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Evaluation Models and Tools for Assessment of Innovation and Sustainable Development at the EU level

MODELLING ICT AS A GENERAL PURPOSE TECHNOLOGY

EXECUTIVE SUMMARY
Of the Final Report

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Executive Summary[1]

Introduction and Scope of the Study

The aim of the present study is to review the existing models focussing on the relationship between ICT investment, technological innovation and diffusion and European performance in terms of growth, employment and social inclusion. To assess the usefulness for impact analyses we focus on both the economic content (richness and detail of relationships and feedback mechanisms included in the models) as well as the methodological aspects.

The main objectives of the study are:

- To identify models and tools that could satisfy the increasing requirements for evidence based impact assessment and evaluation of policies and programmes;
- To assess their availability and capabilities for quantitative evaluation of the impact of IST research and investment in terms of growth, competitiveness, jobs and social inclusion;
- To identify one or two models and tools which could best meet the requirements of DG Information Society;
- To identify which further developments and improvements of these models and tools are needed in terms of modelling and tooling capabilities and in terms of better satisfying innovation policy aims and design;
- To offer a preliminary assessment of the effectiveness of policy action to support ICT adoption and to assess its impact on EU performance;
- To identify the needs for ICT data and for appropriate systems of ICT indicators and suggest improvements where necessary.

[1] This executive summary presents the main results of a study, *Evaluation Models and Tools for Assessment of Innovation and Sustainable Development at the EU level*, a service contract between the European Commission and the College of Europe, Development Office (Contract n°: 30-CE-0039057/00-28). The study was conducted between December 2005 and October 2006 by a team of experts including: Paolo Guerrieri (Director), Sara Bentivegna, Giuseppe Espa, Cecilia Jona, Giovanna Jona, Matteo Luciani, Bernardo Maggi, Valentina Meliciani and Pier Carlo Padoan. The Final Report presents all findings in their technical details and provides an in-depth overview of the methodology, policy simulations, the underlying theoretical framework, and literature references. The Report (200p) as well as the Final Report Paper will be made available at the College of Europe website: www.coleurope.eu/research/modellingICT.

Main Findings on the Modelling of ICT

The research has confirmed that ICT is rightly considered a general purpose technology (GPT) and that its modelling involves a high degree of complexity. GPTs are radical new ideas or techniques that have the potential to have important impacts on many industries in an economy. The recent ICT "revolution" can be seen as one such GPT, since today, computers and related equipment are used in most sectors of the economy.

Factors determining ICT investment and diffusion are numerous; the regulatory and business environment (the so called "facilitating factors") are of crucial importance. It is very difficult however, to include them into a framework for quantitative analysis.

Summing up the main findings of this study in relation to its initial main objectives, one could emphasise the following:

In terms of models and data that could satisfy the increasing requirements for evidence based impact assessment and evaluation of ICT policies and programmes…

- The comparison and evaluation of a set of existing Computable General Equilibrium models has shown that the International Futures (IFs) is particularly adequate to perform simulation exercises, since it includes a specific ICT sector and it allows ICT to exert its impact on the economy via different channels, rather than being modelled as a simple input in a standard production function.
- A complementary approach to modelling the impact of ICT is offered, based on simulations carried out with SETI, a small multi-country structural model, which allows considering ICT as an endogenous variable. It also permits the modelling of interaction between ICT, the structure of the economy, and a number of facilitating factors.
- Several results, including from a number of policy simulations, confirm that these two classes of models (CGE and small structural models) should be seen and could be used as complementary tools in evaluating the impact of ICT.
- Concerning data and indicators, a first conclusion is that information on ICT is still sparse and of low quality in statistical terms. The study considered three databases and identified a core data set that has been obtained as a combination of two data sources (GGDC and STAN OECD) with some overlap. From a sectoral point of view, the GGDC data provide a better coverage than the OECD, whereas for cross-country analysis one should refer to EUROSTAT data.
- A composite indicator to monitor technological diffusion has been presented in the study. This *Technological Development Index* (TDI) jointly captures changes in technological expenditures (as proxied by IT and R&D expenditures), workers' skills and product market regulation. The proposed index can be a very flexible tool for policy makers to monitor technological development and state across countries.

In terms of quantitative evaluation of the impact of ICT research and investment as to growth, competitiveness and social inclusion…

- Modelling the ICT impact on performance, using the IFs and SETI models has emphasised the importance of indirect spillover effects of ICT as a GPT, which resulted to be more pronounced than direct effects. A series of policy simulations has been carried out and concentrated on three elements: i) the relationship between ICT and specific technology accumulation, ii) the relationship between ICT and the structure of the economy, iii) the relationship between ICT and the "facilitating structure".
- The relationship between ICT and specific technology accumulation. One central feature of a GPT such as ICT, is that its impact on productivity and therefore performance is mostly "indirect" rather than direct. More specifically, ICT increases the productivity of direct knowledge accumulation (e.g. investment in R&D), which would otherwise exhibit decreasing returns.
- The relationship between ICT and the structure of the economy is crucial to understand the channels through which such an indirect effect takes place, as well as how strong such an impact will be. As the use of ICT takes different intensities according to the sectors in which it is applied, a given increase in ICT investment will generate a different impact according to the countries' production structure.
- The relationship between ICT and the facilitating structure is very important in understanding the extent to which the economic system is prepared to receive and use a GPT, such as ICT. Precisely because of its nature, ICT introduction requires not only a specific investment in ICT equipment, but even more importantly, a number of facilitating factors (i.e. business environment) that generate the appropriate context for ICT adoption.
- As to the issue of e-and social-Inclusion, a multi-focus approach is suggested in this study that is multi-perspective, multi-methodological, and multi-dimensional. With regard to the multi-dimensional approach the uneven availability of some data limited the field in which indicators may be identified to the dimensions of access to ICT and quality of life, while reference to the dimension of empowerment remained at a purely theoretical level. The construction of the Indices for the two first dimensions results from the selection of indicators to which a specific weight is attributed. The adoption of the Indices thus constructed, enables possible differences within the single dimensions to be identified, but at the same time it accounts for the general evolution of e-Inclusion in Europe. It is therefore, a versatile and practical tool suited to the cognitive and interventional needs of policy-makers.

Implications of Simulation Analysis

Available modelling tools need to be further elaborated as indicated above to fully take the implications of modelling ICT as a GPT into account. However, one of the main results of this study is that, in the short to medium term, existing modelling tools can be adapted to perform simulation analysis, leading to useful insights for the policy debate.

Simulations with the CGE lead to reasonable and expected results, namely:

- a more productive capital factor in the ICT sector increases GDP, but only in the very long run;
- a more rapid rate of adoption and diffusion of ICT in the service sector leads to a different, but rising trend-cycle profile of productivity growth rate (MFP);
- an increase in the percentage of networked persons in the economic system (a proxy for ICT adoption rate) leads to a positive impact on GDP;
- finally, the increase in the productivity (MFP) of the ICT sector for the system leader (The United States) has a positive effect on GDP of other countries through international diffusion

Results with the SETI structural model confirm that:

- services are a powerful driver of growth and that deeper integration in the European market for producers of services does significantly contribute to growth;
- technology accumulation is enhanced especially by human capital accumulation also because it allows to exploit the benefits of knowledge diffusion across countries

To sum up, ICT investment can be boosted by a number of policy strategies such as:

- more investment in human capital
- lower start up costs for business and lower barriers to labour mobility
- more investment in R&D

Recommendations for further Improvements in Modelling ICT

- There is a need of further refinement of Ifs and/or other CGE models when it comes to modelling the impact of ICT on economic performance so as to introduce an explicit treatment of the role of ICT. To move forward it is necessary to capture the interactions between ICT, the complex transmission mechanism, (including the interaction with organisational and structural variables) and performance.

- Modified CGE models can produce useful simulations but such an approach can not fully take the impact of ICT into account. As discussed in the study one should also consider other models that are small and flexible enough to provide additional information on the transmission mechanism of ICT (i.e. the relationship between ICT and the structure of the economy). A first appreciation of such effects would require a model in which ICT is made endogenous through a simultaneous estimation of the equations.

- We propose an enlarged SETI version for carrying out such policy simulations to further analyse the characteristics of ICT as a GPT. Nevertheless other structural models could be proposed as well to this purpose. We reiterate that results from the study confirm that these two classes of models (CGE and small structural models) should be seen as complementary tools in evaluating the impact of ICT.

- The study assesses to what extent data issues and appropriate systems of indicators put limitations to the modelling of ICT and economic performance and on this point, it formulates directions for improvement. Part of the discussion is based on the claim that ICTs produce benefits that go beyond those pertaining to investors and owners. To assess these effects new proxy variables are required; in particular with relation to the e-inclusion area and its multidimensional nature (access to ICT; quality of life; empowerment). In this area new proxies and indicators are needed and they should be inserted and verified in the quantitative models mentioned above.