DEEPENING THE LISBON AGENDA:
Studies on Productivity, Services and Technologies

LISSABON VERTIEFEN:
Studien zu Produktivität, Dienstleistungen und Technologien

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LIST OF CONTENTS

CONTENTS

VORWORT

Dr. Martin BARTENSTEIN
Bundesminister für Wirtschaft und Arbeit

Europa braucht mehr Wachstum

Die Europäische Wirtschaft muss wieder schneller wachsen. Während die USA und Asien hohe Wachstumsraten verzeichnen, kommt die europäische Konjunktur nicht richtig in Schwung. Deshalb hat der Europäische Rat im Juni 2005 einen Neustart der Lissabon-Strategie mit Fokus auf Wachstum und Beschäftigung beschlossen. Die Aufgabe der Österreichischen EU-Präsidentschaft ist es nun, die seither entwickelten Strategien und Maßnahmenpakete der Mitgliedsstaaten zu bewerten und die richtigen Schlüsse daraus zu ziehen.

Das Bundesministerium für Wirtschaft und Arbeit hat in diesem Zusammenhang eine ganze Reihe von Initiativen als inhaltliche Vorbereitung auf die EU-Präsidentschaft gesetzt, die ihren Teil zum gelungenen Neustart des Lissabon-Prozesses beitragen sollen. Eine dieser Initiativen ist der „**Wirtschaftspolitische Expertenkreis**“, der sich aus international anerkannten Wirtschaftswissenschaftern und hochrangigen wirtschaftspolitischen Experten in Führungspositionen der österreichischen und europäischen Verwaltung zusammensetzt. Seit November 2004 hat dieser Expertenkreis eine grundsätzliche Diskussion hinsichtlich möglicher Schwerpunkte einer wirtschaftspolitischen Strategie in Europa geführt - losgelöst von den tagespolitischen Entscheidungsprozessen aber doch mit Anknüpfungspunkten an die Lissabon-Strategie und ihre Neu-Fokussierung auf Wachstum und Beschäftigung.

Die Bestandsaufnahme der Experten zeichnet ein nüchternes Bild der gegenwärtigen Situation der EU vor allem im Vergleich mit den USA: Die EU hinkt in Bezug auf Produktivität und Wirtschaftswachstum hinterher, die Intensität der Nutzung von Informations- und Kommunikationstechnologien ist in den USA weiter vorangeschritten, der amerikanische

Dienstleistungssektor funktioniert besser und die Entwicklung im Bereich Forschung und Entwicklung geht in den USA schneller voran als in Europa.

Dennoch weisen die USA keine generelle Überlegenheit in Sachen Wettbewerbsfähigkeit auf. In einigen Mitgliedstaaten beziehungsweise in einigen Sektoren ist die Performance der EU besser als jene der USA. Das Lissabon-Ziel, also das Ziel die EU bis 2010 zum wettbewerbsfähigsten Wirtschaftsraum der Welt zu machen, ist daher nicht gänzlich außer Reichweite gerückt. Es zu erreichen ist allerdings nur mit einem gesamteuropäischen Kraftakt möglich. Dabei muss vor allem eines passieren: die konsequente Fokussierung auf Wachstumspolitik und die daraus abgeleitet konsequente Umsetzung der im Rahmen des Lissabon-Prozesses erarbeiteten Maßnahmenpakete.

Um diese Fokussierung weiter voranzutreiben, hat der Expertenkreis wirtschaftswissenschaftliche Studien zum *europäischen Binnenmarkt im Bereich Dienstleistungen*, zu zukunftsweisenden *Technologiefeldern und deren Auswirkungen auf Wachstum und Beschäftigung* sowie zur *Rolle der Informations- und Kommunikationstechnologien für den Dienstleistungssektor* in Auftrag gegeben.

Diese nun vorliegenden Studien haben inhaltlich einen starken Konnex zu den Agenden des Wettbewerbsfähigkeitsrates unter österreichischer Präsidentschaft. Denn dort stehen inhaltliche Entscheidungen und Weichenstellungen an, etwa beim Programm für Wettbewerbsfähigkeit und Innovation, der Dienstleistungsrichtlinie und dem Siebten Forschungsrahmenprogramm der EU.

Die Ergebnisse der Studien, die wichtige Erkenntnisse für anstehende Entscheidungen und Weichenstellungen im Rahmen der österreichischen EU-Präsidentschaft liefern, sind in dieser Publikation zusammengefasst.

PREFACE

Martin BARTENSTEIN
Federal Minister of Economics and Labour

Europe needs more growth

The European economy has to grow faster again. While the USA and Asia register high growth rates, the European economy does not really pick up. For this reason, the European Council decided in June 2005 to re-launch the Lisbon Strategy with a stronger focus on growth and jobs. The Austrian EU Presidency now has the task to evaluate the strategies and packages of measures developed since then by the Member States and to draw the right conclusions.

In this context, the Federal Ministry of Economics and Labour took a series of initiatives in preparation of the EU Presidency that are to contribute to the successful re-launch of the Lisbon process. One of these initiatives is the **High-Level Group of Experts on Economic Policy** made up of internationally renowned economists and leading economic-policy experts active in senior positions of the Austrian and European administration. Since November 2004, this Expert Group has engaged in a basic discussion on possible priorities of an economic policy strategy in Europe — independent of day-to-day decision-making processes, but with links to the Lisbon Strategy and its re-focusing on growth and jobs.

In their analysis of the status quo, the experts paint a sobering picture of the EU's present situation, especially in comparison with the USA: The EU lags behind with regard to productivity and economic growth, information and communication technologies are used more intensively in the USA, the US service sector functions better and the USA makes faster progress in research and development than Europe.

Nevertheless, the USA is not generally superior to Europe when it comes to competitiveness. In some Member States and in some sectors, the EU outperforms the USA. The Lisbon objective, i.e. making the EU the most competitive economy of the world by 2010, therefore, is not completely out of reach. However, it can only be achieved if all the European partners join forces. Above all, there is one requirement that has to be met: a determined focus on growth policy and, related thereto, the consistent implementation of the packages of measures developed under the Lisbon process.

To reinforce this focus, the Expert Group commissioned scientific studies on the *European internal services market*, on future-oriented *technology fields and their effects on growth and jobs* as well as on the *role of information and communication technologies in the service sector*.

These studies and their contents are closely related to the agenda of the Competitiveness Council under the Austrian Presidency. After all, this Council will have to take important decisions and make basic choices, for example, with regard to the Competitiveness and Innovation Programme, the Services Directive and the EU's Seventh Framework Programme for Research and Technological Development.

The results of the studies that include significant findings supporting forthcoming decisions to be taken under the Austrian EU Presidency are summarised in this publication.

VORWORT

Günter VERHEUGEN
Vizepräsident der Europäischen Kommission

Vor dem Hintergrund voranschreitender Globalisierung, demographischer Veränderungen und rasantem technologischen Fortschritt sind der Erhalt und die weitere Stärkung der europäischen Wettbewerbsfähigkeit der Schlüssel für den Fortbestand der europäischen Lebensqualität. **Wettbewerbsfähigkeit** und die **europäische Lebensqualität** sind also kein Gegensatzpaar, sondern vielmehr sich wechselseitig verstärkende Elemente. Diese Feststellung ist die entscheidende Grundlage der reformierten Lissabon-Strategie, der so genannten Partnerschaft für Wachstum und Beschäftigung. Im Frühjahr 2005 hat die EU einstimmig eine verstärkte Fokussierung auf Wachstum und Beschäftigung beschlossen, ohne dabei soziale und ökologische Nachhaltigkeit aus dem Blick zu verlieren.

Die treibenden Kräfte der neuen Partnerschaft für Wachstum und Beschäftigung sind **strukturpolitische Reformen** zur Stärkung des Wachstums bzw. Wachstumspotentials durch Förderung von Wissen und Innovation sowie durch eine Steigerung der Attraktivität der europäischen Standorte für Investoren und Arbeitskräfte. Es gibt nunmehr eine klare Arbeitsteilung zwischen EU und Mitgliedstaaten. Die strukturpolitischen Reformmaßnahmen sollen dabei **partnerschaftlich** von den Mitgliedstaaten und der Europäischen Union initiiert und vor allem umgesetzt werden. In den **Nationalen Reformprogrammen** werden auf die besonderen Gegebenheiten abgestimmte wachstums- und beschäftigungsfördernde Maßnahmen festgehalten. Begleitet und ergänzt werden die Nationalen Reformprogramme durch das Lissabon-**Gemeinschaftsprogramm**. Durch diese partnerschaftliche Vorgehensweise sollen jene Synergien genutzt werden, die durch isolierte, einzelstaatliche Maßnahmenkonzeption nicht erzielt werden könnten.

Es freut mich, dass Österreich die EU-Ratspräsidentschaft zum Anlass genommen hat, um auf Grundlage der Diskussionsbeiträge und Perspektiven eines internationalen Kreises wirtschaftspolitischer Experten, darunter auch führende Mitarbeiter der Europäischen Kommission, jene Bereiche herauszufiltern, die ein besonderes Potential zur Erhöhung von Wachstum und Beschäftigung aufweisen, und die deshalb in tiefer gehenden Studien und Diskussionen analysiert wurden. Die Ergebnisse dieser Arbeiten stellen einen wertvollen Input für die derzeitige europäische Diskussion dar. Sie zeigen einerseits mögliche zukünftige Potentiale für Wachstumssteigerung und Beschäftigungserhöhung auf, geben aber andererseits auch - und dies möchte ich hier besonders hervorstreichen - ein Beispiel für eine gelungene Zusammenarbeit zwischen der Ebene der EU und der Mitgliedstaaten.

Der **Rat für Wettbewerbsfähigkeit** nimmt in Bezug auf diese Bereiche eine zentrale Rolle ein, liegen doch die Agenden Binnenmarkt, Forschung und Industrie in seiner Kompetenz. Die vorliegenden wissenschaftlichen Arbeiten werden dazu beitragen, die Diskussionen in den nächsten Sitzungen des Wettbewerbsfähigkeitsrates inhaltlich zu stimulieren, sowohl bei der Vertiefung der allgemeinen wirtschaftspolitischen Diskussion über Produktivität, Wachstum und Beschäftigung, als auch aktuellen Fragen wie das *Siebte Forschungsrahmenprogramm*, das *Programm für Wettbewerbsfähigkeit und Innovation* oder die *Dienstleistungsrichtlinie.*

PREFACE

Günter VERHEUGEN
Vice-President of the European Commission

Against the backdrop of increasing globalisation, demographic change and rapid technological progress, maintaining and strengthening European competitiveness is key to securing the quality of life in Europe. **Competitiveness** and **European quality of life**, therefore, are not conflicting, but rather mutually reinforcing elements. That statement forms the essential basis of the reformed Lisbon Strategy, the so-called Partnership for Growth and Jobs. In spring 2005, the EU unanimously agreed on a stronger focus on growth and jobs without losing sight of social and ecological sustainability.

The driving forces of the new Partnership for Growth and Jobs are **structural reforms** aimed at strengthening growth and growth potentials by promoting knowledge and innovation and making Europe more attractive for investors and employees. There is now a clear division of labour between the EU und the Member States. In this context, the structural reform measures are to be initiated and, in particular, implemented in a **partnership** of the Member States and the European Union. The **national reform programmes** define measures promoting growth and jobs that are adapted to specific national conditions. They are supported and complemented by the Lisbon **Community Programme**. Through this partnership, synergies are to be exploited that could not be tapped by national measures designed by the individual Member States alone.

I am pleased that Austria, prompted by its Council Presidency, has taken the initiative and, on the basis of the discussions and perspectives outlined by an international group of economic-policy experts, including senior officials of the European Commission, started to identify those areas offering particular potential for raising growth and creating jobs. Those areas have been analysed by in-depth studies and discussions. The results of this work will form a valuable input for the ongoing European debate. The findings highlight future potentials for increasing growth and employment while — a fact that I wish to emphasise — this work also is an example of successful co-operation between the EU and the national level.

The **Competitiveness Council** plays a key role in these areas since it is responsible for the fields of internal market, research and industry. The scientific studies presented will contribute to stimulating discussions in the next meetings of the Competitiveness Council — not only deepening the general economic-policy debate on productivity, growth and jobs, but also with regard to current issues, such as the *Seventh Research Framework Programme*, the *Competitiveness and Innovation Programme* and the *Services Directive.*

HIGH-LEVEL GROUP OF EXPERTS ON ECONOMIC POLICY

In October 2004, the Austrian Ministry of Economics and Labour established a **High-Level Group of Experts on Economic Policy**. The aim of the High-Level Group has been to *identify and discuss economic policy challenges* for the European Union which are supposed to be included on the agenda of the 2006 Austrian Presidency. The Group was asked to provide *directions for scientific studies* covering specific aspects of these challenges; the results of these studies were planned to serve as an input for the preparations of the Competitiveness Council, and other events under the Austrian Presidency.

The **members** of the Group were invited with the intention to bring together the *expertise of decision makers* in politics and administration with the expertise of academic researchers on economic policy. The members of the Group are:

Jan-Host Schmidt	Director, Directorate "Economic Evaluation Services", DG Economic and Financial Affairs, European Commission
Gert-Jan Koopman	Director, Directorate "Industrial Policy and Economic Reforms", DG Enterprise, European Commission
Giuseppe Nicoletti	Head of the Structural Policy Analysis Division, OECD Economics Department
Daniel Gros	Director, Centre for European Policy Studies
Wilhelm Kohler	Professor, Chair in International Economics, Department of Economics, University of Tübingen
Karl Aiginger	Director, Austrian Institute of Economic Research
Bernhard Felderer	Director, Institute for Advanced Studies, Vienna
Fritz Breuss	Professor, Europainstitut, Vienna University of Economics and Business Administration
Christoph Weiss	Professor, Chair for Economic Policy and Industrial Economics, Dept. of Economics, University of Economics and Business Administration, Vienna
Wolfgang Polt	Director, Institute for Technology and Regional Policy, Joanneum Research, Vienna

Michael Losch, Stefan Buchinger, Michael Stern, Verena Farré Capdevila and Christian Hederer (all from the Ministry of Economics and Labour) as well as Christa Peutl (from the Austrian Federal Chancellery) formed the **preparatory body** for the discussions of the High-Level Group.

The Group held its first meeting chaired by Federal Minister Martin Bartenstein in November 2004. Based on the shared observation that the EU lags behind the USA both in terms of productivity development and economic growth, the discussion focussed on the Minister's opening question of which **strategies** would be most likely **to spur growth in the European Union**. Three interdependent fields were identified as pivotal for growth-promoting policies:

- productivity,
- research & innovation, and
- the services sector.

The Group agreed about the significance of *knowledge and innovation* for the enhancement of productivity, the importance of *improvements in regulatory designs*, especially in the services sector, and the extension of *R&D-promoting policies* at the EU level as well as in the context of national and regional programmes. The discussion also covered the relevance of labour market reform and the question of possible trade-offs between productivity gains and employment.

Based on this discussion, the Ministry launched several of smaller-scale *preparatory studies* to identify specific economic policy questions that fulfil the double criterion of high policy relevance and scientific interest, with the authors of the studies partly drawn from the Expert Group. The broad discussion of the results within the Ministry and a consultation of Expert Group members finally lead to the identification of the following main topics that form the thrust of this publication:

- Investigation of the **European services sector** in the context of the single market for services and the Lisbon Agenda, focussing on two major questions:
  - the role of *ICTs* in the services sector for employment, productivity, and growth;
  - macro-economic effects of the introduction of a *single market* for services;
- Effects of European **technology fields** on employment and growth.

In March 2005, three studies were commissioned in order to analyse these main topics in depth (the ICT study was commissioned by the Federal Chancellery, the other studies by the Federal Ministry of Economics and Labour). The Expert Group met again in July 2005 under the chair of Director General Michael Losch to discuss preliminary results and suggest directions for the further course of research. The studies were completed in November 2005 and will be presented to a wider audience and discussed with members of the Group in January 2006. The studies reflect the opinions of the authors and do not necessarily represent the position of the Austrian Ministry of Economics and Labour or the Austrian government. Nevertheless, they will form an important basis for the discussions during the Austrian EU Presidency.

INTRODUCTION: DEEPENING ECONOMIC ANALYSIS FOR A COMPETITIVE EUROPE

Michael Losch

This publication deals with key areas of structural reform. It builds on the common ground which has been developed through the Lisbon Strategy over the last years, in particular the Lisbon Midterm Review including the Wim Kok report and the broadly agreed outcome of a sharpened focus on jobs and growth in spring 2005. It tries to offer some added value by further developing economic analyses around several important areas of competitiveness and areas where growth and job creation are expected in the future.

Before outlining these key areas it seems, however, appropriate to address two essential framework conditions for structural reform and micro-economic analysis, namely the macro-economic context with some possible dilemmas and trade-offs, and the institutional context featuring a complex distribution of responsibility between the EU and the Member States. I would like to stress that the following is my personal view of priorities and not necessarily the official position of the EU Presidency.

The Macro-Economic Context of Globalisation

In the current economic situation, the biggest challenge for most EU Member States seems to be globalisation. Under global competitive pressure, many companies choose to outsource their production to regions where wages and resources are cheapest and to benefit from the growing demand in emerging economies. The free movement of capital and goods within the EU's internal market but also within the WTO framework should lead, according to economic theory, to overall benefits and to converging prices and wages amongst those states who participate in trade. However, as this transfer of production becomes less an intra-European phenomenon, but relates more and more to Asian countries like India and China, it is increasingly perceived as a threat to the European industrial base. Evidently, the theoretical point of equilibrium, where wages and working conditions in Asia and Europe converge, can be seen as a threat to the European social model. On the other hand, a defensive strategy simply aimed at preserving the status quo risks not to deliver the expected results. Maintaining rigidities in European labour markets may even aggravate the situation in the long term, as it might lead (1) to higher unemployment in production sectors facing global competition, (2) to a higher than optimal production shift to low-wage countries, and (3) to a less dynamic structural shift of employment from production to service sectors in Europe.

A recent working paper of the Economic Policy Committee[1] analyses the dynamics of globalisation and confirms that the main problem is not an overall reduction of employment through globalisation, but "whether EU labour markets allow for a swift adjustment of jobs and activities from contracting to expanding firms, as globalisation implies ongoing restructuring."

There is no simple remedy to this challenge, and citizens indeed seem to have lowered their expectations towards economic policy to deliver the jobs and the growth which are so desperately strived for. The result has been an increase in savings over the last years which in turn has been inhibiting economic uptake. This eventually contributes to scepticism and frustration with the political institutions, seen as being responsible for a complex set of economic policy measures which do not convincingly improve the economic situation.

Nonetheless, an offensive strategy will have to take up the global challenge, and will have to invest in structural reform in order to maintain Europe's competitiveness. Only competitive companies will create jobs in the future and will generate the resources allowing us to maintain the European social model. This insight is at the heart of the Lisbon Strategy - strengthened by the discussion about the European social model during the UK Presidency, which contributed to a better common understanding of the values and main elements of our European model. It is, finally, essential to know what to defend and what to strive for when it comes to structural reform goals or when it comes to defining a common trade policy.

There are some important issues arising from the challenge of globalisation that need to be taken into account when developing the right mix of structural reform measures for competitiveness, jobs and growth. They would, however, require a profound discussion in a macro-economic context, and are therefore just mentioned briefly:

- **The right priorities in a field of various economic goals.**
  The Lisbon Strategy calls for "jobs and growth" as top priorities. To my mind, from a social and ethical point of view, it could be argued that the job priority is even superior to growth and that the highest priority should be given to fighting unemployment, i.e. to ensuring that

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[1] Economic Policy Committee: Responding to the Challenges of Globalisation, Brussels, November 2005: For example, the stock of world-wide FDI rose from 8% in 1989 to 22.1% of GDP in 2003. Total outstanding foreign assets accounted for 62.6% of world-wide GDP in 1989 and reached 186.1% of GDP in 2003.

society offers opportunities for everybody who is willing to work. The next goal could be to raise employment to the 70% Lisbon target with a view to ensuring the sustainability of global competitiveness, public finances and, in particular, our pension schemes. In concrete numbers, raising the employment rate from currently 63.3% (EU-25 in 2004) to 70% by 2010 means that 23 million jobs are needed.[2] This compares to currently 20 million unemployed and another 13 million persons voluntarily out of work. Unfortunately, it is not evident that attaining the 70% employment level will give a concrete job to the currently unemployed. There is obviously a structural dilemma.

- **The right level of growth and the issue of quality of growth.**

  Looking closer at the concept of growth, one might find that growth is a driver for various other policy goals. A reasonable level of growth facilitates structural change and social redistribution. Many economists still see 3% as a target growth rate, which could create a dynamic rise in demand on the labour market. However, the appropriate level of growth depends on population growth, finite resources, and societal choices. Just as the recent debate about the productivity gap between the EU and the USA brought to light some interesting studies and articles[3] leading straight to the debate about social models and ways of life, similar qualitative questions could be asked in relation to GDP as a measure of economic prosperity. In an ongoing research project, Stefan Schleicher[4] is examining methods for deriving indicators from National Income Accounts that better reflect qualitative performance and welfare.

- **Is there a trade-off between productivity and employment?**

  The key driver of per-capita growth (i.e. growth independent of population growth) is labour productivity. There are two micro-economic scenarios: On the one hand, if labour productivity increases as a result of improving skills and technologies, the resulting competitive advantage of an enterprise may not only secure existing jobs but eventually create even more jobs as the successful company expands. On the other hand, if the increase of productivity merely results from producing the same output with less people, then there is a trade-off.

  There is obviously a macro-economic and a micro-economic view towards productivity. What works for one firm or one small exporting economy, might not hold for the entire European economy.

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2 Economic Policy Committee: Report on the Lisbon National Reform Programmes, 2005.

3 The Economist, 19 June 2004, p.75, and 6 November 2004, p. 83; Banque de France Bulletin Digest Nos 121 and 123, January and March 2004: The study shows that although per-capita labour productivity is significantly lower in the EU, labour productivity per hour worked is higher, e.g. in NL and F, than in the USA. Another interesting econometric finding is that elasticity of productivity per hour is -0.35 relative to hours worked and -0.5 relative to the employment rate.

4 Stefan P. Schleicher: Measuring economic performance and economic well-being based on National Income Accounts, University of Graz, 2005.

Key questions analysed in the studies presented in this publication are whether a positive or a negative employment effect of productivity-stimulating measures will finally prevail and how productivity can be concretely explained on the micro-economic level.

- **A fair account for winners and losers from globalisation and appropriate income distribution policies.**

  An interesting contribution comes from Hans-Werner Sinn[5]. He analyses that there is a dilemma as mostly capital and company owners profit from globalisation while Member States have little margin to impose adequate taxation in order to finance redistribution towards losers from globalisation. He consequently suggests that more employees should have the possibility to participate in capital return. Economic policy could significantly stimulate employee stock ownership plans. Such a strategy would help to increase the number of winners from globalisation.

The Complex Distribution of Competence

Economic policy on the whole is not a common EU policy in the legal sense of the EC Treaty. There are, however, some major areas covered by Community policies or already harmonised to a high degree. An attempt to rank economic policy areas from EU-level to national competence could look as follows:

- **Monetary policy** for the 12 "euroland" Member States clearly is a common competence. Moreover, the high degree of independence of the ECB can be seen as a guarantee for a policy pursuing the common interest.
- **Competition policy** is, except for areas below the thresholds for national antitrust jurisdiction, a clear-cut Community competence with clear rules being applied by the Commission.
- **Trade policy** should also be a clear common policy, but is subject to a co-operation mechanism involving the Member States at the Council level.
- **Internal market** and the four freedoms, on principle, constitute a highly common set of rules. In practice, however, it is often unclear how far the internal market principles apply if they are in conflict with national safeguard legislation relating to environment, health, social or consumer affairs, just to name a few. The debate on the Services Directive illustrates this problem.
- **Industry policy, research and technology** are mainly areas of national competence with specific exceptions, such as Galileo or the Research Framework Programme. The

[5] Hans-Werner Sinn: Das Dilemma der Globalisierung, Walter Adolf Jöhr-Vorlesung an der Universität St. Gallen, August 2004.

national policies are also subject to the strict rules of state aid policy, which is a clear Community competence executed by the Commission as a part of competition policy.

- **Fiscal policy** is mainly a national competence although some degree of harmonisation based on unanimous Council decisions has been achieved, e.g. in the area of indirect taxation. Moreover, the Maastricht criteria and the Stability and Growth Pact created a common framework for national budget policy.
- **Labour market policy** remains mainly a national domain, with exceptions in labour protection legislation.
- **Social redistribution** is a fully national competence with the exception of measures financed by European cohesion and social funds.

Given this mix of competence patterns, is it not already a success that there is a common Lisbon Strategy? Indeed, the Lisbon process tries to offer a framework for co-ordination, nearly irrespective of the actual legal competence. The downside is that there is an implementation gap between the strategic goals identified and concrete measures on the ground. It is not always clearly communicated that so far, most policy instruments and, in particular, the budgetary funding of the measures relevant for the Lisbon Strategy are responsibilities of the Member States. Let us take the famous 3% GDP target for R&D expenditure as an example. There are indeed instruments at the EU level, such as the Research Framework Programme or the Competitiveness and Innovation Programme (CIP). However, the overall funding of these EU measures is well below 0.1% of GDP. It is thus evident that 95% of the measures to achieve the Lisbon target defined for public R&D spending (1/3 of 3%) must be financed by the national level. This is no surprise as the total EU budget is only around 1% of GDP, whereas Member States' budgets are usually around 45% of GDP.

In a nutshell, in order to become a long-term success story, the Lisbon Strategy must clearly identify who is responsible for what, and at the same time offer a method for co-ordinating national measures with those taken at the EU level.

Priorities of Structural Reform and Areas of Deeper Analysis

There are several similar lists of priority areas for structural reform wherever you look in the context of the Lisbon debate. Nevertheless, there seems to be not only a convergence of opinions on key areas, but also a certain development of focus within the analysis of those key areas:

- R&D with a recently increasing focus on the concept of innovation. This corresponds to the need to translate research into concrete applications and successes in the markets.
- Labour market reform with a growing interest in the concept of “flexicurity”. A high level of social security is not in conflict with, but rather can be a stimulating factor for, more flexibility.
- A regulatory framework which realises that it needs to focus on the backbone of the European economy - the small and medium-sized enterprises (SMEs). This requires a well-functioning internal market, less bureaucracy, but also that SME needs are taken into account in various areas ranging from financial market regulation (Basel II), intellectual property rights (software patent), state aid regulations (de minimis rules) to R&D programmes which need to be accessible to SMEs.

It is not the intention of this publication to cover all aspects of the Lisbon priorities. The idea is rather to contribute to a better understanding of a few selected topics which, however, are relevant to the programmes and legislative initiatives currently on the agenda.

The first study (Institute for Advanced Studies, Vienna; Felderer, Graf, Paterson, Polasek, Schwarzbauer, Schuh, Sellner) concentrates on the basis of growth. It tries to improve our understanding of the reasons why labour productivity in Europe is lagging behind the USA. It deals with the micro-economic factors behind productivity in very concrete areas. Based on the discussion in the High-Level Expert Group, the services sector was chosen as the focus of the analysis, and specific attention was given to the role of information and communication technologies (ICTs) as potential drivers of higher productivity. The study also tries to analyse the above-mentioned question of whether there is a trade-off between productivity and employment. The findings do not suggest that there is a significant trade-off and thus, support the position that productivity gains can strengthen competitiveness without negatively affecting and maybe, in the long term, even positively influencing employment.

Another interesting result shows that there are time lags between ICT investment and productivity. The effect of ICT investments on productivity is largely comparable between the EU and the USA in the year of investment. However, one year after investments are made, the productivity effects are markedly stronger in the USA, pointing towards higher efficiency of ICT use in the USA. In other words, there are rigidities in EU companies which inhibit the optimal use of ICT investments.

The second study (Europainstitut, Vienna University of Economics and Business Administration; Breuss, Badinger) looks closer at the internal market for services, which from a regulatory perspective, constitutes largely unfinished business. The Services Directive proposed by the European Commission sparked a very controversial debate. One dimension of this discussion relates to the scope of application of the Directive and the scope of the country of origin principle. Another dimension is the importance of the Directive's economic effects. The most prominent study so far was carried out by Copenhagen Economics. The study of Breuss and Badinger, although using a different method, largely confirms the positive effects on employment and growth. Using a modular approach, the study also makes it possible to estimate the effect of including or excluding certain sectors from the scope of the Directive.

The third study (Institute for Industrial Research, Vienna; Luptacik, Koller, Mahlberg, Schneider) started from the debate about the role of the European research and technology policy in the context of cluster strategies. The importance of clusters as a dynamic and critical mass for innovation has been well known since the works of Michael Porter. The relationship of a certain technology to upstream, downstream and complementary products, technologies and services plays a fundamental role for the dynamics of innovation. A successful cluster strategy may create the new jobs necessary to replace those which are lost through structural change in global competition. The key question is whether it makes sense, at EU level, to identify concrete economic sectors or technology fields with a high growth and employment potential. The preparatory work of the Commission for the 7th Research Framework Programme initiated the establishment of about 30 so-called technology platforms bringing together interested companies from selected technology sectors. The Commission consequently narrowed down its selection to five or six so-called Joint Technology Initiatives. These Joint Technology Initiative sectors were the concrete starting point for this IWI research project. The study tries to evaluate the growth and employment effects of seven technology fields (innovative medicine, nanoelectronics, embedded systems, aeronautics and air traffic management, hydrogen and fuel cells, photovoltaics, food for life), using various techniques of input-output analysis in an innovative and novel approach. It will possibly deliver useful information for the further work on implementing the 7th Framework Programme.

Vienna, December 2005

THE EUROPEAN SERVICES MARKET IN THE CONTEXT OF THE LISBON AGENDA

Productivity and Employment in European Services with High Intensity of Information and Communications Technology (ICT)

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1. Introduction

The main report[6] of the current study presents a detailed analysis of productivity growth in EU service sectors. Other recent studies have drawn attention to the higher growth rates in the USA than in the EU since the mid-1990s, particularly in industries that produce information and communications technologies (ICTs) or that make intensive use of ICTs.

The favourable upswing in US productivity coinciding with the “dotcom boom” has been widely reported and commented. Despite some notable successes, the development of productivity growth in the EU’s economy is downward, reversing the trend of some forty years standing. Productivity growth has been concentrated in ICT-producing manufacturing industries and in ICT-producing and using (“ICT-intensive”) services, not only in the USA but also in Europe, albeit at lower levels. Services, in general, account for the largest part of the economy. For these reasons, the study focuses on the development of service industries in the EU, and particularly on ICT-intensive services, with the outstanding US performance being drawn upon as a benchmark and as a source from which lessons may be learned in many cases.

Topics covered in the study include elucidating causes for the delayed deployment of ICT in Europe compared to the US since the 1990s and the lower growth in productivity in the EU. The expected effects of further liberalisation in the internal services market is assessed. Case evidence from US and European ICT-intensive services is drawn upon to gain an understanding of productivity growth successes. Regional differences in productivity and employment in ICT-intensive branches are highlighted and possible trade-offs between productivity increases and employment are investigated. Other factors that may influence the development of labour productivity in ICT-intensive service sectors are considered in the light of the findings.

The main report is organised into nine sections, corresponding to a list of interrelated questions and/or hypotheses that the study addresses. These topics, and the corresponding section numbers in the report are:

[6] N.B. Citations of authors made in this executive summary may be cross-referenced in the References section of the main report.

1. *ICT investment in the European services sector*. Examination of the extent and causes of a delayed ICT deployment in Europe. Assessment of the role of factors affecting competition in markets such as product market regulation, human capital, etc.
2. *Factors influencing growth in services*, especially that of the US ICT-intensive service sector in the 1990s. The role of ICT investment, demand cycles and other factors.
3. Time lags of ICT investment and effects on productivity. How likely is a “catching-up” process in Europe?
4. *Completion of the Single Market for services in the European Union*. To what extent are associated benefits for the economy likely to be gained in service industries?
5. *Top performers and the related business environment*. Identifying productivity growth performance by country/service industry. Which patterns emerge? The wider implications drawn from particular case studies. [7]
6. *Regional variations in EU and US ICT-intensive services*. Is the distribution of productivity throughout the EU different from that in US regions? Can this be a factor in explaining productivity growth differentials?
7. *Productivity-related issues*. Is productivity growth in ICT-intensive services sometimes achieved at the expense of service quality? Discussion of measurement issues.
8. *Trade-off effects between employment and productivity*. How likely is the joint achievement of the goals of productivity and employment growth, in particular with a view to the US experience in the service sector?
9. *Other factors influencing labour productivity*. A review of trade openness and market size, innovation, size of enterprises, infrastructure, product market regulation, liberalisation and privatisation, labour market regulations, patent legislation and other critical perspectives.

[7] Detailed labour productivity growth rates for individual service industries in single EU Member States, and their development over the period 1980 to 2002 is presented in the appendix of the main report.

2. Facts and Trends in Productivity Development

The service sector of the EU economy accounts for roughly 70 percent of GDP in the EU and its Member States and for a similar proportion of total employment. In this study, we confine our attention to market services, i.e. private-sector service industries, and exclude education, health services, government services and defence, etc., from our analysis.

Market services account for more than two-thirds of all services by value added and 58 percent of all services employment in EU-15. Even without the more labour intensive public services, market services alone account for nearly half (48.1 percent) of EU-15 GDP in 2002, and 41.1 percent of employment.

Market services, thus, form an important part of the economy of the EU. Like in all developed economies, the service sector, in general, and market services, in particular, have continually grown over recent decades and this restructuring process is still going on against the backdrop of the increased role of manufacturing for a global market in developing countries.

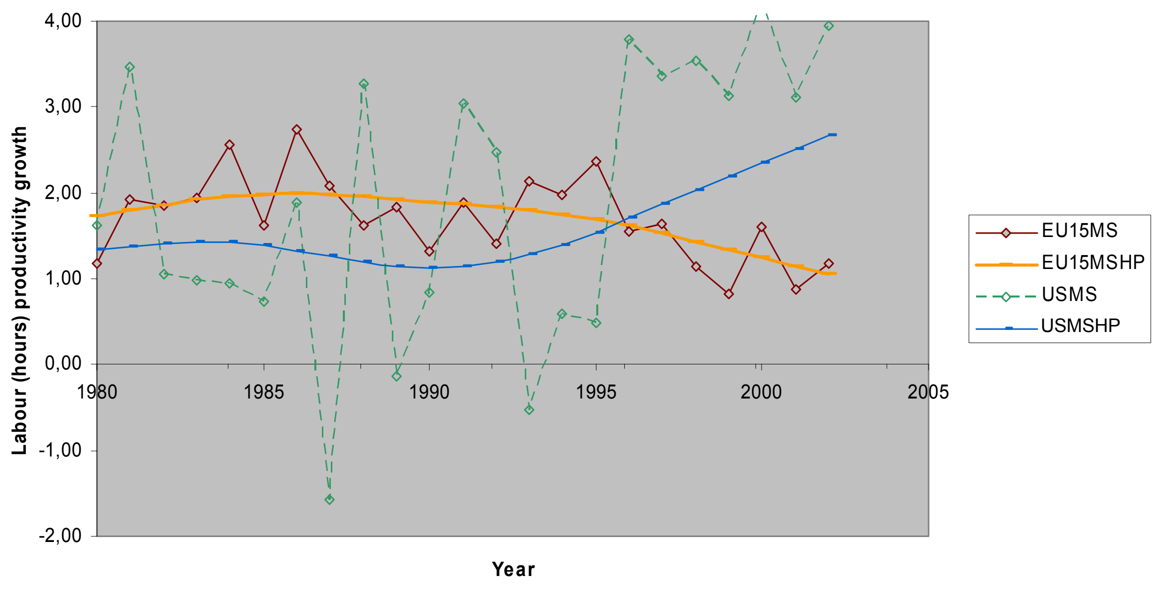
The Contribution of Market Services to Productivity

Since the end of the Second World War, Europe was engaged in a "catching-up" process driven by higher productivity growth rates than in the US economy. This long-term trend has now apparently gone into reverse. The trend productivity growth for the EU and the USA is mirrored in the development of market services. The labour productivity growth of market services is charted for EU-15 and the USA for 1980-2002. Both the year-on-year growth rate data and the trend line[8] – represented by the smooth curve – are shown.

A "structural" break in productivity growth is often dated around 1995-1996. Arguably, the trend reversal had already begun in the early 1990s. Productivity growth stayed higher in the EU until the high US growth resulted in a higher absolute growth rate trend than in the EU around 1998. Of particular note is the "double-trend": a move to high US growth rates and a simultaneous decline of growth rates in the EU.

[8] The trend is calculated by a Hodrick Prescott filter with parameter 100; algorithm of K. Annen.

Figure 1: Productivity Growth of Market Services in EU-15 and the USA, 1980-2002



Sources: GGDC, IHS calculations

The growth rates of EU-15 market services were generally just under 2 percent from 1980 to 1995, compared to just over 2 percent for the whole economy. Over the same period, trend growth rates for US market services were almost identical as for the whole US economy. The similarity of trends reflects the key position of the market services sector in each economy. However, the US market services trend growth pattern overtook its EU counterpart by about 1995, two years earlier than for the economy as a whole, underscoring the extent to which the services sector drives productivity growth.

The role of services and market services played in "industrialised" economies at the turn of the twentieth century is hard to understate. The contribution of particular industries (or industry groups) to productivity growth is calculated by weighting each industry by its share of employment (hours) using a shift-share analysis approach. (Cf. annex A). Table 1 shows:

- Average productivity growth in the whole EU-15 economy at 1.66 percent lagged behind that of the USA at 2.37 percent during the period 1995-2002, while the contribution of all services (public and private) – accounting for nearly 80% of this growth – was very high indeed.
- The contribution of services to the US economy was even higher – just under 87% from 1995 to 2002.

- The contribution of market services alone (i.e. excluding public services such as education, health services, government services and defence, etc.) to the US economy growth was as high as 85%.
- While the importance of market services to productivity growth is also high in the EU, accounting for over two-thirds of growth between 1995 and 2002, this contribution is markedly lower than in the USA, due to the lower productivity growth rates achieved in market services during this period.

ICT-Intensive Market Services

Our particular focus is on the ICT-producing and intensive ICT-using services (i.e. ICT-intensive services for short). The lower part of table 1 shows that the ICT-intensive services accounted for over 82% (2.96 percentage points) of the high growth rate of labour productivity in US market services (3.59 percent) during 1995-2002. The proportional contribution of ICT-intensive services to EU-15 market services was even higher, at over 88% during the same period. This is indicative of an even more pronounced underperformance in the EU non-market services (compared to the US benchmark) than in market services, as the overall productivity growth rate of 1.26 percent in market services is just over one third of the corresponding US productivity growth.

Table 1: Contributions of Services to Productivity Growth, EU-15, USA, 1995-2002

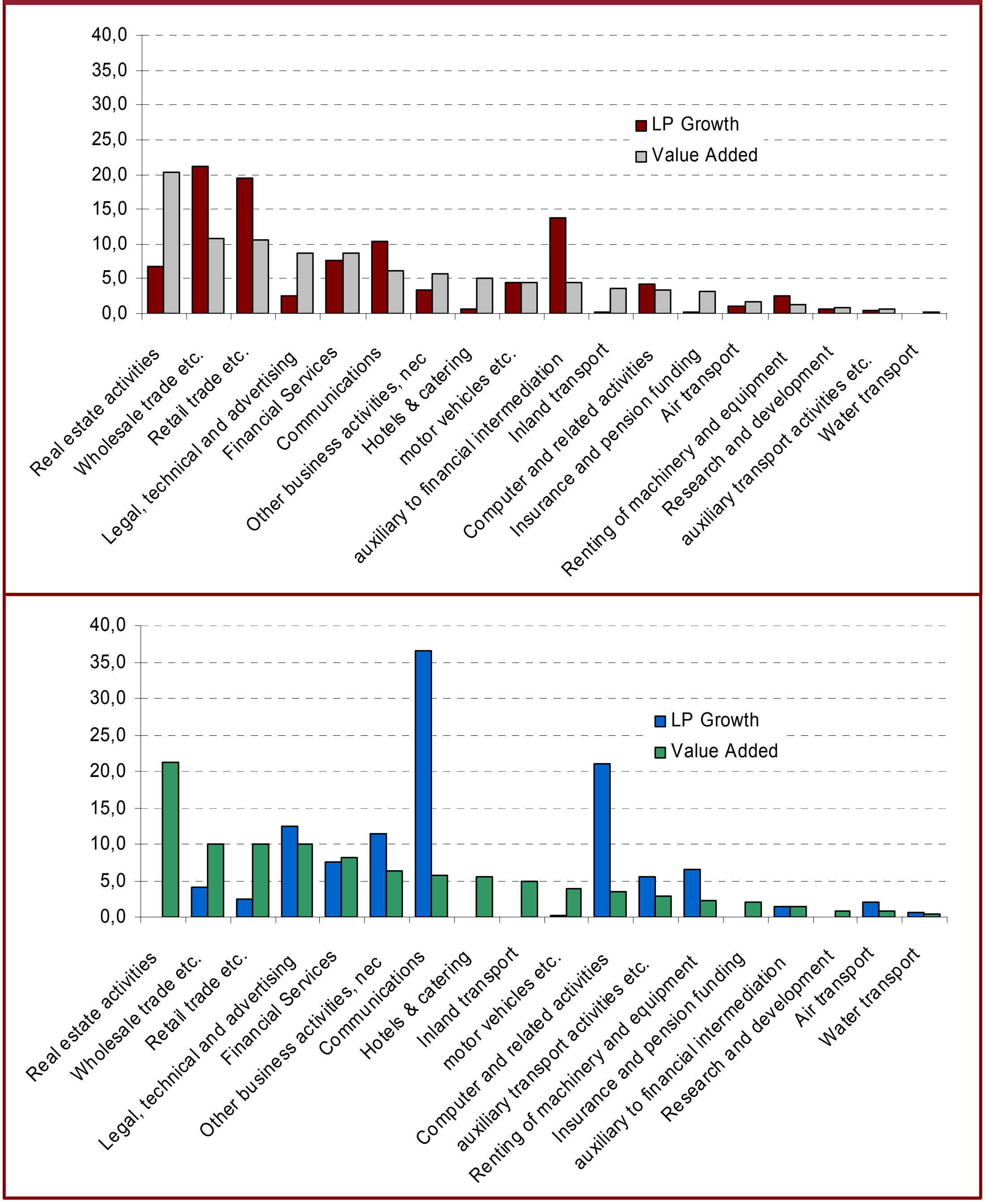
	Growth contribution	as % of growth rate, respectively	Growth contribution	as % of growth rate, respectively
	95-02 US		95-02 EU	
TOTAL ECONOMY [GROWTH RATE]	2,37	100,0%	1,66	100,0%
ALL SERVICES	2,06	86,8%	1,31	79,3%
NON-SERVICES	0,31	13,2%	0,34	20,7%
MARKET SERVICES	2,02	85,1%	1,12	67,8%
Rest Economy	0,35	14,9%	0,53	32,2%
ALL MARKET SERVICES [GROWTH RATE]	3,59	100,0%	1,26	100,0%
ICT INTENSIVE SERVICES	2,96	82,4%	1,12	88,9%
ICT NON-INTENSIVE SERVICES	0,63	17,6%	0,14	11,1%

Source: GGDC, IHS calculations

The productivity growth of 2.37 percent in the USA compared to only 1.66 percent in the EU-15 shows a differential trend that is well reflected in the service sector in the period 1995-2002. From 1995 to 2002, labour hours productivity growth was 3.59 percent in US private services compared to 1.26 percent in EU-15.

There are large contributions to growth from ICT-intensive industries for the EU-15 and the USA in contrast to the value added share of market services (figure 2). These are shown in decreasing order of their contribution to total value added in market services (from left to right). The importance of productivity gains in certain services becomes especially clear.

Figure 2: Percentage Contributions to Productivity Growth and Value Added in Market Services in EU-15 and the USA, 1995-2002



Sources: GGDC, IHS calculations

In the USA, the growth of services recorded in the period 1995-2002 has been due to the large contributions of wholesale trade, retail trade and financial services – in each case, amounting to around 20 percent or more of total sector productivity growth (with “financial services” combining financial intermediation with supporting services, etc.). The only other service industry with an above-average contribution to growth is the *communications* industry, at 11 percent of the overall growth of 3.83%.

In contrast, communications was by far the strongest contributor to growth in the EU-15 in the period 1995-2000, accounting for over one third of all growth. The contribution from computer services was also large in relative terms, comprising over 21 percent of all market services productivity growth in EU-15, with an absolute contribution of one quarter of a percentage point to productivity growth. There were also above-average relative contributions from legal, technical and advertising services and other business services, but the absolute contribution from each of the latter two industries was only 0.15 percentage points.

During the period 1995-2002, the large productivity growth contributors – in the case of the USA, wholesale and retail trades, financial services and communications; in EU-15, communications and computer related activities – are service industries whose relative contribution to growth exceeded their relative contribution to aggregate value added in the sector. In the USA, the wholesale and retail trades are pre-eminent in terms of both size (in value added terms each contribute over 10 percent) and productivity growth (20 percent). While the economic weight of these sectors is only about 0.5-0.6 percentage points of value added less in EU-15 than in the USA, the productivity contribution of each of these service industries was well below average. There was also a lower contribution to growth from financial services, but it is in the two distributive trades services, wholesale and retail, that Europe’s major performance deficits are to be found in comparison with developments in the USA.

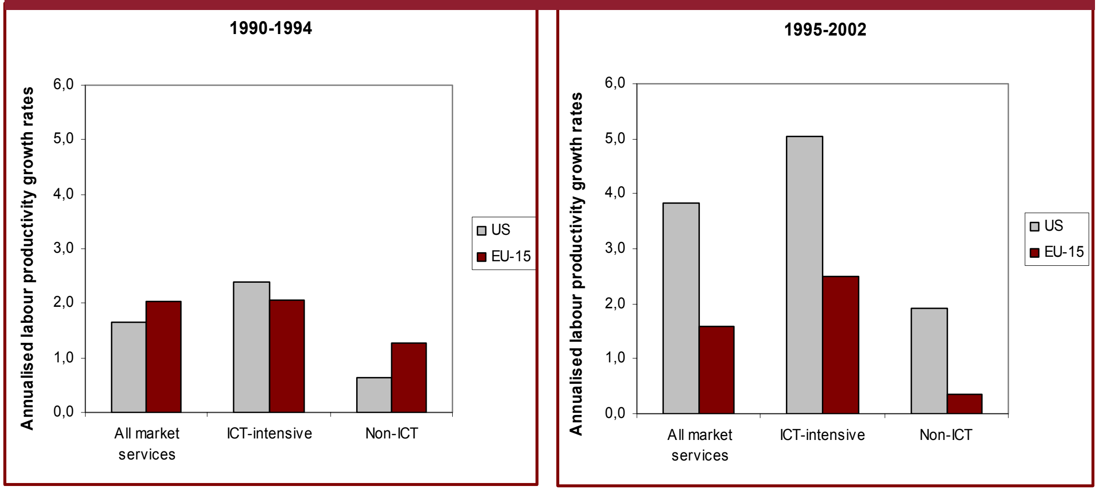
3. The Role of ICTs

3.1 Trends in Productivity Growth in Europe and the USA

Recent studies (cf. O'Mahony et al.; 2003) showed that since the mid-1990s, the growth rates of labour and total factor productivity (TFP) have fallen behind those in the United States. As mentioned in the introduction, this relative decline occurred after a continuous catching-up process of productivity growth faltered in Europe compared to the USA. Due to this development, Europe's shortfall in labour productivity compared to the USA has again increased. For the first time in decades, the EU has now a rate of productivity growth that is lower than that of the USA (Denis et al., 2004).

A number of authors consider ICT use to be a crucial factor in explaining the structural break in regard to the growth performances in Europe and the USA. For example, Van Ark et al. (2003) pointed out that "with the recent boom in ICT investment, labour productivity growth in the US more than doubled." Much research has been undertaken in order to obtain insights into the role of ICTs. To gain a fuller understanding it is, therefore, helpful to differentiate between ICT-intensive and non-ICT service industries when comparing labour productivity growth in Europe and the USA. Figure 3 shows that the US exhibited higher labour productivity growth in regard to all market services between 1995 and 2002. Whereas annualised labour productivity growth was 3.8 percent in the US, it increased only by 1.6 percent in Europe.

Figure 3: Labour Productivity Growth in ICT-Intensive and Non-ICT Services in the EU and the USA



Sources: GGDC, IHS calculations

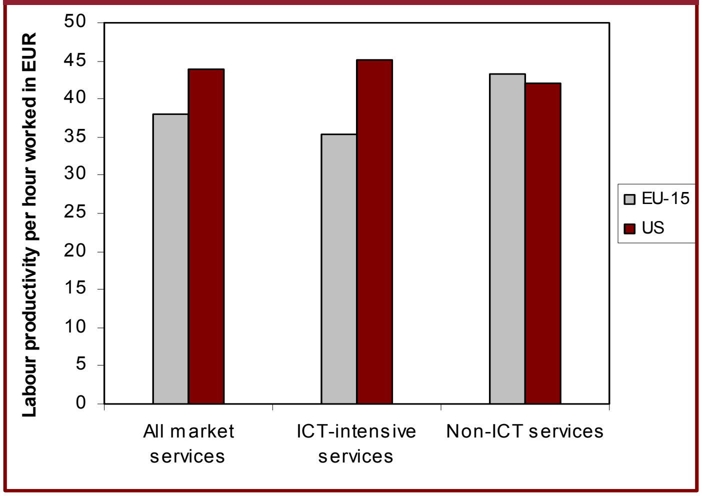
The productivity gap between the EU-15 and the USA registered in the period 1995-2002 applies particularly to ICT-intensive services where the annualised growth rates in labour productivity were 5.1 percent for the USA, but only 2.5 percent for the EU. Both Europe and the USA started from a similar base before 1995. Between 1990 and 1994, the growth rate was 2.4 percent for the USA and 2 percent for the EU. Nonetheless, only the USA could significantly raise growth in labour productivity. Productivity growth increased by 2.7 percentage points in the USA, but only by 0.4 percentage points in the EU-15 countries (figure 3).

Labour productivity growth is generally weaker in non-ICT services than in ICT-intensive market services. Nevertheless, the productivity growth patterns also apply to the group of non-ICT services. While the annualised growth rates decreased in Europe, the development was positive for the USA. It is noticeable that the productivity patterns between the USA and the EU have generally changed since 1995:

- The US productivity growth increased for all groups of services.
- In Europe, productivity growth increased in ICT-intensive services only.
- The USA overtook the EU in regard to non-ICT services after 1995.

Productivity levels in 2002 were higher for the USA with regard to all market services and, in particular, to ICT-intensive services (**figure 4**). Only in non-ICT services the EU-15 surpassed the US productivity levels.

Figure 4: Labour Productivity per Hour Worked in EUR – 2002

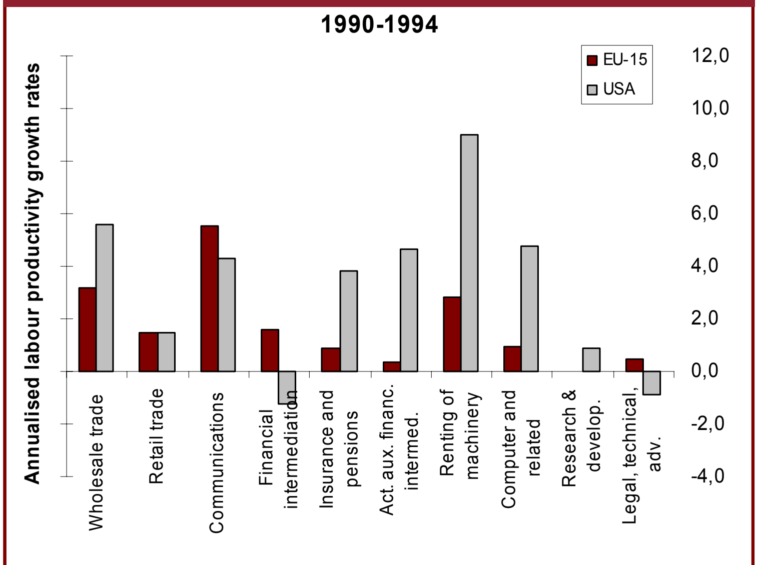


Sources: GGDC, IHS calculations

Focusing on disaggregated growth patterns, it becomes clear that productivity growth differs much between specific industries. This applies to both the EU-15 and the USA. Nonetheless, the advantage lies clearly with the USA: after 1995, the USA surpassed the EU-15 growth rates in seven out of ten ICT-intensive service industries (figure 5).

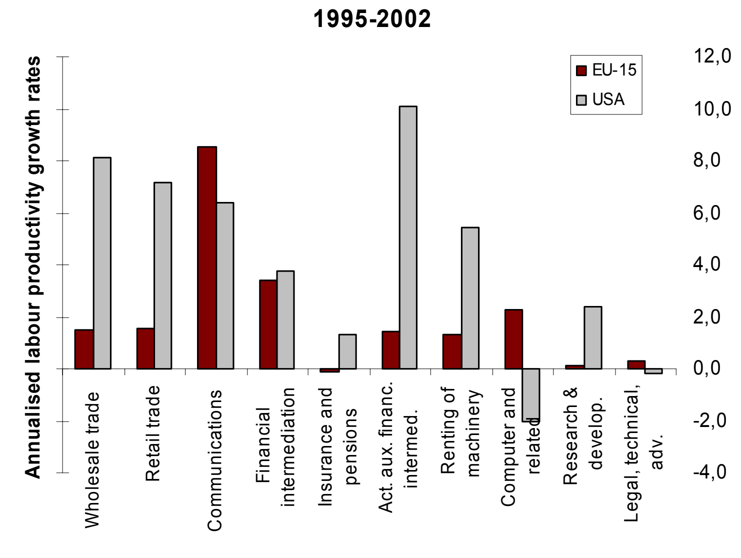
Although some European ICT-intensive service industries show higher productivity growth in the last observation period – for example, communications had an annualised growth of 8.6 percent in Europe compared to 6.4 percent in the US – the majority of ICT-intensive services show advantages for the USA. When the last two observation periods for ICT-intensive service industries are compared, one can see that the USA was in a leading position even before 1995, but whilst productivity growth has increased in the latter period for most of the ICT-intensive services in the USA, productivity has grown more slowly (or has even decreased) in the EU-15 countries. ***As a result, the gap between the USA and the EU-15 has increased in six out of ten ICT-intensive services****.* Once again, this applies in particular to wholesale trade, retail trade, and activities auxiliary to financial intermediation. In regard to the latter, the US economy reached a productivity growth rate of 10.1 percent between 1995 and 2002. In wholesale trade, productivity growth was 8.1 percent in the USA compared to 1.5 percent in the EU-15. In retail trade, productivity growth rates rose from 1.5 percent between 1990 and 1994 to 7.1 percent between 1995 and 2002 in the US, but only from 1.46 percent to 1.55 percent in the EU-15.

Figure 5: Productivity Growth in ICT-Intensive Industries – EU-15 vs. USA, 1990-1994



Sources: GGDC, IHS calculations

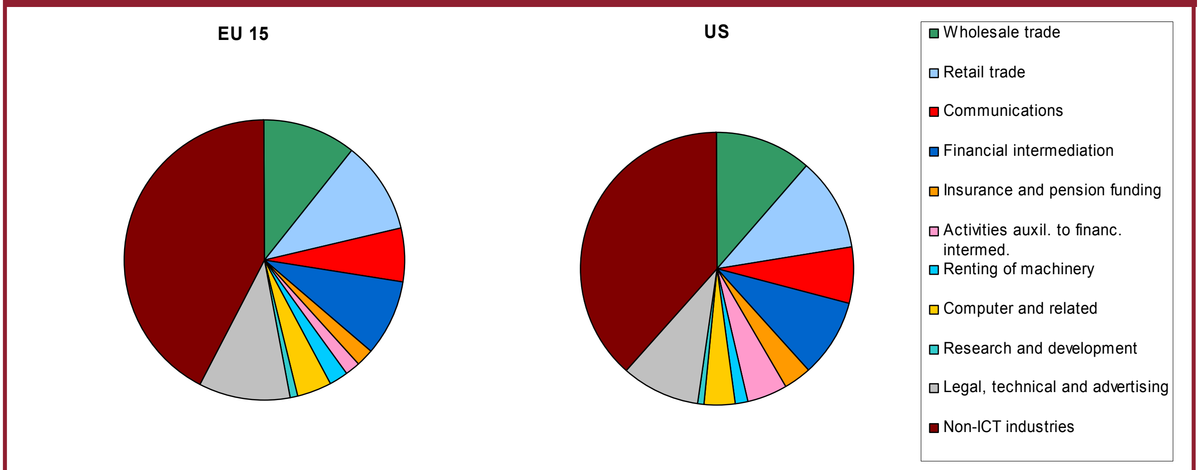
Figure 6: Productivity Growth in ICT-Intensive Industries – EU-15 vs. USA, 1995-2002



Sources: GGDC, IHS calculations

We note that wholesale and retail trade also rank among the most important market service industries in terms of their value added share (figure 7). Between 1995 and 2002, the value added share was 11.4 percent for wholesale trade and 11.2 percent for retail trade in the USA. In Europe, distributive trades are of similar importance in terms of value added shares, albeit slightly less (10.8 percent for wholesale and 10.6 percent for retail trade), and it is shown in section 5.1 that their contribution to overall growth in market services is significantly higher for the USA than the EU.

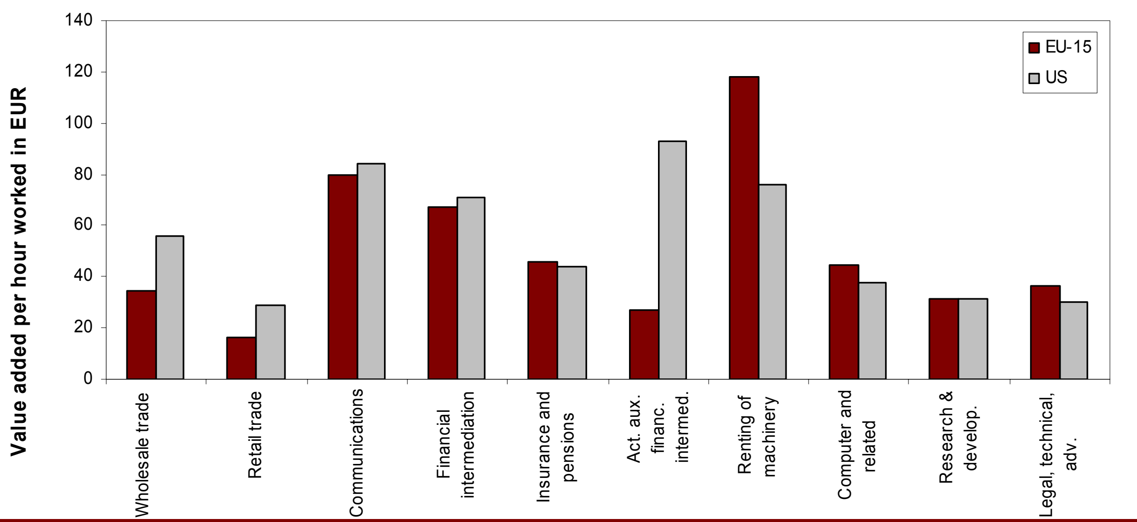
Figure 7: Industry Shares of Value Added in Market Services, 1995-2002



Sources: GGDC, IHS calculations

With regard to productivity levels, the comparison of the EU-15 and the USA offers rather mixed results for individual service industries, with the US showing slightly higher levels in communications and in financial intermediation and slightly lower levels in computer and related activities, research and development as well as legal, technical and advertising services. More substantial gaps in productivity levels concern retail and wholesale trade, activities auxiliary to financial intermediation and renting of machinery. In particular in activities auxiliary to financial intermediation, the US value added per hour worked is more than three times as high as the European productivity levels (figure 8).

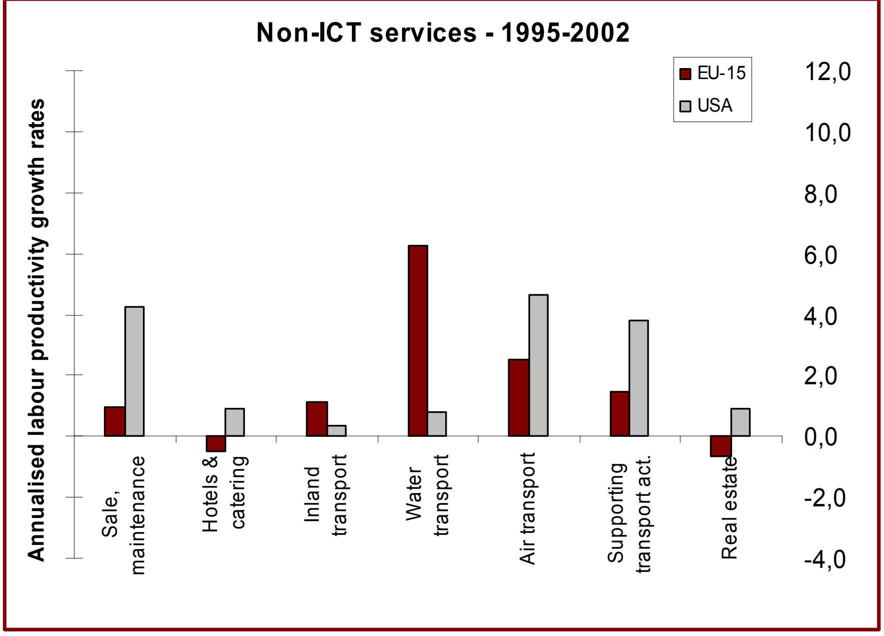
Figure 8: Value Added per Hour Worked in EUR – 2002



Sources: GGDC, IHS calculations

The comparison of ICT-intensive and non-ICT services shows that the European shortfall in terms of labour productivity particularly applies to ICT-intensive services. For non-ICT services, the EU-15 show lower productivity growth rates but still higher productivity levels (figure 4) as well as higher value added shares (figure 7). From a chronological perspective, the growth patterns in the USA and the EU-15 reversed after 1995. While the EU-15 countries were in a leading position before 1995, with aggregated growth rates of 2 percent for non-ICT services compared to 0.5 for the USA, the USA exhibited higher growth rates between 1995 and 2002. All non-ICT services (except the small value added contributors of water transport services and inland transport services) exhibited higher labour productivity growth in the USA than in the EU-15.

Figure 9: Productivity Growth in Non-ICT Industries – EU-15 vs. USA, 1995-2002



Sources: GGDC, IHS calculations

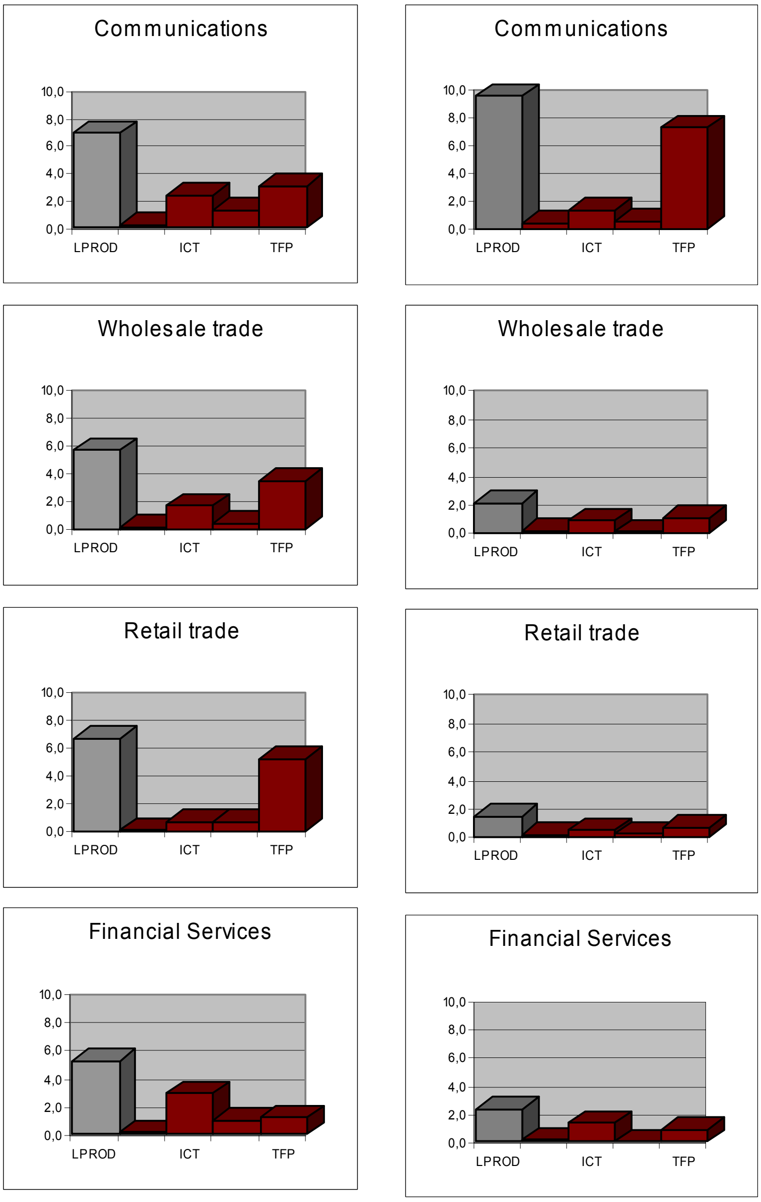
3.2 Growth Accounting

Decomposition of Labour Productivity Growth in ICT Services

An overall increase in productivity is evident in the US economy after 1995: Average labour productivity, at 2.2 percent annual growth, was twice as high as in the first half on the 1990s, and indeed throughout the 1980s. The special role taken on by ICT-producing and intensive-using services (ICT-4) is clear, with growth rates above 5 percent in these industries. ***The large contribution to US productivity from ICT capital deepening, particularly since 1990, is apparent in these industries, and since 1995 a concomitant rise in total factor productivity (TFP) has occurred.*** The contribution of capital deepening has been 30-40 percent of all productivity gains in communications and retail trade services, and over 50 percent in financial services.

Figure 10: Growth Accounting: Contributions to Productivity in Individual ICT-4 Service Industries, EU-4 and USA, 1995-2001

USA 95-01 EU-4 95-01



Source: GGDC, HIS calculations

According to the growth accounting model, contributions to labour productivity are calculated for human capital deepening as evidenced by labour quality (skills) deepening, by ICT capital deepening, by non-ICT capital deepening and by TFP. The (tele-) communications sector is an ICT-producing service industry, while repairs and wholesale trade, retail trade, and financial intermediation are ICT-intensive-using industries. The percentage contributions to labour (hours) productivity (LPROD) from labour quality (LQ), ICT capital deepening (ICT), non-ICT capital deepening (nICT) and, finally, TFP calculated residually, are graphically shown for ICT-intensive services in the EU-4 and USA in figure 10 for the period 1995-2001. The height of the left bar (LPROD) is the sum of the other bars in each diagram.

It is noticeable that TFP is correlated with labour productivity gains. Furthermore, percentage TFP contributions to productivity in each of the ICT-intensive market services – communications, wholesale trade and retail trade in the USA, communications in EU-4 – are higher than the TFP contribution to labour productivity gains for the respective economies as a whole in the years 1995-2002. In financial services, a relatively high contribution to productivity growth (as a proportion of labour productivity growth) originated from ICT capital deepening in both EU-4 and US in the same period. ***In general, growth effects are noticeable in the same service industries in the EU-4 services sector as in the US, but the level of ICT investment is lower, (or equivalent levels have been reached later).*** This would appear to play a significant part in explaining the drift apart in productivity levels in the services sector between the EU and the USA.

The Contribution of ICT to Productivity in Market Services

We now consider the ICT-4 service industries together as a group. The background for the analysis, a combination of growth accounting and shift-share analysis, is presented in annex A, and results are shown in tables 2 and 3. The contributions to overall growth in ICT-4 are composed of a within-industry contribution and a between-industry shift component of productivity growth. The contribution to productivity growth within each industry is split into the drivers of growth, namely ICT capital, non-ICT capital, labour quality and TFP that together with the between-industry shift, accounts for the entire contribution of each industry.

At 6.6 percent, productivity growth in the four ICT-intensive services was outstanding in the US in the period 1995-2001. While European productivity growth in ICT-4 was not weak at 2.8 percent, it lacked the strong surge experienced in the US. We have already commented on the industries in which fast growth occurred in the USA; we now look at the sources. Major reasons for the difference are to be found in the ICT and TFP contributions. ***Differences in ICT contributions are especially noticeable in wholesale trade and financial services; while the EU failed to match US TFP growth in distributive trades, but outperformed the USA in TFP growth in communications.***

Table 2: Contributions to Productivity Growth in ICT-4, EU-15, 1995-2001

[Percentage points]	EU15 1995 - 2001					
		Sources of Productivity Growth				
Origins of Productivity Growth, ICT-4	LPROD	LQ	ICT	nICT	TFP	Shift
Communications	1,34	0,060	0,192	0,078	1,053	-0,039
Repairs and wholesale trade	0,54	0,028	0,178	0,018	0,218	0,094
Retail trade	0,31	0,028	0,098	0,046	0,146	-0,003
Financial Intermediation	0,59	0,048	0,395	0,004	0,261	-0,118
ICT-4 SERVICES	2,79	0,16	0,86	0,15	1,68	-0,07

Sources: GGDC, IHS calculation

Table 3: Contributions to Productivity Growth in ICT-4, USA, 1995-2001

[Percentage points]	US 1995 - 2001					
		Sources of Productivity Growth				
Origins of Productivity Growth, ICT-4	LPROD	LQ	ICT	nICT	TFP	Shift
Communications	0,92	0,021	0,269	0,144	0,341	0,149
Repairs and wholesale trade	2,28	0,052	0,718	0,167	1,474	-0,131
Retail trade	1,51	0,015	0,165	0,156	1,234	-0,058
Financial Intermediation	1,88	0,041	0,925	0,314	0,375	0,228
ICT-4 SERVICES	6,60	0,13	2,08	0,78	3,42	0,19

Sources: GGDC, IHS calculations

In relative terms, there are only distributional differences between EU and US ICT contributions. However, in both cases, the contribution of ICT capital deepening to growth consistently accounted for 31 percent of productivity growth in the ICT-intensive industries during the period 1995-2001. The contrast to the contribution of non-ICT capital deepening and labour quality is stark.

The contribution of TFP from communications to ICT-4 productivity growth in EU-15, and from that of wholesale and retail trades in the USA is remarkable, each being greater than one percentage point. This indicates that productivity has been due to disembodied technical change in these industries. ICT investment may be driving this TFP growth, but ICT capital deepening itself is a strong factor in the productivity growth of wholesale trade in the USA, and financial services in both the USA and EU-15 (in relative terms).

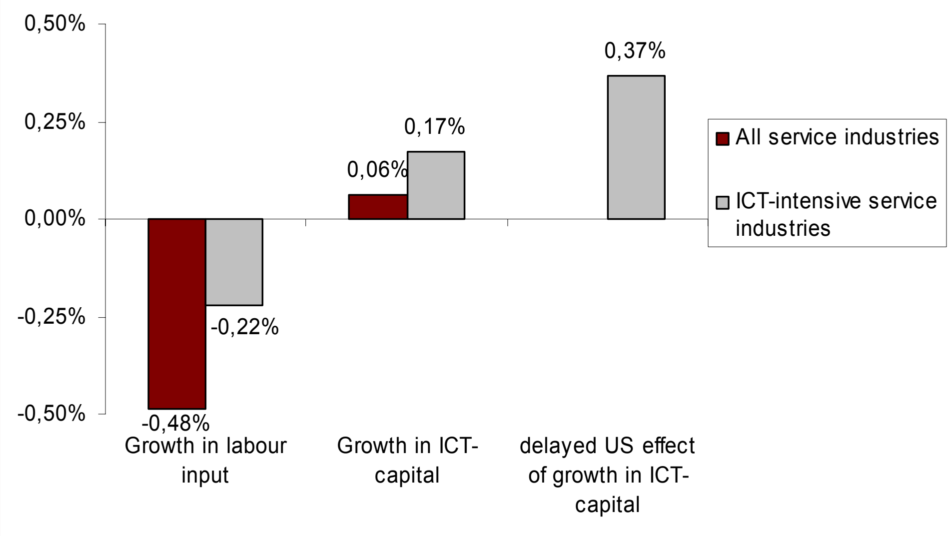
The shift contribution is relatively minor in terms of overall productivity growth, however there is a striking difference between the EU and the USA. The negative sign of the EU shift is associated with a drift of employment share towards services with lower productivity growth. The stronger gain in employment share in European retail trades, for example, does not match the gain in employment share experienced in US financial services. ***In contrast to the EU, labour mobility from US service industries has, in net terms, been to industries with higher productivity levels.***

3.3 The Effects of ICT Capital on Productivity and Growth

The Effects of ICT on Productivity Growth

Using the production function approach (cf. annex B), the effect of the different types of capital on development of productivity can be analysed. Growth in average labour productivity has been regressed on growth in labour input (measured by total hours worked), ICT capital and non-ICT capital. Additionally, specifications including first lags of growth in ICT capital have been modelled to show possible delayed impacts of ICT capital on productivity growth as well as dummy variables capturing the differences of the effects between the USA and EU-4. The bars in figure 11 depict the estimated coefficients for all services industries[9] (ICT-intensive service industries[10]) for the USA and EU-4 (separately[11]) for 1990-2000.

Figure 11: Coefficients for the USA and EU-4 for 1990-2000, Dependent Variable: Average Labour Productivity Growth



Sources: GGDC (2005), IHS calculations

We first note that labour growth has a significant negative influence on labour productivity growth. An increase in employment growth by one percent reduces labour productivity growth by about 0.48% in all service industries and 0.22% in ICT-intensive service industries.

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[9] Repairs and wholesale trade, retail trade, hotels and catering, transport, communications, financial intermediation and real estates and business services.

[10] Repairs and wholesale trade, retail trade, communications, financial intermediation, real estates and business services and other services.

[11] Germany, France, the Netherlands and the UK have been included separately and not aggregated to EU-4.

Labour productivity growth is more inelastic in ICT-intensive service industries compared to all service industries. ***Thus, the negative effect on productivity growth associated with increased employment is less pronounced in ICT-intensive services than in other services.***

Looking at ICT capital effects, we first observe that in the equation for all service industries, an increase in ICT capital growth by 1% is associated with an increase of labour productivity by 0.06%[12]. In case of the ICT-intensive service industries, we observe an effect about three times as high as for all services. Furthermore, there is no delayed European effect of ICT capital growth on productivity growth, nor is there any difference between the USA and the EU-4, neither in contemporaneous nor in lagged values. ***However, in contrast to all service industries, there is a lagged effect in the USA, which is even larger than the contemporaneous effect.***

To summarise, a growth in ICT capital by 1% in the USA causes a contemporaneous rise in labour productivity of about 0.17%, and also a rise of about 0.37% one year later, which amounts to a combined effect of 0.54%. Note that this effect (in absolute terms) is larger than the labour effect in the US service industry. ICT investments in the USA appear to have had a more sustained effect on productivity than in the EU. MGI (2002) reports (cf. main report, section 5.3) in a US context that tailored IT applications combined with sustainable organisational decisions may help firms to increase productivity and to achieve competitive advantages.

This shows that 1% ICT capital growth enables ICT-intensive US service industries to raise productivity growth to a larger extent (0.55% in two years) than a 1% reduction in labour input, which would increase productivity growth by only 0.22% in ICT-intensive services. For the European case, we only find a contemporaneous effect of ICT capital on labour productivity amounting to about 0.17%, while a reduction in labour input by 1% would increase productivity by 0.22%. ***Therefore, it is not surprising that the US ICT-intensive service industries seek ongoing productivity gains fuelled by new input of ICT capital, while Europe appears to be hampered in productivity growth by a restrictive labour market.***

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[12] 10% significance level.

The Effects of ICT on Value Added Growth

Table 4 shows that on average, the US value added growth rates of 3 out of 4 ICT-intensive industries exceeded those of EU-4 industries for 1990-2000.

Table 4: Average Annualised Value Added Growth Rates for the USA and EU-4, 1990-2000

	US	EU4	US - EU4
Repairs and wholesale trade	5,30 %	3,16 %	2,14 %
Retail trade	4,76 %	2,53 %	2,24 %
Communications	5,78 %	7,40 %	-1,62 %
Financial Intermediation	4,44 %	2,25 %	2,19 %

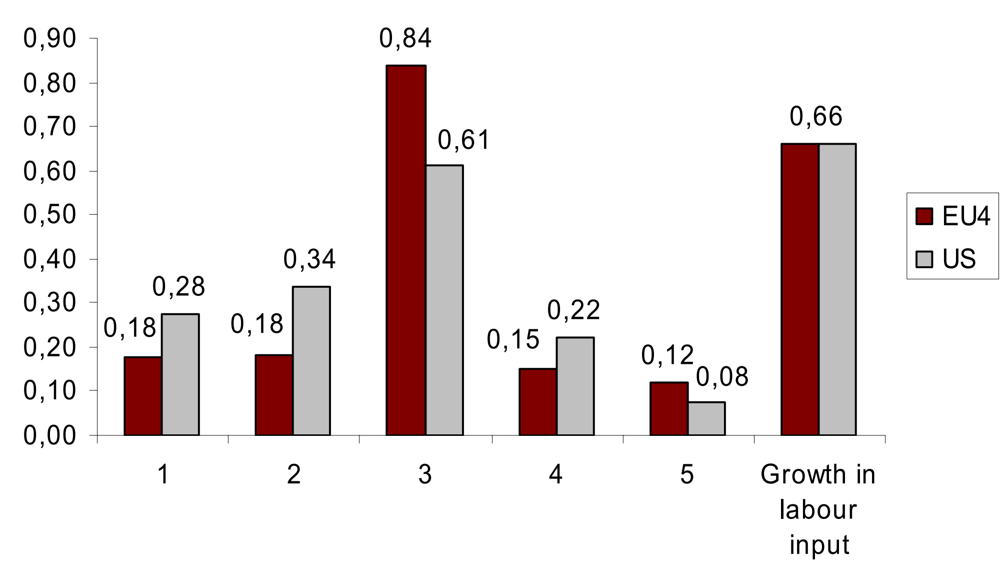
Sources: GGDC (2005), IHS calculations

Value added growth patterns resemble those already observed for productivity growth:

- For *repairs and wholesale trade, retail trade and financial intermediation,* the USA show a value added growth advantage of about 2.2 percentage points.
- The average EU-4 value added growth rates for *communications* exceeded those of the USA by 1.6 percentage points.

To investigate the causes for this, growth in value added has been regressed on growth in labour input, labour quality, non-ICT capital input and ICT capital input using the production function approach described in annex B. In order to simplify the specification, variables found to be insignificant (labour quality and non-ICT capital) were excluded and statistically similar coefficients (labour input) were restricted. The data set used includes the five ICT-intensive service industries for the USA and EU-4 for 1990-2000.

Figure 12: Coefficients for ICT Capital and Labour Input for the USA and EU-4 for 1990-2000, Dependent Variable: Growth in Value Added



Legend: Figures show growth rates in ICT capital stock for: 1 = Repairs and wholesale trade, 2 = Retail trade, 3 = Communications, 4 = Financial intermediation, 5 = Real estate activities and business services.
Sources: GGDC (2005), IHS calculations

The estimation results can be summarised as follows:

- Labour input growth and growth in ICT capital have a significant and positive influence on growth in value added.[13]
- An increase of growth in labour input of 1 percent leads to an increase in value added growth of 0.66 percent.
- ICT capital growth impacts are higher in the USA for the industries wholesale trade, retail trade and financial intermediation. The EU-4 communications industry outperforms the US counterpart in terms of ICT efficiency. An increase in ICT capital growth of 1 percent in this industry leads to a rise in value added growth of 0.61 percent in the USA and 0.84 percent in the EU-4.

Statistical tests suggest that the coefficients for the retail trade and communications industries are significantly different[14] between the USA and the EU-4:

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[13] The coefficients for growth in ICT capital for real estate and business services are significant at a 5% level for the EU-4 and insignificant for the USA. ICT capital coefficients for all other industries are significant at a 1% level.

[14] At a 10% level.

- In the retail sector, the US is able to reap more benefits from investing in ICT capital in terms of value added growth than the EU-4.
- In communications, ICT capital is used in a more efficient way in the EU-4countries.

We consider now whether or not causes for the higher impact of ICT capital growth in communications in Europe and for retail trade in the USA can be traced back to patterns in ICT usage in these industries. The following figures show the ICT shares of ICT-intensive service industries for the USA and EU-4 and the gap between them (i.e. US share minus EU-4 share) for 1980-2000.

Figure 13: Share of ICT Capital in Total Capital for the Repairs and Wholesale Trade Industry

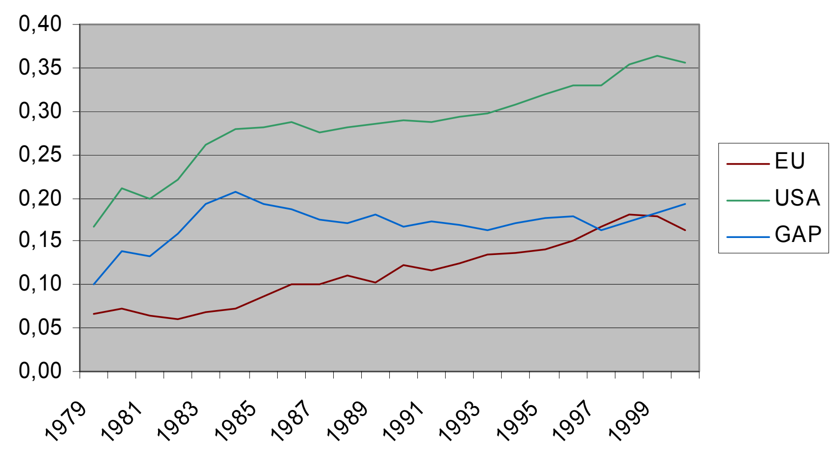
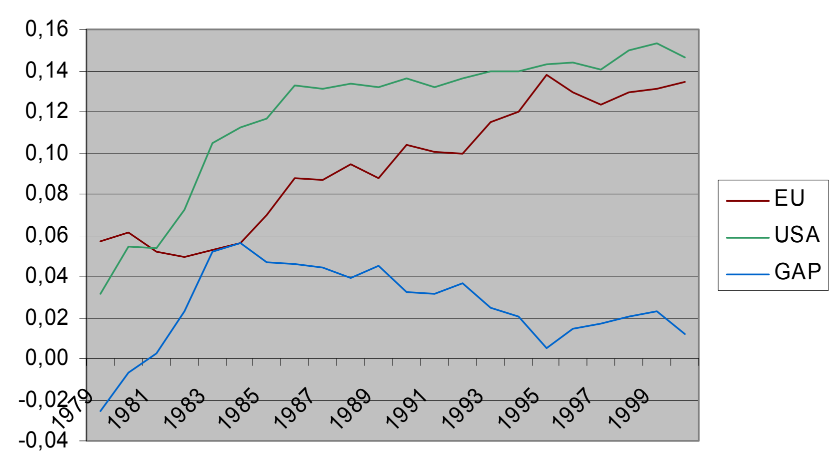


Figure 13 shows the shares for the *wholesale trade industry* in the USA and EU-4: They developed in parallel over the period 1982 to 1998, the gap between the shares being constant at about 20 percentage points. Since 1999, there has been a slight decline in the shares in both economic regions.

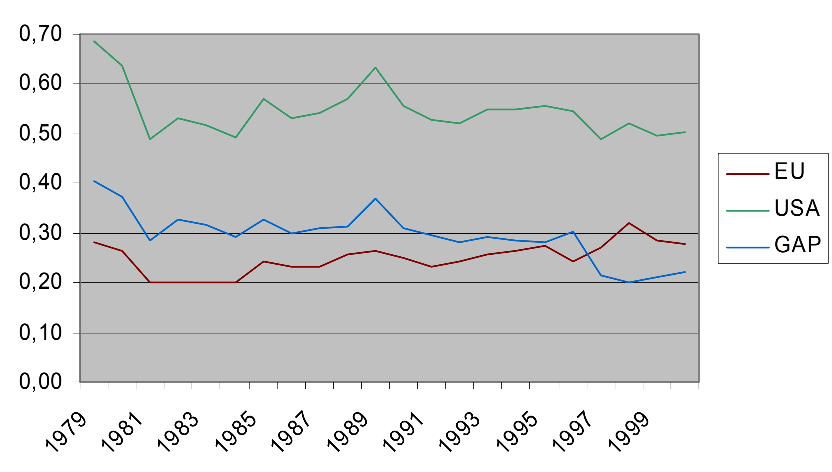
Figure 14: Share of ICT Capital in Total Capital for the Retail Trade Industry



Source: GGDC (2005)

Figure 14 shows that in the USA, the *retail trade industry* started investing heavily in ICT in the period between 1982 and 1986, and then the increase was rather small. In the EU-4 the investments in ICT only started in 1985, but since then have grown almost steadily until 2000, to approach the US level of share in total capital.

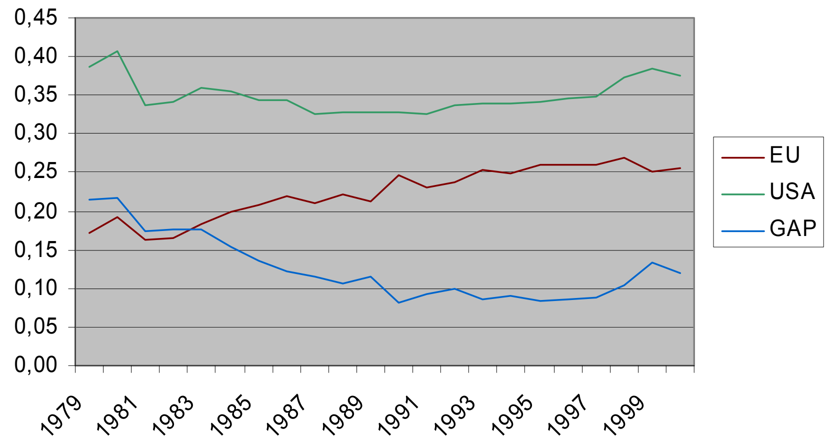
Figure 15: Share of ICT Capital in Total Capital for the Communications Industry



Source: GGDC (2005)

Figure 15 shows that the share of ICT capital in *communications* has been almost constant in the USA – with a slightly downward tendency in the 1990s – while in the EU-4 there was a steady increase from 20% to 30%.

Figure 16: Share of ICT Capital in Total Capital for the Financial Intermediation Industry



Source: GGDC (2005)

Figure 16 shows that, except for the last two years 1999-2000, the development of ICT shares in *financial intermediation* had been slowly converging until 1998. The shares of the EU-4 countries have grown from 1982 onward and now reached a level of 25%, but still 10 percentage points off the US level.

The above figures show that the USA recorded higher ICT capital shares in all ICT-intensive service industries. While there are still considerable gaps in the wholesale trade and communications industries, the gaps for retail trade and financial intermediation are narrowing.

Given the observations and estimation results presented above, it is clear that ICT usage alone does not explain all growth patterns. We now consider other causes for growth differentials in the retail trade and communications industries.

Retail Trade

The ICT share of EU-4 in retail trade has steadily increased during the 1990s (figure 14), suggesting a possible catching-up process of the EU-4. However, a catching-up in terms of higher value added growth rates cannot be observed (table 4). To identify the driving forces behind the more efficient use of ICT capital in the US retail trade industry (cf. coefficient for retail trade in figure 12), other factors explaining the more efficient use of ICT capital than ICT intensity have to be taken into account.

MGI (2002) found, for example, that US food retailers started collecting point-of-sale data, introducing data warehouses and using advanced forecasting tools prior to European retailers. They have therefore been able to exploit the full benefits of ICT investment through collaborative supplier relations and organisational innovations, while European retailers solely focused on using their market power to bring prices down.

The success story of the US retail trade market heavily relies on big players like Wal-Mart. Case studies show that by using ICTs efficiently, Wal-Mart gained market share and obtained the required economies of scale to operate more productively.[15] Gordon (2003) found evidence that productivity growth in the US retail trade industry was completely due to new establishments and not to the growth in ICT investments. Big players, like Wal-Mart, Home Depot and Best Buy, have been responsible for organisational innovation which boosted productivity growth. Gordon (2003) also doubts the effects of ICT investment on productivity growth. He argues that Europe used the same ICT hardware and software as the USA did, without achieving high productivity benefits. According to Gordon (2003), the ICT investment boom coincided with favourable macroeconomic conditions, positive supply shocks, reduced inflation and the stock market boom.

Another crucial factor often mentioned is product market regulation. French hypermarkets, for example, are protected from competition through zoning laws (MGI, 2002). These laws have limited the opening of new outlets, which led to substantial scale effects in this industry. Those scale effects result in less employment per output, i.e. increased labour productivity measured in levels, but decrease the growth rate of productivity and value added due to less competition and innovation.

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[15] FRBSF Economic Letter (2004).

Communications

For the communications industry, it can again be seen that higher ICT intensity (figure 15) does not lead to a stronger impact of growth in ICT capital on value added growth (cf. coefficient for communications in figure 12). Much more ICT capital was deployed in the USA than the EU-4 without resulting in higher value added growth rates. Again, other factors have to be taken into account.

An important factor for explaining the growth advantage of the EU-4 communications industry may be the liberalisation of the European telecommunications market during the late 1990s. New suppliers entered the market and invested heavily (increasing growth rates for ICT and non-ICT capital). MGI (2002) mention the license auction system in the telecommunications market as a source of slow growth in the USA, where 50 mobile providers serve fewer than 200,000 customers each, while in Europe there are only a few providers serving millions of customers.

Although consolidation has started in the USA, there are still negative effects on growth and productivity.[16] The consolidation process of the US telecommunications industry is not yet completed, while the liberalisation of the European fixed-line market has already led to faster productivity growth. The liberalisation of German and French markets forced the incumbents to improve their performance due to competition. Consolidation increases the average firm size of an industry and enables larger benefits from ICTs due to scale effects. The cause of the higher exploitation rate of ICT investment in the EU-4 is likely to originate from a more liberalised market structure in Europe.

Thus, our results suggest that growth in certain service industries, most notably retail trade and communications, has been significantly influenced by ICT investment, but differences in ICT capital shares alone cannot explain the US growth advantage.

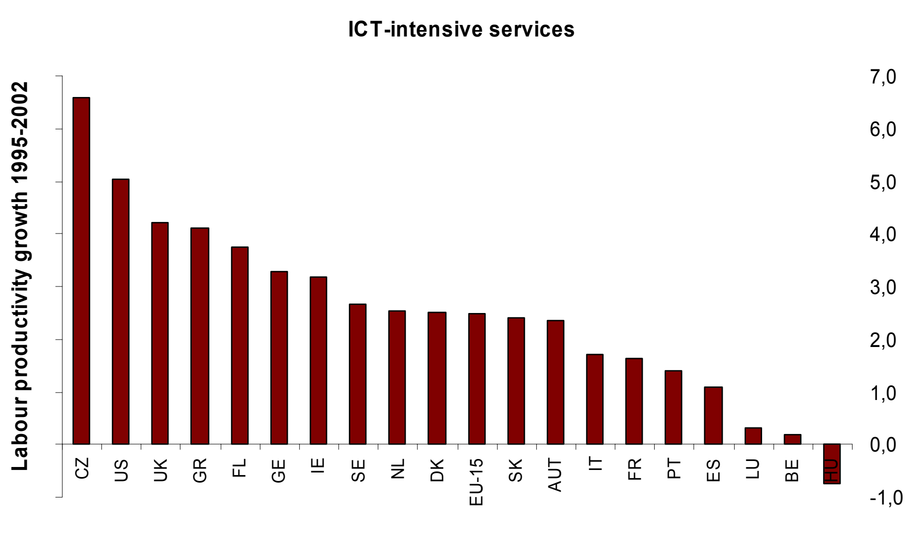
[16] See MGI (2002).

4. Regional Differences

4.1 Labour Productivity in EU Member States Compared to the USA

The productivity performance of the US economy has outstripped that of the EU as a whole since the mid-1990s. The major differences that have contributed to this overall trend have been observed in ICT-intensive services. The US economy surpassed the EU-15 counterparts in particular in regard to labour productivity in ICT-intensive industries, and, driven by this growth, in market services in general. Between 1995 and 2002, annualised labour productivity growth for the EU-15 countries was lower than in the USA in seven out of ten ICT-intensive services observed. This applies especially to wholesale trade, retail trade, and activities auxiliary to financial intermediation. The US service sector also leads in respect of productivity levels and value added shares. These services as well as financial intermediation itself exhibit higher value added shares and higher productivity levels.

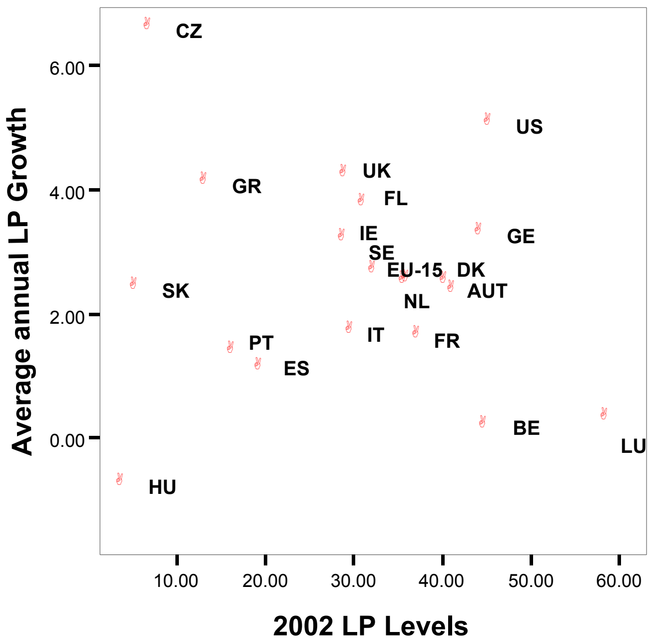
Figure 17: Annualised Productivity Growth in ICT-Intensive Services – Country Comparison 1995-2002



Sources: GGDC, IHS calculations

The ICT-intensive services in the USA took second place, not only with regard to productivity growth rates (figure 17) but also according to productivity levels (figure 18). Although the Czech Republic had higher growth rates between 1995 and 2002, its ranking in terms of productivity levels is relatively low, as is to be expected in a new Member State engaged in the catching-up process. Conversely, Belgium and Luxembourg rank high with regard to productivity levels, but exhibit rather low productivity growth. As illustrated by the position in the top right quarter of the scatter diagram (figure 18), ICT-intensive services in the USA generally developed better than their European counterparts.

Figure 18: Country Dispersion According to Labour Productivity Growth 1995-2002 and Productivity Levels 2002 in ICT-Intensive Services



Sources: GGDC, IHS calculations

The scatter diagram (figure 18) shows countries' positions in terms of both labour productivity growth between 1995 and 2002 and labour productivity levels (value added per hours worked in euro in 2002) for ICT-intensive services. The following remarks can be derived from this comparison. First, as already mentioned, the USA exceeded the EU-15 averages with regard to growth and levels, ranking second with regard to both dimensions. European countries, however, may be grouped into four categories according to their productivity patterns. These are:

- *"Catching-up"* countries with comparatively high productivity growth rates, but low productivity levels (Czech Republic, Greece).
- *"Not yet catching-up"* countries with average or low productivity growth rates and low productivity levels (Hungary, Portugal, Slovakia, Spain).
- *"Low growth/high level"* countries with high productivity levels (for Europe), but comparatively low productivity growth (Luxembourg, Belgium).

- *"Average"* countries, where slightly higher growth rates can be observed for countries with slightly lower than average productivity levels (rest of the EU).

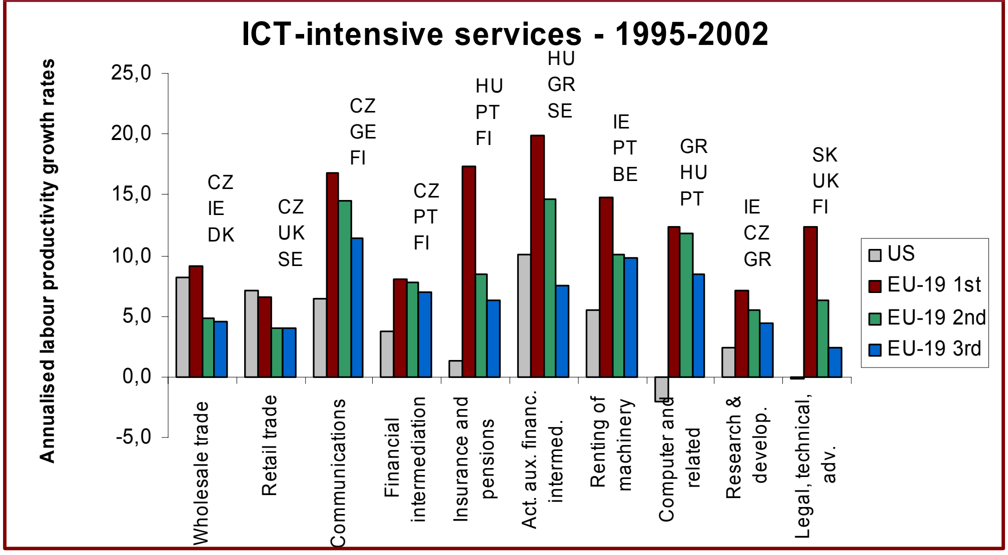
The overall weaker performance of the EU services sector compared to that of the USA conceals, however, a more differentiated picture at the regional industry level. The productivity growth performance of some service industries in a few EU Member States has been as strong, or even stronger, than in the USA.

Some European countries had better performances than the USA in terms of productivity growth (figure 19). This especially applies to countries like the Czech Republic in communications, financial intermediation, and research and development or for Hungary in the field of insurance and pension funding. Apart from these countries, also Finland, Portugal, and Germany partially show higher dynamics in ICT-using industries (financial intermediation, insurance and pension funding, legal, technical and advertising) than the USA. It is notable that Ireland has top ranks in several service industries.

In general, the Czech Republic, Hungary[17] and Ireland were often among the top-performing EU countries in ICT-intensive services from 1995 to 2002. In spite of the presence of "catching-up", old and new Member States feature prominently among European countries with higher growth rates than the USA, the strong productivity growth performance not only of these but also of certain other EU-15 countries should not be overlooked when the relatively poor productivity in Europe as a whole is compared to that of the USA. The productivity performance of European countries is by no means uniform, which has positive as well as negative connotations.

[17] Paradoxically, Hungary's productivity successes are offset by low productivity growth in industries such as retail and financial intermediation so that the aggregate productivity growth rate 1995-2002 is relatively low (figure 18.)

Figure 19: Productivity Growth in ICT-Intensive Services 1995-2002 – USA versus European Top Performers[18]



The impression of varying productivity performances among European countries intensifies, as we observe, on a disaggregated single-industry perspective. ***Although there are countries that are among the top performers in various industries*** (for example, the Czech Republic or Portugal), ***there is no definite pattern that applies to all industries.***

Observing ranking patterns (or the lack of such, see table 5), the following points can be made:

- First, ICT-intensive industries can exhibit quite different country patterns with regard to their productivity performance. This makes it likely that industry specific factors besides ICT investment have to be taken into account in order to explain differences in productivity growth.
- Second, there is considerable variation with regard to industry-related productivity growth performances within countries. Thus, productivity growth differences cannot be completely explained by factors that apply to all service industries in a country such as the overall institutional framework and general regulations on market entry and behaviour.

[18] The figure compares annualised growth in labour productivity in the USA with European top performers in the related service industry. The first bar in each group illustrates the US growth rate. The next three bars identify the EU-15 top performers' growth rates in descending order, left to right, of the level of growth in the respective service industries. The top performers differ from industry to industry and are indicated above the related bars. For example, in wholesale trade, the Czech Republic reached the highest growth rates. The USA ranked 2nd. Amongst the EU-15 –countries, Ireland showed the 2nd highest rates followed by Denmark. In retail trade, the USA surpassed all European top performers' growth rates.

These variations and complexities of productivity performance in ICT-intensive service industries in Europe lend a note of caution to the interpretation of the overall or average EU performance.

Table 5: Country Rankings: Annualised Labour Productivity Growth Rates in ICT-Intensive Services between 1995 and 2002

Industry	Whole-sale trade	Retail trade	Commun-ications	Financial inter-mediation	Insurance and pension funding	Activit. auxiliary to financial inter-mediation	Renting of machin-ery	Computer and related	R & D	Legal, technical
EU-15	16	12	8	11	16	11	11	8	11	5
Austria	17	6	14	10	6	16	9	18	18	14
Belgium	14	20	20	20	18	18	3	15	9	20
Czech Republic	1	2	1	1	7		20	4	3	15
Denmark	4	21	16	6	5	14	18	16	10	11
Spain	20	19	17	14	19	5	16	14	20	8
Finland	13	10	3	3	4	8	10	12	13	3
France	18	13	11	16	9	9	15	11	12	6
Germany	15	15	2	4	21	13	13	6	6	17
Greece	10	7	13	7	8	2	5	1	4	16
Hungary	8	18	7	21	1	1	17	2	15	18
Ireland	3	5	21	17	15	17	1	7	2	10
Italy	21	17	4	12	12	19	19	10	8	7
Luxemburg	6	11	12	19	20	15	12	20	19	19
Netherlands	7	14	5	15	17	12	7	17	16	4
Poland	5	8	6	5	11	6	8	13	21	9
Portugal	9	16	19	2	2		2	3	1	21
Sweden	11	4	9	18	3	4	4	21	14	13
Slovakia	19	9	18	13	10	7	21	5	5	1
UK	12	3	10	8	14	10	14	9	17	2
USA	2	1	15	9	13	3	6	19	7	12

Sources: GGDC, IHS calculations

Table 6: Country Rankings: Labour Productivity Levels 2002

Industry	Whole-sale trade	Retail trade	Commun-ications	Financial inter-mediation	Insurance and pension funding	Activit. auxiliary to financial inter-mediation	Renting of machin-ery	Computer and related	R & D	Legal, technical
EU-15	11	11	6	8	10	13	6	6	9	5
Austria	6	6	5	2	3	14	5	7	5	6
Belgium	5	9	14	12	9	4	3	1	1	1
Czech Republic	19	18	18	18	18	19	20	20	17	21
Denmark	3	4	10	3	5	2	13	5	8	7
Spain	15	15	13	13	15	7	17	14	16	15
Finland	12	12	9	5	7	3	15	12	14	13
France	13	3	7	10	12	11	8	4	6	4
Germany	7	10	2	4	13	9	1	2	7	2
Greece	17	16	16	16	17	17	16	17	19	19
Hungary	18	21	19	20	19	10	18	18	18	17
Ireland	8	14	17	17	14	12	12	3	3	3
Italy	14	8	8	7	6	16	2	11	11	12
Luxemburg	2	2	1	1	2	5	4	13	4	11
Netherlands	4	7	3	14	1	8	7	10	12	10
Poland	20	20	20	21	21	20	21	21	20	20
Portugal	16	17	15	11	20		11	15	2	16
Sweden	10	5	11	9	4	6	10	16	15	14
Slovakia	21	19	21	19	16	18	19	19	21	18
UK	9	13	12	15	8	15	14	8	13	9
USA	1	1	4	6	11	1	9	9	10	8

Sources: GGDC, IHS calculations

With regard to productivity levels (value added per hour in EUR) the ranking patterns are more homogenous (table 6). This may be due to the fact that service industries within a country are operating under similar economic conditions. Nevertheless in most of the countries there are outliers from the general country patterns. In Austria, for example, this applies to activities auxiliary to financial intermediation.

4.2 Homogeneity – Differences EU vs. USA

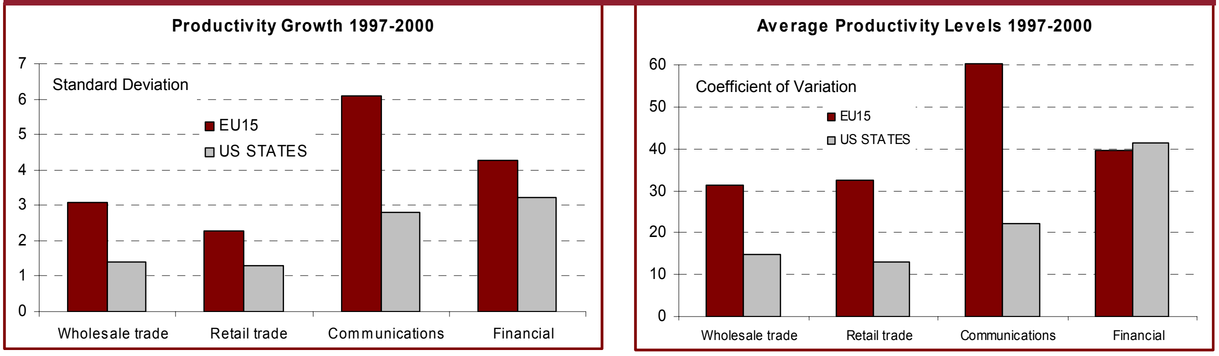
In lieu of a direct source of regional productivity data in the USA, either at the state or economic/geographic regional level, we have pursued an indirect method based on available regional data. The Bureau of Economic Analysis (BEA) publishes Gross State Product (GSP) statistics for states and regions and also employment data at these disaggregated levels. GSP represents value added in current US dollars in the respective region, and employment as the number of employees. In order to maintain consistency with the GGDC, these data were adjusted to US aggregates in constant price dollars, making use of the GGDC deflators. Likewise, the employment data was adjusted to US aggregates in total hours worked, making use of the US data on hours worked per employee. This indirect method is a proxy, due to incongruities in the industry definitions used in the databases we wish to compare. However, we are concerned with regional variations in productivity and we can obtain an adequate picture of the regional distribution of labour productivity with the estimated data.

A comparison of regional variations in ICT-intensive services - wholesale and retail trades, communications, and financial services - is thus available for the Member States of EU-15 and the 50 US states (plus D.C.).

- Productivity growth rates also vary to a greater extent in the 15 countries of EU-15 than in the 50 US states. In addition, differences between ICT-4 service industries are apparent, especially in the EU (figure 20). In the period 1997-2001 the most heterogeneous (or least homogeneous) development in ICT services was in communications, followed by financial services. (For example, growth rates in productivity over 10 percent in communications were achieved in Finland, Italy, and Germany, in the latter reaching a remarkable 17.4 percent. Financial services productivity grew at around 5-7 percent in Spain, Finland, Greece, and Portugal in this period, but at the same time these activities had a negative growth of 3-4 percent in Belgium, Ireland, and Luxembourg.)
- In terms of productivity levels, there is a stark contrast between the large variation found among the 15 EU Member States in the distributive trades and communications and the comparatively homogeneous pattern in US states. In financial services, however, the

degree of variation of productivity levels found in EU and US is nearly equal and relatively high, most likely reflecting an uneven distribution of financial centres in countries/states on each of the two continents (figure 20).

Figure 20: Degree of Heterogeneity in Productivity Growth and Levels in ICT-4 Services, EU-15 and the USA (States), 1997-2000[19]



Sources: (1) IHS estimates and calculations, based on Bureau of Economic Analysis GSP and employment data: (2) GGDC 60-Industry database, IHS calculations

Figure 20 shows that the dynamics of labour productivity growth is consistently more heterogeneous[20] in the EU than in the USA. The results reinforce, at the regional level, the findings already reported – namely, that the strong productivity growth performance of the USA over the EU in ICT-intensive market services is also widespread across states. Even the strong average productivity growth of communications in the EU is not spread evenly across Member States, which exhibit widely varying levels of productivity. The relatively higher degree of variation in US communications may, to a certain extent, be a reflection of market structure, stemming, at least in part, from regulatory effects at the state level.

The emerging picture shows that the USA is a relatively homogeneous market for services, while there is a higher degree of heterogeneity throughout the EU, as witnessed by variations in productivity growth and levels in ICT-intensive services. This puts the relatively smaller number of European productivity successes in services (cf. 4.1 above) into perspective: In service industries where the USA leads in terms of productivity growth, the advantage is also widespread across many states. This observation adds to doubts that the EU may soon be able to follow the high productivity growth path of the USA, especially in

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[19] The differences in heterogeneity between EU and US productivity growth and levels are statistically significant (5% level) for wholesale trade, retail trade and (tele-)communications.

[20] The coefficient of variation is appropriate for measuring degrees of heterogeneity for levels which vary widely between countries and industries; the standard deviation is preferable for assessing variation in productivity growth which may approach zero or be negative.

wholesale and retail trade services where there is a large presence of nation-wide firms in the market. This tendency is perhaps only to be expected when comparing the EU with the economy of a single large country. The Member States of the EU have yet a long way to go before their degree of market integration reaches US levels. One step in this direction would be the establishment of regulatory conditions that foster the completion of the single market for services.

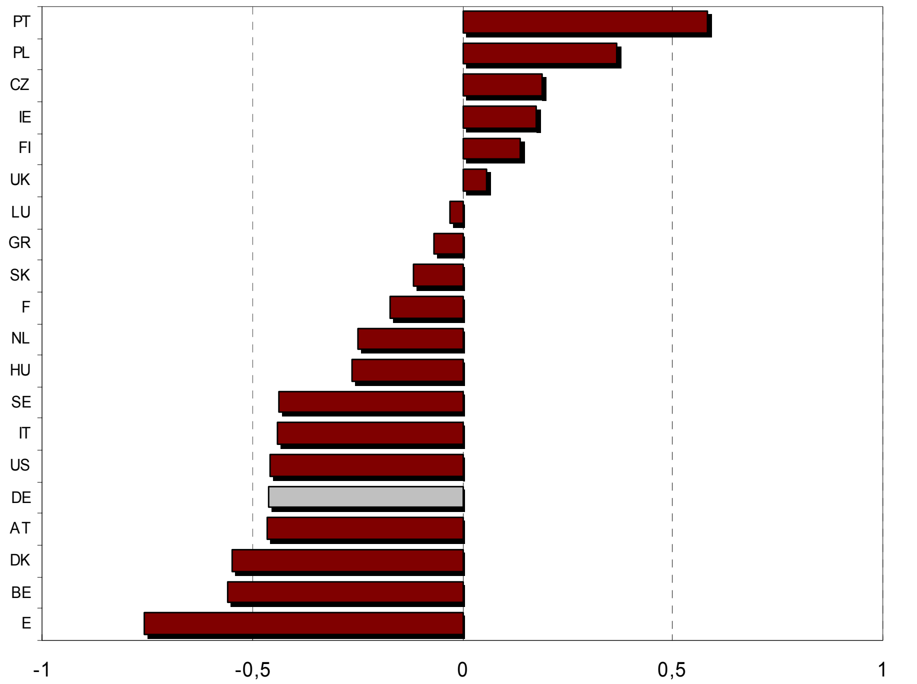
5. Employment and Productivity

There is only sparse evidence of productivity growth being associated with gains in employment in the period 1995-2002. Some of the successes in this regard, however, are to be found in Europe, particularly in ICT-producing services.

- In both EU and USA, the communications industry, for example, achieved a high productivity rise along with a favourable development in employment. The performance of the EU-15 stands out in this industry, however, where a higher absolute contribution to productivity growth was achieved than in the USA.
- The European computer services industry also shows a striking pattern of very high increases in employment, reinforcing a trend already apparent in 1988-1995. As with communications, this other ICT-producing services industry is a success story for the EU-15, as a comparison with the US productivity development shows.

As noted already, ICT-intensive service industries display, on average, higher productivity growth rates than non-ICT industries. We ask whether this enhanced productivity growth generally translates into higher employment growth.

Figure 21: Correlation between Average Annual Productivity Growth and Average Annual Employment Growth (1995 - 2002)

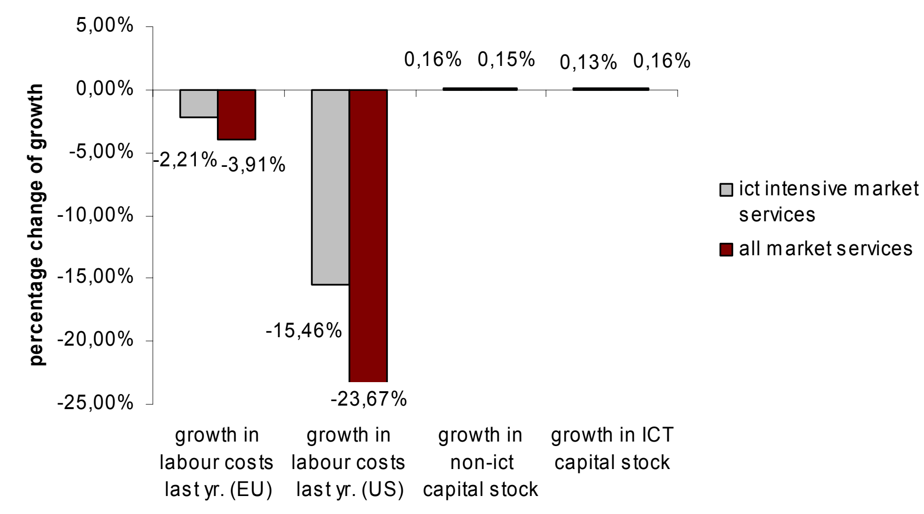


Sources: GGDC, IHS calculations

Figure 21 reveals that above-average productivity growth in service sectors does not automatically result in higher employment growth in these sectors over a longer time period. This is true for most of the countries under consideration, as for 14 out of 20 there is a negative correlation between productivity growth and employment, i.e. in general, higher productivity growth is not associated with above-average employment growth.

It is evident from the discussion above that there is no clear pattern concerning the employment-productivity trade-off, but in some, primarily ICT-intensive, industries in a minority of countries we do observe a positive trade-off. On the other hand, there is evidence that, within economies, service industries that experience higher than average productivity growth are not those which show increased employment growth. This applies both to Europe and the USA. We now take a more analytic look at the connections between productivity growth and employment, while considering the presence of other factors that may be important for explaining employment growth.

Figure 22: Coefficients for USA and EU-4 for 1990-2000, Dependent Variable: Labour Growth.



Sources: GGDC, IHS calculations

According to our regression estimates, which are presented in figure 22, growth in capital inputs in the services sector only marginally affects employment growth. What really drives employment growth are labour costs. If labour cost growth was to decrease by 1%, employment growth would be boosted by approximately 4% in European service industries. Compared to the results for the USA, this is quite small. In US service industries, a labour cost reduction would cause a 20% increase of employment growth. ***This difference in the***

magnitude of the reactions is considered to be indicative of European labour market rigidities which are due to a higher degree of regulation than in the USA.

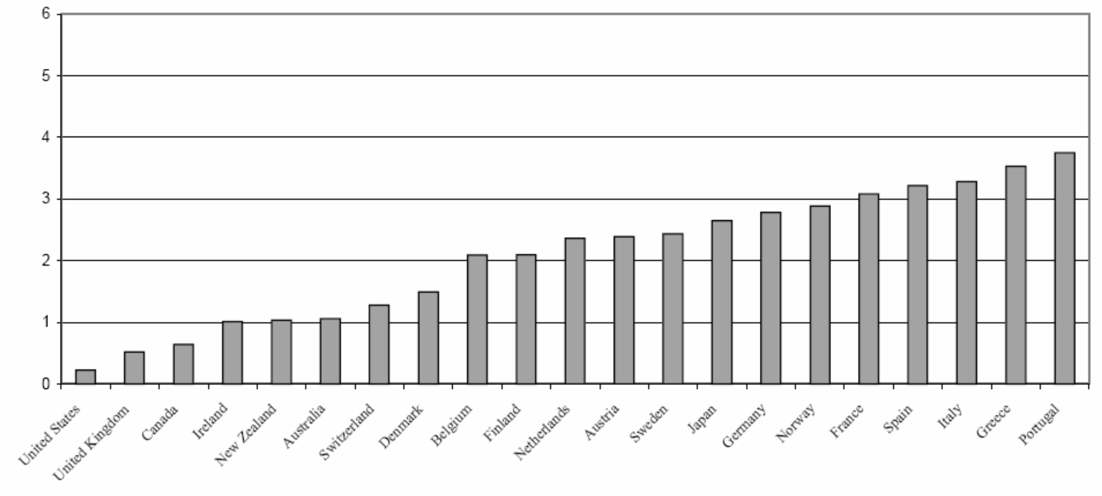
6. Other Factors Relevant to Productivity in Services

6.1 Regulation

Labour Market Regulations

A factor that exerts an apparent adverse influence on productivity growth is the degree of labour market regulation. In many European countries, employment regulation, most importantly employment protection legislation, is more rigid than in the USA, which is depicted in the employment protection indices of figure 23. ***There is a considerable difference in the degree of employment protection between the USA and most European countries.*** In particular, the USA shows an employment protection index that is close to zero, whereas for the majority of European countries, the index values are between two and three or even more.

Figure 23: Employment Protection Index in 1998



Source: Extracted from Nicoletti, Scarpetta and Boylaud (2000)

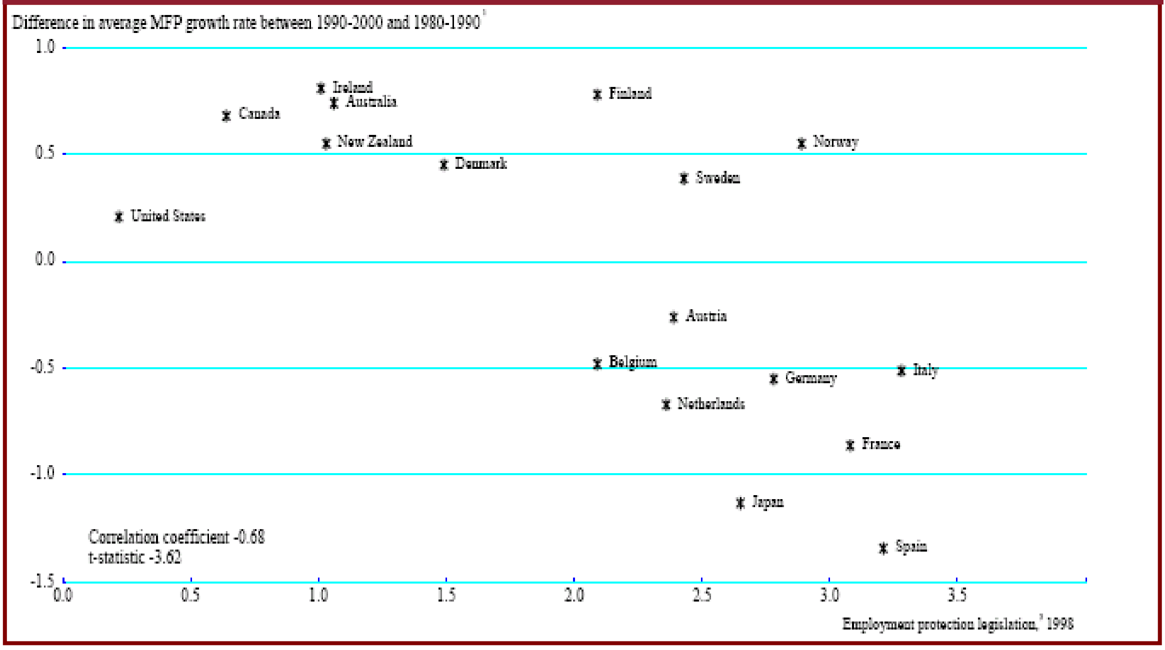
Nicoletti, Scarpetta and Boylaud (2000), who calculated the index, also show that the pattern did not change much throughout the 1990s as far as regular contracts are concerned.

When there is a high degree of employment protection, workers have little incentive to leave their "secure" jobs in an industry that is not experiencing high growth rates and take on jobs in expanding industries. Furthermore, investment that enhances productivity growth will be lower if firms cannot switch from tasks carried out by lower-skilled employees to employees with higher skills in order to achieve higher productivity growth rates.

From a comparative static point of view, there are two ways to increase labour productivity: to decrease labour input for a given output or to increase output for a given labour input.[21] Highly restrictive employment protection systems restrain the flexibility of new firms with respect to their choice of input factors. Regulations that curb the substitution process from unproductive labour to efficient new capital goods or prevent companies from dismissing employees clearly have a negative impact on productivity growth. In countries where wage setting is subject to bargaining at the industry level, firms are not able to shift the costs of personnel reorganisation, stemming from restrictions in hiring and firing, to lower wages.

The OECD presents evidence of a negative relationship between employment protection and productivity growth. Figure 24 shows country differences in TFP between 1980-1990 and 1990-2000 plotted against an index for employment protection legislation. Countries like Germany, France, Spain and Italy show considerably higher values for labour regulation than the USA.

Figure 24: Employment Protection Legislation and TFP Growth



Source: Extracted from OECD (2002)

21 This is of course a simplification: productivity increases when the rate of output growth exceeds the growth rate of employment.

Product Market Regulation

Regulation of markets is another important determinant influencing growth of service industries. Regulation is changing over time, as recent research on regulation (Conway, Janod, and Nicoletti, 2005) has shown. In OECD countries, average product market regulation decreased from about 2.1 in 1998 to about 1.5 in 2003 on a scale from one to six (denoting the highest level of regulation).

Why is regulation an important issue? Regulation generally is of two types: regulations governing *market behaviour*, and regulations pertaining to *market entry*. In his theory of contestable markets, Baumol (1982) states that under free entry of firms, the threat of new firms entering a market alone leads to a high degree of competition within that market. As a consequence of competitive pressures, firms will seek to raise productivity as much as possible to stay competitive. This causes prices to be lower and output higher than these would otherwise be. Regulations that restrict free market entry will, therefore, have adverse effects on competition and, thus, for the sector's growth. As a result, regulations that affect the opportunity for entry of firms are an important feature influencing the outcome in markets. There are several forms of entry regulations such as product range limitations, zoning laws (e.g. retail sector in France), access to vertically integrated networks (e.g. telecommunications in the EU), vertical separation between infrastructure and service provision (e.g. railways in the UK), or general network access. Alesina et al. (2003) show that general investment rates in the German, French and Italian transport and communications service industries would have been close to or even higher (Italy) than US levels between 1994 and 1998, had there been the same degree of market regulation in these respective service industries. ***This illustrates the importance of market regulation that concerns the entry of new firms and thereby affects competition.*** (cf. Cincera and Galgau, 2005)

Nicoletti (2001) points out that most restrictions in services are industry-specific. We will, therefore, discuss some relevant aspects of service industry regulation on an industry-by-industry basis. In general, regulation affects the two main dimensions, market entry and market behaviour.

Evidence of a negative impact of restrictions on market entry was found for the *retail industry in France*:

> According to case studies carried out by MGI (2002b), hypermarkets have established a very strong market position due to zoning law protection. In this environment, incumbents can hold their market position even if they are less productive. As a possible result, France faced stagnating productivity growth since the mid-1990s, albeit still ranking third in terms of productivity levels.
>
> In previous sections, we found that the retail sector is a main contributor to productivity growth in the USA. According to Doms et al. (2003), in the retail industry, most of the productivity growth comes from the net entry of establishments. In a competitive environment, firms with lower productivity exit and are replaced by new entrants with higher productivity. For instance, when Wal-Mart opens a new establishment, it may not be more productive than other Wal-Mart establishments, but the new Wal-Mart store would be more productive than the other retail stores it would displace. In this manner, productivity for the retail sector would increase, although the productivity of individual enterprises does not change.

Kox, Lejour, and Montizaan (2004) showed that removing heterogeneity from trade barriers (i.e. removing regulatory differences) and, thus, rising *trade openness* could increase trade in commercial services by 15% to 30% on average. This would boost growth in those industries, spur competition and enable productivity growth. Another approach was chosen by Copenhagen Economics (2004), by using a general equilibrium model to simulate the effects of the introduction of the Services Directive; they discovered possible decreases in prices and increases in trade.

Hung, Salomon, and Sowerby (2004) analysed the importance of certain channels through which increased trade openness promotes productivity growth. They found that the international reallocation of resources along with the effect of competition influence productivity growth strongest. For US manufacturing industries, 32 percent of average labour productivity growth registered during 1996-2001 was due increased competition subject to decreased import prices.

Regulation affects market behaviour in many respects and thus also has a considerable effect on outcomes. Nicoletti (2001) discusses studies on regulation in a number of service industries and reports some important insights into the effects of regulation on competitive industries.

- Studies about the *retail trade* industry have shown that restrictive regulation hinders retailers from improving the efficiency of their distribution systems, thereby decreasing output, i.e. sales volumes, as well as employment. Too rigid regulation may, therefore, impede the modernisation of the industry as a whole. This effect may lie behind poorer productivity performance in Europe, in contrast to that in the USA, which has been highlighted. However, there are reasonable doubts as to whether a full catch-up in wholesale and retail industries would be feasible, given the differing physical and social characteristics in each continent.
- For *mobile telephony*, which is a part of communication services, studies find a lower productivity prior to liberalisation. However, it becomes apparent that productivity gains are only passed on to the consumers if there is a high degree of competition.
- For *fixed-line telephony,* there is cross-country evidence that relaxed entry regulations for the provision of long-distance calls improved innovation in this industry through competitive pressures.

Openness as well as more liberal market regulation not only foster productivity growth directly, but there is also an indirect effect through innovation. By increasing the competitive pressure, innovation becomes important as a means to achieve higher productivity gains.

When *innovation* (measured by R&D expenditure) increases, productivity growth also rises, an observation that is undisputed today. It is important, however, to distinguish between product and process innovation. According to Griliches (1998), a process innovation is more likely to raise total factor productivity than a product innovation. Criscuolo and Haskel (2003) account for those differences and found a statistically significant association between process innovation and TFP growth for the UK. The estimation results of Madden and Savage (2000) confirm a significant and positive long-term relationship between R&D investment and productivity growth for 15 OECD and 5 Asian countries for 1980-1995.

With regard to the communications industry, there is some evidence that the restrictiveness of regulations and the time of *market liberalisation* had an influence on productivity and growth. By increasing productivity, firms can realise potentials to reduce prices and thus succeed in a competitive environment. Insofar, increasing productivity is an important strategy to endure price competition.

One interesting example for the positive impact of liberalisation is the *German communications industry*:

> Since the mid-1990s, several steps have been taken to liberalise market entry conditions. As a result, the number of operators increased. Deutsche Telekom AG, the incumbent operator, is still the largest provider of telecommunication services, but its market share decreased in several business areas like fixed-line telephony or international services. Especially during the first years after liberalisation, new entrants were able to gain market shares rapidly.
>
> Regarding prices for telecommunication services, the OECD (2004) states that before liberalisation, Germany had been one of the countries with the highest prices, in particular for international long-distance calls. Since the German voice telephony market was deregulated on 1 January 1998, there has been a decrease in prices. The Regulatory Authority for Post and Telecommunications (RegTP) estimates that the prices for national long-distance calls during weekdays are now only about 7 percent of what they were during the monopoly period. According to OECD data, German telecommunication prices became comparable with the OECD average in 2002.
>
> Germany's leading position with regard to productivity growth rates in communications (including telecommunications) between 1995 and 2002 was achieved by leaps of varying size. On a year-on-year basis, the highest growth rates were reached immediately after the liberalisation in 1999 (34.5 percent) and 2000 (20.8 percent).
>
> There is some evidence that the positive dynamism leading to decreasing prices and market shares for Deutsche Telekom as a consequence of the opening of the telecommunication market in 1998 slowed down in recent years. The OECD concludes that while a good start to regulatory reform has been made for Germany, there is a need to reinforce competitive standards. This is especially so since early signs of success in pro-competitive reform are fading in the face of rising concerns over Deutsche Telekom AG regaining market power in the telecommunication market.

Firm Size and Market Structure

Firm size is often considered to be important for productivity growth (Schumpeter (1942), Panzar and Willig (1981) or Cohen and Klepper (1996)). On the one hand, larger firms may find easier access to financial markets for obtaining finance. On the other hand, achieving higher productivity growth can be realised more easily by firms that already have a certain size. This particularly applies to the field of co-operation between firms and research. Kim, Lee, and Marschke (2004) found that labour productivity of scientists rises with increasing firm size. Apart from that, investment in productivity-enhancing technology does not pay until a certain size is reached. Below this critical size, productivity-enhancing technology might show negative consequences for productivity.

> In the *retail industry,* it is apparent that protection of smaller stores does not create incentives for them to apply sophisticated supply-chain management techniques. However, when a retailer reaches a certain size it appears more profitable to optimise many business processes. The adoption of new technologies in this respect helps to achieve higher benefits in terms of productivity growth. This point can be made for US retailers as opposed to European retailers, which do not extensively operate across Member States. Another industry that can be characterised by increasing returns to scale in certain firm size classes is the telecommunications industry.
>
> At the outset, *telecommunications* firms face high fixed costs that can only be covered if the stock of new customers is sufficiently large. When telecom regulations apply to large economies and not to smaller regions within one economy (e.g. states) this is more likely to occur. Thus, we see higher productivity in European countries as opposed to the USA where regulation is undertaken by individual states.

The structure of markets can be of crucial importance. According to MGI (2002b), the lower productivity levels in the US mobile telecommunications segment is not determined, as is sometimes thought, by the lack of a common technology standard or even by the use of analogue technology. A key factor is the market structure in the USA. Despite similar penetration rates, more than 50 mobile telephone providers serve fewer than 200,000 customers, while for example in France and Germany, there are in total only three and four providers respectively, each serving, on average, 10 million customers. MGI points out (2002b) that this is a direct result of the regional license auctions in the USA. Although competitive market forces start to produce consolidation, the legacy of this regulation approach continues to have a negative impact on productivity.

Evidence for the positive relationship between firm size, ICT investment and productivity was found for the US retail industry. According to Doms et al. (2003), large firms account for most of the ICT investment within the retail industry, employment and establishment growth. With regard to the US retail industry, there is also a significant relationship between ICT investment intensity and productivity growth.

General Considerations

Up to now, attention has been directed to considering factors that may be relevant to the explanation of Europe's failure, thus far, to emulate the productivity growth successes in specific ICT-using service industries, most notably retail and wholesale trade, or, on the other hand, offer an explanation for the outstanding example of productivity growth in Europe, namely in communications, an ICT-producing service industry.

Some writers on the subject of productivity growth take a broader, and longer-term, view of the conditions required for sustained productivity growth. The OECD (2003) acknowledges that the use of ICTs is not a panacea and that certain conditions, which accompany the introduction, or increased use, of ICTs may be just as important. In addition to price levels of equipment and software, the OECD highlights the role of *human capital* (in terms of qualified labour), and other *complementary factors,* such as organisational changes made by firms that maximise the effects of innovation, as well as the competitiveness of the environment in which enterprises work. In regard to European market services, the potential of liberalisation under the completion of the single market for services would serve to increase the level of competitiveness when the regulatory environment is simplified for 25 and more Member States, as we have discussed already.

The leading role taken on by ICTs in the US economy since the mid-1990s may be regarded in the same light as other phases of far-reaching general purpose technical innovations, from electricity to automobiles, where the resources of human capital and capital markets available in the USA combined with US market potential were turned into upswings in productivity growth. Gordon (2004) identifies *favourable US conditions*, including the connection of industry with an openly competitive system of private and public universities, the US patents and intellectual property rights system, the market for equity through public offerings and venture capital financing for innovative start-up companies, and the immigration of highly skilled people from, for example, India and East Asia.

Raising productivity growth, thus, requires a multi-faceted approach, with a policy agenda that encompasses *inter alia* longer-term aspects of education and research.

7. Conclusions and Policy Perspectives

The "structural break" in productivity growth that occurred in the economies of the USA and of the EU as a whole in the mid-1990s, and in market services in particular, was marked not just by the beginning of a period of exceptionally strong US growth, but also by a deterioration of productivity growth in the EU.

The sectoral location of productivity growth is rooted in ICT-intensive using and producing services, in addition to ICT-producing manufacturing industries. The contribution of ICT-intensive services alone is nearing one half of the total value added of the USA and EU. The largest contributions to US productivity growth in services since 1995 are to be found in the ICT-intensive using distributive services, *wholesale and retail trade*, followed by *financial services*, whereas the *communications industry* has by far the best performance in Europe, with a productivity growth exceeding that of US communications services, and matching the absolute contribution to productivity growth achieved in the US.

- ***The share of investment in ICT in Europe has lagged behind the US ICT share*** - the data for Germany, France, UK and the Netherlands (EU-4) confirm this. Furthermore, the gap between the US and the EU-4 share of ICT capital has steadily widened. This discrepancy is unlikely to be adequately explained by a single factor like lower US computer prices alone: the respective size of services markets, and the degree of competition in these, for example, also is of importance.

- ***Although productivity growth outcomes in the EU fell behind the USA, the response to ICT through capital deepening is almost identical but only in relative terms.*** Measured over the four ICT-intensive service industries wholesale trade, retail trade, financial services, and communications (ICT-4), capital deepening accounted for 31 percent of EU and US productivity growth. The US annualised growth rate of productivity in ICT-4, between 1995 and 2001 was, however, more than twice as high as in Europe.

- ***Increasing ICT investment in EU services should contribute to improved productivity growth performance*** if targeted by firms to increase their competitive advantage, but a full "catch-up" of the EU in distributive trades to US growth performance is not to be expected under the prevailing conditions.

- ***There is an additional lagged effect on productivity growth in the USA from ICT investment that is not found in the EU.*** This hints at tailored ICT investments in the USA having a more sustained effect on productivity than in the EU.

- ***Growth in ICT capital stimulated value added growth in ICT-intensive service industries*** during the 1990s, but the impact of ICT capital in two industries, communications and retail trade, differs significantly between the USA and EU-4. The EU-4 ICT capital share for *retail trade* converged to the US share during the 1990s, without value added growth catching up, whereas the EU-4 achieved considerably higher value added growth rates in *communications* with nearly half the ICT share of the US.

- ***The ICT intensity of an industry alone can thus not explain all differences in growth performances***. Other advantages such as regulation (telecommunication liberalisation in Europe), competition, firm size and market structure (distributive trades), and organisational structure (supply chain management) may explain much of the differential growth patterns in specific industries.

- ***One set of favourable conditions that would have an impact on productivity and growth in the EU is specified by the attainment of a higher degree of integration of the internal market for services.*** GDP growth in the EU could be boosted by regulatory conditions aimed at completing of the market for services (as intended, for example, by the currently proposed Services Directive).

- ***There are widely varying productivity performances in the EU across countries and industries.*** For example, in all other service industries apart from retail trade in the period 1995-2002 there were single EU Member States with higher annualised growth rates in labour productivity compared to the USA. The strong productivity growth performance in particular service industries by individual EU-15 countries, assisted by the presence of "catching-up" new Member States should not be overlooked when the relatively poor productivity in Europe as a whole is compared to that of the USA. Nevertheless, given the high degree of variation, it is difficult to speak of "average" Member States in terms of productivity performance.

- ***The pattern of productivity development in services is, however, clearly more heterogeneous in the EU than in the USA.*** The variation of productivity growth, for example in ICT-intensive services, among the 15 older Member States is significantly greater than that found among the 50 US states. This finding puts the smaller number of European productivity successes in individual services into proper perspective.

- ***There is little evidence of employment growth going hand –in hand with productivity growth.*** An exception are computer and related activities, especially in the EU where, alongside strong productivity growth, employment growth was high, even stronger after 1995 than previously. So it has to be recognised, specifically in the context of the Lisbon Strategy, that policies aimed at raising growth via higher productivity are not automatically achieving the goal of higher employment.

- ***Employment growth reacts strongest to labour cost developments*.** This is found to be stronger in the USA than in the EU, indicative of the presence of more restrictive labour markets in Europe.

- ***The findings support claims that there are several aspects of labour and product market regulation that need to be addressed in order to improve European GDP and productivity performance in services.*** At the European policy level, completion of the single market for services will serve to increase the level of competitiveness, and ease market entry of firms in the services sector.

In addition to addressing the regulatory conditions directly impinging on services, there is a case to be made that Europe needs improvement in several background areas where the USA holds an advantage, such as the connection between industry and universities, financing of innovative start-up companies, and human capital. In the long term, such favourable developments would improve the EU prospects for the next technologies to come. In the shorter term, productivity benefits associated with higher ICT investment may be expected in the market services sector if accompanied by appropriate regulatory reform.

Annex A: Growth Accounting Models

The following variables are used in growth accounting calculations based on the GGDC database:

Output growth $= \overset{\circ}{Y}$

Hours growth $= \overset{\circ}{L}_H$

Labour quality growth $= \overset{\circ}{L}_Q$

ICT capital growth $= \overset{\circ}{K}_{ICT}$

Non-ICT capital growth $= \overset{\circ}{K}_{N-ICT}$
and, additionally,

$s_L =$ *average share of labour compensation in value added*

= average (share of labour compensation in value added: years $t, t+1$)

$s_{ICT} =$ *average ICT share in value added*

= $(1 - s_L) *$ average(ICT share in total capital compensation: years $t, t+1$)

$s_{N-ICT} =$ *average non-ICT share in value added*

= $(1 - s_L) * (1 -$ average(ICT share in total capital compensation: years $t, t+1$)

[So that $s_L + s_{ICT} + s_{N-ICT} = 1$]

The underlying model (aggregate production function) of the GGDC growth accounting database can be taken as being Cobb Douglas of the form[22]

$$Y = K_{ICT}^{\;s_{ICT}} K_{N-ICT}^{\;s_{N-ICT}} (AL_H L_Q)^{s_L}.$$

So that
$$\frac{Y}{L_H} = \frac{K_{ICT}^{\;s_{ICT}} K_{N-ICT}^{\;s_{N-ICT}} (AL_H L_Q)^{s_L}}{L_H^{\;s_{ICT}} L_H^{\;s_{N-ICT}} L_H^{\;s_L}}$$

[22] This is the labour augmenting form.

i.e. labour (hours) productivity y is expressed as

$$y = k_{ICT}^{\;s_{ICT}} \, k_{N-ICT}^{\;s_{N-ICT}} \, (AL_Q)^{s_L}$$

where small k represents capital deepening, the ratio of capital applied to hours worked

Taking logarithms to obtain instantaneous growth rates [with circles denoting these], total factor productivity (TFP) may be calculated residually, following the procedure of Solow (1957) either as

$$TFP = \mathring{Y} - s_{ICT}\,\mathring{K}_{ICT} - s_{N-ICT}\,\mathring{K}_{N-ICT} - s_L\,\mathring{L}_H - s_L\,\mathring{L}_Q \qquad (2.1)$$

or $$TFP = (\mathring{Y} - \mathring{L}_H) - s_{ICT}(\mathring{K}_{ICT} - \mathring{L}_H) - s_{N-ICT}(\mathring{K}_{N-ICT} - \mathring{L}_H) - s_L\,\mathring{L}_Q \qquad (2.2)$$

where $(\mathring{Y} - \mathring{L}_H) = \mathring{y}$, productivity growth, as defined above.

Analytical Framework for Splitting Productivity into its Components of Location and Origin

In section 5 of the main report labour productivity growth in market services was split into contributions from the component service industries. The method employed is known as shift-share analysis, whereby the share of growth attributable to each industry separately (the share component) and the possible movement of labour from less productive into more productive industries (the shift effect) is calculated. In section 2 of the main report labour productivity growth in individual market services was split into sources of growth – labour quality effects, contribution of ICT and other capital inputs, and into total factor growth (TFP) using the growth accounting approach. In the following, we present a methodology that combines these approaches – a “contributions and sources” analysis.

Productivity in year t is denoted by $y_t = \frac{Y_t}{L_{Ht}}$ where Y_t and L_{Ht} denote valued added and total labour hours, respectively. We calculate the instantaneous growth rate over n, say, periods by $\overset{\circ}{y}{}_t^{t+n} = \frac{\ln y_{t+n} - \ln y_t}{n}$. Writing Δy for $y_{t+n} - y_t$, we get $\overset{\circ}{y}{}_t^{t+n} = \frac{1}{n}\ln\left(\frac{\Delta y}{y_t} + 1\right)$. Using the approximation $\ln(x+1) \cong x$ for small values, say $x \le 0.5$, we obtain

$$\overset{\circ}{y} = \overset{\circ}{y}{}_t^{t+n} \cong \frac{\Delta y}{n\, y_t} \qquad \text{`(1)}$$

In the growth accounting model, we split productivity growth rates $\overset{\circ}{y}$ into components – in our model the components are labour quality (LQ), ICT, non-ICT (nICT) and TFP. Writing the proportional contribution of each component as x_c we have $\overset{\circ}{y} = \sum_c x_c \overset{\circ}{y}$ where $\sum_c x_c = 1$. We can therefore also split the total change in growth, looking at (1), thus

$$\Delta y = \sum_c x_c \Delta y \qquad (2)$$

Assuming that $Y \cong \sum_i Y_i$ for a group of industries labelled by i (an approximation when aggregations are based on Törnqvist indices, for example) we can write

$$y = \sum_i Y_i \Big/ L_H = \sum_i \left(\frac{Y_i}{L_{Hi}}\right)\left(\frac{L_{Hi}}{L_H}\right) = \sum_i y_i\, s_i \qquad (3)$$

i.e. productivity of the group is a weighted sum of industry productivities where the weight s_i is the share of each industry in total labour.

Also, $\Delta y = \sum_i \left(y_{i,t+n} s_{i,t+n} - y_{i,t} s_{i,t}\right)$.

Writing averages of start and end period values as $\bar{y}$ and $\bar{s}$, consider the expression

$$\Delta y \cdot \bar{s} + \Delta s \cdot \bar{y} = \left(y_{t+n} - y_t\right)\cdot\frac{\left(s_t + s_{t+n}\right)}{2} + \left(s_{t+n} - s_t\right)\cdot\frac{\left(y_t + y_{t+n}\right)}{2} = y_{t+n}s_{t+n} - y_t s_t \qquad (4)$$

Substituting the single industry version of (4) in the above gives

$$\Delta y = \sum_i \left(\Delta y_i \cdot \bar{s}_i + \Delta s_i \cdot \overline{y_i} \right) \tag{5}$$

Combining into (1)

$$\overset{\circ}{y} = \overset{\circ}{y}{}_t^{t+n} \cong \frac{\Delta y}{n\, y_t} = \frac{1}{n\, y_t} \sum_i \left(\Delta y_i \cdot \bar{s}_i + \Delta s_i \cdot \overline{y_i} \right) \tag{6}$$

(6) is the shift-share equation used in the main report to decompose the growth of productivity in market services into the contribution from single service industries. The intra-industry productivity $\frac{1}{n\, y_t} \sum_i \Delta y_i \cdot \bar{s}_i$ comprises individual industry growth changes weighted by average share of labour, and the inter-industry effect of possible employment restructuring $\frac{1}{n\, y_t} \sum_i \Delta s_i \cdot \overline{y_i}$ is given by the change in labour share of each industry weighted by the average productivity level.

We take the decomposition further. In the growth accounting procedure (2) applies to each industry, i.e. the change in growth Δy_i can be split in each industry into appropriate components $x_{c,i}$ where $\sum_c x_{c,i} = 1$ for each i. yielding

$$\overset{\circ}{y} \cong \frac{1}{n\, y_t} \sum_i \left(\sum_c x_{c,i} \Delta y_i \cdot \bar{s}_i + \Delta s_i \cdot \bar{y}_i \right) \tag{7}$$

The contribution of each industry to the aggregate growth of the group of industries thus consists of a sub-contribution from each of LQ, ICT, nICT, TFP for each industry, which together make up the within-industry productivity growth component plus a fifth contribution capturing the shift effect. The latter is usually quite small in comparison, but is included for the sake of completeness.

The deviations that would be incurred due to the approximations used in the above analysis are avoided in the tables of results presented by normalising with respect to industry sums instead of using the aggregate as a denominator. The approximation errors are, however, negligible.

Annex B: The Production Function Approach

For our econometric estimates we used the production function approach as in Stiroh (2002). The central assumption is that production in the market service industries takes place according to the function

$$Y_{it} = A_{it} L_{it}^{\alpha} K_{it}^{\beta} \tag{A.1}$$

The production function is a standard Cobb-Douglas specification which states that **value added** (y) is explained by labour input (L), capital input (K), their respective shares in production (α and β) and a technology shift parameter (A). The subscript i denotes countries and industries while t denotes the respective time period. Taking first differences of the logarithm and splitting up capital into non-ICT and ICT components, and measuring labour input by total hours worked and taking into account labour quality, equation (A.1) can be re-written as:

$$\Delta y_{it} = \alpha_1 + \alpha_2 \Delta lab_{it} + \alpha_3 \Delta laq_{it} + \beta_1 \Delta k_{it}^{N-ICT} + \beta_2 \Delta k_{it}^{ICT} + \varepsilon_{it} \tag{A.2}$$

where lower case letters indicate logarithms, Δ is the difference operator, and ε is the residual term. Equation (A.2) extends the specification of Stiroh (2002) and O'Mahony and Vecchi (2003) by adding the labour quality variable. The labour quality time series, nevertheless, should be interpreted with care.

Determining the effect of production inputs on **labour productivity**, we again start with equation (A.1) but now divide both sides by the labour input variable, which yields

$$ALP_{i,t} = \frac{Y_{i,t}}{L_{i,t}} = \frac{A_{i,t} L_{it}^{\alpha} K_{it}^{\beta}}{L_{i,t}} \tag{A.3}$$

where $ALP_{i,t}$ denotes average labour productivity. Simplifying, taking logs and first differences we obtain the following equation that was estimated:

$$\Delta alp_{i,t} = \alpha_{0i} + (\alpha_1 - 1)\Delta l_{i,t} + \beta_1 \Delta k_{i,t}^{N-ICT} + \beta_2 \Delta k_{i,t}^{ICT} + \varepsilon_{i,t} \tag{A.4}$$

Note that the growth of labour negatively influences the growth of average labour productivity, as $\alpha_1 - 1$ is negative. The economic intuition behind this is that labour is not the only factor in production, it only determines production, and therefore productivity, partially.

To estimate the **labour demand** equation, which is discussed later, we again start with equation (A.1). Now, we also have to take the costs of the production function and labour into account. To obtain the demand equation, we have to solve the following optimisation problem:

$$\min_L C = wL + rK \text{ s.t. } Y = AL^{\alpha}K^{\beta}.$$

The first order condition of the problem is given by $w = A\alpha L^{\alpha-1}K^{\beta}$. Rearranging terms we obtain

$$L = \left(A\alpha K^{\beta} w^{-1}\right)^{\frac{1}{1-\alpha}} ,$$

which, after taking logs and differences and allowing for two types of capital, yields

$$\Delta l_{i,t} = \frac{1}{1-\alpha}\Delta a_{i,t} + \frac{\beta_1}{1-\alpha}\Delta k_{i,t}^{ICT} + \frac{\beta_2}{1-\alpha}\Delta k_{i,t}^{N-ICT} - \frac{1}{1-\alpha}\Delta w_{i,t} + \varepsilon_{i,t}. \quad \text{(A.5)}$$

Equation (A.5) is the labour demand equation that follows from the production function approach and the specific functional form of the production function.

All estimated equations (A.2), (A.4) and (A.5) were first estimated by OLS. It should be clear, however, that OLS does not produce consistent estimators. As a result of this idea, supported by residual tests, coefficients using feasible GLS to account for heteroscedasticity and autocorrelation were estimated. If autocorrelation was discovered even with this approach, the estimates for the standard errors were corrected by estimating a heteroscedasticity and autocorrelation consistent variance-covariance matrix according to the idea first proposed by White (1980).

After having obtained consistent and unbiased coefficient estimates, the number of estimated parameters was reduced by excluding insignificant parameters, on the one hand, and improving the fit of the estimated regression by maximising the adjusted R-square, on the other hand. All the estimates shown in this report are final results after undertaking these procedures.

Annex C: Data and Methods

Available sources of data include the Groningen Growth and Development Centre (GGDG) databases[23], in particular the 60-Industry Database and the Industry Growth Accounting Database, as well as the OECD Structural Analysis (STAN) Database.

Data on labour productivity mainly build upon the 60-Industry Database which provides data for 19 European countries and the USA. Regarding the data, GGDC has taken care to avoid measurement errors between the USA and EU. The 60-Industry Database provides data on value added, employment, hours worked, value added deflators and labour compensation for 56 industries in 27 countries[24] for 1979-2002. It also includes, on a per industry basis, data on total hours worked, value added at constant prices (chained at 1995) as well as labour productivity per hour and per employee. The 60-Industry Database is a successor database of the Industry Labour Productivity Database which comprises data of the OECD Structural Analysis (STAN) Database at a more disaggregated level and complemented with information from industry surveys.

The Industry Growth Accounting Database includes detailed data of growth rates of ICT capital investments and ICT shares. However, detailed data about ICT investments and intensity are only available for the USA, Germany, France, the UK and the Netherlands. The Industry Growth Accounting Database classifies industries at a more aggregated level than the 60-Industry-Database. It covers 26 industries for four European countries, the USA and the aggregated EU-4 for 1979-2001. GGDC provides data on labour skills and investments for those countries and industries. The labour skills variable has been derived by dividing labour input into skill categories and weighting each skill group by its wage share. For capital input, six asset types have been distinguished. The data for the respective countries were collected from the countries' national statistical institutions.

For analysing the ICT shares of industries and estimating the effects of investments in ICT capital on value added or productivity, the Industry Growth Accounting Database is of considerable importance. However, only growth rate data are available for ICT and non-ICT capital stock, limiting our economic and econometric repertoire.

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[23] See http://www.ggdc.net/

[24] The countries included are 19 EU Member States, the USA, Canada, Japan, Norway, Switzerland, Korea, Taiwan and Australia.

Methods used include growth accounting, shift-share analysis, including an analytical framework for combining these approaches, and econometric analysis of time-series data. Details are presented in the Annex to this Executive Summary.

ICT-Intensive Services

O'Mahony and Van Ark(2003) introduced a useful taxonomy comprising ICT-producing, ICT-using and non-ICT industries, further differentiated between manufacturing and services (plus a "rest" category). In our analysis of the service sector, we use the term ICT-intensive to cover both ICT-producing and ICT-using service industries. The classification of industries in the 60-Industry Database and the Industry Growth Accounting Database, in terms of the International Standard of Industrial Classification of economic activities (ISIC, Revision 3) code, is as follows: (Note the colour coding - red: ICT-producing; green: ICT-using; blue: non-ICT-intensive.)

Market Services in the 60-Industry Database

ISIC rev 3	ICT-INTENSIVE (Producing / Using) SERVICES	NON-ICT-INTENSIVE SERVICES	ISIC rev 3
64	Communications*		
72	Computer and related activities*		
51	Wholesale trade and commission trade, except motor vehicles and motorcycles	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	50
52	Retail trade, except motor vehicles and motorycles; repair of personal and household goods	Hotels & Catering	55
65	Financial intermediation, except insurance and pension funding	Inland transport	60
66	Insurance and pension funding, except compulsory social security	Water transport	61
67	Activities auxiliary to financial intermediation	Air transport	62
71	Renting of machinery and equipment	Supporting and auxiliary transport activities; activities of travel agencies	63
73	Research and development	Real estate activities	70
741-3	Legal, technical and advertising	Other business activities, nec	749

* ICT-producing services

Market Services in the Industry Growth Accounting Database

ISIC rev 3	ICT-INTENSIVE (Producing / Using) SERVICES	NON-ICT-INTENSIVE SERVICES	ISIC rev 3
64	Communications*	Hotels & Catering	50
50+51	Repairs and wholesale trade	Transport	60+61+62+63
52	Retail trade	Communications	64
65+66+67	Financial intermediation	Other Services	90-93 + 95
70-73 + 741-3 + 749	Real Estate Activities and Business Services**		

* ICT-producing services

**Note remarks on classification, main report section 2.3.

Glossary and Definition of Terms

To clarify the taxonomy used, a distinction is made between:

EU-4 (including only Germany, France, the UK and the Netherlands),

EU-15 (including all EU Member States until the enlargement of 2004),

EU-19 (including EU-15, the Czech Republic, Hungary, Poland and Slovakia), and

EU-25: the current European Union of 25 Member States.

ICT-4: ICT-intensive service industries (retail trade, wholesale trade, financial services, communications)

Growth Rates

Unless otherwise indicated, growth rates used in the report are *annualised rates of growth* calculated as $\overset{\circ}{y} = (\log y_t - \log y_0)/t$ for levels of labour productivity y over t time periods. These are also known as "instantaneous" or "exponential" rate of growth and approximate the annual compound growth rate $\exp(\overset{\circ}{y}) - 1$.

The change in the level of productivity y, Δy, from y_0 to y_t, over time period t is given by $\frac{\Delta y}{t} \Big/ y$ which has the continuous time equivalent of $\frac{dy}{dt} \Big/ y = \frac{d \log y}{dt}$, designated as $\overset{\circ}{y}$. This instantaneous growth rate would lead to exponential growth at a constant rate of $\overset{\circ}{y}$, i.e. $y_t = y_0 \exp(\overset{\circ}{y} \cdot t)$. Taking logarithms, we get $\overset{\circ}{y} = (\log y_t - \log y_0)/t$ in general so that the growth rate from period t to period $t+1$ is given by $\log y_{t+1} - \log y_t$. These relationships define the connection between the growth accounting and the levels databases.

THE EUROPEAN SINGLE MARKET FOR SERVICES IN THE CONTEXT OF THE LISBON AGENDA: MACRO-ECONOMIC EFFECTS

Europainstitut, Vienna University of Economics and Business Administration

Abridged Report

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Study commissioned by the Federal Ministry of Economics and Labour of Austria

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1. Introduction

Making the Single Market more dynamic has been identified as one of the top priorities to improve the EU's growth performance (Sapir et al., 2004). In contrast to manufacturing industries, where the Single Market appears to be working quite well (see Badinger, 2005), a recent assessment by the European Commission (2002) on the state of the internal market for services has identified a large gap between the vision of an integrated European economy and reality in service industries. There are still many impediments to the free movement of services in the EU. Particularly for small and medium-sized enterprises, the bulk of service providers, entry barriers in new EU markets are often prohibitive. In its Draft Directive on Services in the Internal Market (European Commission, 2004), henceforth referred to as the Services Directive (SD), the European Commission aimed at removing the remaining barriers in this area to enable firms to exploit the full potential of cross-border services. This would be an important step forward in bringing the EU closer to its Lisbon targets.

Previous studies suggest sizeable macro-economic effects of the SD. Kox et al. (2004, and the revised version of 2005) econometrically estimate the implications of the SD for the cross-border provision of services; their results suggest that (in the service industries investigated) intra-EU trade would increase by some 44 percent and intra-EU FDIs by some 26 percent. Copenhagen Economics (2004) simulates the effects of the SD using a computable general equilibrium (CGE) model, assuming a reduction in tariffs equivalent to the obstacles to cross-border provision of services (estimated in a first step). Their simulations suggest an increase in employment by around 600,000 persons and an increase in activity (value added) by some 1.1 percent.

This study supplements previous studies, using a simple econometric approach to estimate the effects of the SD on productivity, employment, value added and investment. We focus on the role of trade and competition, the two main channels via which the effects of the SD are supposed to materialise. We do not find a direct effect of trade on productivity. However, for service industries covered by the SD (except travel), we do find both economically and statistically significant effects of trade on competition, and of competition on productivity, employment and investment. More trade leads to more competition (pro-competitive effect) which is associated with higher productivity, employment, investment and output. Assuming a reasonable range of values for the increase in competition, our simulations suggest that productivity in the service industries covered by the SD could rise by 0.80 percent, employment by 0.85 percent (or by 612,000 in the EU-25), and the investment ratio by 0.55 percentage points. Value added of the services covered will increase by 1.65 percent, which corresponds to an aggregate GDP effect of 0.69 percent.

The remainder of this paper is organised as follows: Section II provides a concise description of the main features of the SD. Section III outlines the main transmission channels via which the SD is supposed to contribute to the Lisbon goal of more jobs and growth. Section IV briefly reviews previous studies on the effects of the SD, while Section V presents the results of our own estimates, including a description of the data and the method used. Section VI gives an overview of the results of our simulation of the macro-economic effects of the SD. The final section VII summarises the results and outlines several policy conclusions.

2. The Services Directive

The proper functioning of the Single Market is key to the EU's Lisbon agenda: "The Single Market and active competition policy remain the cornerstone of efforts at EU level to improve European growth performance. They represent a foundation without which other efforts would be wasted." (Sapir et al., 2004, p. 130). The state of the Single Market for services is still very poor as detailed in European Commission (2002). The main instrument proposed by the European Commission to overcome this deficiency is the Draft Directive on Services in the Internal Market (European Commission, 2004), presented by the Prodi Commission in January 2004. The SD has met heavy resistance from different parties, in particular the trade unions. And while the European Council stressed the importance of a functioning internal market for services in March 2005, it also emphasised that the "European social model" should be preserved. The directive's current version was not considered to fulfil these requirements completely. At present, the SD is discussed in the European Parliament. In the meanwhile, the SD took a large step forward, when the Parliament's Committee on the Internal Market and Consumer Protection adopted the Gebhardt report on the SD maintaining the disputed country of origin principle on 22 November 2005. MEPs watered down the Commission's draft less than rapporteur Evelyne Gebhardt had wanted. Despite this vote, the debate is not over. Negotiations between the political groups on the precise coverage and the country of origin principle will continue up to the first reading vote by the full Parliament, which is scheduled for January or February 2006. As a result, considerable uncertainty remains about the ultimate version of the directive (industry coverage, country of origin principle, protection of welfare and environmental standards of the country where the service is provided) and the time schedule for its implementation.

The SD builds on Articles 43 and 48 ("freedom of establishment") and Article 49 ("freedom to provide services within the Community") of the EC Treaty. In practice, these principles are often violated. The SD is aimed at removing the manifold remaining barriers that have been identified by the European Commission (2002).

The SD is based on a horizontal approach, reflecting the fact that many impediments to the free movement of services are common across industries. It should be noted, however, that the SD does not apply to non-market services such as public administration, public defence, etc. In addition, financial services, transport and telecommunications are excluded from the SD since they are already covered by other existing (or forthcoming) Community instruments (e.g. the Financial Services Action Plan). Hence, only half of all services, which in sum account for some three quarters of GDP of the EU-15 countries, are covered by the SD: these industries, however, still make up some 40 percent of GDP, roughly twice as much as total manufacturing. We will return to a discussion of the particular industries covered and their quantitative importance below.

The SD contains two main elements: (1) freedom of establishment for service providers in other EU Member States, and (2) free movement (trade) of services between EU Member States. We briefly discuss each of them in turn.[25]

2.1 Freedom of Establishment for Service Providers in Other EU Member States

This part aims at removing all barriers that hinder European companies to set up subsidiaries in other EU countries. This involves several measures to simplify procedures. Most importantly, it suggests the establishment of a "single point of contact", where firms wishing to establish in a country can do all the necessary paperwork and formalities; and it requires each country to provide clear (and electronically accessible) information on procedures and formalities through this point of contact.

[25] For more details, see European Commission (2004), O'Toole (2005) and OECD (2005).

Other elements of this part deal with authorisation requirements: in general, they should not discriminate on the basis of nationality, must be justifiable and precise, and the conditions for granting the authorisation must be made public in advance. In addition, there are a number of particular authorisation requirements that are explicitly banned (so-called "black list"). Member States are required to screen their current legislation and remove such illegal requirements.

2.2 Free Movement of Services

This part is designed to facilitate the cross-border provision of services, which often requires the temporary movement of staff. Its core element is the so-called "country of origin principle", which states that service providers are only subject to the regulatory provisions of their own country. This enables firms to provide cross-border services without having detailed knowledge of the regulatory framework of all other EU countries. There are several exceptions from this principle for certain activities, however. Most notably, the country of origin principle does not overrule the Posting of Workers Directive providing that temporary workers are subject to host country provisions with respect to employment conditions (minimum wage, holidays, insurance).[26]

Another element aims at removing barriers for recipients of services, i.e. consumers. In particular, the SD requires the Member States to abolish any provisions favouring domestic suppliers.

3. Possible Economic Impacts of the Services Directive

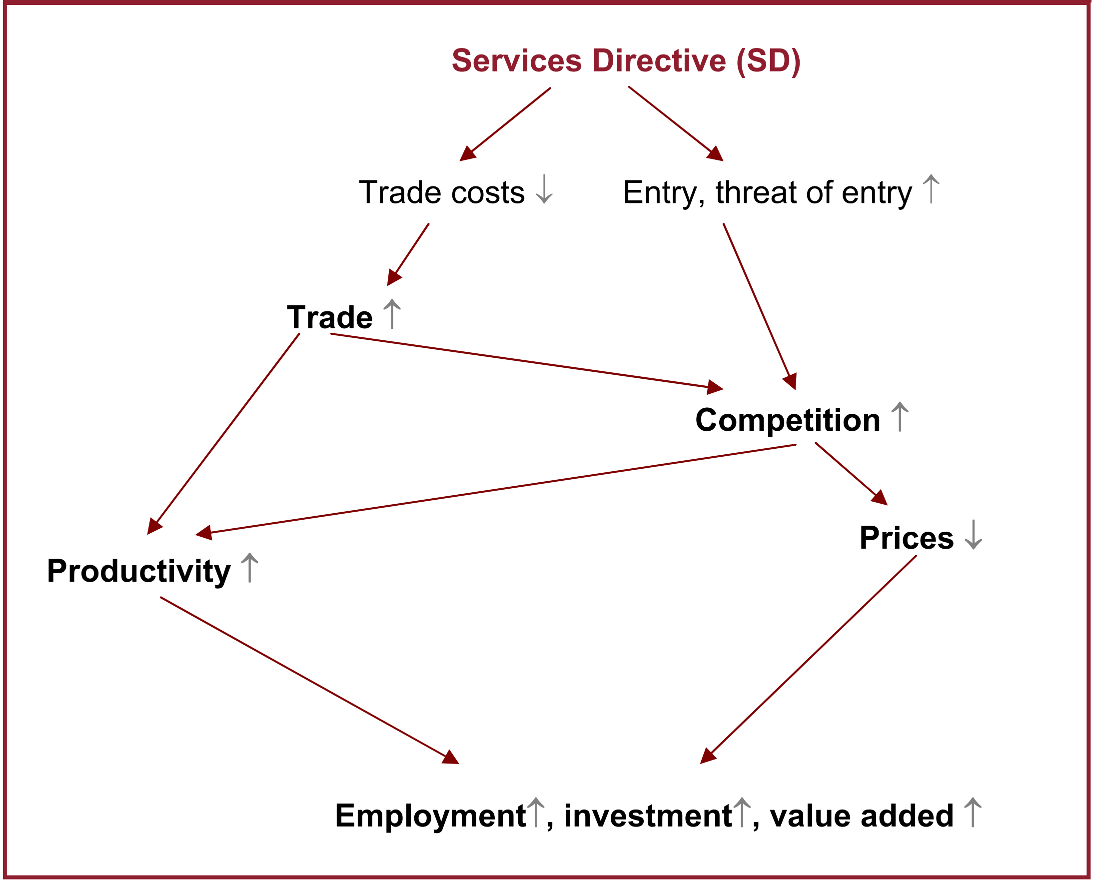
Extending the (functioning of the) Single Market to service industries by implementing the four freedoms has no direct effects on growth and employment, but it is supposed to generate its effects mainly via an increase in trade and competition.

Figure 1 illustrates the main channels through which the Single Market may contribute indirectly to an improvement of macro-economic performance. The abolishment of non-tariff barriers leads to an increase in intra-EU trade and easier market access for foreign (EU) firms. Apart from increasing competition, more trade is supposed to raise productivity mainly through three channels: the exploitation of economies of scale as a result of larger markets,

[26] For a more detailed discussion of the SD and its relation to the Posting of Workers Directive, see OECD (2005, p. 126ff).

international specialisation according to comparative advantages, and its contribution to the international diffusion of technology and knowledge (see Frankel and Romer, 1999). This is the first transmission channel we will investigate.[27]

Figure 1. The Services Directive and Macro-economic Performance



The second and potentially more important channel we will investigate is the increase in competition triggered by an implementation of the SD. Abolishing market barriers and reducing the start-up costs for firms increases entry as well as the threat of entry, both contributing to a more competitive environment. Competition, in turn, increases productivity by bringing prices more in line with marginal costs, which reduces distortions of the price mechanism and enables a more efficient allocation of resources and higher productivity of the factors capital and labour (allocative efficiency); higher competitive pressure also

[27] A related channel involving similar mechanisms is foreign direct investment (FDI); the effects of FDIs, however, are not investigated in this paper.

increases the incentives for the management to organise work more efficiently and to reduce slack, as well as potential gains from exploiting increasing returns to scale as market size increases (productive efficiency). Finally, competition might also raise dynamic efficiency by increasing incentives for R&D activities and innovations and thereby boosting technological progress and growth of total factor productivity.[28]

An increase in competition will also reduce prices for two reasons: first, marginal costs go down as a result of higher productivity. Second, as a consequence of diminished market power, firms' mark-ups over marginal costs decrease as well. This reduction in prices increases the demand for services and thus also output. Whether the demand for production factors (employment and investment) ultimately increase, too, is a question that has to be answered empirically; it is conceivable that the increase in demand for services can be met with a given (or even with a smaller) input of production factors as a result of the original increase in productivity.[29] For a more detailed discussion of the transmission channels of the Single Market and the effects on macro-economic performance, see Griffith and Harrison (2004), Nicodème and Sauner-Leroy (2004), and OECD (2003).

4. The Economic Implications of the Services Directive: Previous Studies

Most studies on the effects on the Single Market focus on manufacturing, and here in turn often only on selected industries where strong effects of the Single Market were to be expected according to Buiges et al. (1990). To date, there are only three studies on the service industries and the likely implications of the SD: Kox et al. (2004, and the revised version of 2005), Copenhagen Economics (2004), and O'Toole (2005) for Ireland. We will briefly discuss the studies by Kox et al. and Copenhagen Economics.

4.1 Kox et al. (2004, 2005)

The core argument in the analysis of Kox et al. (2005) is that it is not only the degree of regulation in service industries, but also the heterogeneity of regulations across EU countries

[28] Recently, it has been suggested that there might be an inverse U-shaped relationship between competition and innovation (Aghion et al., 2005), i.e. there could be an optimal degree of competition between too little and too much competition.

[29] In a recent paper, Nordhaus (2005) shows that - in contrast to widely held views - the increase in productivity in US manufacturing has rather mitigated than caused the large reduction in employment in manufacturing, whose primary cause turns out to be the increase in productivity and decline in prices of international competitors.

that hampers the free movement of services within the EU. Building on previous work by the OECD, particularly Nicoletti et al. (2000) and Golub (2003), Kox et al. develop an index for the heterogeneity of regulation in service industries (with sub-indices), based on a bilateral comparison of 183 aspects of market regulation. In a next step, they investigate the consequences of an implementation of the SD on the heterogeneity indices. While the Commission's proposal still leaves some room for differences in national preferences regarding regulations, the creation of a unified framework leads to a reduction in the heterogeneity of regulation. Table 1 shows the estimated reductions in the heterogeneity of regulation as a result of the implementation of the SD. To account for uncertainty (degree of implementation, statistical uncertainty), Kox et al. provide a range of estimates for each sub-index and the overall heterogeneity indicator.

Table 1. ***Expected Impacts of Proposed EU Measures in the SD on Intra-EU Policy Heterogeneity***

Sub-index	Reduction
Regulatory and administrative opacity	66-77%
Explicit barriers to trade and investment	73-78%
Administrative burdens on start-ups	34-46%
Barriers to competition	29-27%
State control	3-6%
Overall heterogeneity indicator	31-38%

Source: Kox et al. (2005, S. 32)

Subsequently, Kox et al. (2005) estimate the effects of regulatory heterogeneity on bilateral intra-EU trade in services (chapter 4) and intra-EU FDIs (chapter 5) in services. For trade, they use a gravity model, the standard approach to estimating trade potentials; for FDIs, the gravity model is slightly modified in line with the knowledge-capital model by Markusen (2002). The indices of regulatory heterogeneity are used as explanatory variables in both models; then the effects of the SD's implementation are simulated using the (significant) parameter estimates and the expected reduction of the respective indices (according to the values in table 1). The sample comprises bilateral trade flows of the 14 old EU countries

(Belgium and Luxembourg are aggregated) for the years 1999-2001. In the investigation of bilateral FDI stocks, three new Member States are also contained in the sample (Czech Republic, Hungary, and Poland), but here only the years 1998 and 1999 are considered. Kox et al. take the commercial services sector as an aggregate, where only those sectors are covered that are affected by the SD ("transport" and "travel", which together make up some 50 percent of total trade in services are excluded).

According to the results of the latest version of the study (Kox et al., 2005), the implementation of the SD would have the following effects: (1) Intra-EU trade in services increases by 44 percent (range: 30-62 percent),[30] and (2) Intra-EU FDIs in services increase by 26 percent (range: 18-36 percent).

4.2 Copenhagen Economics (2004)

Similar to Kox et al. (2005), but using alternative methods, Copenhagen Economics (2004) constructs indices for barriers in service industries. In a next step the effects of these barriers on price cost margins of firms are estimated. The results are difficult to summarise since Copenhagen Economics (2004) differentiates between cost and rent creating barriers, whose estimates in turn vary considerably across countries and industries (Copenhagen Economics, 2004, p. 80ff). Roughly speaking, the estimates of the price and cost impacts range from zero to 14.5 percent (Copenhagen Economics, 2004, table 5-6). Then these effects are converted into tariff equivalents, i.e. tariffs that would imply the same effect on price cost margins as the barriers. Naturally, there is also considerable cross-country and cross-industry variation.

In a third step, Copenhagen Economics investigates, using a computable general equilibrium (CGE) model, how an elimination of the barriers in services (that is an elimination of the tariff equivalents) affects the economy. The simulation is carried out for the current EU, including the new Member States (EU-25). The most striking result that has received most attention is, that the model predicts an economy-wide increase in employment by 0.3 percent, that is 600,000 new jobs. Employment in the services industries is predicted to go up by 0.5 percent and value added by 1.1 percent.

[30] Intra-EU trade covers approximately half of total trade in services. Consequently, the estimated effect on total trade in services is half of the effects given above. In terms of total intra-EU trade (including goods), the estimated effect corresponds to an increase by 2 to 5 percent.

5. Econometric Estimation of the Economic Effects of the Services Directive

5.1 Data Sources and Country Coverage

Our data set draws on several sources. Data except those on trade were taken and derived from the *60-Industry Database* of the Groningen Growth and Development Centre (GGDC, 2005) as well as from the *Structural Analysis (STAN) Database* of the OECD. The latter source was particularly important for obtaining investment data needed to calculate investment ratios, capital stocks (and to derive estimates for mark-ups). Trade data were taken exclusively from the *Statistics on International Trade in Services* database of the OECD.

As far as country coverage is concerned, our initial approach was to use the EU-25, of course; it turned out, however, that even four of the EU-15 countries had to be excluded due to missing data (Denmark, Luxembourg, Ireland, and Portugal). For several specifications, particularly those requiring data on mark-ups, the cross-section dimension had to be further reduced since not all countries have data for real investment in all industries considered.[31] Nevertheless, the coverage is large enough to regard our results as representative, at least for the EU-15, and to a smaller extent for the EU-25 as well. As control countries and to add observations, we also included Norway and the USA, two further OECD countries for which sufficient data were available. We emphasise that we checked the sensitivity of the results, when these two non-EU countries were excluded or when country dummies for the USA and Norway were used, and found that their inclusion makes no important difference to the results.

5.2 Industry Classification and Coverage of the Services Directive

We use the most detailed classification of service industries which our data sources permit. Restrictions are placed by all sources, also since the industry classifications used by the STAN and the GGDC data (International Standard of Industrial Classification) are not exactly the same as the one used in the OECD Statistics on International Trade in Services (Extended Balance of Payments Services Classification). Fortunately, the correspondences

[31] This is particularly true for Belgium, Spain, Italy, Sweden and the United Kingdom.

(see UN, 2002) turned out to be close enough to obtain a reasonable sub-classification of the service sector into 13 detailed service industries.

Table 2. Composition of EU-15's Total Value Added (VA) and Employment (EMP) in 2002

			VA	EMP	VA	EMP
		ISIC Rev3	(million euro)	(1000)	(percent of total)	
TOTAL (ALL INDUSTRIES)		**01-99**	**9,233,547**	**170,059**	**100**	**100**
Agriculture, forestry, fishing		01,02,05	146,731	6,993	1.59	4.11
Mining and quarrying		10-14	76,925	368	0.83	0.22
Manufacturing		15-37	1,707,667	29,409	18.49	17.29
Electricity, gas and water supply		40-41	191,940	1,017	2.08	0.60
Total services		45-99	7,110,284	132,272	77.00	77.78
Total services		**45-99**	**7,110,284**	**132,272**	**77.00**	**77.78**
Service industries included in estimation		**45-749**	**5,006,293**	**81,730**	**54.22**	**48.06**
Construction	SI01	45	561,000	11,803	6.08	6.94
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	SI02	50	166,110	3,786	1.80	2.23
Wholesale trade and commission trade, except motor vehicles and motorcycles	SI02	51	424,100	7,430	4.59	4.37
Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	SI02	52	425,910	14,920	4.61	8.77
Hotels & restaurants	SI03	55	256,440	8,275	2.78	4.87
Inland transport	SI04	60	202,410	4,460	2.19	2.62
Water transport	SI04	61	21,465	182	0.23	0.11
Air transport	SI05	62	39,098	388	0.42	0.23
(Supporting and auxiliary transport activities; activities of travel agencies)		63	135,580	2,094	1.47	1.23
Communications	SI06	64	259,080	2,645	2.81	1.56
Financial intermediation, except insurance and pension funding	SI07	65	333,090	3,284	3.61	1.93
Insurance and pension funding, except compulsory social security	SI08	66	77,841	983	0.84	0.58
(Activities auxiliary to financial intermediation)		67	65,285	1,157	0.71	0.68
Real estate activities	SI13	70	928,360	1,713	10.05	1.01
Renting of machinery and equipment	SI09	71	110,360	531	1.20	0.31
Computer and related activities	SI10	72	185,330	2,299	2.01	1.35
Research and development	SI11	73	39,814	690	0.43	0.41
Legal, technical and advertising	SI12	741-3	469,550	6,628	5.09	3.90
Other business activities, nec	SI12	749	305,470	8,462	3.31	4.98
Service industries excluded from estimation		**75-99**	**2,103,991**	**50,542**	**22.79**	**29.72**
Public administration and defence; compulsory social security		75	601,680	11,915	6.52	7.01
Education		80	472,420	11,051	5.12	6.50
Health and social work		85	613,320	15,509	6.64	9.12
Other community, social and personal services		90-93	359,200	8,440	3.89	4.96
Private households with employed persons		95	57,371	3,627	0.62	2.13
Extra-territorial organisations and bodies		99	0	0	0.00	0.00

Table 2 gives a detailed overview of the composition of the EU-15's value added and employment by industry. Which of the industries listed in table 2 are most likely to be covered by the SD? Starting from a broad view, total services constitute 77 percent of value added or 78 percent of total employment. It should be added, however, that several service industries are not considered to be covered by the SD: these are typical non-market or government provided services (such as public administration, public defence, health and social work, etc.). Together these industries make up 23 percent of total value added (or 30 percent of total employment), leaving services industries totalling 54 percent of total value added (or 48 percent in terms of total employment) to be potentially covered by the SD. These industries, referred to as SI01 to SI13, constitute our most comprehensive sample.[32]

From this sample, however, not all industries will be covered. First, transport (SI04, SI05) is excluded from the SD; the same is true for financial services (SI07, SI08). We also exclude travel (SI03) (though it is largely covered by the SD) for two reasons: first, to make our sample as consistent as possible with the Kox et al. (2005) study that excludes travel from the estimates (which we will use in the simulation); second, travel turns out to be an outlier in the sense that results change significantly when it is added to the sample. (The relevance of the sample choice will be discussed in greater detail below). Communication (SI06), which includes telecommunication, and construction (SI01) are partly excluded from the SD. It should also be noted that revisions of the SD are still under discussion so that its ultimate coverage and the degree of implementation are uncertain; further restrictions on the industry coverage or a watering down of the envisaged "country of origin principle" are possible (see also Vogt, 2005).

We handle this uncertainty by applying the "LEGO approach", that means we start from the most comprehensive sample including all industries, and then exclude, step by step, industries which are not covered (or not fully covered) by the SD. The final industry classification and the samples used are given in table 3.

To give some impression of the relevance of the respective samples, table 3 shows the corresponding shares of the services industries contained in the samples in total value added and total employment. While we will use the "LEGO approach" and carry out the estimation

[32] For reasons of data availability two industries are not contained in our samples (supporting and auxiliary transport activities; activities of travel agencies as well as activities auxiliary to financial intermediation); together, they account for 2.18 percent of total value added.

for all samples, sample D, which is closest to both the study by Kox et al. (2005) and the coverage of the SD, will be the preferred one on which we will focus in the interpretation.

Table 3. *Overview of Final Industry Classification and Samples Used in Estimation*

(a) Detailed industries contained in full sample		Value added	Employment
		Percent of total	
SI01	Construction	6.08	6.94
SI02	Trade and repair	11.00	15.37
SI03	Travel (hotels and restaurants)[1)]	2.78	4.87
SI04	Water, land transport, etc.	2.42	2.73
SI05	Air transport	0.42	0.23
SI06	Post and telecommunications	2.81	1.56
SI07	Financial intermediation	3.61	1.93
SI08	Insurance and pension funding	0.84	0.58
SI09	Renting of machinery and equipment	1.20	0.31
SI10	Computer and related activities	2.01	1.35
SI11	Research and development	0.43	0.41
SI12	Other business activities	8.39	8.87
SI13	Real estate activities	10.05	1.01
(b) Samples used in estimation			
Sample A	All (SI01-SI13)	52.04	46.15
Sample B	Sample A, excluding transport (SI04,SI05)	49.20	43.19
Sample C	Sample B, excluding financial services (SI07,08)	44.74	40.68
Sample D	Sample C, excluding travel (SI03)	41.97	35.82
Sample Da	Sample D, excluding construction (SI01)	35.89	28.87
Sample Db	Sample D, excluding communication (SI06)	39.16	34.26

Data refer to EU-15 and the year 2002. Sources: GGDC-60 industry database (see table 2). Sample A does not include the industries in parentheses from table 2. [1)] For SI03 ("Travel") no perfect correspondence could be achieved: trade data for SI03 include both hotels and restaurants as well as travel agencies, whereas SI03 for the other variables covers only hotels and restaurants (since activities of travel agencies and tour operators are only available aggregated with transport activities, and cannot be allocated accordingly).

5.3 Methodological Issues

In this section we briefly outline the empirical approach to estimating the effects of the SD. We keep the discussion brief and informal, referring the reader to Breuss and Badinger (2005) for more details.

Our empirical analysis can be divided into three classes of empirical models which are all similar in their structure and motivated by the transmission channels of the SD illustrated in figure 1:

- First, we explain competition (measured as mark-up ratio, i.e. the ratio of prices over marginal costs) by domestic market size (in terms of population) and trade (more precisely, the ratio of imports to production) to figure out the likely pro-competitive effect of the increase in trade triggered by the SD.
- Our second group of models investigates the link between productivity (measured in terms of value added per hour worked) and domestic market size and trade. This should help us to assess the first important channel of the SD, the direct effects of trade on productivity. The basic specification used is similar to the study by Frankel and Romer (1999) who, however, use aggregate data and a large sample of countries.
- The third group of models tries to examine the relation between economic performance (productivity, employment, investment) and market size and competition. These models are similar in spirit to the approach taken by Griffith and Harrison (2004).

Endogeneity is likely to be a problem in all models: trade is endogenous with respect to productivity and competition, and competition is likely to be endogenous with respect to performance (particularly productivity). Previous studies with similar specifications suggest that least squares estimates are not far off (or often tend to underestimate the effects). Nevertheless, we check the robustness of the results using instrumental variable (IV) techniques, thereby exploiting the exogeneity of geography.[33] The basic message of this exercise is that the least squares estimates are not misleading.

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[33] In particular, we use the fact that aggregate "proximity" of a country and industry is an important determinant of both trade and competition (through trade and threat of entry). Ideally, these proximity measures would be constructed from (industry-specific) geographical trade shares calculated from the estimates of bilateral gravity models including geographical variables only (as suggested by Frankel and Romer, 1999). Such an approach was chosen in a similar setting for manufacturing industries by Badinger and Breuss (2005). For service industries at the level of disaggregation used here, however, bilateral trade data are not available; hence, we use an auxiliary approach and construct the instruments for trade and competition for a sample of services industries from industry-specific proximity measures for manufacturing industries from Breuss and Badinger (2005).

We use two approaches: a cross-section approach referring to averages of the period 1995-2000, and a panel approach with regard to the period 1978-2002. The advantage of the cross-section approach is that it refers to more actual data and that geography-based (i.e. time-invariant) instruments can be used to address endogeneity concerns. Here, the advantage of the panel estimates lies in the use of much more observations; a disadvantage is that we are forced to rely on the least squares estimates; this is not too much of a problem, however, in light of the small differences between the least squares and the IV results in the cross-section analysis.

As to the industry dimension, we always start from the most comprehensive sample A, including all industries, and then, step by step, exclude industries not covered by the SD until we arrive at sample D.

5.4 Estimation Results

As far as the direct effects of trade on productivity are concerned, the results are disappointing. In contrast to aggregate estimates as in Frankel and Romer (1999) and industry estimates for manufacturing in Badinger and Breuss (2005), we do not obtain a direct effect of trade on productivity for any of the samples of service industries considered. This result remains a puzzle: it might be due the fact that that local commercial presence and FDIs are a more important source of international service provision. This channel is not covered by our trade data and thus omitted from our analysis. Since FDIs have been predicted to increase significantly as a result of the SD in the study by Kox et al. (2005), the role of FDIs in service industries may be worth being considered in future work. What we conclude from this result is that no direct productivity-stimulating effects of trade can be identified in the service industries covered by the SD.

Regarding the relationship between competition and economic performance, results correspond more closely to the theoretical presumptions. Table A1 in the appendix illustrates some key regression results, referring to sample D. The main results can be summarised as follows:

- For our preferred sample D (see table 3) we can identify indirect effects of the SD on the economic performance via an increase in competition. We find both economically and statistically significant effects of trade on competition (mark-ups), and of competition on productivity, employment and investment. More trade leads to more competition (lower mark-ups) which is associated with higher productivity as well as higher employment, investment and output.

- The IV results of our cross-section estimates tend to be higher than the least squares estimates. While the IV results should be treated with caution since only an auxiliary approach can be used for the construction of instruments, they nevertheless suggest that the least squares estimates are not fundamentally misleading.
- The results of the least squares panel estimates are in line with the results from the cross-section models, though the panel results suggest a somewhat smaller magnitude of the effects.
- As far as the relevance of the sample choice is concerned, it should be noted that the results are not completely robust for all samples given in table 3. As far as transport services are concerned, adding them to sample D hardly affects the results. This is not true for financial services; results are sensitive to adding this industry so that the results for sample D cannot be extended to financial services without qualification.
- A further point that deserves some discussion is the exclusion of “travel” from our preferred sample. On principle, travel (including hotels and restaurants, catering, as well as activities of travel agencies and tour operators, tourist assistance activities) is covered by the SD, but we nevertheless excluded it from the estimation for two reasons: first, to make our industry coverage as consistent as possible with the study by Kox et al. (2005) who excluded travel as well; second, “travel” (SI03) turned out to be an outlier in the estimation in so far as the results changed significantly when travel was added to the estimation. There is no fully convincing explanation for this phenomenon: particularly pronounced measurement problems in this industry may be one explanation; another issue is that competition in travel industries exhibits several idiosyncratic characteristics (as the role of local, region-specific amenities); a further point (at least for the regressions including trade) is that for this particular industry there is only a rough correspondence between our trade and production data.

6. Simulation of the Economic Implications of the Services Directive

Figure 2 illustrates our finding that the main channel through which the SD will contribute to macro-economic performance is an increase in competition. To obtain an assessment on the likely magnitude of these effects we need to quantify: (1) the likely increase in competition as a result of the SD, and (2) the magnitude of the effects of competition on performance.

Figure 2. Simulation of the Effects of the Services Directive

Services ⇒ **(1)** ⇒ **Competition** ⇒ **(2)** ⇒ **Performance**

6.1 Effects of the Services Directive on Competition

As a benchmark estimate of the likely effects of the SD on competition, we use our estimation results for the links between imports and competition, together with the trade effects of the SD according to Kox et al. (2005). As already mentioned above, they estimate that intra-EU trade (in the industries covered by the Directive) will increase by 30 to 62 percent as a result of the SD; in our simulation we focus on their central estimate of 44 percent. Please note that our estimates refer to total rather than intra-EU trade. Since intra-EU trade in services accounts for around half of total trade in services, we assume that the SD will increase total trade in services by some 22 percent.[34] The average of our estimates for our preferred sample D (see table A1 in the appendix) suggests that an increase in imports by one percent reduces mark-ups by 0.127 percentage points.

This implies that an increase in trade (imports) by 22 percent will translate into an increase in competition, i.e. a reduction in mark-ups by some 2.5 percentage points. It should be borne in mind, however, that the SD will enhance competition not only through an increase in trade but also by making market entry easier and increasing the threat of entry. Against this background we interpret the mark-up reduction of 2.5 percentage points as a lower bound; as an upper bound we will use a mark-up reduction of 5 percentage points (which also corresponds to the effects obtained using the coefficient from the cross-section IV

34 Hence, we assume that the effects estimated by Kox et al. are fully realised in terms of additional trade; it is conceivable that part of this additional intra-EU trade is simply substituted for extra-EU trade, yielding a smaller increase in total trade.

estimates).[35] As a central estimate for the simulation, we use a mark-up reduction by 3.75 percentage points.

6.2 Effects of Competition on Productivity, Employment, and Investment

Our estimates provide us with a range of coefficients for the effects of competition on productivity, employment and investment. Again, we focus on our preferred sample (D), but still we have three estimates: least squares and IV from the cross-section, and least squares from the panel. As a benchmark, we decided to use the average of the three estimates; as a consequence, the following coefficients are used in the simulation:

- semi-elasticity between productivity and mark-ups: -0.214,
- semi-elasticity between employment and mark-ups: -0.225,
- semi-elasticity between investment and mark-ups: -0.145.

Together with the assumed increase in competition (reduction in mark-ups) by 2.5 to 5 percentage points this will provide us with a range of estimates for regarding the effects of the SD on productivity, employment, investment and value added.

6.3 Results of Simulation

Table 4 summarises the results of the simulation for the EU as a whole. Please note that our estimation is carried out only for eleven EU countries due to limited data availability (see section V), but throughout we calculate the results for the EU-15 countries, too, and we also regard them as representative for the EU-25.

[35] This upper bound implies a relative reduction in mark-ups by 10 percent; this is still clearly below the mark-up reduction in manufacturing as a result of the Single Market according to the estimates by Badinger (2005).

Table 4. ***Economic Effects of the Services Directive – Estimates for the EU***			
	Minimum	Central	Maximum
Increase in competition (reduction in mark-ups in percent)	-2.5	-3.75	-5
Increase in productivity (percent)	0.53	0.80	1.07
Increase in employment (percent)	0.56	0.85	1.13
Increase in value added (percent)	1.10	1.65	2.20
Increase in investment ratio (percentage points)	0.36	0.55	0.73
Absolute increase in employment (in 1000)			
EU-11	323.6	485.3	647.1
EU-15	343.1	514.7	686.2
EU-25	408.0	612.0	816.0

The simulation suggests that in the service industries considered (sample D, see table 3), productivity in terms of value added per hour worked will go up by 0.53 to 1.07 percent (central estimate: 0.80 percent), employment by 0.56 to 1.13 percent (central estimate: 0.85 percent). Taken together, this implies an increase in value added by 1.10 to 2.20 percent (central estimate: 1.65 percent). The investment ratio is predicted to rise by 0.36 to 0.73 percentage points (central estimate: 0.55 percentage points).

Bearing in mind that the share in total value added of the industries considered makes up some 42 percent (EU-15, 2002 see table A1 in the appendix), the central estimates imply an aggregate GDP effect of 0.69 percent. Combining the relative effects on employment with the employment figures for the EU-11 and the EU-15 (sample D, values for 2002, see table 2), employment in service industries of the EU-11 is predicted to increase by some 485,000 persons, or by 515,000 persons in the EU-15: extrapolating the results to the EU-25 using the ratio of aggregate employment in the EU-25 to aggregate employment in the EU-15 (1.19), the predicted increase in employment for the EU-25 amounts to 612,000 persons. Table 4 shows the absolute changes in employment by country based on the central estimates.

Table 5. ***Absolute Employment Effects of the Services Directive – Estimates by Country***

		Minimum	Central	Maximum
AUT	Austria	7.0	10.6	14.1
BEL	Belgium	8.4	12.5	16.7
DEU	Germany	76.6	114.9	153.2
ESP	Spain	32.2	48.3	64.4
FIN	Finland	4.1	6.2	8.2
FRA	France	49.2	73.7	98.3
GBR	United Kingdom	66.8	100.2	133.6
GRC	Greece	6.7	10.0	13.3
ITA	Italy	46.0	69.0	92.0
NLD	Netherlands	18.8	28.2	37.6
SWE	Sweden	7.8	11.8	15.7
DNK	Denmark	5.3	7.9	10.6
LUX	Luxembourg	0.7	1.0	1.4
IRL	Ireland	3.7	5.5	7.3
PRT	Portugal	9.9	14.9	19.9
EU-15	European Union (15)	343.1	514.7	686.2

The same pro-competitive effect is assumed for each country here, i.e. the variation is only due to the different levels of employment in sample D across countries.

Comparing our aggregate estimates with the CGE simulations by Copenhagen Economics (2004), we find surprisingly similar results. The estimated increase in employment by Copenhagen Economics (2004, p. 31) amounts to around 600,000 persons, which is very close to our central estimates for the EU-25; the increase in value added in service industries according to Copenhagen Economics (2004, p. 32) amounts to 1.1 percent, which is also in the range of our estimates.

There is no reason to assume that changes in competition have fundamentally different effects across countries. This was also confirmed when trying to estimate country-specific coefficients for competition in the models for productivity, employment and investment, which yielded implausible results. However, the SD is likely to have different effects on the degree of competition in the EU countries, depending on the current level of regulation and regulation heterogeneity in the respective country. Kox et al. (2005) calculate country-specific changes of their regulation heterogeneity indices and use them to simulate country-specific effects of the SD on trade in services. Countries with a higher level of regulation (or more heterogeneity with respect to the other EU countries) will experience a larger opening up of markets and hence larger trade effects.

It is plausible to assume that the increase in imports relative to the EU average (implied by the country-specific estimates in Kox et al. (2005, p. 43)) is a good indicator for the increase in market access due to the SD relative to the EU average and thus for the increase in competition relative to the EU average. Table 6 shows the implied country-specific effects of the SD on productivity, employment, value added, investment and absolute employment, each of them based on the central estimate. Above average winners are Portugal, Denmark, Greece, Austria, and Italy; the effects in Germany, Spain, Finland, and France correspond roughly to the average EU effects, while Belgium, the Netherlands, Ireland, and Sweden gain less than the EU average. This is not a new result, of course, but an implication shared with the Kox et al. study.

It should be added that these figures are "bottom-line" results; potential reallocations between industries and countries are not investigated here. In particular, the fear of trade unions that the SD could lead to "social dumping" is not addressed in our study. On the one hand, the huge disparities in wage costs (roughly 1:10) could lead to an unbeatable comparative advantage of service providers from the new EU Member States of Eastern Europe. On the other hand, the old EU countries have a much stronger competitive edge in providing services when it comes to quality competition (for a related discussion, see Vogt (2005, p. 19)).

Table 6. ***Economic Effects of the Services Directive – Country-Specific Results***

		Pro-competitive effect relative to EU average[1)]	Competition	Productivity	Employment	Value added	Investment ratio	Employment
			percent	percent	percent	percent	percentage points	1000s
AUT	Austria	1.27	-4.77	1.02	1.08	2.10	0.69	13.4
BEL	Belgium	0.84	-3.15	0.67	0.71	1.38	0.46	10.5
DEU	Germany	1.07	-4.01	0.86	0.90	1.76	0.58	122.8
ESP	Spain	1.02	-3.84	0.82	0.86	1.68	0.56	49.4
FIN	Finland	1.00	-3.75	0.80	0.85	1.65	0.55	6.2
FRA	France	1.02	-3.84	0.82	0.86	1.68	0.56	75.4
GBR	United Kingdom	0.93	-3.49	0.75	0.79	1.53	0.51	93.4
GRC	Greece	1.55	-5.80	1.24	1.31	2.54	0.84	15.5
ITA	Italy	1.20	-4.52	0.97	1.02	1.98	0.66	83.1
NLD	Netherlands	0.84	-3.15	0.67	0.71	1.38	0.46	23.7
SWE	Sweden	0.93	-3.49	0.75	0.79	1.53	0.51	11.0
DNK	Denmark	1.32	-4.94	1.06	1.11	2.17	0.72	10.4
LUX	Luxembourg	0.84	-3.15	0.67	0.71	1.38	0.46	0.9
IRL	Ireland	0.84	-3.15	0.67	0.71	1.38	0.46	4.6
PRT	Portugal	1.52	-5.71	1.22	1.29	2.51	0.83	22.7
EU-15	European Union (15)	1.00	-3.75	0.80	0.85	1.65	0.55	514.7

[1)] Relative pro-competitive effect of the SD in the respective country corresponding to the relative trade effects estimated by Kox et al. (2005, p. 43). Since Belgium and Luxembourg are treated as aggregate in the study by Kox et al., we assume the same value for both countries. The aggregate value for the EU does not correspond to the sum of country values due to mechanics of aggregation and averaging.

7. Policy Implications and Conclusions

Making the EU's Single Market more dynamic has been identified as one of the top priorities to improve the EU's growth performance (see Sapir et al., 2004). While the Single Market in manufacturing appears to be working quite well, there are still many impediments to the free movement of services in the Internal Market. Particularly for small and medium-sized enterprises, the bulk of service providers, entry barriers in new EU markets are often prohibitive. In its Draft Directive on Services (SD) in the Internal Market (European Commission, 2004), the European Commission aimed at removing the remaining barriers in this area in order to enable firms to exploit the full potential for cross-border services. This would be an important step forward in bringing the EU closer to the Lisbon targets.

This study builds on previous work on the economic impact of the SD (Copenhagen Economics (2004), Kox et al. (2005)) and investigates its economic implications using an alternative approach. In particular, we use a simple partial econometric framework to estimate the effects of trade and competition (the two main channels through which the effects of the SD are supposed to materialise) on productivity, employment, investment, and value added. We do not find a direct effect of trade on productivity. However, for the sample of service industries covered by the SD, we do find both economically and statistically significant effects of trade on competition, and of competition on productivity, employment and investment.

More trade leads to more competition which is associated with higher productivity, higher employment, investment and output. Based on previous estimates of the trade effects of the SD by Kox et al. (2005), and recognising that the SD increases competition also via easier market entry by reducing the start-up costs of firms, we assume that the SD leads to a reduction in mark-ups (in terms of value added) by 2.5 to 5 percentage points; this is smaller than the mark-up reductions in manufacturing due to the Single Market according to the estimates of Badinger (2005). Using this range of effects of the SD on competition, we estimate its effects on productivity, employment, investment and value added. Results suggest that productivity in the service industries covered by the SD increases by 0.80 percent, employment by 0.85 percent (or by 612,000 persons in terms of the EU-25), and the investment ratio by 0.55 percentage points. Value added of the services covered will go up by 1.65 percent, which corresponds to an aggregate GDP effect of 0.69 percent. All these effects, however, have to be understood as potentials, realised in the medium and long term.

Some words of caution are advisable here: First, it should be noted that the results are not completely robust across all specifications, when additional service industries are included. Particularly sensitive industries turn out to be travel (covered by the SD) and financial services (not covered by the SD). There is no straightforward explanation for this discrepancy. While the choice of the preferred sample is well motivated and corresponds most closely to that used in previous studies and the coverage of the SD, this remains a qualification to our results which has to be borne in mind.

Second, there is considerable uncertainty with respect to the magnitude of the effects; this is not only true for the trade effects estimated by Kox et al. (2005) with a range from 30 to 62 percent, whose central estimate of 44 percent we use to get a benchmark estimate of the magnitude of the SD's pro-competitive effect. It should also be emphasised that our estimated coefficients regarding the effects of competition on productivity, employment and investment used in the simulation are point estimates with sizeable confidence intervals. In addition, it is assumed that the SD is implemented as envisaged in the original version by the European Commission. Any amendments to the SD that mitigate its pro-competitive effect or that further restrict the industry coverage of the SD will also result in lower macro-economic effects.

On the other hand, it should also be added that our estimates do not capture the effects of the significant increase in foreign direct investment which is to be expected according to the estimates by Kox et al. (2005). Moreover, our industry-specific models do not capture inter-industry spillovers and general equilibrium effects), which would be taken up in estimates using data at a higher level of aggregation. Since services industries are intricately inter-twined this could imply that the particular specification chosen underestimates the effects of the SD.

Despite these qualifications we find it reassuring that the results from our simple partial econometric approach are in line with that of previous studies such as Copenhagen Economics (2004) and O'Toole (2005) who carry out simulations with a computable general equilibrium (CGE) model. Hence, the overall evidence suggests that the SD may be viewed as a significant contribution to the Lisbon goals, though as argued in Sapir et al. (2004, chapter 11), it is certainly not the only major reform step required to bridge the gap to the United States.

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Appendix

Table A1. ***Competition and Performance (Trade and Competition) in Service Industries: Least Squares and IV Results for Sample D***

Dependent variable	Productivity			Employment			Investment			Mark-ups		
	Cross-section[1)]		Panel[2)]	Cross-section[1)]		Panel[2)]	Cross-section[1)]		Panel[2)]	Cross-section[1)]		Panel[2)]
	LS	IV	LS	LS	IV	LS	LS	IV	LS	LS	IV	LS
Constant[3)]	2.689	2.836	3.124	-4.934	-4.768	-2.799	0.460	0.488	0.523	0.973	0.875	0.543
Mark-up	-0.221**	-0.345**	-0.075***	-0.214**	-0.352***	-0.110***	-0.147***	-0.171***	-0.124***			
	(-2.20)	(-1.77)	(-3.973)	-2.20	-3.83	(-3.813	(-2.79)	(-2.88)	(-4.972)			
Pop	0.160***	0.163***	0.128***	1.011***	1.015***	1.005***	0.009	0.010	0.013***	0.011	-0.020	0.054***
	(2.89)	(2.95)	(14.360)	(29.00)	(28.75)	(320.48)	(0.84)	(0.86)	(4.685)	(0.22)	(-0.43)	(7.86)
M										-0.099	-0.234*	-0.044**
										(-1.51)	(-1.82)	(-2.64)
SE	0.464	0.469	0.438	0.368	0.375	0.395	0.156	0.156	0.191	0.395	0.415	0.480
R^2	0.805	0.802	0.791	0.974	0.973	0.966	0.723	0.722	0.653	0.309	0.239	0.218
Observations	62	62	1271	61	61	1217	62	62	1221	57	57	700

Notes: LS … least squares estimates; IV … instrumental variable estimates. [1)] Cross-section estimates refer to the average of the period 1995-2000; the cross-section dimension comprises 13 countries (see section V) and 7 industries (sample D, see table 3). [2)] Panel estimates are pooled estimates with industry dummies and time-specific fixed effects included and refer to period 1978-2002 (for longest time series). [3)] Average of industry-specific constants. *** Significant at 1 percent; ** 5 percent, * 10 percent. T-values in parentheses are based on robust standard errors. *Pop* denotes population; *m* is the ratio of imports to production. Productivity is measured in value added per hour worked. *L* denotes total employment in persons. Investment is measured as the ratio of gross fixed capital formation over value added. Mark-ups is the ratio of prices over marginal costs. All variables except the investment ratio and the mark-up ratio are in natural logs. For more details on the estimation, see Breuss and Badinger (2005).

GROWTH AND EMPLOYMENT POTENTIALS OF CHOSEN TECHNOLOGY FIELDS

Institute for Industrial Research, Vienna

Executive Summary

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Study commissioned by the Federal Ministry of Economics and Labour of Austria.

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Abstract

The development of **European technology platforms** is a valuable building block of European science and technology policy, with the aim to define and realise a common research agenda. In this study, the impacts of seven technology fields on selected economies of the European Union are investigated. Out of the range of technology platforms, the following **technology fields** were chosen: *innovative medicines*, *nanoelectronics*, *embedded systems*, *aeronautics and air traffic management*, *hydrogen and fuel cells*, *photovoltaics* and *food for life*.

The study is based on **input-output analyses**, thus enabling us to model the complex interrelationships between the sectors of the economy that are related to technology fields (either as origin sectors or as user sectors) and the other sectors of the economy. **Multiplier analysis** is used to quantify the impacts of demand for goods produced by the sectors related to the chosen technology fields on output and employment are quantified. The **key sector analysis** performed yields suggestions as to whether these sectors play a key role within the network of intermediate inputs. By linking the input-output tables with data on business enterprise R&D, **technology flow matrices** are calculated, which allow the quantification of R&D spillover effects. When a sector related to a technology field carries out R&D, other sectors benefit through the channel of embodied technology flows. Finally, **subsystem minimal flow analysis** (SMFA) is carried out in order to find out whether sectors related to technology fields are part of growth bipols.

Taking into account the difficulty to relate information about technologies which are not yet applied to actual economic data, the results of this study require **great care in interpretation**. Despite careful preparation of the database and cross classification of technology fields and economic activities, the overall picture can change because of any radically new innovation.

The results of the **multiplier analysis** suggest that relatively high impacts can be expected from *food for life*, *aeronautics and air traffic management*, and *hydrogen and fuel cells*. For employment multipliers, relatively high effects are found in sectors related to *food for life*, *innovative medicines* and *photovoltaics*. The results of the **key sector analysis** show that key sectors can be found more frequently in fields related to *innovative medicines*, *hydrogen and fuel cells* and *food for life* than in other sectors.

In all technology fields - except *food for life* –, origin sectors of technology have high **R&D multipliers** and are, accordingly, classified as “high technology” or “medium-high technology” by OECD. Only four technology fields, i.e. *nanoelectronics*, *embedded systems*, *hydrogen and fuel cells* and *photovoltaics*, tend to have a high performance in terms of **R&D spillovers** and **growth bipols**. According to **SMFA**, sectors pertaining to these technology fields tend to be better integrated into the **National Innovation System** (**NIS**) in many of the selected European countries. Thus, it may seem promising to promote future R&D efforts in these technology fields, since these sectors are assumed to form the growth core of the economy.

1. Background

"The European area of knowledge should enable undertakings to build new competitive factors, consumers to benefit from new goods and services and workers to acquire new skills. With that in mind, it is important to develop research, education and all forms of innovation insofar as they make it possible to turn knowledge into added value and create more and better jobs."[36]

In spring 2005, the heads of government of the countries of the European Union agreed on deepening co-operation for growth and employment which had been initiated on 23/24 March 2000 when the 15th European Summit was held in Lisbon (**Lisbon Strategy**[37]). The conclusions of the European Council strengthen the key roles of **knowledge** as well as **innovation** as major triggers of sustainable economic growth. In order to achieve this ambitious goal, networks of technological structures of the European region should be further intensified, whereby the focus should be especially put on co-operation between research and business.

According to numerous studies (e.g. Mahony and van Ark, 2003), the average growth rates of real GDP, labour productivity and total factor productivity of the European Union have fallen behind those of the United States since the mid-1990s. In order to catch up, the **European Commission** launched several initiatives. As innovations are vital for economic growth, European research networks (consisting of stakeholders of universities, public institutions, economic actors and so forth) should be better co-ordinated. Finally, this leads to increased competitiveness and, thereafter, to a stronger position on the global market and towards competitors. In particular, the European Council focuses on public-private partnerships, which in turn are realised by researchers, businessmen and policy-makers in the framework of European technology platforms.

The development of **European technology platforms** is a bottom-up process, implying that stakeholders themselves further the process with the assistance of the European Commission. The objective is to define and realise a common research agenda. Consequently, a critical mass of public and private resources is created on both a national as well a European level. Today, more than 20 technology platforms exist in various stages of

36 European Commission (2005d, p. 2).

37 see http://www.europarl.eu.int

development. Each of them is unique in its origin and concerning its implementation – this is also true for the underlying technology of each platform.

From the range of technology platforms, **seven technology fields** — *innovative medicines*, *nanoelectronics*, *embedded systems*, *aeronautics and air traffic management*, *hydrogen and fuel cells* (see amongst others European Commission, 2005b), *photovoltaics* and *food for life* — have been chosen which are especially important in the economic-policy and European context. The selection was made taking into account the strategic relevance of the subject, the existence of market failures, the evidence of a substantial long-term commitment of the economy. In certain fields, the sample is identical to the issues covered by the Communication of the European Commission of 6 April 2005 (focus on six main programmes, joint European technology initiatives).

The primary **aim of the study** is to provide deeper insights into possible impacts of different technology fields, especially with respect to production, employment and technology flows for selected European countries. Taking into account the difficulty to relate information about technologies not yet applied to actual economic data, the results of this study require great care in interpretation. Recommendations for economic policy cannot be derived in a straightforward manner, but have to be indirectly deduced from assumptions on the input structure of particular industries and commodities related to new technologies. Likewise, expected changes in productivity implied by the new technologies largely depend on assumptions in the absence of reliable estimates.

The objective of the study, providing **decision support** and a well-founded **contribution** to the **discussion** dealing with the impact of new technologies for the competitiveness of Europe, can only be achieved on the basis of trustworthy information relating assumed and known properties of technology fields to available data of economic statistics.

The problem lies in the **cross classification of new technologies and production activities**, on the one hand, and in the multiple dimensions of the subject on the other hand. Moreover, there is a lack of data on **technology indicators** like R&D expenditures and patented innovations in particular technology fields considered in the study. Although total R&D expenditure is available for industries, data do not exist for particular technology fields. With respect to the technology fields considered in the present study, one study dealing with the economic impact of hydrogen and fuel cells for the German economy (Erdmann and

Grahl, 2000) could be considered as a valuable source of information. Similar studies for other fields were not available.

Modern economies are characterised by **complex interrelations** between industries that need to be taken into account in **analysing the impact** of different technology fields on the competitiveness of the economy. The definition of policy measures requires that beyond the separate analysis of each industry, each industry is considered as a part of a complex set of interdependencies. "Input-output tables, which concern the web of intermediate inputs, encapsulate interrelations through which innovation and technology embedded in intermediate inputs diffuse throughout the economy. Input-output analysis shows that the competitiveness of the EU economy is not the result of merely aggregating individual industries' performance but the result of a complex network of relationships between them."[38] In this way, innovation or R&D in one sector can have repercussions in other sectors of the economy. Input-output analysis is therefore a useful tool to model the knowledge flows and transmission of economic rents that arise from R&D and was used in numerous studies (e.g. special issue of the Journal of Economic System Research in 1997 and 2002, European Commission, 2005c, and others). It provides the methodological background for the presented study, too.

38 European Commission (2005b, p. 33)

2. Chosen Technology Fields with European Perspectives

This analytical survey focuses on seven different **technology fields**. They all have in common that they are of vital importance for the future development of the European economic area. Knowledge and technology flows might appear between the single fields; moreover, they are likely to take place.

Each single technology would deserve to be treated comprehensively in terms of content. To what extent are these fields integrated in the European research, technology and innovation policy? What are the major development and production areas (in statistical terms and classifications)? Where are interfaces to the economy? These and other elementary questions need to be discussed.

Table 1: Description of Technology Fields

	EU-Level Coordination	Potentials
Innovative Medicines	European Technology Platform on Innovative Medicines	In 2000, the market volume of the pharmaceutical sector is estimated to amount to 320 bn USD. The market potential of technologies which recognise the effects of substances in preclinical phases vary. For example, DNA chip technology is assumed to surmount a market potential of 1 bn USD in 2005. Enormous capabilities are assigned to the pharma market, not only on the basis of demographical developments.
Nanoel-ectronics	European Nanoelectronics Initiative Advisory Council (ENIAC)	The market volume of the microelectronic and nanoelectronic value chain is estimated to be nearly 1% of the world wide gross domestic product; with high growth rates amounting to 15% annualy. The weight of industries influenced directly by nanoelectronics – amongst others telecommunications operators, consu-mers' products, internet services, constructors of vehicles, defense, space – is estimated to be higher.
Embedded Systems	Advanced Research and Development on Embedded Intelligent Systems (ARTEMIS)	The development of embedded systems is pushed by new options, which result from increasing computing power, decreasing costs as well as networking of components. More and more embedded systems are used in order to offer services for firms and persons. In 2003, on average about 8 billion embedded systems existed worldwide. Conservative estimations forecast a doubling of this figure to 2010.
Aeronautics and Air Traffic Management	Advisory Council for Aeronautics Research in Europe (ACARE)	The contribution of the air transport sector to GDP will continue to grow. The sector forecasts that over the next decade, both passenger and freight traffic is expected to increase at an average of 4 to 5% p.a. ACARE expects that the sector will create between 2 and 4 million new jobs by 2020, even assuming conti-nued productivity gains at historic levels, with the GDP contribution of the air transport sector increasing from 2.6% to about 3.3%. The contribution to the wider economy through reliance effects that enable a diversity of businesses to succeed better is expected to rise from its present 8 to 10% to 11 to 13%.
Hydrogen & Fuel Cells	European Hydrogen and Fuel Cell Technology Platform (HFP)	If pure hydrogen could be used directly to power fuel cells, a number of environmental and engineering advantages would arise. Fuel cells in vehicles combine very high-energy efficiency with zero exhaust emissions and potentially low noise. In the medium to long term, fuel cells have a strong energy saving potential for decentralised co-generation in households and buildings and for power production. In the long term, they could replace a large part of the current combustion systems in all energy end use sectors. According to the state of knowledge at present, the estimated market volume for fuel cells in 2010 for Germany can be around 3.5 bn EURO. Experts estimate the market volume of fuel cell cars for 2020 to 14 million cars world wide; this corresponds to a market share of 25% based on 1999.
Photovoltaics	European Technology Platform on Photovoltaics *(A vision report throws light on the way ahead for the Photovoltaic Technology Platform)*	Solar power is a key technology and an investment into the future. This can be demonstrated by the increasing interest of the finance industry (until 2010 the turnover is estimated to reach 30 bn USD). Japan is the world leader with a market share of 45% (notably, the Japanese government supports photovoltaics). The second largest share of the market (28%) belongs to European firms, whereby the production of the European enterprises outstrips the output of US firms. Five of the "top 10" firms of this industry are European ones, four are of Japanese origin and one firm is American.
Food for Life	European Technology Platform on Food for Life	The European agriculture and food industry is the largest manufactoring sector in Europe. 4.1 million people in the European Union are employed in this sector – predominantly in small and medium-sized enterprises. In 2004, the turnover of the food and beverage industry turned out to be 810 bn EURO; moreover, the food and beverage industry turned over 70% of the agricultural raw materials.The food and drink industry covers a market of 450 million consumers in the EU. The preferences of consumers for quality and health, and their justifiable expectations of safety, ethics and sustainable food production serve to highlight the opportunities for innovation. New products will have to fit the needs, lifestyles and incomes of consumers.

Sources: ACARE (2004), ADVISORY COUNCIL FOR AERONAUTICS RESEARCH IN EUROPE (2004), CONFEDERATION OF THE FOOD AND DRINK INDUSTRIES OF THE EU (2005), ENIAC (2003), European Commission (2005a), GROUP OF PERSONALITIES (2001), MAHLICH (2005), NOWAK (2005), europa.eu.int/comm./research/energy, www.bics.be.schule.de, www.europa.eu.int, www.cordis.lu/ist/artemis, www.cordis.lu/technology-platforms/summaries.htm, www.fona.de, www.fumatech.com, www.solarserver.de, www.tci.uni-hannover.de

By summing up the most important aspects, the table above provides a rudimentary overview in order to offer the background needed for this survey.

But how can these technology fields be related to **economic activities**? A link between technology and economic sectors has to be created as this is needed for the input-output analysis, which is carried out later on.

Basically, numerous technologies can neither be commonly classified nor are there any internationally accepted definitions. This **lack of definitions** exists for both classifications of economic fields in which technologies are developed and for classifications of economic fields in which technologies are applied. These circumstances are intensified in case of technologies that are in the stage of development and/or have high development potential. Future capabilities and concrete fields of application, as a rule, can only be guessed vaguely, but not defined precisely. Again, the prevailing processes are extremely **dynamic and statistically hard to grasp** – especially when processes are concerned which are initiated in an economy that is based on division of labour. The dynamic aspect is also concerned when a technology is significantly combined with another one or when it serves to enable innovative activities in the first place. Against the background of these remarks, an assessment can only be feasible to a certain degree.

Table 2: Cross-classification of Technology Fields and Economic Activities (Fields of Origin) on a Two-Digit Level

		Innovative Medicines	Nanoelectronics	Embedded Systems	Aeronautics and Air Traffic Management	Hydrogen and Fuel Cells	Photovoltaics	Food for Life
Food products and beverages	15	-	-	-	-	-	-	YES
Chemicals, chemical products (incl. Pharmazeuticals)	24	YES	-	-	-	YES	-	YES
Fabricated metal products	28	-	-	-	-	YES	-	-
Machinery and equipment n.e.c.	29	-	-	-	-	YES	-	-
Electrical machinery and apparatus	31	-	-	-	-	YES	-	-
Radio, TV and communication equipment	32	-	YES	YES	-	-	YES	-
Motor vehicles, trailers and semi-trailers	34	-	-	-	-	YES	-	-
Other transport equipment (incl. Aircraft and Spacecraft)	35	-	-	-	YES	-	-	-
Electrical energy, gas, steam and hot water	40	-	-	-	-	YES	-	-
Construction work	45	-	-	-	-	-	YES	-
Air transport services	62	-	-	-	YES	-	-	-
Supporting transport services; travel agency services	63	-	-	-	YES	-	-	-
Computer and related services	72	YES	-	YES	-	-	-	-

Source: IWI; Note: A "Yes" entry implies that the respective sector is an origin sector of the respective technology.

In spring 2005, the IWI started a debate which should deliver new hints. Based on work already done[39], this **discourse** included the participation of about **35 experts**[40] from the academic sector, on the one hand, and various market actors, on the other hand. The results of this process, which in turn focuses on the technology origin in a consistent sectoral classification, can be seen in table 2.[41]

The overall picture can change because of any radically new innovation. In addition, technologies are not coequal when national borders are crossed and overlaps exist – e.g. the electronic industry performs research and development on the field of nanoelectronics as well as on the field of information and communication technologies. The European

39 E.g. by National Science Foundation, OECD and others.

40 Predominantly from human medicine, natural sciences, technical sciences as well as economic sciences.

41 The survey is based on recent Eurostat data (see section *Data*). A more detailed analysis would be possible in sectors 24 (pharmaceuticals, medical chemicals and botanical products, 24.2) and 35 (aircraft and spacecraft, 35.3) for some countries, but only on the basis of data that are not as up to date as the ones used in the survey.

technology initiative on *innovative medicines* can relatively precisely be transferred in economic activities, while the aggregation of *hydrogen and fuel cells* needs a broader classification. According to the physicist Ernst Winter from the Vienna University of Technology, hydrogen and fuel cell are “mit großen technischen Problemen behaftet”[42] (are afflicted by major technical problems).

The experts were asked to allocate statistical weights to the technologies in question, whereby the statistical weight of a certain technology was measured according to their economic performance. Notably, the answers are very heterogeneous and allow a wide spectrum of interpretation and, thus, are not taken into account in the survey. Basically, the IWI recommends **setting up expert groups** (consisting of statisticians, technicians, economists and business actors who carry out statistical assignments and attribute weights in a decision-making process) for the technologies mentioned above. This information would be important for an impact assessment on which economic analysis can be based.

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42 “Die Presse”, 18 November 2005.

3. Data and Methods

3.1 Database

There are two sources for **input-output tables**: **Eurostat** and **OECD**. The advantages of the OECD tables are:

- The tables are available in an industry-by-industry classification.
- In these tables, pharmaceuticals (CPA 24.4) and aircraft and spacecraft (CPA 35.3) are shown separately, which is good for the analysis of technology fields.

However, the most recent OECD data refer to 1997 and less recent than the input-output table provided by Eurostat for the year 2000. We, therefore, use Eurostat input-output tables in the product-by-product dimension and computed under the assumption of commodity-based technology. The tables cover 59 groups of products classified on a CPA 2-digit level.[43] We analyse the six countries listed in Table 3.

Table 3: Data Overview

Country	Year of IO-Table	Year of employment data	Year of R&D data
Austria	2000	2000	2002
France	2000	2000	2000
Germany	2000	2000	2000
Italy	2000	2000	2000
Netherlands	2001	2001	2001
Poland	2000	2000	2000

Source: IWI

Since this study is a pioneer study and not all 25 EU Member States could be investigated due to time restrictions, a **sample** had to be selected. The choice is motivated by the aim to have a mixture of small and big countries as well as old and new Member States situated in different geographic regions of the continent. A **wide diversification of countries** is beneficial because the results of the input-output analyses depend on size, economic structure and the geographic location of countries. The choice is also influenced by data availability. An important criterion is the up-to-dateness and the quality of data. France and

[43] CPA stands for statistical classification of products by activity (CPA) in the European Economic Community. For further details, see Commission Regulation (EC) No 204/2002 of 19 December 2001 and Council Regulation (EEC) No 3696/93 of 29 October 1993.

Germany are selected because of their large size and Austria and the Netherlands because of the small size of their economies. Italy is chosen because it is located in the south of the European continent. Finally, Poland is included because it is a former transition country and its membership is relatively new.

The input-output tables used do not contain any information about **employment**. Employment data are taken from the 60-industry database of the Groningen Growth and Development Centre.[44]

In the original tables used for the simple multiplier analyses, pharmaceuticals (CPA 24.4) and aircraft and spacecraft (CPA 35.3) are aggregated in chemical products (CPA 24) and other transport equipment (CPA 35), respectively.

For the technology flow and subsystem minimal flow analyses (SMFA) some **additional aggregation and disaggregation procedures** are applied to the tables. First, in order to have pharmaceuticals and aircraft and spacecraft available as separate sectors, they were isolated from their respective sectors using the best available information about the structure of the intermediate consumption of these two sectors and about the structure of the intermediate consumption of other sectors with respect to these two sectors. This information is taken from OECD input-output tables either from the same country or from France, depending on the detail of disaggregation available in the OECD tables. Some other information is introduced to verify this procedure. More details thereon are available in the longer version of this paper or upon request.

Second, in order to reduce the number of sectors in a way suitable for the SMFA, several sectors that are not connected to the technology fields considered are aggregated following a scheme corresponding largely to the structure of the OECD input-output tables. The input-output tables applied have 45 sectors. Appendix C provides a table with sector definitions and abbreviations.

With respect to the subject of the analysis, different versions of input-output tables are used. **Version B**, which contains domestic input-output relations only and treats imports as separate variable, is used for the multiplier analysis and estimation of key sectors. In contrast, **version A**, which treats both domestic and imported intermediate goods, is used for the analysis of the technology flows and SMFA. This differentiated approach seemed appro-

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[44] For further details, see http://www.ggdc.net/dseries/60-industry.html.

priate because multiplier analysis deals with the impact on domestic production while the SMFA is related to the technological structure regardless of the origin of inputs used.

Technology flow analysis and SMFA are based on data of **business R&D expenditures**. Alternatively to R&D data, technology flow analysis could also be based on other indicators and methods[45]. We use the OECD Analytical Business Enterprise R&D database (OECD 2004) which largely corresponds to the classifications of input-output tables. Data is cross-checked (and in some cases ameliorated) with the Eurostat Business Enterprise R&D Expenditure (BERD) database (Eurostat 2004). Only for Austria, Eurostat data are used. The data are broken down by activity and reclassified by products applying the algorithm by Almon (2000).[46] The data are in current prices.

In order to prevent possible misinterpretation it should be made clear that **no data** are available on **R&D carried out in specific technology** fields. Thus, our technology flow and SMFA analyses are based on the assumption that high (or low) R&D expenditures of sectors related to certain technology fields contain also high (respectively low) expenditures related to this technology field.

3.2 Multiplier Analysis

In order to get a better insight into the structure and interdependencies of the economy, the **standard multipliers** are estimated in the first step. It is assumed that the demand for related products increases because of the introduction of new technologies (e.g. because of a better position of the European industry in the international market). A rise in demand affects economies in terms of production, value added, employment, etc.

The impacts of technology fields are analysed by using a demand-oriented open **Leontief input-output model**. In this model, changes in final demand are translated via Leontief inverse coefficients into corresponding changes in the production of goods which is necessary to satisfy final demand (for details, see the full version of this study or Miller and Blair, 1985, chapters 2 and 4).

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[45] In recent years, several authors have proposed different kinds of technology-specific matrices (e.g. Economic Systems Research, vol. 9, issues 1 and 2). According to Dietzenbacher and Los (2002), “it seems useless to apply the methodology we proposed in this section to other technology-specific materials, despite its initial attractiveness. In particular, the proportionality assumption with regard to inputs and outputs is extremely awkward in this respect.”

[46] This algorithm uses the information contained in the make matrix and therefore could not be applied to data for Poland due to a lack of the make matrix. For the Netherlands and Germany, additional corrections were necessary in two sectors.

The ***output multiplier*** (production or backward linkage multiplier) measures the output in the economy that is necessary to deliver one unit of a particular commodity (e.g. EUR 1 million) to final demand.

The ***employment multiplier*** of a commodity gives us the total employment in the economy generated by one unit (e.g. EUR 1 million) of that commodity delivered to final demand. The employment multipliers take into account interdependencies between sectors in the economy on the one hand, and the labour intensity in the production of particular commodities on the other hand.

Additional insights into the structure of the economy are provided by the so-called ***output-to-output multiplier*** that can be derived by the mixed model (see, for example, Miller and Blair, 1985, chapter 9). The output-to-output multipliers reveal the output value induced in the economy by one unit (e.g. EUR 1 million) of production of a particular commodity.

3.3 Key Sector Analysis

In the framework of an input-output model, production by a particular sector has two kinds of economic effects on other sectors of the economy. If sector *j* increases its output, this means that there will be an increased demand of sector *j* (as a purchaser) on sectors whose products are used as inputs for production of commodity *j*. This is the direction of causation in the usual demand-side model presented above and used in this study.

The term ***"backward linkage"*** is used to indicate this kind of connection between a specific sector and those sectors from which the inputs come. If the power of dispersion for the backward linkages is greater than 1, this indicates that a unit change in final demand of commodity *j* will create an above-average production increase in the economy.

The term ***"forward linkage"*** is used to indicate this kind of interconnection of a particular sector to those sectors to which it sells its output. If the power of dispersion for forward linkages is greater than 1, this asserts that a proportional change in all commodities' final demand would create an above-average increase of production in sector *i*. The comparison of the strengths of backward and forward linkages for sectors in an economy provides one mechanism for identifying key sectors. A key sector is usually defined as one in which both indices are greater than 1 (see Sonis, Hewings and Guo, 2000).

3.4 Technology Flow Analysis

The analysis of technology flows helps to identify **technology diffusion patterns** for technology fields, respectively for those sectors that are linked to the technology fields. Research and development activities within the originating sectors of a new technology lead to **spillover effects** in other sectors of the economy based on several possible channels. A basic distinction is made between disembodied and embodied technology diffusion. Disembodied technology transfer encompasses direct knowledge transfer through experts, literature or imitation. Embodied technology transfer comes about through the purchase of intermediate or investment goods that contain a new technology.

The **hypothesis of positive spillover effects** of embodied technology transfers guided the research agenda in this field from the beginning (e.g. Griliches 1979). The main arguments are that the use of better intermediate and investment goods leads to productivity gains in the user industry. Because of the limited market power of the provider of the new technology, the provider can not appropriate the entire rent of the new technology and some of it is taken by the user industries. However, depending on the market power constellation, negative spillover effects may arise when sectors using new technologies are forced to pay higher prices for intermediate or investment goods, but are not able to effect the corresponding productivity gains or market prices (see Dietzenbacher and Los, 2002, for a more detailed discussion). Thus, a more complete analysis of the effects of technology flows has to take account of competition.

Embodied technology transfer is usually measured by **linking** an indicator of the **innovation activity** to the **input-output system** of an economy. By following this approach, the present analysis links business R&D expenditures to the input-output table. As discussed in earlier contributions, a limitation of this approach is that technology flows embodied in the purchase of investment goods are omitted in the analysis. It would be desirable to include these since many investment goods are produced by R&D-intensive industries. However, including investment flows in the analysis would require an extension of the simple static input-output model. Furthermore, the database (including capital stock data) is not available in a quality that allows the comparison of the six countries chosen.

By linking the innovation indicator (e.g. R&D expenditure) to the input-output system, one gets the **technology flow matrix**. This is a table that specifies how the R&D expenditure of one sector is received by the sector itself or by other sectors through direct or indirect intermediate relationships.

In this study, we analyse two versions of the technology flow matrix (for the technical derivation of technology flow matrix, see the longer version of the study or a textbook exposition, e.g. Schnabl, 2000). The so-called **actual structure** incorporates information on the actual final demand and, thus, represents actual technology flows[47]. We use this matrix to calculate R&D spillover rates, defined as the sum of R&D expenditures of sector *j* received by other sectors divided by the total R&D expenditures of sector *j*.

In contrast thereto, the **standard structure** neglects information on the actual final demand by substituting final demand by a vector of 1 in the calculation formula. We use this matrix to calculate R&D backward multipliers according to Dietzenbacher and Los (2002). These measure the R&D expenditures that are stimulated in the economy by one unit (e.g. EUR 1 million) of final demand for a specific commodity.[48] The empirical results by Dietzenbacher and Los (2002) confirm that high-tech industries are characterised by high total backward R&D multipliers. The result is not surprising because the production of these commodities requires relatively more R&D intensive commodities produced by other sectors.

It is also possible to analyse the technology flows that come from selected sectors only. Based on the actual structure, this approach will be used to identify the main technology users of those sectors which are related to the selected technology fields as originating sectors of the technology.

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[47] For calculating the actual structure of the technology flow matrix, we corrected the vector of final demand by the vector of imports destined for final demand (for further details, see the full version of the paper).

[48] There is a strong empirical correlation between R&D backward multipliers and R&D intensity, defined as the ratio of R&D expenditures of sector *j* to the output of sector *j*. This is to be expected, since the final demand for commodity *j* regularly stimulates R&D primarily in the sector that produces commodity j.

3.5 Subsystem Minimal Flow Analysis (SMFA)

In a next step of our analytical procedure, we apply **subsystem minimal flow analysis (SMFA)** to our data. This part is based on the technology flow matrices defined in the previous section. It aims at analysing and visualising the core of the **National Innovation System (NIS)**.

Freeman (1987) describes an **NIS** as “the network of institutions in the public and private sectors whose activities and interactions initiate, modify and diffuse new technologies.” Thus, the NIS typically includes organisations and institutions such as R&D departments, technological institutes and universities. A broader definition by Lundvall stresses the system aspect (Lundvall 1992, p. 4): “The broad definition … includes all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring – the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place.”

SMFA (Düring and Schnabl 2000, Schnabl 2000) is an advancement of Minimal Flow Analysis (Schnabl 1995) and qualitative input-output analysis. Like these, it is an input-output based method for finding **qualitative structures** in a system of interrelationships between sectors that would otherwise not be visible at a first glance. By considering only those flows that exceed a certain filter value, the complexity of the system is reduced, thereby enabling analyses. The focus is on those technological links that are relatively intensive and, therefore, provide strong impulses for growth of the NIS.

When a link between two sectors is only strong in one direction it is called a **unidirectional** link. A **bilateral** link exceeds the filter value in both directions. The sectors forming part of bilateral links are considered to be the growth core of the economy.

SMFA deals with both versions of technology-flow matrices introduced in the previous section (“actual structure” and “standard structure”). The sectors that show up as core sectors in both versions are called **“growth bipols”** or **“bipols”** and are considered as the core of the NIS.

The SMFA captures the technological interrelationships of the sectors of the economic system. Thus, it encompasses an important part, but not the entire National Innovation System (NIS) since it leaves out other important parts, like the education and university system. Schnabl (2000, p. 186) argues that if the NIS is a “real” phenomenon, it should emerge as a consistent phenomenon, independent of the analytical approach.

4. Results of Multiplier Analysis

This part presents standard multipliers as well as results of key sector analyses.

4.1 Standard Multipliers

The results show that the values of multipliers differ significantly from country to country and with respect to the commodities related to the technology fields. These varieties are not only caused by differences in the economic structure or in labour productivity, but also by the size of countries. Like in other studies, the multipliers of **big countries** are systematically **higher** than the multipliers of small countries. These variations come from differences in the openness of countries to foreign trade. In small countries, enterprises generally use a smaller portion of domestically produced intermediate inputs than is the case in big countries. Consequently, indirect effects of their activities on their home economies are smaller than in big countries.

Let us start with a detailed description for the technology field of *innovative medicines*. The results for this technology field are summarised in Table 4a, while the results for the remaining technology fields will be presented later.

Table 4a: Multipliers for Commodities Related to Innovative Medicines

		Output multiplier		Employment multiplier (pers. per 1 m EURO)			Output-to-output		Key Sectors
		min	max	min	max	max (without Poland)	min	max	no. of cases
Origin	PHARM	1,49	**1,96**	**6,55**	36,01	10,02	1,38	1,62	3
	COMPU	**1,29**	1,71	10,88	**40,85**	**19,19**	1,16	1,53	1
Users (top 5)	HEALT	1,31	1,75	20,68	112,40	28,45	1,28	1,45	0
	FOODP	1,90	2,43	11,78	151,71	22,36	1,59	1,91	4
	ADMIN	1,35	1,54	15,27	44,80	20,46	1,35	1,50	0
	MACHI	1,52	1,97	10,62	60,72	14,10	1,47	1,83	2
	CONST	1,52	1,97	13,80	52,01	20,59	1,42	1,78	5

Innovative medicines has **two** origin sectors: pharmaceutical goods (PHARM) and computer and related services (COMPU). Looking at the first row of Table 4a related to pharmaceuticals (PHARM), the **production multiplier** for the six countries under consideration lies between 1.49 (for Austria), indicated in the column ‘output multiplier min’, and 1.96 (for France), indicated in the column ‘output multiplier max’. Increasing final demand in pharmaceuticals (PHARM) by one unit (e.g. EUR 1 million) increases the production in the selected European countries by 1.49 to 1.96 units (e.g. million euro). Multipliers for the second commodity, computer and related services (COMPU), range from 1.29 (for Germany) to 1.71 (for France). Summarising the results, we can see that output multipliers for commodities related to *innovative medicines* lie between 1.29 and 1.96 (see figures printed in bold face). In other words, increasing final demand for commodities of this group by one unit generates additional production in the selected European countries by 1.29 to 1.96 units, depending on the proportions of both commodities in final demand.

The **top five users**[49] of the goods belonging to *innovative medicines* are: health and social work services (HEALT), food products and beverages (FOODP), public administration services (ADMIN), machinery and equipment (MACHI) and construction work (CONST), indicated in the last five rows in table 4a. Analogously to the previous interpretation of the first two rows in table 4a, increasing the final demand in commodities of this group by one unit (e.g. EUR 1 million) generates an increase of production by 1.27 to 2.43 units (depending on the structure of the final demand) in the selected European countries.

The next three columns of table 4a contain the results for **employment multipliers.** They indicate the employment effect of an increase in final demand for particular commodities by EUR 1 million. As the first row related to pharmaceuticals (PHARM) shows, the employment multiplier for the six countries under consideration ranges from 6.55 (for the Netherlands) to 36.01 persons employed per EUR 1 million (for Poland). The high multiplier for Poland is caused by its low labour productivity relative to all other countries investigated in this study. The productivity of Poland is between one quarter and one fifth of the productivity in other economies of the sample. This low labour productivity results in a larger labour input for producing EUR 1 million of output compared to all other countries in the sample. If Poland is excluded, the multiplier ranges from 6.55 to 10.02 employees per EUR 1 million. Multipliers for the second commodity, computer and related services (COMPU), lie between 10.88 (for

[49] The top five users were identified on the basis of a technology analysis, which is the subject of the following section.

Austria) and 40.85 persons employed per EUR 1 million (for Poland); if Poland is excluded, multipliers range from 10.88 to 19.19 persons employed per EUR 1 million (for Italy). In summary, it be can seen that employment multipliers for commodities related to *innovative medicines* lie between 6.55 and 19.19 persons employed per EUR 1 million (see bold figures in the fifth column). Increasing final demand for the commodities of this group by EUR 1 million generates an increase of employment by 6.55 to 19.19 persons in the selected economies (excluding Poland). The employment multiplier can be interpreted in a similar way with respect to the users of *innovative medicines*.

Output-to-output multipliers in columns 6 and 7 of table 4a describe the effects caused by an increase in the production of the commodity in question in the rest of the economy. Increasing output of pharmaceuticals (PHARM) by one unit implies that the output will rise by 1.38 to 1.68 units in the selected European countries. The output-to-output multiplier for computer-related services (COMPU) ranges from 1.16 to 1.53. Summarising the output-to-output multipliers over the six European countries under consideration, we have a range from 1.16 to 1.62. In the same way, the output-to-output multiplier for the users (the last five rows) can be provided.

The discussion of the results for the remaining technology fields summarised in table 4b is straightforward.

Table 4b: Multipliers for Commodities Related to Selected Technology Fields (Except Innovative Medicines)

		Output multiplier		Employment multiplier (pers. per 1 m EURO)			Output-to-output multiplier		Key Sectors
		min	max	min	max	max (without Poland)	min	max	no. of cases
Nanoelectronics									
Or.	RADEQ	1,32	2,12	6,22	29,45	12,19	1,31	1,78	0
Users (top 5)	MACHI	1,52	1,97	10,62	**60,72**	14,10	1,47	1,83	2
	OFFMA	1,34	1,76	5,64	37,86	10,95	1,33	1,71	0
	PTELE	1,46	1,86	11,26	50,46	14,02	**1,25**	1,64	2
	CONST	1,52	1,97	13,80	52,01	**20,59**	1,42	1,78	5
	MOTOR	**1,27**	**2,23**	**5,06**	33,15	14,06	**1,25**	**1,97**	0
Embedded Systems									
Origin	RADEQ	1,32	**2,12**	**6,22**	29,45	12,19	1,31	**1,78**	0
	COMPU	**1,29**	1,71	10,88	**40,85**	**19,19**	**1,16**	1,53	1
Users (top 5)	MACHI	1,52	1,97	10,62	**60,72**	14,10	1,47	1,83	2
	CONST	1,52	1,97	13,80	52,01	**20,59**	1,42	1,78	5
	ADMIN	1,35	1,54	15,27	44,80	20,46	1,35	1,50	0
	MOTOR	**1,27**	**2,23**	**5,06**	33,15	14,06	**1,25**	**1,97**	0
	OFFMA	1,34	1,76	5,64	37,86	10,95	1,33	1,71	0
Aeronautics and Air Traffic Management									
Origin	AIRCR	**1,51**	2,27	8,37	58,96	12,95	1,48	1,73	1
	TRAIR	1,53	2,04	**6,94**	32,65	9,77	1,49	**1,96**	0
	TRSER	1,58	**2,34**	9,66	**70,09**	**19,00**	**1,15**	1,73	3
Users (top 5)	TRAIR	**1,35**	1,54	15,27	44,80	20,46	1,35	1,50	0
	ADMIN	1,53	2,04	**6,94**	32,65	9,77	1,49	**1,96**	0
	TRANS	1,46	1,76	12,61	46,39	**24,01**	1,39	1,70	0
	CONST	1,52	1,97	13,80	52,01	20,59	1,42	1,78	5
	TRSER	1,58	**2,34**	9,66	**70,09**	19,00	**1,15**	1,73	3
Hydrogen and Fuel Cells									
Origin	CHEMI	1,49	1,96	6,55	36,01	10,02	1,38	1,62	3
	PRDMT	1,51	1,90	11,78	52,98	**16,67**	1,35	1,72	5
	MACHI	1,52	1,97	10,62	**60,72**	14,10	1,47	1,83	2
	EMACH	1,47	1,93	9,55	47,56	16,28	1,43	1,80	1
	MOTOR	**1,27**	**2,23**	5,06	33,15	14,06	1,25	**1,97**	0
	ENERW	1,48	1,91	**4,90**	45,53	11,80	**1,20**	1,77	4
Users (top 5)	CONST	1,52	1,97	13,80	52,01	20,59	1,42	1,78	5
	MOTOR	**1,27**	**2,23**	**5,06**	33,15	14,06	**1,25**	**1,97**	0
	MACHI	1,52	1,97	10,62	**60,72**	14,10	1,47	1,83	2
	ADMIN	1,35	1,54	15,27	44,80	20,46	1,35	1,50	0
	MTREP	1,45	1,74	14,63	43,83	**23,51**	1,35	1,67	1
Photovoltaics									
Origin	RADEQ	**1,32**	**2,12**	**6,22**	29,45	12,19	**1,31**	**1,78**	0
	CONST	1,52	1,97	13,80	**52,01**	**20,59**	1,42	**1,78**	5
Users (top 5)	MACHI	1,52	1,97	10,62	**60,72**	14,10	1,47	1,83	2
	OFFMA	1,34	1,76	5,64	37,86	10,95	1,33	1,71	0
	ADMIN	1,35	1,54	15,27	44,80	**20,46**	1,35	1,50	0
	MOTOR	**1,27**	**2,23**	**5,06**	33,15	14,06	**1,25**	**1,97**	0
	PTELE	1,46	1,86	11,26	50,46	14,02	**1,25**	1,64	2
Food for Life									
Origin	FOODP	1,90	**2,43**	11,78	**151,71**	**22,36**	1,59	**1,91**	4
	CHEMI	**1,49**	1,96	**6,55**	36,01	10,02	**1,38**	1,62	3
Users (top 5)	CONST	1,52	1,97	13,80	52,01	20,59	1,42	1,78	5
	RUBBP	1,40	1,91	10,26	43,97	13,67	1,39	1,75	2
	MOTOR	**1,27**	2,23	**5,06**	33,15	14,06	**1,25**	**1,97**	0
	FOODP	1,90	**2,43**	11,78	**151,71**	22,36	1,59	1,91	4
	HOTRE	1,59	1,88	18,61	87,47	**38,15**	1,57	1,87	0

Source: IWI

Considering the **source (originating) sectors**, we can see that relatively higher production effects can be expected from goods related to the technology field *food for life*: The lowest value is 1.49 and the highest value reaches 2.43 (highest lower bound and highest upper bound for the output multipliers over all technology fields).

With regard to the multipliers of the **sectors using** the goods related to technology fields *innovative medicines* and *aeronautics and air traffic management* might have slightly higher impacts on production than the other technology fields. An increase of final demand by EUR 1 million in commodities related to the above-mentioned technology fields can generate a value of production in the economy from EUR 1.31 million to EUR 2.43 million (due to the multiplier for food products). In comparison, the average output multiplier (output generated by one unit of final demand) lies between 1.52 and 1.77 over the six European countries under consideration.

Summarising the employment multipliers for selected technology fields, the results show that relatively higher employment effects can be expected from goods related to the technology *food for life* having the highest lower bound (6.55 persons per EUR 1 million) and the highest upper bound (151.71 per EUR 1 million or 22.36 per EUR 1 million if Poland is excluded) over all technology fields. As far as the users of technology fields are concerned, the lower bound of multipliers is slightly higher for goods belonging to *innovative medicines* and *aeronautics and air traffic management*. With respect to the upper bound, relatively higher employment effects can be expected from the technology fields *innovative medicines* and *food for life*. An increase of final demand in the commodities related to *innovative medicines* by EUR 1 million can generate employment for 10.62 to 28.45 persons (excluding Poland). In comparison, the average employment multipliers of final demand (employment generated by EUR 1 million of final demand) range from 14.27 to 17.66 (excluding Poland).

The results of the multiplier analysis discussed above do not take into account any innovation indicators. Therefore, the analysis has been extended by technology flow analysis and SMFA. Before we proceed to this part of the analysis, useful insights can be provided by a key sectors analysis.

4.2 Key Sectors

This section shows the results of the **key sector analysis**. Like in the previous section, the investigation focuses on domestic production. The outcome differs from country to country. Results are determined by interdependencies between sectors. Key sectors are characterised by their pronounced linkages to other sectors. They create above-average impacts on the rest of the economy generated through changes in final demand.

The results of the key sector analysis are indicated in the last column of tables 4a and 4b. In each row of this column, the number of countries is displayed in which a sector is identified as a key sector. Appendix A contains more country-specific details on the results of key sector analysis.

In the first row for pharmaceuticals (PHARM), this sector is classified as a **key sector** in three countries (France, Germany, and the Netherlands). In these countries, this sector generates above-average effects on economic production in the rest of the economy. The second commodity, computer and related services (COMPU), is identified as a key sector in one country (Austria). In summary, we can see that commodities from originating sectors of *innovative medicines* are identified as key sectors in one to three countries. The top five users of the goods belonging to *innovative medicines* (as an input) are classified as key sectors in zero to five countries. The results of the key sector analysis for other technology fields can be interpreted in the same way. The more often the sectors belonging to a technology field are identified as key sectors, the higher are its **economic potentials**.

By surveying **source sectors** of new technology, we can distinguish **two groups** of technology fields. The **first group** consists of the fields *innovative medicines*, *hydrogen and fuel cells*, and finally *food for life* with a relatively high number of key sectors. For *innovative medicines,* pharmaceuticals (PHARM) are indicated as a key sector in three countries and computer and related services (COMPU) in one country. Supposing that pharmaceuticals (PHARM) are more important for this field, above-average production impacts can be expected in the European Union. Chemical products (CHEMI), the most important commodity among the goods related to *hydrogen and fuel cells*, is a key sector in three countries. Several other goods which belong to this technology field are also key sectors in several countries. Therefore, there can be above-average economic impacts from this field. The most important sector for *food for life*, food products (FOODP), is a key sector for four countries and the second important sector for this field, chemical products (CHEMI), is a key sector in three countries. Consequently, there may be **above-average impacts** on the goods of this field.

The **second group** consists of the fields *nanoelectronics*, *embedded systems*, *aeronautics and air traffic management*, and finally *photovoltaics*. The goods of *nanoelectronics* are products of a key sector in no country. The important commodities for *embedded systems*, i.e. radio, television and communication equipment (RADEQ), are not a key sector in any country. The other less important goods, computer and related services (COMPU), are a key sector in one country only. For *aeronautics and air traffic management*, the most important goods, aircraft and spacecraft (AIRCR), are a key sector in one country only and the second important good is a key sector in no country. With regard to *photovoltaics*, radio, television and communication equipment (RADEQ) is key sector in no country. Only the less important good, construction work (CONST), is a key sector in five countries. Therefore, an increase in final demand of commodities belonging to these fields might induce **below-average effects**.

To get a complete picture of the influences of goods belonging to technology fields, it is advisable to take into consideration a key sector analysis for **technology users**. From the point of view of technology users, the distinction between a first group of technology fields with a relatively high potential of above-average impacts and a second group with below-average effects is less clear. But in principle, the classification is similar to the one of origin sectors, particularly if the interpretation focuses on the three most meaningful users.

The **first group** consists of *innovative medicines*, *embedded systems*, *hydrogen and fuel cells*, and finally *food for life*. In all of these technology fields, related goods which are counted as user sectors in many countries are frequently indicated as key sectors. Therefore, from this point of view there is also some potential of above-average impacts of technology users on the economies of some countries.

The **second group** comprises *nanoelectronics*, *aeronautics and air traffic management*, and finally *photovoltaics*. The goods related to these fields are less frequently classified as products of key sectors. Thus, it is less probable that technology users generate above-average impacts in many EU countries compared with the first group.

5. Results of Technology-Flow and Subsystem Minimal Flow Analyses

While the results of multiplier analysis presented in the previous section are based on interdependencies between sectors or production of commodities only, technology flow analysis takes into account R&D expenditures spent in one sector and spillover effects generated in other sectors of the economy.

The results of the technology flow analysis and SMFA are summarised in table 5. First, we discuss the results of the technology flow analysis. Second, SMFA results are presented, which are based on technology flow matrices.

Table 5: R&D Flows of Selected Technology Fields

		R&D-Multiplier (x 100)		OECD Tech. Categ.	R&D Spill-Over (in %)		Growth Bipols (Num.)	Top 5 Users (Number of Growth Bipols in Parantheses)				
		min	max		min	max		Top 1	Top 2	Top 3	Top 4	Top 5
Innovative Medicines												
Origin	PHARM	2,59	16,35	high	18,58	66,66	2	HEALT (0)	FOODP (1)	ADMIN (0)	MACHI (5)	CONST (0)
	COMPU	0,22	3,71	-	54,09	74,94	1					
Nanoelectronics												
Or.	RADEQ	2,53	23,12	high	28,78	52,33	4	MACHI (5)	OFFMA (0)	PTELE (0)	CONST (0)	MOTOR (0)
Embedded Systems												
Origin	RADEQ	2,53	23,12	high	28,78	52,33	4	MACHI (5)	CONST (0)	ADMIN (0)	MOTOR (0)	OFFMA (0)
	COMPU	0,22	3,71	-	54,09	74,94	1					
Aeronautics and Air Traffic Management												
Origin	AIRCR	2,07	30,88	high	10,77	88,82	0	ADMIN (0)	TRAIR (0)	TRANS (0)	CONST (0)	TRSER (0)
	TRAIR	0,89	2,54	-	22,84	70,08	0					
	TRSER	0,26	1,00	-	31,95	70,08	0					
Hydrogen and Fuel Cells												
Origin	CHEMI	0,86	6,45	med.-high	33,01	69,37	5	CONST (0)	MOTOR (0)	MACHI (5)	ADMIN (0)	MTREP (0)
	PRDMT	0,35	2,59	med.-low	61,41	70,08	2					
	MACHI	1,10	6,22	med.-high	15,77	53,66	5					
	EMACH	1,04	5,21	med.-high	51,64	68,75	4					
	MOTOR	0,84	9,44	med.-high	3,74	22,66	0					
	ENERW	0,27	1,38	-	51,74	83,42	0					
Photovoltaics												
Origin	RADEQ	2,53	23,12	high	28,78	52,33	4	MACHI (5)	OFFMA (0)	ADMIN (0)	MOTOR (0)	PTELE (0)
	CONST	0,29	1,33	-	12,23	25,44	0					
Food for Life												
Origin	FOODP	0,24	2,16	low	16,84	30,44	1	CONST (0)	RUBBP (2)	MOTOR (0)	FOODP (1)	HOTRE (0)
	CHEMI	0,86	6,45	med.-high	33,01	69,37	5					

Source: IWI

5.1 Technology Flows

Technology flow matrices can be evaluated in many different ways. Here, we focus on **three main aspects**, all of which are summarised in table 5:

- How large are the **R&D expenditures stimulated by final demand** for commodities produced by sectors related to technology fields? In close relation to this aspect: What technology category do the sectors belong to?
- What is the **fraction of R&D expenditures** of technology origin sectors related to technology fields that **spills over** to other sectors via technology flows embodied in intermediary goods?
- What are the **major user sectors** of the selected technology fields?

We will answer each of these questions separately. As in the previous chapters, we explain how table 5 is read by using the technology field *innovative medicines* as an example first. We then proceed to the other technology fields.

The answer to the **first question** is provided by the **R&D backward multipliers** that are to be interpreted in the following way: An increase of final demand for pharmaceutical goods (PHARM) by one unit stimulates R&D expenditures by 0.0259 (Poland) to 0.1635 (Germany) units. These values are relatively high. Most of the R&D stimulated by final demand for pharmaceuticals is, of course, carried out by the sector itself, which has a very high R&D intensity. For purposes of comparison, the **OECD classification by technology category** for manufacturing sectors is included in a separate column of table 5. The pharmaceutical sector is classified as a high-technology sector. The other origin sector of *innovative medicines*, computer and related services (COMPU), has a multiplier ranging from 0.0022 to 0.0371. Since it is not a manufacturing sector, no OECD technology category classification is available for this sector.

The analysis of R&D backward multipliers for the seven selected technology fields yields **results that are confirmed** by the OECD classification by technology category. Besides *innovative medicines*, the group of technology fields that have a main origin sector with high R&D multipliers also includes *nanoelectronics*, *embedded systems*, *aeronautics and air traffic management, and photovoltaics*. In the technology field *hydrogen and fuel cells,* several related sectors have medium to high R&D multipliers and are accordingly classified by the OECD in the medium-high technology category. Only *food for life* stands out, having a main sector with a relatively low R&D multiplier and being classified low technology by the OECD.

In order to answer the **second question**, we calculate R&D spillover coefficients (as percentages). Again, table 5 contains the range of values observed for the six countries. In *innovative medicines* this means, for example: When the pharmaceutical sector (PHARM) spends 1 euro on R&D, at least 18.58 percent (in France) and at most 66.66 percent (in Italy) thereof are used by other sectors. In fact, the value for Italy is an outlier that can partly be explained by the comparatively high weight of intermediary demand for pharmaceuticals of the health sector (HEALT) as compared to final demand. Without that outlier, the maximum would be 35.57. The range of R&D spillover coefficients for the other sector related to *innovative medicines,* i.e. computer and related services (COMPU), is 54.09 to 74.94.

An overall evaluation of R&D spillover coefficients shows that the ranges of R&D spillovers are **relatively narrow** in most cases. This result confirms the expectation that the role of sectors within the economic system is comparable across countries. For example, the general pattern that the production of motor vehicles (MOTOR) is primarily dedicated to final demand (typically consumption, investment or exports) is reflected in low R&D spillover percentages (between 3.74 and 22.66 percent). On the other extreme, fabricated metal products (PRDMT) are primarily demanded as intermediate goods by other sectors, mirrored in R&D spillover percentages between 61.41 and 70.08. Though some outliers exist, patterns of R&D spillover percentages emerge quite clearly and allow the intended comparison of technology fields.

The sample of technology fields can be divided into **three categories according to their R&D spillovers**. The first category consists of only one field that generates rather high R&D spillovers to other sectors. The second category comprises several technology fields that induce medium R&D spillovers to sectors which receive goods from sectors of the technology field. Finally, a third category of fields whose related goods generate a rather low R&D spillover can be identified.

The **first category** contains only hydrogen and fuel cells. The most important good, chemistry products (CHEMI), as well as several other goods belonging to this field generate more than 50 percent of R&D spillovers in the majority of countries in our sample.

As a **second category**, the four technology fields, nanoelectronics, embedded systems, photovoltaics and aeronautics and air traffic management belong to a group of fields with goods generating medium sized R&D spillovers. The three technology fields *nanoelectronics*, *embedded systems* and *photovoltaics* present a similar picture since radio, TV and communication equipment (RADEQ) play a major role in them. This good induces R&D spillovers between 28.8 and 52.3 percent. For *aeronautics and air traffic management,* the good aircraft and spacecraft (AIRCR) is the most important product. Only in three countries, this good generates R&D spillovers of more than 30%. The other goods related to this field induce higher R&D spillovers, but they are less important. The four technology fields *nanoelectronics*, *embedded systems*, *photovoltaics* and *aeronautics and air traffic management* belong to a group of fields with goods generating medium R&D spillovers.

The **third group** comprises *innovative medicines* and *food for life*. The technology field *innovative medicines* generates rather low R&D spillovers, taking into account the outlier mentioned above and the fact that pharmaceutical products (PHARM) form the most important sector in this technology field. The technology field *food for life* induces also rather low R&D spillovers, taking into consideration those of food products (FOODP). Though R&D is important in *innovative medicines* and *food for life*, other sectors will not receive high shares of it through technology flows embodied in intermediate goods.

The **third question** posed at the beginning of this section concerns **major technology users** of R&D carried out by sectors belonging to the selected technology fields.[50] For each selected technology field and for each selected country, the top five technology user sectors are identified.

Again, *innovative medicines* may serve as an example and is discussed in more detail. The R&D expenditures of pharmaceuticals (PHARM) and computer and related services (COMPU) are received by other sectors that purchase from them. By far the most important user sector of *innovative medicines* is health and social work services (HEALT). It is the top user sector in all six European countries selected. The other user sectors of this field vary from country to country and are less important in volume. In all countries, the sectors most frequently found among the top five users are HEALT, FOODP, ADMIN, MACHI and

50 We do not give absolute values of received R&D on which this ranking is based since the ranking involves summing up R&D expenditures of potentially heterogeneous sectors. In fact, a thorough procedure would require the definition of a weight for each sector depending on the ratio of R&D carried out, specifically, for the technology field related to the total R&D of the sector. This is a nearly impossible task since it would have to be done separately for each country.

CONST.[51] MACHI and CONST show up among the top five because they are mainly users of COMPU.

In *nanoelectronics*, *embedded systems* and *photovoltaics,* the same typical user sectors are listed among the top five in many countries: Machinery and equipment (MACHI), motor vehicles, trailers and semi-trailers (MOTOR) and office machinery (OFFMA).

In *aeronautics and air traffic management,* sectors using the technology are also origin sectors. This indicates strong interrelationships within the technology field itself.

The user sectors of *food for life* do not seem very plausible as they are mainly determined by receiving R&D flows originating from the chemical sector, which in turn is not the most important sector in this technology field.

5.2 Subsystem Minimal Flow Analysis (SMFA)

This part of the analysis centres on identifying the core of the **National Innovation System** (NIS) by means of SMFA. The core of the NIS is formed by **growth bipols** and comprises those sectors which are part of bilateral connections in both the actual structure and the standard structure.

Before discussing the results of the SMFA in more detail, it is therefore interesting to see whether growth bipols emerge as clear phenomena in the selected countries. Indeed, this is the case as growth bipols in the actual and in the standard structure are **highly congruent** in all countries. Typically, the standard structure contains two to four additional growth bipols (as opposed to the actual structure), while one or two growth bipols are contained in the actual structure (but not in the standard structure).[52]

Appendix A provides more details about country-specific results of the SMFA. Furthermore, appendix B shows presents graphs showing the results of SMFA for two of the six countries chosen, namely Germany and Austria[53]. This is indeed appropriate, since NIS incorporate

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51 Among these are two sectors, MACHI and CONST that obviously do not have much relevance as users of *innovative medicines*. This may be seen as a deficiency of our technology flow approach. Since technology flow analysis is based on input-output relations it is not able to account for finer structures than sectors. However, in the case of *innovative medicines,* it is difficult to name other sectors that would more likely be users than MACHI and CONST.

52 This general feature of the results is as expected, since in the actual and in the standard structure, technological coefficients are the same and only the final demand is different. Due to the implementation of the endogenisation of the filter used in the SMFA, the number of bilateral connections is always approximately 10, but the number of sectors forming the core can vary.

53 Detailed results for all six countries are presented in the longer version of the study.

national peculiarities and it is not clear a priori that the NIS of six selected European countries are similar enough so that common conclusions can be reached for the selected technology fields.

Table 5 provides the results of the SMFA and of the **matching of growth bipols with technology fields**. For each sector belonging to a technology field either as origin sector or as a top five technology user sector, the question is asked whether it is part of the core of the NIS (i.e. it shows up as part of a bipol in both the actual and the standard structure) or not.

For example, the part of table 5 that covers *innovative medicines* has to be interpreted in the following way: The sector PHARM is part of a bilateral connection in two countries out of six (Italy and Germany) and the sector COMPU only in one country (Italy). Thus, the origin sectors of *innovative medicines* seem to be not very well integrated into the NIS according to the SMFA. Likewise, the user sectors of *innovative medicines* are not frequently bipols, with the exception of MACHI which is not a user sector of the more important origin sector of *innovative medicines*.

When summarising the results of SMFA for all technology fields, a clear distinction between **two groups** can be drawn. The first group contains four technology fields that are highly integrated into the NIS. The second group contains three technology fields that seem to be less integrated into the NIS. Clearly, the results show that this distinction concerns both origin sectors and user sectors of technologies.

The **first group** comprises the four technology fields *nanoelectronics*, *embedded systems*, *hydrogen and fuel cells* and *photovoltaics*. Their **strong integration into the NIS** can be explained by important origin sectors being part of the NIS. These sectors are radio, television and communication equipment (RADEQ identified as part of a bipol in four out of six countries), chemical products (CHEMI which is part of a bipol in five out of six countries) and electrical machinery and apparatus (EMACH, which is part of a bipol in four out of six countries).

In this first group, values for R&D multipliers and R&D spillovers are generally higher, which is not surprising. Thus, it is safe to say that the NIS of the selected European countries are well prepared for bringing forward these four technology fields.

There is a **second group** of three technology fields for which the SMFA yields **less promising results**. However, in this group, interpretation requires more care since it is possible to identify peculiarities that help explain these results and that suggest other channels that might link these technology fields to the NIS.[54]

According to the SMFA, *aeronautics and air traffic management* is very weakly integrated into the NIS. This result can be partly explained by the fact that aircraft and spacecraft (AIRCR) delivers a large part of its production to final demand and, therefore, generates not very high R&D spillovers through the channel of embodied technology flows. This is the case despite the impressing R&D intensity of the aircraft and spacecraft sector (AIRCR).

The same applies more or less to *innovative medicines*. Here, the more important of the two origin sectors, pharmaceuticals (PHARM), is part of a bipol in two countries, even though it has a relatively high R&D intensity of about 10% in many European countries.

The last technology field of the second group, *food for life*, could also be considered as NIS-integrated if its main origin sector were chemical products (CHEMI) and not food products (FOODP). FOODP is found among growth bipols in only one out of six countries. A closer look into data reveals that the generally low R&D intensity in this sector contributes to this poor result.

As mentioned above, the results of the SMFA should not be interpreted such that technology fields in the second group are not linked at all to the NIS.

5.3 Industry Growth Clusters

The results of the SMFA bear some **implications for growth**, since they provide information for identifying the growth core of the economy. However, in this section a more direct link of the sectors related to the technology fields and their growth prospects shall be established. A study carried out by the European Commission (2005c) identifies five large **industry growth clusters** (table V.2 on p. 93). By matching the technology fields to these industry growth clusters, further implications can be derived with respect to growth potentials of the technology fields.

54 For example, some technology fields, such as *innovative medicines*, have strong ties with universities, the health sector and public administration, which are not covered by our R&D data.

In the European Commission study (2005c), a sector's growth is characterised by the **growth of three variables**, namely **value added** in constant prices, **employment** and **labour productivity**. The study uses time series of these three variables ranging from 1979 to 2001. A classification of sectors according to their growth profile can be obtained from a cluster analysis based on the values of these three variables. The approach is based on a hierarchical cluster analysis that has been carried out to identify groups of sectors that are similar in their growth profile.

The European Commission (2005c, p. 90-92) outlines five growth sector clusters. An overview of the five clusters is provided in appendix D. Cluster 1 (from mining and quarrying and textiles, through building and repairing of ships) is characterised by the poorest performance in terms of both output and employment growth. The median of its growth rate in value added is slightly below zero, and its performance in terms of employment is even worse. It is, therefore, formed by industries that stagnate or exhibit very low growth rates, but which undergo a process of adjustment resulting in high increases in productivity. Cluster 2, which encompasses a high number of manufacturing industries, exhibits on average relatively low, though positive, growth rates in value added, and poor performance in employment. Productivity growth is high, although on average inferior to that of cluster 1. Clusters 3 and 4 are, with two exceptions ('rubber and plastics' and 'telecommunications equipment' in cluster 3), formed by service sectors. Cluster 3 exhibits high growth rates in value added, positive, though relatively low, growth in employment, and consequently high increases in productivity. Cluster 4, from 'hotels and catering' to 'computer and related activities', exhibits high rates of growth in output and employment and the poorest performance in productivity. Finally, cluster 5 encompasses two sectors ('office machinery' and 'electronic valves and tubes'), which exhibit very high growth rates in value added and productivity, and negative growth rates in employment.

The **matching** of the **industry growth clusters** with the **technology fields** shows that the sectors of the five technology fields *nanoelectronics*, *aeronautics and air traffic management*, *hydrogen and fuel cells*, *photovoltaics*, and *food for life* belong to industry clusters 2 or 3, which are characterised by high productivity growth. For the remaining technology fields, *innovative medicines* and *embedded systems*, the sectors are contained in cluster 2 and 4. Cluster 4 is characterised by high rates of output and employment growth and the poorest performance in productivity growth.

6. Conclusions

In this study, the impacts of seven technology fields on selected economies of the European Union are investigated. The multiplier analysis and key sector analysis are based on the interdependencies between sectors or production of commodities only. Additionally, the technology flow analysis takes into account R&D spent in one sector and spillover effects generated in other sectors of the economy. The main conclusions are the following:

- With respect to **production** multipliers related to source sectors, the highest effect can be expected from the field *food for life*. *Aeronautics and air traffic management and hydrogen and fuel cells* may have also relatively high impacts on production. Concerning **employment** multipliers of goods related to source sectors, the highest effects can be expected from goods related to the technology *food for life* as well*. Innovative medicines* and *photovoltaics* may also create relatively high employment impacts. With respect to user sectors, taking into account the model assumptions and available data base, it is very difficult to derive simple implications.

- With regard to **key sectors**, technology fields can be classified into two groups. The first group consists of *innovative medicines*, *hydrogen and fuel cells* and finally *food for live*. In all of these technology fields, related goods are frequently indicated as key sectors. Therefore, some potential of above-average impacts of increasing final demand for the commodities of this group is given. The second group comprises *nanoelectronics*, *embedded systems*, *aeronautics and air traffic management* and *photovoltaics*. The goods related to these fields are less frequently classified as key sectors. Thus, in comparison with the first group, the expected effects of changing final demand are weaker.

- **Technology flow analysis** provides a helpful view on R&D multipliers and spillover effects of technology fields. Since R&D multipliers turn out to be closely correlated to R&D intensities and to OECD's four technology categories (e.g. published in European Commission, 2005c, p. 136), the results can be summarised in terms of these. In all technology fields except *food for life*, the origin sectors, in particular the most important origin sector of the technology field, frequently belong to the categories high tech and medium-high tech. Among those, the technology fields *nanoelectronics*, *embedded systems*, *hydrogen and fuel cells* and *photovoltaics* also contain sectors that tend to have high R&D spillover coefficients, which means that R&D carried out by these sectors generates high positive externalities in other sectors of the economy.

- Results of the **SMFA** give a very clear picture, which also yields suggestions for policy recommendations. There is a group of four technology fields that are highly integrated into the National Innovation System (NIS) in many of the six selected countries. It may seem promising to promote future R&D efforts in these technology fields since the existing bilateral links between the related sectors create the growth core of the economy. These technology fields are *nanoelectronics*, *embedded systems*, *hydrogen and fuel cells* and *photovoltaics*. Another group of technology fields comprising *innovative medicines, aeronautics and air traffic management* and *food for life* seems to be less integrated into the NIS according to the SMFA. The particular reasons for this might be identified and there may be other links to the NIS that our SMFA-based approach is not able to account for. Hence, a negative judgement must be avoided.

- Relating our empirical results to the **industry growth clusters** (European Commission, 2005c) and, in particular, to productivity growth, we can observe that the sectors of the five technology fields *nanoelectronics, aeronautics and air traffic management, hydrogen and fuel cells, photovoltaics,* and *food for life* belong to the industry clusters 2 or 3, which are characterised by high productivity growth. For the remaining technology fields, i.e. *innovative medicines,* and *embedded systems,* the sectors are contained in clusters 2 and 4. Cluster 4 is characterised by high rates of output and employment growth and the poorest performance in productivity growth.

The **merits and drawbacks of input-output analysis** used in our study are well known. The study places more emphasis on qualitative input-output analysis (key sector analysis, SMFA). The results are presented in broad ranges implying relative robustness and validity. In a previous study (Schnabl, 2000), the empirical results of SMFA have shown the relative stability of NISs over time.

Taking into account the **complexity** of the problem analysed and the **availability of data** on technologies that are not applied yet, the results provide decision support and a well-founded contribution to the discussion on the economic impact of new technologies. With great care, we tried to summarise the different economic effects for the sectors related to the technology fields under consideration. This summary is shown in table 6.

Table 6: Classification of Goods Belonging to Technology Fields with Respect to their Potential Economic Effects

	Output-multiplier	Employment-multiplier	Key Sector	R&D Multipliers *and* OECD classfication	R&D Spill-Over	Growth Bipol
Innovative Medicines	-	high	high	high	-	-
Nanoelectronics	-	-	-	high	high	high
Embedded Systems	-	-	-	high	high	high
Aeronautics and Air Traffic Management	high	-	-	high	-	-
Hydrogen and Fuel Cells	high	-	high	high	high	high
Photovoltaics	-	high	-	high	high	high
Food for Life	high	high	high	-	-	-

Source: IWI

The classification presented in table 6 is a very rough approximation of the broad compendium of results of our study illustrating the potentials of the technology fields selected.

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Appendix

A Table of Country-Specific Results on Key Sector Analysis and SMFA analysis

		Key Sector	Growth Bipol
Innovative Medicines			
Or.	PHARM	France, Germany, Netherlands	Germany, Italy
	COMPU	Austria	Italy
Users (top 5)	HEALT	-	-
	FOODP	Austria, Netherlands, Italy, Poland	Netherlands
	ADMIN	-	-
	MACHI	Germany, Netherlands	Austria, France, Germany, Netherlands, Poland
	CONST	France, Germany, Italy, Netherlands, Poland	-
Nanoelectronics			
Or.	RADEQ		Austria, France, Germany, Italy
Users (top 5)	MACHI	Germany, Netherlands	Austria, France, Germany, Netherlands, Poland
	OFFMA	-	-
	PTELE	Austria, Poland	-
	CONST	France, Germany, Italy, Netherlands, Poland	-
	MOTOR	-	-
Embedded Systems			
Origin	RADEQ	-	Austria, France, Germany, Italy
	COMPU	Austria	Italy
Users (top 5)	MACHI	Germany, Netherlands	Austria, France, Germany, Netherlands, Poland
	CONST	France, Germany, Italy, Netherlands, Poland	-
	ADMIN	-	-
	MOTOR	-	-
	OFFMA	-	-
Aeronautics and Air Traffic Management			
Origin	AIRCR	France	-
	TRAIR	-	-
	TRSER	France, Germany, Italy	-
Users (top 5)	TRAIR	-	-
	ADMIN	-	-
	TRANS	-	-
	CONST	France, Germany, Italy, Netherlands, Poland	-
	TRSER	France, Germany, Italy	-
Hydrogen and Fuel Cells			
Origin	CHEMI	France, Germany, Netherlands	Austria, France, Germany, Italy, Poland
	PRDMT	France, Germany, Italy, Netherlands, Poland	France, Germany
	MACHI	Germany, Netherlands	Austria, France, Germany, Netherlands, Poland
	EMACH	Germany	Austria, France, Italy, Poland
	MOTOR	-	-
	ENERW	Austria, Germany, Netherlands, Poland	-
Users (top 5)	CONST	France, Germany, Italy, Netherlands, Poland	-
	MOTOR	-	-
	MACHI	Germany, Netherlands	Austria, France, Germany, Netherlands, Poland
	ADMIN	-	-
	MTREP	Poland	-
Photovoltaics			
Origin	RADEQ	-	Austria, France, Germany, Italy
	CONST	France, Germany, Italy, Netherlands, Poland	-
Users (top 5)	MACHI	Germany, Netherlands	Austria, France, Germany, Netherlands, Poland
	OFFMA	-	-
	ADMIN	-	-
	MOTOR	-	-
	PTELE	Austria, Poland	-
Food for Life			
Origin	FOODP	Austria, Netherlands, Italy, Poland	Netherlands
	CHEMI	France, Germany, Netherlands	Austria, France, Germany, Italy, Poland
Users (top 5)	CONST	France, Germany, Italy, Netherlands, Poland	-
	RUBBP	France, Italy	France, Germany
	MOTOR	-	-
	FOODP	Austria, Netherlands, Italy, Poland	Netherlands
	HOTRE	-	-

B SMFA Examples

Appendix B presents, by way of example, the graphs pertaining to the SMFA for Germany and Austria. Graphs for the actual and the standard structure are shown in two different graphs. They only contain bilateral connections between sectors. Alternative graphs that also identify unidirectional connections can be found in the full version of the study.

In the graphs below, an arrow between two sectors means that a significant R&D flow goes in both directions, i.e. a certain filter value is exceeded in both directions. Two different filter values are indicated by the different strengths of the arrows. The filter values are selected such that the number of the connections is as close as possible to 5 or 10. Out of the 45 sectors (see Appendix B for the definition of aggregated sectors) only those are plotted that are part of a bilateral connection. Furthermore, the position of the sectors in the graph indicates whether the sector has more outgoing or more ingoing unidirectional connections. Thus, sectors are arranged clockwise from technology providers in the lower left to technology recipients in the lower right.

Figure 1: SMFA: Bilateral Connections in the Actual Structure of Germany

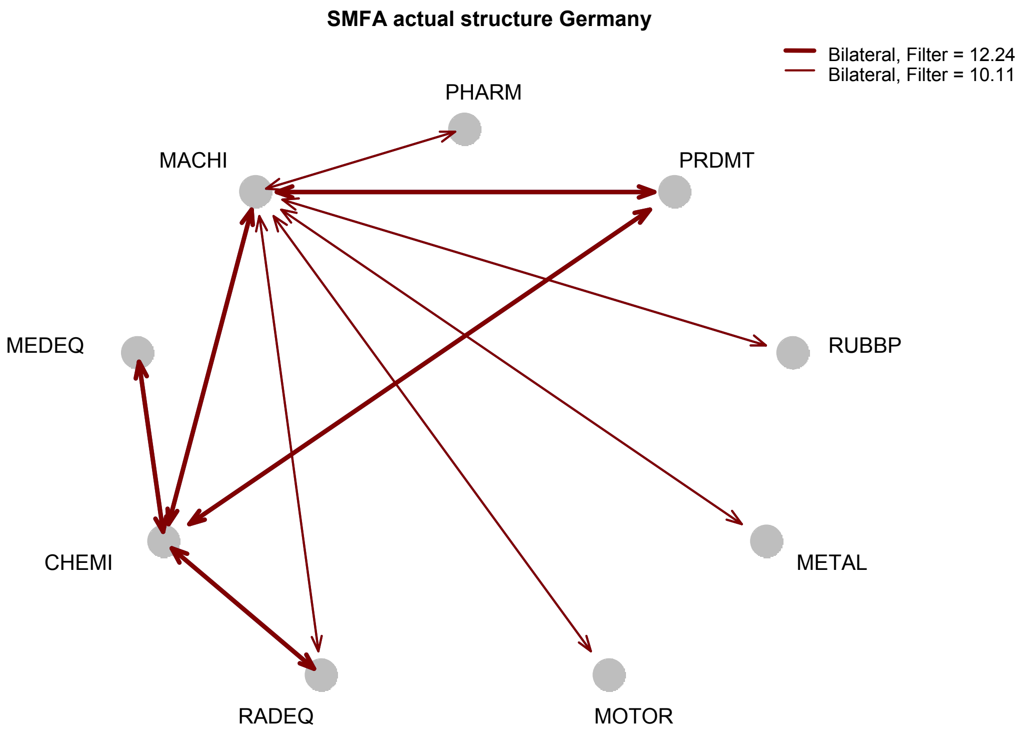


Figure 2: SMFA: Bilateral Connections in the Standard Structure of Germany

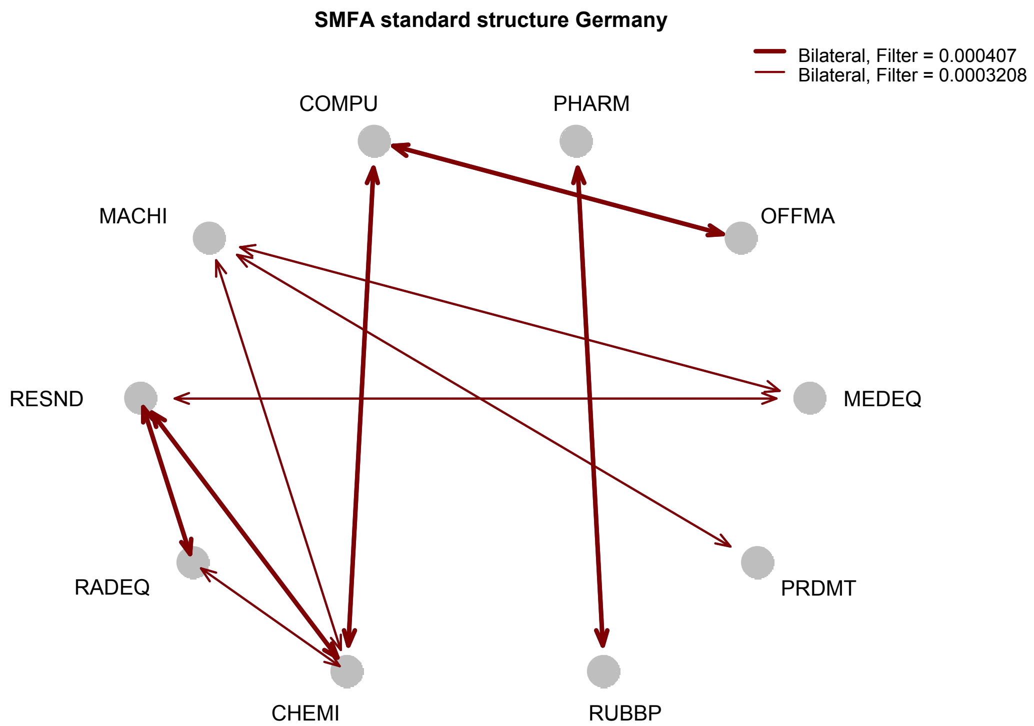


Figure 3: SMFA: Bilateral Connections in the Actual Structure of Austria

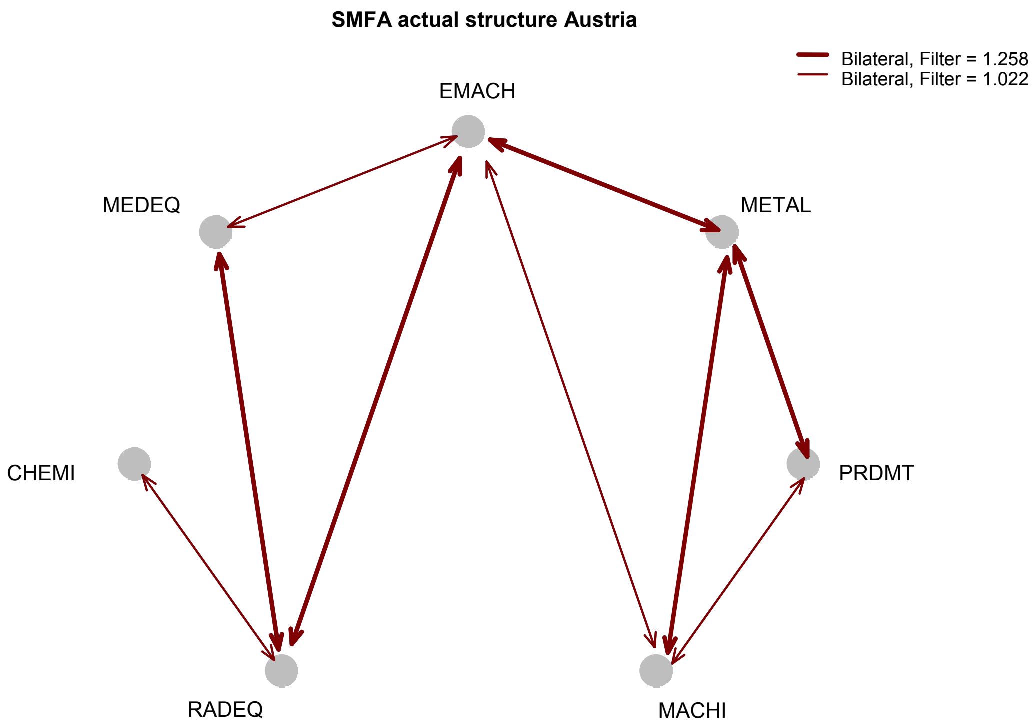
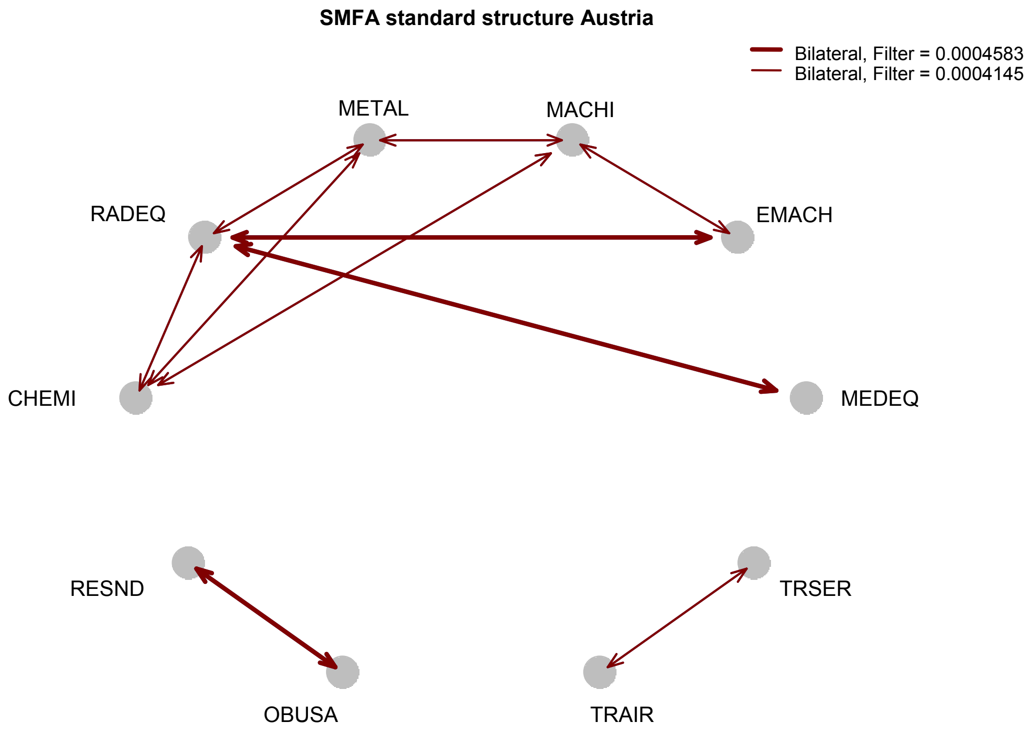


Figure 4: SMFA: Bilateral Connections in the Standard Structure of Austria



C Table of Sector Names, Abbreviations and System of Aggregation/Disaggregation

CPA official long name	Eurostat	Sectors after aggregation/ disaggregation
Products of agriculture, hunting and related services	a01	AGRIC
Products of forestry, logging and related services	a02	
Fish and other fishing products; services incidental to fishing	b05	
Coal and lignite; peat	ca10	MININ
Crude petroleum and natural gas, services incidental to oil and gas extraction, excluding surveying	ca11	
Uranium and thorium ores	ca12	
Metal ores	cb13	
Other mining and quarrying products	cb14	
Food products and beverages	da15	FOODP
Tobacco products	da16	
Textiles	db17	TEXTI
Wearing apparel; furs	db18	
Leather and leather products	dc19	
Wood and products of wood and cork (except furniture); articles of straw and plaiting materials	dd20	WOODP
Pulp, paper and paper products	de21	PAPER
Printed matter and recorded media	de22	PRINT
Coke, refined petroleum products and nuclear fuel	df23	REFIN
Chemicals, chemical products and man-made fibres	dg24	CHEMI
Pharmaceuticals, medicinal chemicals and botanical products		PHARM
Rubber and plastic products	dh25	RUBBP
Other non metallic mineral products	di26	GLASS
Basic metals	dj27	METAL
Fabricated metal products, except machinery and equipment	dj28	PRDMT
Machinery and equipment n.e.c.	dk29	MACHI
Office machinery and computers	dl30	OFFMA
Electrical machinery and apparatus n.e.c.	dl31	EMACH
Radio, television and communication equipment and apparatus	dl32	RADEQ
Medical, precision and optical instruments; watches and clocks	dl33	MEDEQ
Motor vehicles, trailers and semi-trailers	dm34	MOTOR
Other transport equipment	dm35	OVEHI
Aircraft and spacecraft		AIRCR

CPA official long name	Eurostat	Sectors after aggregation/ disaggregation
Furniture; other manufactured goods n.e.c.	dn36	OTHMA
Secondary raw materials	dn37	
Electrical energy, gas, steam and hot water	e40	ENERW
Collected and purified water; distribution services of water	e41	
Construction work	f45	CONST
Trade, maintenance and repair services of motor vehicles and motorcycles; retail trade services of automotive fuel	g50	MTREP
Wholesale trade and commission trade services, except of motor vehicles and motorcycles	g51	WHOLE
Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods	g52	RETAI
Hotel and restaurant services	h55	HOTRE
Land transport and transport via pipeline services	i60	TRANS
Water transport services	i61	
Air transport services	i62	TRAIR
Supporting and auxiliary transport services; travel agency services	i63	TRSER
Post and telecommunication services	i64	PTELE
Financial intermediation services, except insurance and pension funding services	j65	FIMSE
Insurance and pension funding services, except compulsory social security services	j66	INSUR
Services auxiliary to financial intermediation	j67	SEVFI
Real estate services	k70	REALE
Renting services of machinery and equipment without operator and of personal and household goods	k71	RENTI
Computer and related services	k72	COMPU
Research and development services	k73	RESND
Other business services	k74	OBUSA
Public administration and defence services; compulsory social security services	l75	ADMIN
Education services	m80	EDUCA
Health and social work services	n85	HEALT
Sewage and refuse disposal services, sanitation and similar services	o90	OCSPS
Membership organisation services n.e.c.	o91	
Recreational, cultural and sporting services	o92	
Other services	o93	
Services of households as employers of domestic staff	p95	

D EU-15 Industry Growth Clusters (Average Annual Growth Rates in Percent, 1979-2001)

	Sector	Value added	Employment	Productivity
Cluster 1	Mining and quarrying	-0,2	-5,2	5,4
	Textiles	-0,8	-3,2	2,6
	Clothing	-0,2	-3,5	3,4
	Leather and footwear	-1,1	-3,3	2,4
	Basic metals	0,7	-3,1	4,1
	Building and repairing of ships	-0,1	-3,3	3,6
Cluster 2	Food, drink and tobacco	1,1	-0,6	2,1
	Wood and products of wood	1,1	-1	2,4
	Pulp, paper and paper products	2	-1	3,3
	Printing and publishing	1,6	-0,1	2,1
	Mineral oil refining and nuclear fuel	-3,7	-2	-1,6
	Chemicals	3,3	-1,3	4,9
	Non-metallic mineral products	1	-1,3	2,7
	Fabricated metal products	0,8	-0,8	1,9
	Mechanical engineering	0,6	-1,1	2
	Insulated wire	2,8	-1	4,1
	Other electrical machinery n.e.c.	0,5	-0,7	1,5
	Radio and television receivers	0,2	-2,4	2,9
	Scientific instruments	-2,6	-0,2	-2,1
	Other instruments	1,6	-1,9	3,8
	Motor vehicles	1,6	-0,7	2,9
	Aircraft and spacecraft	1,7	-0,6	2,8
	Railroad and transport equipment n.e.c.	1	-2,1	3,4
	Furniture; manufacturing n.e.c.	0,4	-0,7	1,6
	Electricity, gas and water supply	2,1	-1,3	3,7
	Construction	0,8	-0,2	1,2
	Inland transport	2,3	0,2	2,6
	Water transport	0,7	-2,5	3,6
Cluster 3	Rubber and plastics	2,4	0,6	2,1
	Telecommunication equipment	9,6	-1,3	11
	Sale and repair of motor vehicles	1,9	0,9	1,4
	Wholesale trade	2,7	1,1	2,2
	Retail trade	2,1	1	1,6
	Air transport	6	1,4	4,9
	Supporting transport activities	3,7	1,3	2,9
	Communications	6,3	0,3	6,5
	Financial intermediation	3,2	1,1	2,6
	Insurance and pension funding	2,2	1,1	1,7
	Research and development	2,4	1,7	1,2
Cluster 4	Hotels and catering	1	2,4	-0,9
	Auxiliary to financial intermediation	3,1	2,7	0,8
	Real estate activities	2,5	3,4	-0,5
	Renting of machinery	5,3	3,4	2,2
	Computer and related activities	7,6	6,5	1,5
	Legal, technical and advertising	4,3	4,2	0,6
	Other business activities n.e.c.	4	4,7	-0,2
Cluster 5	Office machinery	29,9	-0,6	30,5
	Electronic valves and tubes	33,3	-0,1	33,7

SELECTED CONTRIBUTIONS BY MEMBERS OF THE HIGH-LEVEL GROUP OF EXPERTS

LESSONS FROM PERFORMANCE DIFFERENCES IN EUROPEAN COUNTRIES SINCE THE NINETIES

Karl Aiginger[55]

Income per capita in the United States is 40 per cent higher than in Europe, a situation that has hardly changed over the past decades. Productivity per worker is 30 per cent higher, per hour about 10 % higher. Europe had been catching up in productivity per worker over a long period in the post-war years, but in the past 10 years the United States has one again increased its lead. Employment indicators show that the United States created 78 million jobs between 1990 and 2003, while Europe created 42 million. The employment rate in Europe, which up to the 1970s was higher, is now 13 percentage points lower than that of the United States. Unemployment which used to be lower, is now higher in Europe, even excluding the significant number of people on disability or in early retirement schemes, which reduces headline unemployment. There are fewer hours worked in Europe, partly voluntarily and partly due to the lack of full-time jobs. Leisure takes a higher priority in Europe, as does equity, but the changes between the 1980’s and the current situation cannot be attributed to different preferences alone.

International organizations, and particularly analysts in the US, often blame higher welfare costs and stricter labour and product regulations for the lack of dynamism in the European economies (let us call this “Paris consensus” since it is often explicitly or implicitly referred to in OECD documents). However, assessing performance differences in Europe reveals that the best performing countries (besides Ireland, which experienced a remarkable catching up) are three Nordic European welfare States: Denmark, Finland and Sweden. All three countries had suffered structural and cyclical crises, which appeared to confirm some of the bleak predictions for welfare States, but over the past 10 years they have been performing better than the other European countries, with a growth performance similar to that of the United States. At the same time, they are successfully trying to combine welfare with higher efficiency, indicating a new European model of a reformed welfare State. It provides an alternative model to that of the United States in that it aims at achieving economic efficiency while maintaining the traditional European concerns for social welfare and environmental quality.

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Towards a new European model: a tentative sketch of its features

The structures and policies of the most successful European countries are very different from those of the United States system, both for government involvement in welfare and in their commitments to training and redistribution as goals of labour market policy. Their labour market policies offer a high degree of flexibility for firms (e.g. easy dismissals, rather unregulated temporary labour and low corporate taxes), but also provide security to individuals in helping them to find new jobs and upgrade their qualifications (and providing high replacement ratios, however often contingent on mobility, training etc.). This system is therefore called “flexicurity” and builds on the broader concept of “active labour market policies”. However, labour flexibility is a necessary but not sufficient condition for success: these countries also accord high priority to new technologies, efficiency of production and the competitiveness of firms. They have achieved the Lisbon criteria for research expenditures, and are leading in quality of education and life long learning. In contrast to the United States, they rely on proactive industrial policies, with government support for information technology, for agencies promoting research, for regional policies and for clusters. This contrasts with the Paris consensus of “liberalize and wait for firms to innovate”). Let us repeat, these countries suffered severe financial crises when many of those problems expected to dampen growth in highly developed welfare States surfaced: for example, costs increased faster than productivity and government expenditures increased faster than taxes. Subsequently they changed their course, though without abandoning the principles of the welfare State and without giving up their environmental goals. The specific elements of the political reforms in the northern European countries suggest that there may be a new kind of reformed European model, which combines welfare and sustainability on the one hand with efficiency and economic incentives on the other.[56]

The new welfare State, as represented by policy strategy in these leading European countries, is different from the old welfare State in the following ways:

- The social system remains inclusive and tight, but social benefits may depend on the individual’s input; these benefits may be conditional on certain obligations; and replacement rates are lower than they used to be (though still high by international standards) to provide better incentives to work.

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[56] For earlier suggestions along this line, see Aiginger (2002), Aiginger and Landesmann (2002) and Aiginger (2004).

- Taxes are relatively high, but in line with expenditure, aiming at positive balances to take care of future pensions or to repay existing debt.
- Wages are high, but the individual's position is not guaranteed, as business conditions vary. However, personalized assistance and training opportunities , that are less bureaucratic and centralized, are offered to people who lose their jobs.
- Welfare-to-work elements are introduced, usually on a decentralized – sometimes even private – basis; conditions differ according to the size and kind of problem, the background philosophy being one of giving help but without encouraging laziness.
- Part-time work and adaptation of work to life-cycles is encouraged – not prevented – and social benefits are pro rata extended to part-time work, which becomes an individual right and a measure voluntarily taken to enforce rather than prevent gender equality.
- Technology policy and adoption of new technologies, rather than subsidizing old industries, are a precondition for the survival of the welfare State, and lead to more challenging and interesting work.[57]

Remaining differences to the US

The new European model differs still from the United States model in the following ways:

- Even where welfare costs are streamlined and incentives improved, the welfare system offers comprehensive insurance against economic and social risks and a broad coverage of health risks.
- Environmental and social goals as well as equity of income distribution and prevention of poverty are high on the political agenda.
- Government and public institutions play a proactive role in promoting innovation, efficiency, structural change, higher qualifications and lifelong learning. Public institutions also provide the largest share of education and health care.
- Social partners (institutions comprising representatives of firms and employees) determine many elements of wage formation, and together develop labour laws and institutions specifically and economic policy in general.
- Government is large and taxes are high, even if there are mechanisms to limit increases in spending and goals for achieving a sound fiscal policy in periods of increasing demand.

[57] Surprisingly, the policies pursued by the leading countries have many similarities with the economic policy recommendations of the Steindl-Kalecki tradition, as described in Guger, Marterbauer, Walterskirchen (2003).

The model is sustainable, if reforms increase flexibility and a proactive policy enforces innovation

The fact that welfare States performed well in the 1990s does not imply that costs are irrelevant for performance. After suffering severe crises, these countries realized that costs needed to be cut and fiscal balances stabilized, that incentives had to be implemented and institutions reformed. But most importantly, they realized also that cost-cutting represents a short-term strategy which needs to be complemented by proactive policies to promote research, education and the diffusion of new technologies. This leads us to the tentative hypothesis that a new European model is in the offing, with an emphasis on cost balances, institutional flexibility and technology orientation. Even in the trough period, from 2001 to 2004, the budgets in all three countries were balanced. Firms are more flexible with regard to the use of labour, and workers who are laid off are efficiently assisted in finding new jobs. Replacement ratios have been reduced and benefits are conditional upon job searches and training efforts.

Thus the new European model of the reformed welfare State has three major elements: social and environmental responsibility, openness and technology promotion.[58]

[58] This is a shortened version from: Towards a New European Model of a Reformed Welfare State: An Alternative to the United States Model , Economic Commission for Europe, United Nations, New York and Geneva, No. 1, 2005, pp. 105-114.

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CAN THE RELAUNCH OF THE LISBON AGENDA SOLVE THE PUZZLE OF WHY DEEPER INTEGRATION DID NOT LEAD TO MORE GROWTH IN EUROPE?

Fritz Breuss[59]

After a disastrous performance of the Lisbon Agenda so far, European Commission José Manuel Barroso announced a relaunch in spring 2005, streamlining the numerous goals to "jobs, growth, the environment and a proper social network". With the slogan "growth and jobs" he hopes to reconnect with the original Lisbon expectations in the second half of the decade. Although such ten-years plans are reminiscent of Krushchev 1960s' plans to overtake the United States in the production of steel, the ideas behind this strategy are theoretically sound. It is enough if we re-iterate the catch words of the Presidency Conclusions of the Lisbon European Council of 23 and 24 March 2000: information society for all; European area of research and innovation; helping SMEs; genuinely completing the internal market (including for financial markets and services); coordinated macro-economic policies (sustainable fiscal policies); education and training; active employment policy; new open method of coordination.

In principle we know – at least from economic theory - exactly how to create jobs and growth. Why then does this not happen in Europe in practice – at least in the last decade? It is an irony in the history of European integration that it is precisely since the EU began its most ambitious projects - from the Internal Market in 1993 to Economic and Monetary Union (EMU) in 1999 - that the EU has falled furthest behind the United States, at least in terms of the primary macroeconomic goals of growth and jobs. The response to the not- very-successful start to the Internal Market program in 1993 was the Lisbon Agenda of March 2000. With its strategy one wanted to speed up the growth engine in Europe – but it has still not materialized!

The diagnostic findings of the Lisbon Agenda, however, did not answer the essential question: Why does deeper integration in Europe – in sharp contrast to integration theory and all the ex-ante model estimations on the possible impact of the Internal Market program

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(just to mention the numerous studies of the so-called "Cecchini Report" of 1988) - *not* lead to more welfare, as measured by GDP growth and more job opportunities? Whereas in the United States – where there was no change in the overall economic and political framework in the last fifteen years - Europe has changed and integrated its landscape dramatically. On the one hand this has been done by implementing the Internal Market und the Euro, and on the other through an ongoing process of enlargement: in 1995 by three new countries to EU-15; and in 2004 by ten further new member states to EU-25. The process of enlargement continues, with Bulgaria and Romania to become EU members in 2007 or 2008, followed by some Balkan states (Croatia and Macedonia) and later on maybe by Turkey. Nevertheless, the United States experienced an unprecedented boom, starting in the early nineties of the last century, whereas the EU's economy on average only grew very modestly in the same period. Only one partial – and expected - outcome of the whole integration process has been delivered: the internal market and particularly EMU have stimulated intra-EU trade. However, this positive consequence of integration did not (sufficiently) spill-over to other welfare measures, such as GDP per capita or labour market performance.

Will the most recent EU enlargement help to speed up growth in the EU? For the new member states in Eastern Europe, enlargement will help to stimulate annual growth by around one percentage point. The impact in the old member states varies depending on the level of current trade with the new member states. On average, EU-25's real GDP will grow faster than those of EU-15 by merely one tenth of a percentage point per year. The primary winners in the enlargement game are Austria and Germany with an expected boost of a 1/4 percentage point in additional GDP growth per year. Austria in particular has already enjoyed much of the enlargement boost since the opening-up of Eastern Europe in 1989. This may explain the lead in GDP growth over many other old EU member states, such as Germany. On the one hand the Eastern enlargement of the EU may lead to slightly more GDP growth in the EU on average, on the other hand it has caused a statistical decline in GDP per capita in the EU as a whole by around 10 percentage points.

The same is true for labour productivity. The level of EU's average labour productivity declined after enlargement, its annual growth will increase.

Many analysts erroneously compare the United States economic performance with that of the EU on average. Such comparisons neglect the fact that the United States is a homogenous economy and a federal nation state whereas the EU is far from being a nation.

Even if the “Treaty establishing a Constitution for Europe” had been come into force as planned in November 2006 (which will not now happen following the negative referendum results in France and the Netherlands), the European Union (the “Union”) would not have been transformed to a federal nation or state. The German Constitutional Court (Bundesverfassungsgericht) ruled that the EU is a federation of states (Staatenverbund) and not a state. The EU is still a Europe “United in diversity”, and de facto the EU is divided in many areas of economic and political integration. There are several expressions to describe the present integration status of the EU: “differentiated integration”, “Kernel Europe”, “Europe à la carte”, “Enhanced cooperation” etc. Prominent examples of incomplete integration are EMU (only a minority of 12 out of 25 EU member states belongs to the Euro zone) and Schengen. The Schengen agreement means there are no longer any frontier controls at borders, but only between more than half of the EU countries (Ireland, the United Kingdom and the new 10 member states do not (yet) participate in Schengen). The EU also has a huge number of transitional arrangements in many areas of the acquis communautaire of the Internal Market. A key example is the seven year transitional period before full free movement of people, agreed as part of the most recent enlargement (the only exceptions make Ireland, Sweden and the United Kingdom). In addition, the highly praised Internal Market is far from being completed.

The fact that the Internal Market and the EMU are not yet completed (in addition to the examples of financial markets and services, one could also add the less flexible labour market in Europe) may be the biggest difference from the United States and could be an explanation of why Europe lags behind in economic growth, employment and technology – though not so far in “international competitiveness”. In view of the huge and increasing deficits in the trade and current accounts the United States can hardly claim to be competitive. Europe on average and Germany in particular is “export world champion”. This indicates that, as far as international competitiveness is concerned, the EU and its member states are far ahead of the USA. When looking at the EU, however, one must keep in mind that its average consists of countries with very good performance and countries with bad performance. Behind the meagre average annual GDP growth of EU-25 in the period 2000-2006 of 2.1% (EU-15 2%; USA 2,8%), we can identify 12 countries with growth rates well above the famous Lisbon target of average GDP growth of 3% (9 of the new 10 member states, Greece, Ireland and Luxembourg); six countries have a growth rate higher than or equal to that of the average of EU-15 (Belgium, Finland, France, Spain, Sweden and the

United Kingdom). Only 7 EU member states perform worse than the average GDP growth of EU-15 (Austria, Denmark, Germany, Italy, Malta, Netherlands and Portugal). The problem with the latter group is that Germany has the worst growth performance - only 1.3% annual GDP growth in the period 2000-2006. Germany, the third largest industrial nation in the world and by far the most potent economy in the EU, alone comprises a fifth of the economic weight in EU-25. An ongoing mediocre economic performance of Germany threatens negative spill-over effects for its neighbouring countries.

As well as GDP growth rates within the EU, unemployment rates also vary greatly betweenMember States. Interestingly, even the faster growing member states in Eastern Europe exhibit higher unemployment rates (e.g. Poland more than 18%) than low growth countries such as Germany (around 9%). The fact that the new member states, which are partially still in a transformation process, exhibit higher unemployment rates also affects the average EU rates. In the EU-25, the average unemployment rate amounts to 9%, one percentage point higher than in the slower growing "old" EU-15.

Which situation then are we confronted with in Europe? A constellation of "jobless growth" or cases of "growthless jobs"? In their 2005 Joseph Schumpeter lecture *"Appropriate Growth Policy: A Unifying Framework"*, delivered to the 20th Annual Congress of the European Economic Association in Amsterdam, August 25, 2005, Philippe Aghion and Peter Howitt tried to explain theoretically the puzzle why European labour productivity growth was much higher than US growth during the sixties and seventies (3.5% versus 1.4% on average during the 1970s), given that R&D investments were higher in the US (2.5% of GDP) than in Europe (2%) throughout this period, and why since the early 1990s GDP growth was persistently slower in the EU (less than 2% a year against 3% in the US between 1995 and 2000). They argue that Schumpeterian theory, in which growth results from quality-improving innovations, may provide a good explanation and could also lead to a reasonable theory for policies aiming at growth. With the Aghion-Howitt approach à la Schumpeter, one can explain how a country's growth performance (in our case the EU average) will vary with its proximity to the technological frontier (For example the USA in the 1990's). One can also assess the extent to which the country will tend to converge to that frontier, and what kinds of policy changes are needed to sustain convergence as the country approaches that frontier. After World War II the European economy caught up technologically to the US, surpassing the growth performance of the US. However its growth began to slow before the gap with the US had been closed, because its policies and institutions were not designed to optimize growth when close to the frontier. All things being equal, this would have resulted in the growth rate dropping to that of the US but no further. What happened then, however, was that the IT revolution resulted in a revival of the US frontier growth rate in the late 1980s and early 1990s. Starting with the Internal Market program, followed by the EMU, meant Europe was not as well placed as the US to benefit from this technological revolution. As a result a growth gap between Europe and the US opened up. The Aghion-Howitt model implies different policies for frontier countries (at present the US; "the innovators") than for the lagging-behind countries (Europe as a whole, "the imitators"):

(i) *Education policy:* As a country moves closer to the technological frontier (like Europe as a whole), tertiary (higher) education (especially graduate and university) education should become increasingly important for growth compared to primary/secondary education. Presently, Europe spends less on higher education than the US;

(ii) Competition policy: So far competition policy in the EU has emphasized competition among incumbent firms, but paid insufficient attention to entry. Aghion-Howitt's model shows entry and entry threat as enhancing productivity growth and innovation in sectors or countries that are close to the technological frontier; entry and entry threat, however, discourage innovation and productivity growth among incumbents in sectors or countries that are far below the frontier.

(iii) Macropolicy: What are the consequences of the interplay between countercyclical budgetary policies and structural reforms such as product or labour market liberalization? It can be demonstrated that the two are complementary: a higher degree of product or labour market liberalization increases the positive growth impact of countercyclical budgetary policy.

In taking stock there are some explanations why Europe – despite putting considerable effort into accelerating the economic integration process - fell behind the US in the growth performance. However, many questions remain unanswered. Comparing the starting positions in the early 1990s, one can state the following transatlantic differences:

(i) The United States is a nation state with a well functioning, long established single market with highly flexible labour, product and housing markets; the whole US single market operates with a single currency (the Dollar) and has the advantage of a single language.

In addition, the macro-political architecture is symmetrical, with a centralized monetary and fiscal policy which acts very countercyclically.

The European Union is still no nation state and only began the Internal Market in 1993; the Internal Market is far away from being completed (financial markets; services markets); labour markets are still very rigid; only a minority of the EU member states operates with the Euro; EMU's political architecture is asymmetric, implying a centralized monetary policy and a decentralized (and badly coordinated) fiscal policy; as the unpleasant experience with the Stability and Growth Pact showed, it mainly acts procyclically; and last but not least the EU does not possess a common language!

SERVICES REGULATION AND ECONOMIC PERFORMANCE

Paul Conway and Giuseppe Nicoletti[60]

1. Introduction

After decades of convergence, the process of catch-up has been stalling in OECD countries since the early 1990s and only a few high-growth countries continue to converge towards the GDP per capita levels of the United States. In the large continental countries of the Euro-zone, GDP per capita growth has been particularly disappointing. Changes in the patterns of labour productivity growth and, to a lesser extent, labour utilisation are the predominant cause of this stalling of convergence.

This note summaries recent empirical work on the role of product market regulation (PMR) in this process. It begins with a brief reminder of recent trends in product market regulation in OECD countries before going on to summarise empirical work on the effect of PMR on labour productivity and employment growth. Based on these empirical estimates, it concludes with a quantitative assessment of the potential benefits of further product market reform.

2. Recent trends in product market regulation

Product market regulation has become more linked to market mechanisms in OECD countries over recent years as governments have liberalised potentially competitive markets, re-regulated natural monopoly markets and established pro-competitive regulation where possible, and privatised previously state-owned assets. From the late-1990s, cross-country differences in the stance of product market regulation in the OECD area have fallen in part because regulation in the euro area and former transition countries has moved some way towards that of the more liberal countries. Notwithstanding a degree of convergence, however, product market regulation in the OECD area is still characterised by significant differences across countries (Conway *et al.,* 2005).

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[60] OECD, Paris. The views in this paper are those of the authors and do not necessarily reflect the views of the OECD.

In OECD countries, anti-competitive product market regulation is concentrated in non-manufacturing sectors. The effect of this regulation is most visible in the form of lower competitive pressures and higher costs and mark-ups in these sectors, even after the specific technological and market features of some of them – for example, network industries – are taken into account (OECD, 2005a). However, the effect of restrictive regulation in non-manufacturing is by no means confined to these sectors. It also has a less visible impact on the cost structures faced by firms that use the output of non-manufacturing sectors as intermediate inputs in the production process. Other channels, such as the price of investment goods and "Baumol disease" effects that act through wages, will also propagate the effects of anti-competitive regulation in non-manufacturing sectors through the economy. This is especially the case given the large and increasingly important role of the non-manufacturing sector in OECD countries.[61] Recent estimates suggest that ICT-intensive sectors, which are typically service-intensive, are bound to suffer most from the impact of restrictive non-manufacturing regulations (Figure 1).

3. Product market regulation and productivity growth

Over recent years aggregate productivity in the Euro-zone countries has been diverging from US levels. Differences in productivity growth in sectors that use ICT intensively have been found to be an important source of this divergence (van Ark *et al.*, 2002). There are good reasons to believe that differences in competitive pressures across countries can partly explain these differences in productivity performance. Indeed, at first glance, countries with a relatively liberal approach to competition have tended to experience a greater acceleration in productivity growth after 1995 in comparison to relatively more restrictive countries (Figure 2).

There are a number of reasons why competition enhances productivity growth. In a competitive environment with low barriers to entry the incentive to invest and adopt new technology so as to increase productivity and retain market share may be stronger than in a more restrictive regulatory environment where incumbents are sheltered from competition. In addition, the costs of adjusting firm structure and reorganising the production process, which are necessary if new vintages of capital and technology are to be successfully integrated, will tend to be lower in a competitive environment. As a result, increasing the intensity of

[61]. The service sector now accounts for roughly 70% of all jobs and value-added in the OECD area, up by more than five percentage points since 1990. See Kongsrud and Wanner (2005).

competition can enhance productivity by improving the allocation of resources and encouraging a stronger effort by managers to improve efficiency.

Recent empirical work has explored this relationship between policy and productivity in detail and identified a number of inter-related channels through which anti-competitive regulations negatively impact on productivity growth. Specifically, restrictive product market regulation has been found to:

1. lower capital formation in crucial sectors,
2. reduce the speed of catch-up to best practice production techniques, and
3. reduce innovation

Lower capital formation in crucial sectors

Empirical studies have shown that inappropriate regulatory settings can curb both domestic and foreign investment. Firms that enjoy excessive product market rents have less incentive to expand productive capacity. In addition, a high regulatory burden increases the cost of adjusting productive capacity, again reducing the incentive to invest. Evidence of this has been found in crucial non-manufacturing sectors such as communications, transport and energy, with inappropriate regulations accounting for a large part of the increasing gap in domestic investment rates between continental European countries and the United States observed over the past two decades (Alesina *et al*., 2005).

Regulatory policies that restrict market access or reduce the potential returns to foreign investment were also found to curb significantly inward FDI stocks in many countries, hampering the efficient allocation of resources in the OECD area (Nicoletti *et al,.* 2003).[62] Anti-competitive and excessively burdensome regulations discourage the establishment of foreign affiliates and their propensity to increase employment. Although this effect is small relative to the aggregate economy, inappropriate regulation may still erode the scope for

[62]. Other non-policy factors that might influence the location decisions of foreign affiliates include 'gravity' effects such as size and distance, and the host country's relative endowment of productive inputs.

productivity spillovers from foreign to domestic firms and competitive pressures in domestic markets that are sheltered from foreign trade (such as in many service industries).[63]

Reduce the speed of catch-up to best-practice production techniques

Empirical work suggests that restrictive regulations slow the process of adjustment through which positive supply shocks diffuse across borders and new technologies are incorporated into the production process. In some of the more restrictive OECD countries the loss of adaptability to global supply shocks that occurs as a result of anti-competitive regulation are estimated to be sizeable, implying significant costs in terms of a lower speed of catch-up (OECD, 2005b). Because well-functioning product markets increase the incentive and lower the cost of incorporating new technologies into the production process they are an important condition for rapid productivity catch-up.

Different rates of ICT investment across countries provide a good example of the effect of product market regulation on the adoption of new technology. Empirical evidence (Gust and Marquez, 2002; OECD, 2005b) strongly suggests that firms operating in an environment with low barriers to entry are more inclined to incorporate ICT into the production process than firms operating in an environment in which regulation is more restrictive of competition (Figure 3). As well as increasing the incentives to improve productivity and lowering the costs of adjustment, a competitive environment also exerts downward pressure on the cost of ICT, thereby promoting its diffusion.

Since restrictive product market regulations slow the adoption of new technologies and production processes, they tend to have a stronger influence on productivity patterns in times of rapid technological change. Accordingly, the emergence of ICT over the past decade may have amplified the effect of cross-country differences in anti-competitive regulation on productivity growth, thereby contributing significantly to the recent divergence of productivity levels in the euro-zone and US economies. This effect is reinforced by the fact that the majority of sectors that use ICT intensively are non-manufacturing sectors where anti-competitive product market regulation is concentrated.

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[63]. Previous empirical work has typically shown that foreign affiliates tend to be more capital and skill intensive and invest more in research and development than domestic firms in the same industry. As a result, foreign affiliates tend to grow more quickly and make a larger direct contribution to productivity growth in comparison to domestic firms (Criscuolo 2005). Foreign affiliates may also contribute indirectly to domestic productivity growth by generating positive productivity spillovers for local firms. For example, foreign affiliates may speed the diffusion of new technology and management practices across borders or train labour that is subsequently employed by local firms.

As well as influencing the diffusion of new technology there is also evidence that restrictive or burdensome entry regulations curb the creation of new firms, which may also inhibit the diffusion of technology and the process of factor reallocation from less to more efficient uses, especially in innovative sectors (OECD, 2003).

Less innovation

The link between competition and innovation is complex, multifaceted and somewhat controversial. Some recent theoretical studies have demonstrated that the relationship between competition and innovation may be 'bell shaped' in that too much, as well as too little, competition can result in a lower innovative effort from firms. Empirical research, however, has found that in most cases increased competition is beneficial for innovation measured in terms of R&D spending, provided adequate protection of intellectual property rights is ensured (Bassanini and Ernst, 2002**;** Jaumotte and Pain 2005**).** Estimates also suggest that regulations that promote competition have significantly enhanced multifactor productivity growth, a measure of innovation outcomes, in countries that have extensively reformed product markets (Nicoletti and Scarpetta, 2003).

4. Product market regulation and employment

Consistent with recent theoretical studies (Blanchard and Giavazzi, 2003; Ebelle and Haefke, 2005), empirical work has also found that regulations that curb entry and competitive rivalry among firms have a negative effect on employment growth. Firstly, in a restrictive regulatory environment lower entry and rent-seeking behaviour from incumbents may restrict economic activity and therefore the demand for labour. Second, wage premia also tend to be higher in countries with a restrictive regulatory environment as labour attempts to capture a share of these rents (Nicoletti and Scarpetta, 2005). In conjunction with a lower level of labour productivity, this also leads to a reduction in labour demand, by increasing the wage-productivity gap.

As well as inducing firms to hire less labour, restrictive product market regulation has also been shown to hinder structural adjustment towards employment-generating service industries, which tend to be 'luxury goods' (Messina, 2005). Indeed, there is a very strong negative cross-country correlation between service regulation and the share of employment in services (Figure 4). In countries with a relatively restrictive regulatory environment demand for services may be lower than in more liberal countries as a result of lower GDP per capita and higher prices for services which curbs demand and make it more convenient to resort to home production in many cases. In addition, barriers to entry may also directly restrict the supply of services.

5. The benefits of further reform

Empirical estimates from econometric models suggest that the benefits of ongoing product market reform may be considerable for some countries. Very briefly, recent empirical work indicates that enhancing the role of competition in product markets would:

- increase multifactor productivity growth
- increase domestic investment rates, particularly in ICT
- increase the entry rates of new firms
- increase foreign direct investment and broaden the activities of foreign affiliates
- lead to a deepening in services trade

Empirical models estimated at the sectoral level tend to suggest that these improvements in economic performance that arise as a result of product market reform would be larger in ICT-using sectors given that these sectors tend to be services sectors in which anti-competitive regulation is concentrated. Stronger competitive pressure, faster capital deepening and adoption of best practice techniques would, in turn, increase the speed of catch-up in aggregate labour productivity and increase rates of employment.

Although estimates of the magnitude of these effects entail a degree of uncertainty, model simulations suggest that the performance dividend from further reform of product market regulation may be considerable for some countries and could go a long way towards meeting the Lisbon targets (Table 1).

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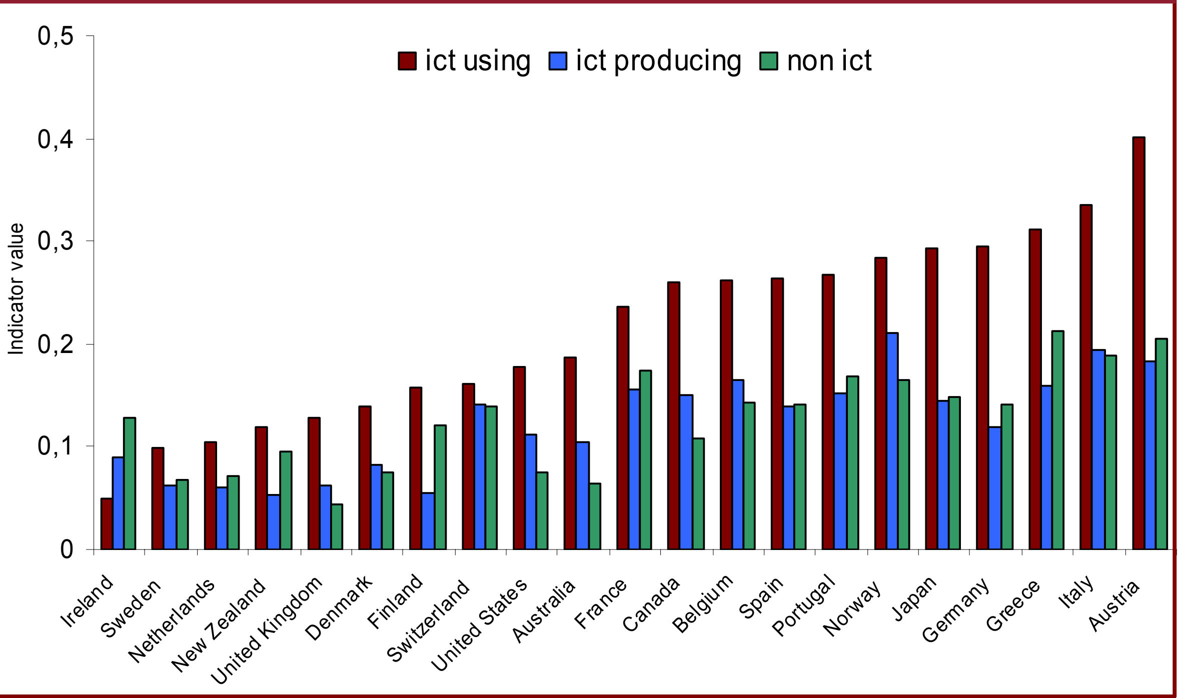
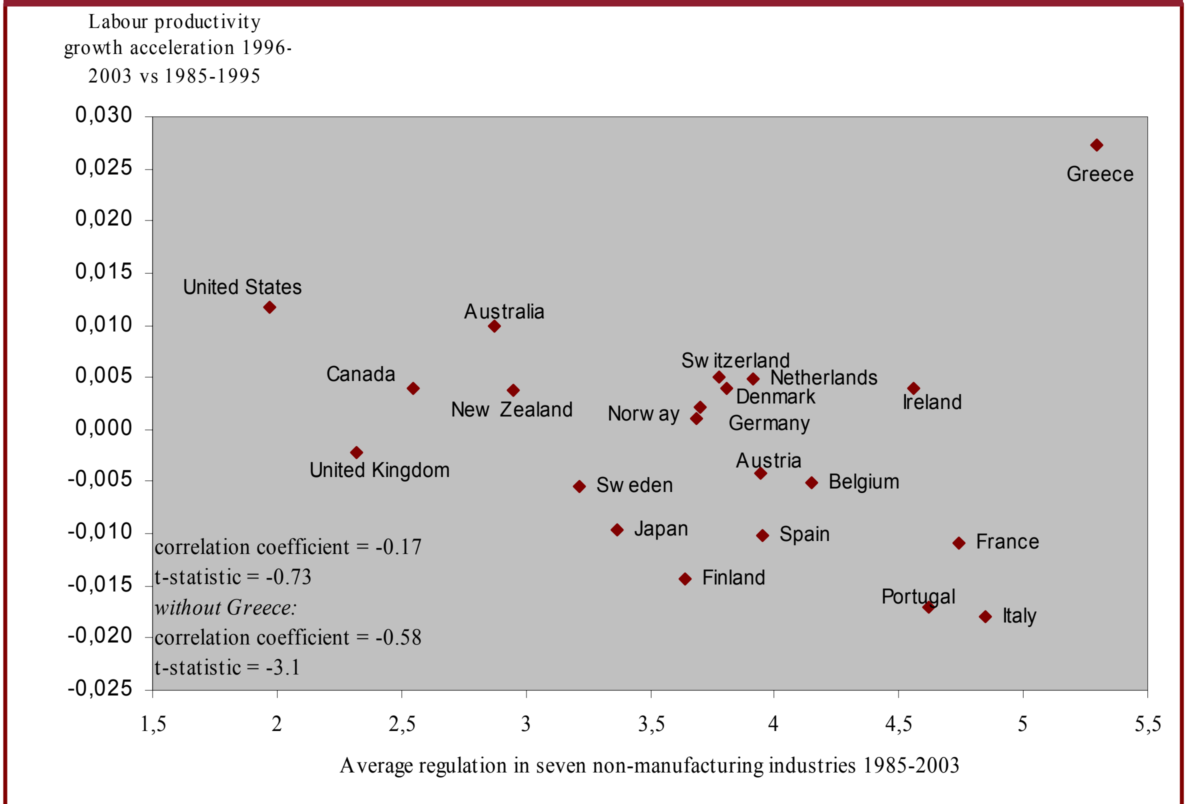
Figure 1: The impact of regulation on ICT-using, ICT-producing, and non-ICT-intensive sectors[1]



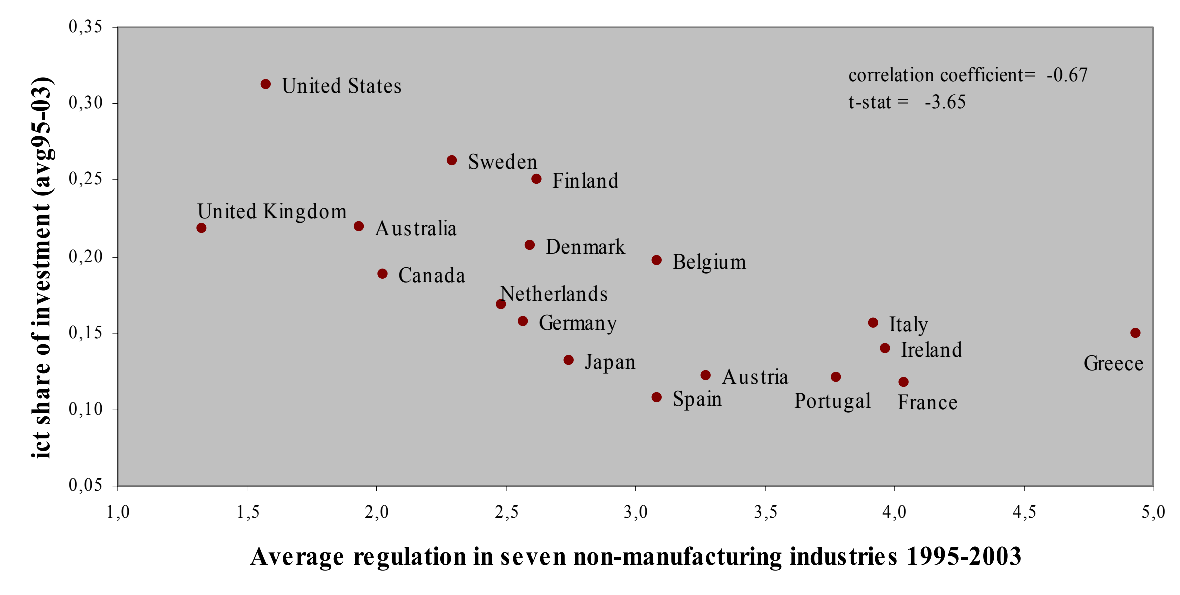
[1.] The scale of the indicator is 0-1 from least to most restrictive

Figure 2: Productivity acceleration and regulation[1]



[1.] The scale of the indicator is 0-6 from least to most restrictive

Figure 3: ICT investment and regulation[1]



[1] The Scale of the indicator is 0-6 from least to most restrictive

Figure 4: Service regulation and the service employment share

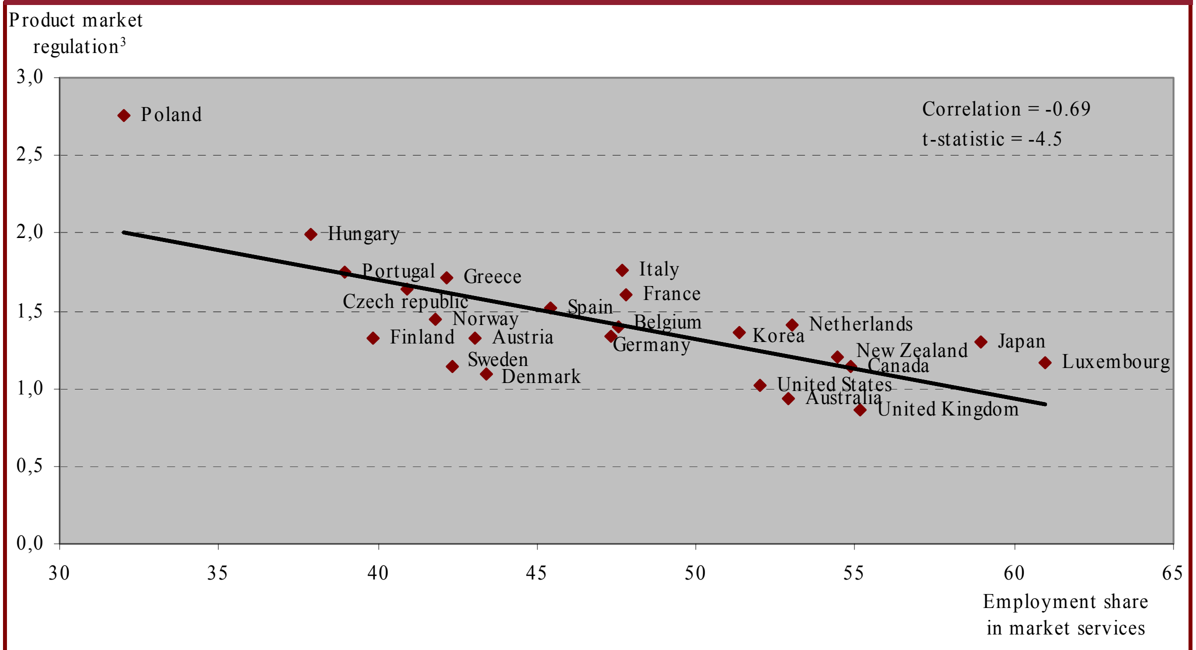


Table 1: Estimated benefits of further services liberalisation

	Percentage Point increase									
	Investment in network industries (% capital stock)				Share of ICT in total investment		Entry rate of new firms		Employment share of foreign affiliates	
	Cumulative effect of regulatory reform 1980-02	*Effect of further reform aligning on best practice*	*Total potential effect*	*Country (level in base year)*		*Country (level in base year)*		*Country (level in base year)*		*Country (level in base year)*
Maximum effect	1,9	2,3	4,2	*FRA (5,9)*	8	*GRC (18,2)*	1,5	*ITA (2,5)*	11	*AUT (3)*
Minimum effect	0,3	1,4	1,7	*USA (9)*	1	*USA (32,9)*	0,2	*SWE (1,2)*	1	*SWE (13)*

	Percentage Point increase							
	Labour productivity growth (average annual increase over 10 years)		Multifactor productivity growth (average annual increase over 10 years		Employment rate			
					Cumulative effect of regulatory reform 1980-02	*Effect of further reform aligning on best practice*	*Total potential effect*	
Maximum effect	1,2	*GRC*	1,1	*GRC*	1,7	1,4	3,1	*FRA*
Minimum effect	0,1	*GBR*	0,1	*GBR*	1	0,2	1,2	*USA*

HOW TO MAKE EUROPEAN RESEARCH MORE COMPETITIVE?

Daniel Gros[64]

There can be little doubt that technological progress has accelerated over the last decade and that the extraordinary productivity gains recorded in the US are not only due to the absorption of new technologies, but also the ability of the US to stay at the technological frontier. Given Europe's continuing backwardness in innovation it is thus not surprising that growth has not taken off in the EU.

Innovation does not come out the blue. It is the result of investment in (often years of) research and development. It is well known that the US invests substantially more in R&D than Europe. Table 1 below shows the relevant numbers, which indicate that that there is indeed a gap, both in terms of overall spending, with the US investing 2.76 % of GDP compared to the 1.93 % of GDP for the average of the EU-25. But there is also a transatlantic difference in terms of the share of public spending, which is close to one half for the EU, but less than one third for the US.

Table 1: R&D spending in the EU and US

	Total in billion euro	**% GDP**	**% public**
EU(-25)	186	1.93	44.6
US	268	2.76	32.7

Source: Eurostat

This much is well known, what is less well known, and seldom addressed, is that there exists also a large transatlantic gap in quality or efficiency of the R&D spending. The attention of national and EU policy makers has remained on the quantitative side of this issue. The Lisbon targets of spending for R&D were confirmed at several European Council meetings and the official line is now that investment in European R&D must be increased to 3% of GDP by 2010, with at least two-thirds of the total investment coming from the private sector.

[64] Centre for European Policy Studies (CEPS), Brussels

At present, R&D amount to less than 2% of EU GDP, as documented above. Increasing this to 3% of GDP would imply an increase of about €100 billion. It is clear that only a small share of this increase could and should come from the EU budget. Even under most optimistic assumption, as embodied in the Commission's proposed financial framework, the funding for the 'European Research Area' would increase by around €8 billion (from €5 billion p.a. today to around €13 billion in 2013), constituting around 8% of the total increase required.

While the 'quantity' gap, i.e. the difference in overall spending on R&D between the EU and the US has been the focus of attention at the political level, another, less well known, gap might be more important. This might be called the 'quality gap' and concerns the rate at which R&D spending generates commercially-exploitable ideas. The latter can be measured quite simply by patent application per workers as shown in Table 2.

Table 2. Comparisons in research intensity and productivity

Country	Research intensity (% of workers in R&D)	Research productivity (patents per thousand employees)		
		EPO	USPTO	Average EPO and USPTO
EU	0.28	0.29	0.17	0.23
US	0.69	0.19	0.63	0.41
Japan	0.65	0.26	0.47	0.37

Soruce: Own calculations based on Botazzi (2004). EPO means European patent office and USPTO stands for the US patent office.

This table shows clearly that that US knowledge workers are on average almost twice as productive as their EU counterparts, On the own home turf, namely regarding patents filed with the European Patent Office, EU researchers marginally beat their US counterparts, but this is more than compensated by the huge gap in the US. Since the economy of the US and the EU are of a comparable size one can just take the simple average between the filings in the US and the EU. This is done the last column, which shows that on this score the productivity of US research workers is at 0.41 almost twice as high as for the EU, which scores only 0.23.

The relative inefficiency of European R&D must be linked to the segmentation of public research efforts, overlapping of competing research programmes, and thus, underutilisation of available human resources. National research funding is usually reserved, either de facto or de jure, for national recipients. It is clear that this must reduce its efficiency. The best talent to undertake a specific research in, for example, micro-biology, will typically not be found at home, thus ensuring that the funds go to a national researcher, who might be good in this field, but who is unlikely to represent the best of Europe.

The 6th Framework Programme constitutes a useful tool to streamline research and promote cross-frontier collaboration and a certain degree of integration of research projects. Nevertheless, the total resources of the 6th Framework Programme amount to only some 5% of the total public spending on research in the EU and thus can only exert marginal influence on the structure and direction of research.

The quality problem (the low rate of commercially exploitable ideas per worker) cannot be solved by governments alone, and certainly not by action at the EU level alone. But it also certain that more competition in the R&D sector should help to increase its productivity. At present almost all national R&D funding (which constitutes over 95% of the EU total) is reserved for national applicants (i.e. national universities, research centres, etc.). Opening this sector to EU-wide competition should help to increase concentration and avoid duplication. To continue the example of micro-biology above: if any member country wants to foster research in this area the funds should be allocated on a competitive EU-wide basis. In this way it would become much more likely that the funds would go to the best researchers or research institutes at the EU level. A world-class European Institute of Technology is more likely to emerge through competition for the best ideas than by EU fiat. The experience with R&D institutions that are financed directly by the EU budget is also mixed.

A simple calculation can illustrate the cost-effectiveness of market opening versus a larger EU budget for R&D. Opening national (public sector) R&D funding to EU-wide competition could probably increase productivity by 20% or more in this sector, as many studies have shown that in a number of member countries R&D spending is effectively captured by a small group of well-connected insiders. Such a gain on 1% of GDP would be equivalent to an increase in effective R&D equivalent to 0.2% of GDP (or €20 billion), much more than what the EU is spending in this area.

Given that public resources of R&D spending in Europe are becoming ever scarcer it becomes more important to look at the quality and efficiency of spending. The time has therefore now come to create an integrated EU market for research and for researchers, as already proposed by the Commission a decade ago.

Action in this area is urgent as one has to keep in mind that a low intensity of research gradually translates into a low level of accumulated knowledge tomorrow. This effect seems to have worked to increase the distance between the EU and the US over the last decade. Some recent research finds that the knowledge capital per worker[65] has more than trebled in the US and Japan from 1972 to 1995, while it rose much less in the EU countries. As this trend must have continued over the last decade, the distance between the EU and the US can only have increased.

Europe urgently needs to improve its innovative capacities. The policy discussion has so far centered on the quantitative side, emphasizing the Lisbon goal of spending 3 % of GDP on R&D. However, the weakness of Europe in this field is not only due to the limited resources available, but also, and perhaps even more, to the relative in-efficiency of European spending in terms of commercially exploitable ideas. One simple way to increase the quality or efficiency of spending on R&D in Europe would be to open national spending to EU-wide competition, thus establishing an EU-wide research area. Efficiency would surely increase if research funding were no longer fenced into 25 segmented national markets.

[65] The proxy for innovative or knowledge capital is the cumulated number of patents (with each patent weighed with the average yearly number of citations a patent posted with the US patent office receives in its first three years of existence). See Bottazzi, Laura (2004), "R&D and the Financing of Ideas in Europe", CEPS Working Document No. 203, Centre for European Policy Studies, Brussels, October.