Figure 1 : GDP in Before and After-Crisis Scenarios, billion € 2000



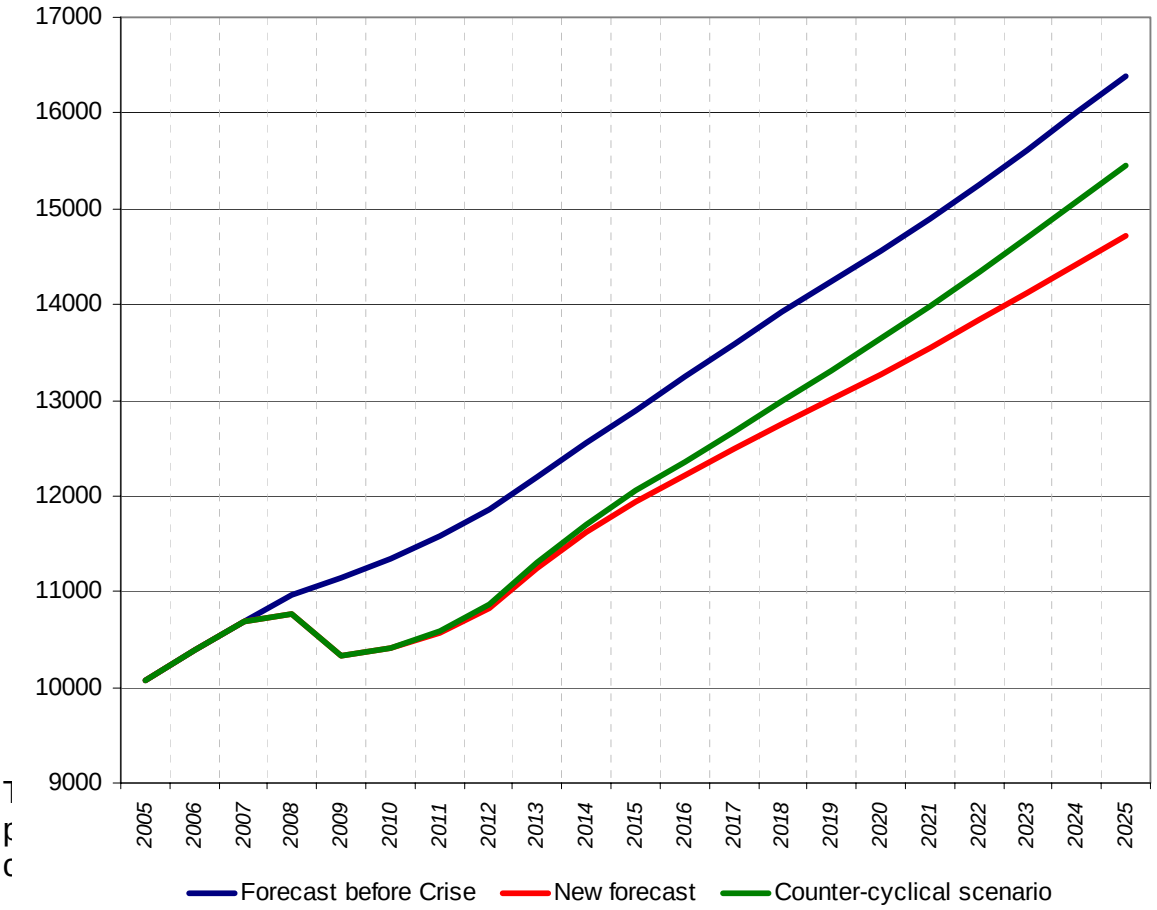
(2) Autumn 2009

This shows that the GDP gap tends to be maintained and even accentuated spontaneously by the end of the considered period.
In fact, the sectoral distribution of GDP and its components by econometric functions shows that R&D intensive sectors are the ones that suffered at most from the crisis, particularly capital goods sectors. This lack of R & D will rebound later on the long-term trajectory of the economy and will tend to deepen the GDP gap.

3- Active policies of R & D and innovation to emerge from the crisis: a possibility to wipe-off almost all the effect of the crisis on employment by 2015

As R & D spending is pro-cyclical, it should be supported during times of crisis and especially since its weakness may contribute to maintain or even worsen the crisis.
We built for this a scenario in which a successful research policy allows, from 2010 to 2020, to gradually increase the R&D effort up to 3% and thus correspondingly increase innovation.
Simulations show that this policy helps to fill by 2025 nearly half -43% exactly- of the GDP gap expected before and after crisis, with an evolution that allows to consider a GDP level catch up, although much later.
Regarding employment, the gap is almost filled in 2015: as the crisis has greatly reduced wages, which makes the economic recovery intensive in job creation.

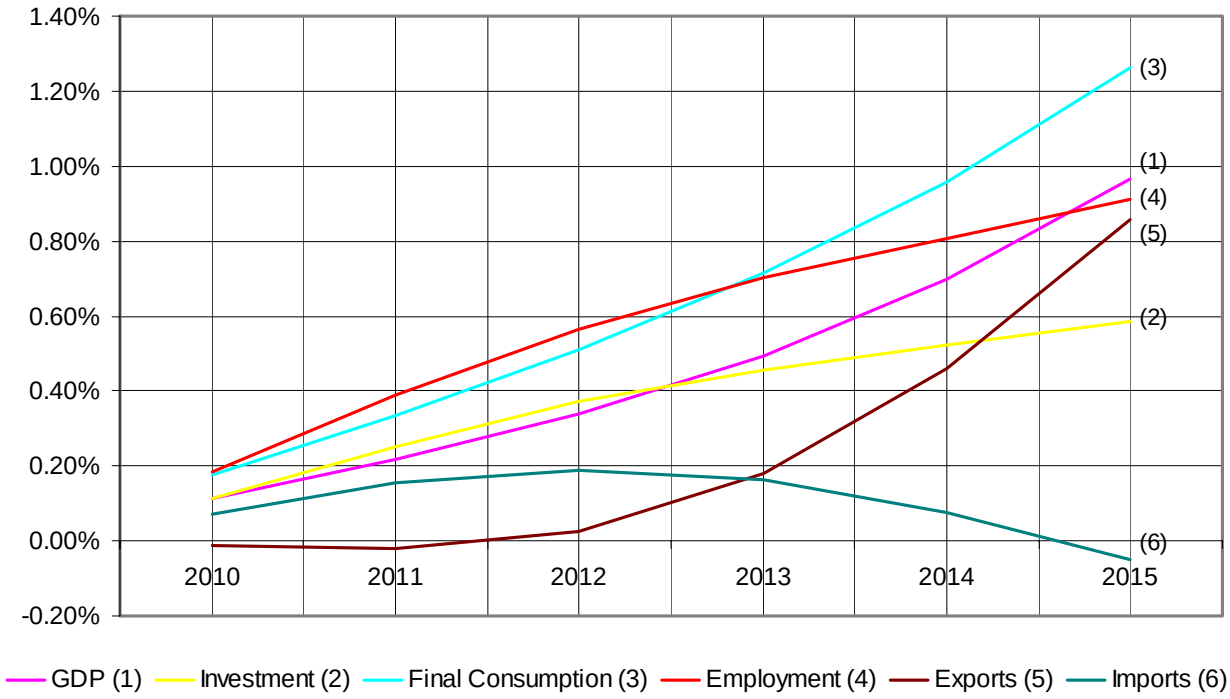
Figure 2 : Impact on GDP of a counter-cyclical R&D policy, billion € 2000



4- The crisis decreases the cost of R&D policies

A new timeframe for the 3% R&D spending target gives a good measure of the reduction of costs during crisis. It can create up to 3.7 million jobs in 2025.
The exercise for which we present the results here is a simulation of the Barcelona target, with three differences from the 2004 work: A new expenditures schedule, with the gradual increase of R&D spending from 1.8% up to 3% of GDP between 2010 and 2020 and a strict persistence of the 3% level after 2020; an expansion of the number of models to the 27 EU countries; a crisis context for the baseline scenario.

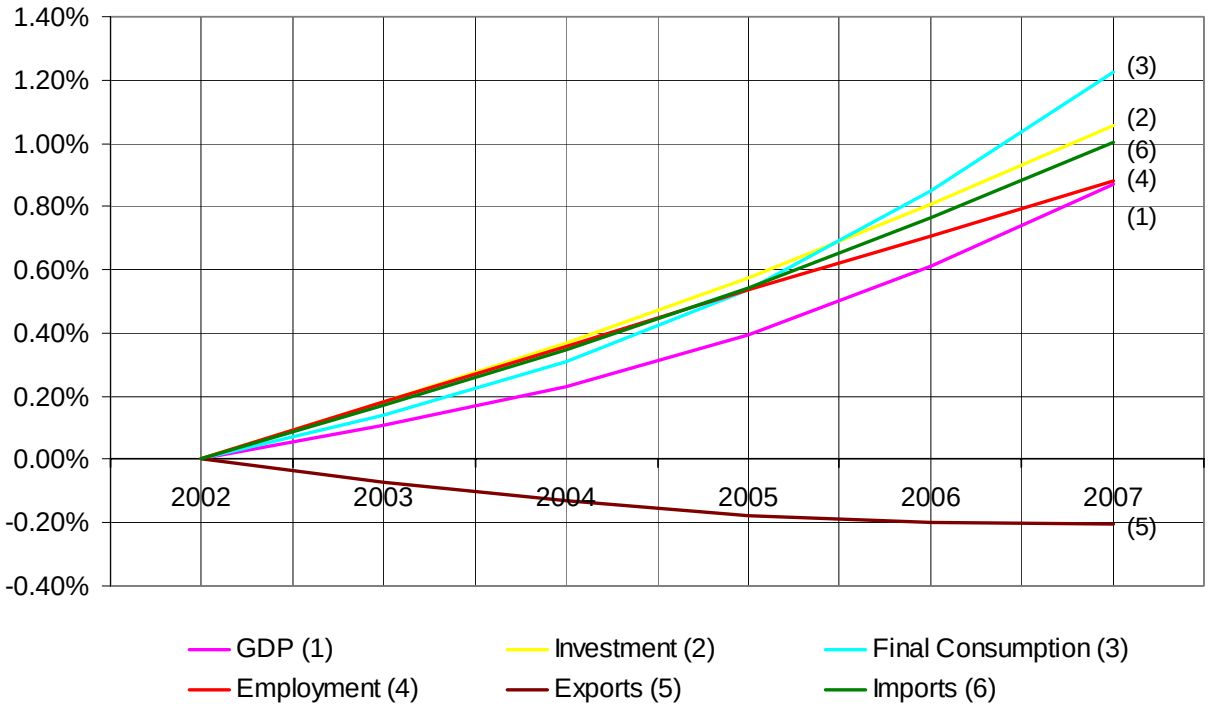
Figure 3 : New assessment for the 3% R&D objective, investment phase



For the investment phase, the new assessment shows that before the arrival of innovations, inflationary pressures, deterioration of imports and hence deficits are less pronounced due to a higher unemployment rate and lower production capacity utilisation.
For the phase of innovation and growth, results are comparable to that of the previous assessments, except for the fact that exports in the new study exceed consumption, whereas the reverse was true earlier: falling wages due to unemployment boost competitiveness and reduce consumption.

Thus, for the years 2020 and 2025, respectively 3 and 5.4 percentage points of GDP (i.e. 398 and 795 billion of Euros) will be generated thanks to the new 3% objective as well as 2.7 and 3.7 million extra jobs.

Figure 4 : Previous assessment of the 3% R&D objective, Investment Phase



We notice in this picture that imports are relatively high whereas exports are deteriorated, which is not the case in figure 3.

5- The 6.5 billion Euros spent in 2010 for FP7: 165,000 jobs created immediately and a total of 275,000 job years including 160,000 for unskilled workers.

The Framework Programs for Research and Development can be an incentive for increasing R&D effort. We will now consider in depth the effects of the 6.5 billion Euros spending decided in 2010.

It has been judged useful by the Commission to assess for the impact of the 6.5 billion euros spending decided in 2010 and solely of those 6.5 billion, without accounting for other FP7 spending. The benefits of this exercise are twofold: first, methodological, because isolating expenditure and following its evolution into the economy allows for a better understanding of the phenomena at play: the message is not obscured by other years spending. The second benefit is economical, as we can carry a cost-benefit analysis of such a measure.
Firstly, because the shock was not renewed, we chose a very low leverage effect; lower than in the existing literature (see the note of Fougeyrollas, Le Mouël and Zagamé, 2010) in the order of 0.5. That is to say that the 6.5 billion Euros spent on the EU budget will lead to a total of 10 billion Euros spending. We will return on this important issue of leverage at the end of this note.
From a methodological point of view the occasional shock revealed four phases that previous exercise -based on renewed or even rising spending- did not allow us to observe:

- A phase of R & D spending where employment is growing fast at the time of the shock: nearly +165,000 including nearly 110,000 skilled jobs. Essentially researchers' jobs are created. Other expenditures being mostly, constituted of research materials.

- A phase of restructuring and innovation: three years after the initial shock, R&D starts yielding innovation. However, the initial employment expenses are not renewed. Therefore, employment will decrease and even more so as innovation has increased labour productivity and increased demand caused by price cuts will need time to materialise.

- A diffusion and increasing demand phase: employment goes up to 21,000 in 2020 which may seem small compared to the increase in GDP (+0.04) but can be explained by labour productivity gains caused by innovation.

- The last phase is that of obsolescence: with a gradual downgrading of knowledge capital, the effects of innovation will decrease over time.

But, what is important to consider after the shock are cumulative effects (3), which generate 275.000 job years in the 2010-2025 timeframe for example, including 160.000 unskilled jobs. Moreover, this initial spending resulted in a cumulative creation of value added (GDP) of 63 billion Euros.
These results are to be assessed in relation with the initial cost is 10 billion Euros, including 6.5 at the expense of community budgets. The cumulative GDP multiplier is 6.3 whereas the cost of employment for one year is $\frac{10^7}{275}$ = 36.000 € for all stakeholders and of $\frac{6,5\times10^6}{275}$ = 24.000 € for European funds.
Finally, it should be noted here that more than the half of the created jobs are unskilled jobs, which allows us to say that there is no crowding out of unskilled jobs by skilled ones.
In that exercise, research funds were allocated according to the "grand fathering" principle, that is to say to each sector in proportion to its spending. We now question that hypothesis by seeking for the best possible allocation of these funds.

6- Even more jobs, if research funds are allocated to sectors with low research intensity, particularly in the corporate and individuals services sector

The idea here is to concentrate funds, either on the most R & D intensive sectors, primarily in the capital goods sector, or on the low intensity sectors such as consumption and corporate and individuals services. In both cases, the allocation for each family of sectors will be based on "grand fathering", that is proportionally to historical expenditures.

(3) The cumulative effects sum jobs creation over all the simulation period. It is an integral that must be expressed in jobs × years.

Focusing on export-oriented R&D intensive industrial sectors

The focus on intensive sectors degrades the previous results in terms of GDP and employment since the wealth generated by the 10 billion Euros expenditure during the period 2010-2025 amounts to 57 billion Euros.
The percentage of skilled jobs increases relatively to the previous case, as sectors using most researchers and most skilled workforce are advantaged. We need to examine this finding, which challenges an entrenched idea that investment in R & D must focus primarily on R&D intensive industrial sectors oriented towards foreign trade and that should improve external competitiveness. In fact, when considering the decomposition of GDP improvement, compared to the previous case, we observe that the improvement emerges more from net exports than from consumption, the latter suffering from the lack of research investment in sectors underlying it.

Table 2 : Focus on R&D intensive sectors, cumulative effects in 2025

	Intensive sectors	All sectors
GDP (in billion)	57 (X 5,7)	63 (X 6,3)
Total Employment (thousands)	220	275
Skilled Employment (thousands)	119	160

Focusing on least R&D intensive sectors

The concentration of the funds in the least R&D intensive sectors, such as consumption and services, produced better results both in terms of wealth creation by 2025 (+81 billion) and employment (437,000 men × years).
As a matter of fact, consumption explains a large share of GDP growth: innovation in the consumer sectors lowers prices and creates demand. This point is sufficient to explain the much better performances.

Table 3 : Focus on low R&D intensity sectors, cumulative effects in 2025

	Low intensity sectors	All sectors
GDP (in billion)	81 (X 8,1)	63 (X 6,3)
Total Employment (thousands)	437	275
Skilled Employment (thousands)	277	160

Indeed, consumption alone constitutes more than 65% of European GDP, while exports account for only 16%, in the “consolidated” Europe.
In these sectors, the main beneficiary is the market sector of corporate and individuals services which is a low R&D intensity sector but the extent of which (25% of GDP) makes it a sector spending a lot in research. In those sectors much of R&D is related to the adoption of information and communication technologies (ICT). Would this variant be a good remedy to the problems of productivity in services in Europe? Answering this question demands further investigation, and would require a modification of R&D in services, to account for the innovation “single market”.

7- The importance of international and intersectoral externalities: 2/3 of the value added creation

Knowledge spillovers are behind the revival of the economic theory of growth and technological progress: they explain endogenous growth and, to a large extent, justify the implementation of research policies because they generate a social productivity of research superior to that of individual productivity. Accurate information on these externalities is essential for policy makers in order to implement the most appropriate research policy and to give a better definition of the instruments capable of straightening up these spillovers.

For the European Union, a valuable piece of information for the implementation of policies, at this level of responsibility, is that which is related to international externalities, both intra-European and between European countries and the rest of the world.

Intersectoral externalities would normally belong to the national domain but things are not that simple, as interferences are high between the intersectoral and the international spillovers. In NEMESIS, intersectoral externalities are described using patent flows between sectors, built using the matrix developed by Johnson (2002). The international externalities are based on foreign trade bilateral flows exchange matrices. It is in both cases a “compromise” that will be improved under the DEMETER project with the work of UNU-MERIT with L. Soete and ERASME-EPFL with D. Foray and P. Zagamé.

But we realised these simulations, for guidance, and to stimulate discussion with economic policy officials and with researchers.

The protocol that was used here is to compare the model results on variants of 6.5 billion Euros, which we have just presented, in the following three cases: V0 previous variants with all externalities; V1 variants obtained by removing international externalities; V2 variants without any externalities. Therefore V0 - V1 indicate the importance of international externalities and V1 - V2 the importance of spillovers across sectors.

The results we found indicate clearly the importance of these spillovers: the value added created by the overall increase in research spending decreases by 65% when removing all externalities and by 15% to 20% when only international externalities are removed.

This means that two thirds of the value added generated by research policies comes from knowledge spillovers. In this contribution, one third comes from international externalities and two thirds from intersectoral externalities.

It is likely that if the policy had been conducted in countries that are major emitters of externalities, such as the USA and to a lesser extent Japan, the international externalities would have been higher.

Regarding employment, the effect of the abolition of externalities is less important since the decline in employment gains is about 40%. The explanation comes from the fact that in this case the gains in labour productivity are lower than previously.

These results seem substantiated by current research in the DEMETER project conducted by the EPFL, MERIT and ERASME, particularly regarding the hierarchy between international spillovers and spillovers across sectors.

8- Stopping European research programs would cost each year at least 0.7 % of GDP and 380.000 jobs from 2025 onwards

The simulations presented here relate to the removal of FPs from the FP8. The two assumptions tested here are respectively the continual of FP8 at an annual spending level identical to that achieved by the FP7 in the last year (2013), i.e. 10 billion Euros, against the suppression of all FP expenses from 2014, starting with the FP8 and beyond.

The hypothesis followed here is that Member States do not replace the decline of European funding. We have tested in the past other cases where Member States took a relay for all or part of EU spending. For time constraints reasons and since it is likely that the debt level of the States would not allow for this substitution, we have simulated a "dry" suppression.

The value of the leverage effect used here is 1.1, that is to say that every euro spent in the case where programmes would be extended, would lead to a total spending of 2.1 euros, including 1.1 that would be borne by investors, which also may slightly increase inflationary pressures relative to the 0.54 leverage hypothesis used in previous work. The results are presented in Table 4.

Table 4: FP suppression after 2013 consequences, cumulative effects in 2025

	2015	**2020**	**2025**
GDP (%)	-0.10	-0.32	-0.63
Employment (thousands)	-262	-125	-382

It first appears that the initial shock in 2015 would cost 0.1% of GDP and 262.000 jobs that the spending incurred by the Commission and augmented by private agents would have immediately created. Recall that, symmetrically to what we had considered earlier, the European economy is in the "no spending" phase in 2015, without it having any effect on innovation reduction, since we are in an R&D maturation phase.

Next, we would be in a symmetric phase compared to that of restructuring: the implementation of FP8 would lead to gains in labour productivity, without demand increasing immediately. Here, the opposite occurs, for the lack of R&D spending means that labour productivity does not increase, thereby saving jobs compared to FP8 because the latter had not yet met increased demand while having generated productivity innovations. That is why we observe in 2020 a smaller decrease in employment (-125.000 instead of -262.000).

Finally in the last stage, innovations due to FP8 would have met demand caused by improved competitiveness and lower domestic prices.

The difference between the situation without FP and with FP8 widens in terms of GDP and employment and it will be nearly 400,000 jobs that will be missing from 2025 on and likely even more beyond.

9- The inclusion of the Risk Sharing Finance Facility (RSFF) allows a substantial increase in the efficiency of FP funds

The following assessment is based on the suggestion of L. Soete's note on the effects of the implementation of the Risk Sharing Finance Facility set up by an agreement of cooperation between the European Commission and the European Investment Bank (EIB). This actually leads to a double action: first to a risk cover and more importantly to the possibility of a complementary loan for companies whose projects have been accepted by the FP7 and the RSFF.
In Soete's note, the measure that started mid 2007 has already resulted in the granting of 0.5 billion euros under the FP that were completed by means of guaranteed loans, and eventually that half billion resulted in 16 billion of funds spent on research. Yet, the leverage is very important on these funds.
The 0.5 billion spent over two and a half years are in fact 0.2 billion per year and the assumption that we are now making to reassess the impact of the 6.5 billion Euros FP7 funding decided in 2010 is that :

- 6.3 billion, using the leverage effect (equal to 0.538) result in an actual R&D expenditure of 9.7 billion and 0.2 billion, using the RSFF effect, result in 0.2 × 32 = 6.4 billion Euros spending.

- In total, the 6.5 billion Euros FP7 spending generate an effective spending of 16.1 billion, representing an average leverage of 1.48.

We conducted a simulation for the 6.5 billion of FP spending in 2010 using this leverage. We did not take into account the change in charges schedule arising from the EIB loan. In other words, we have retained as immediate expense that part of R&D emerging from firms. This should have little effect in the short term and no long-term effect.

Table 4 : Effect of a one-off 6.5 billion Euros rise in FP in 2010, cumulative effects

		2010	2020	2025
Former leverage	GDP (billion €)	6	45	63
	Employment (thousand)	165	191	276
New leverage	GDP (billion €)	10	75	108
	Employment (thousand)	267	348	516

One can therefore reassess to 267.000 the number of jobs immediately created and to 516.000 men × years the cumulative employment in 2025.

10- Conclusion: and now?

We present in conclusion the different work perspectives that emerged during discussions with the Commissioner's Counsellor, with P. Vallette, D. Rossetti and L. Soete. The prospects are also based on L. Soete's and P. Vallette's notes and on all the discussions that took place during the Demeter mid-term review meeting.

Several points were considered:

- The demand driven innovation aspect. Even if it is present in the R&D decision and in innovation, it is still too schematic in the models. Such innovation accounting should be improved. An initial progress may be achieved by incorporating the results of research conducted by the DEMETER consortium on General Purpose Technologies, especially ICT.

- The issue of services should be examined more thoroughly, including all aspects related to internationalisation. All innovations related to ICT may enable these services to develop dramatically their internationalisation and therefore play a significant role on the trade balance and growth. The effectiveness of services in innovation will also have to be examined.

- The latter work should make it possible to give a better justified content or, conversely, to reject the result that we have found in current simulations, namely that it is advantageous to focus R & D consumption and services sectors rather than industries.

- Innovation is implicitly detailed in the variation of knowledge or R&D. It is thus, as a concept, a little too simplistic. How could we design a concept that would still be operational but that would broaden the scope of variables: intangible capital other than R&D and externalities, institutional data, etc?

These factors should lead to more or less important modifications of models and some will probably not be completed within the DEMETER project's timeframe, but what is important is to try, based on experts quantification, to start simulations before the completion of these studies on related economic policies. The simulations will focus in particular on issues related to the major challenges facing Europe by 2020.

References

Brécard D, Fougeyrollas A., Lemiale L., Le Mouël P, Zagamé P. (2004), *A 3 % R&D effort in Europe 2010 : an analysis of the consequences using the NEMESIS model*, Report for the European Commission, January 2004

Brécard D., Fougeyrollas A., Lemiale L., Le Mouël P, Zagamé P. (2006): *Macroeconomic consequences of European research policy: Prospects of the Nemesis model in the year 2030*, Research Policy 35 (2006) 910–924

Chevallier C., Fougeyrollas A., Lemiale L., Le Mouël P, Zagamé P (2006): *A time to sow, a time to reap for the European countries: a macro-econometric glance at the RTD national action plans*, Revue de l'OFCE, June 2006

Delanghe H. and Muldur U. (2007), Ex-ante impact assessment of research programmes: the experience of the European Union's 7th Framework Programme, Science and Public Policy, Volume 34, Number 3, April 2007, pp. 169-183(15)

Fougeyrollas A ; Le Mouël P. et Zagamé P. (2010), *Conséquences sur l'économie et l'emploi Européens du budget 2010 du FP7*, projet DEMETER, juillet 2010.

Fougeyrollas A., Haddad P., Le Hir B., Le Mouël P. and Zagamé P., *R&D effort during the crisis and beyond: some insights provided by the NEMESIS model*, DEMETER project – simulations.– 20/05/2010.

Gelauff, George and Lejour, Arjan (2006): *The new Lisbon Strategy: An estimation of the impact of reaching 5 Lisbon targets.* Published in: Industrial Policy and Economic Reform Papers 1 (2006)

Johnson, D.K.N. (2002), *The OECD Technology Concordance (OTC): Patents by Industry of Manufacture and Sector of Use*. Organisation for Economics Cooperation and Development, Directorate of Science, Technology and Industry Working Paper 2002/5.

Soete L. (2010), The costs of a non-innovative Europe: The challenge ahead, DEMETER project, Sept. 2010.

Executive summary

- The use of detailed econometric model NEMESIS for 27 European Countries, USA and JAPAN and of small scale models for rest of world, incorporating endogenous technical change and knowledge spillovers allows quantitative assessment of R&D and innovation policies in a coherent framework.

- Results are open to discussion but many of them seem robust with time and when compared to competing assessments with other models. The 3% R&D effort objective and some other assessments (Framework Programme, national action plans, etc.) show similarly two phases:
    - A maturation phase made by R&D efforts without any supply effect due to a maturation period for R&D: it is a deficit phase with inflationary pressure.
    - An innovation phase with a takeoff for GDP and decrease for employment driven by innovation efforts: internal demand, competitiveness.

- Simulation of the crisis by NEMESIS shows a lasting crisis partly due to R&D drop: the GDP gap of 8.7% lasts after 2011 and increases even more after 2020. The employment gap is about 3%.

- An active R&D and innovation policy that would increase R&D efforts steadily up to 3% of GDP in 2020 could fill the employment gap as early as 2015 and reduce almost half of the GDP gap in 2025.

- Crisis reduces the opportunity costs of R&D policies: unemployment and underutilization of capacities lowers inflationary pressures and deficits during the first phase. Then, the innovation takeoff phase is more driven by exports than without crisis: in total, with a new 3% R&D effort for 2020 more than 3.7 million jobs are created in 2025.

- The 6.5 billion Euros decided in 2010 for the FP7 will allow an immediate creation of 165.000 jobs and at least a total of 275.000 job x years until 2025, including 160.000 unskilled workers. Moreover, this initial spending will create cumulatively more than 60 billion Euros on the same period. All theses results are based on a weak crowding effect that turn the 6.5 billion Euros expense into 10 billion Euros effective R&D spending.

- The value-added is more important. 80 billion Euros and more jobs created (437.000) if R&D is concentrated on low intensity R&D sectors and mainly services. It is to a certain extent a remedy to the low productivity of services disease in Europe.

- The simulations show the importance of international and intersectoral knowledge spillovers. They are responsible for 2/3 of the value creation. One third of the two thirds ($2/9^{th}$) is due to international spillovers and two third ($4/9^{th}$) is due to intersectoral knowledge spillovers. These results, important for the implementation of R&D policies, induce new research on knowledge spillovers.

- The Risk Sharing Finance Facility (RSFF) increases the leverage effect of FP. So, for the 2010 6.5 billions Euros spending, more than 100 billion Euros cumulative value-added is generated in 2025 and more than 500.000 job x years are created.