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Paul J.J. Welfens

Information and Communication Technology: Dynamics, Integration and Economic Stability

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Paul J.J. Welfens

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EUROPÄISCHES INSTITUT FÜR INTERNATIONALE WIRTSCHAFTSBEZIEHUNGEN (EIIW)/
EUROPEAN INSTITUTE FOR INTERNATIONAL ECONOMIC RELATIONS
Bergische Universität Wuppertal, Campus Freudenberg, Rainer-Gruenter-Straße 21, D-42119 Wuppertal, Germany
Tel.: (0)202 – 439 13 71
Fax: (0)202 – 439 13 77
E-mail: welfens@uni-wuppertal.de
www.euroeiiw.de

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Abstract: Information and Communication Technology (ICT) has become a major driver of investment and growth in OECD countries. The analysis puts the focus on key developments in the ICT sector and international outsourcing dynamics as well as the specific role of ICT in the financial sector. One can show that the expansion of ICT is not only contributing to national and international outsourcing but to insourcing as well. Furthermore, ICT affects regional integration. In the context of a modified Dornbusch model – including foreign direct investment – the impact of ICT on output and the exchange rate are discussed. The risk of overshooting in foreign exchange markets is likely to be reduced through the expansion of ICT which allows a more pro-active monetary policy.

Zusammenfassung: Die Informations- und Kommunikationstechnologie (IKT) is a wesentlicher Treiber für Investitionen und Wirtschaftswachstum in den OECD Ländern geworden. Die Analyse behandelt Schlüsselentwicklungen im IKT-Sektor und thematisiert die internationale Outsourcing-Dynamik sowie die spezifische Rolle von IKT für den Finanzsektor. Man kann zeigen, dass die IKT-Expansion nicht nur zu nationalem und internationalem Outsourcing führt, sondern auch zu Insourcing. IKT beeinflusst auch die regionale Integration. Im Kontext eines modifizierten Dornbusch-Modells wird der Einfluss – bei Berücksichtigung der Rolle von Direktinvestitionen – auf Produktion und Wechselkurs diskutiert. Das Risiko eines Overshooting im Devisenmarkt dürfte durch die IKT-Expansion verringert werden, was eine stärker aktive Geldpolitik erlaubt.

Prof. Dr. Paul J.J. Welfens, Europäisches Institut für Internationale Wirtschaftsbeziehungen (EIIW) an der Bergischen Universität Wuppertal, Lehrstuhl Makroökonomik und Jean Monnet Chair für Europäische Wirtschaftsintegration, Gauß-Str. 20, D 42119 Wuppertal, Germany, (www.euroeiiw.de), welfens@uni-wuppertal.de

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1. Introduction

The sector of information and communication technology (ICT) is a major driver of the economy in the 21st century. ICT represents a rising share of investment and R&D in OECD countries and thus is of particular relevance for growth and economic competitiveness. From a EU25 perspective, it also is crucial to note that the expansion of ICT is associated with the growth of a networked society in which the flow of information and technology on the one hand is accelerating; at the same time both ICT and digital networking facilitate international outsourcing and offshoring. Offshoring involves foreign direct investment while international outsourcing occurs through trade and arm's length market transactions.

In the context of the Lisbon Agenda of the European Community, the growth-enhancing aspect of ICT is quite important; at the same time one may anticipate impulses for:

- Structural change: as the relative price of ICT capital goods is expected to continue to fall sectors using ICT capital will intensively expand.
- Shifts in employment demand: as skilled labor is complementary to ICT capital the demand for skilled labor will rise while the relative demand for unskilled labor will fall; this will require transitorily higher wage differentials and indeed could imply that wages of unskilled workers will have to fall if rising unemployment rates are to be avoided.
- Digital education: In the European Learning Space – as defined by the Community – there will be new opportunities to embark upon digital learning/teaching projects which could be quite useful in meeting key challenges in the field of human capital building and productivity growth in an ageing EU society.
- Enhanced economic globalization through both trade and foreign direct investment as trading costs – relevant for international outsourcing – are reduced in a digitally networked economy on the one hand; on the other hand firm-internal transaction costs are falling due to modern ICT so that larger multinational companies can be established in larger international markets. The share of intra-company trade might rise in this context – reflecting increased offshoring – although the pressure for national and international outsourcing is a counter-balancing effect.
- The increasing use of ICT facilitates the creation, processing and storing of information, which should affect adjustment parameters in goods markets and financial markets; for example, the learning speed in the formation of exchange rate expectations might increase and information about international availability of liquid assets could become more easily accessible so that the interest elasticity in the demand for money would rise – both parameters are relevant in the Dornbusch model with its focus on the problem of exchange rate overshooting.

Many economists have classified ICT as a general purpose technology which affects productivity in almost all sectors as the use of ICT is associated with considerable technological progress and facilitates innovation dynamics in many sectors. HEMPELL (2006) has emphasized that the concept of ICT as an "enabling technology" means that

productivity increases are contingent on adequate company strategies and complementary efforts – this includes an impulse for human capital formation, as skilled labor is complementary to ICT investment. The implication is that the diffusion of ICT will increase the trend growth rate in many countries. At the same time, one must consider the potential problem that ICT capital accumulation will primarily increase the demand for skilled labor and thus could bring about a relative rise in the skill premium in wages. If the wages of unskilled labor were insufficiently flexible (and if progress is labor-augmenting with respect to unskilled labor), a rising unemployment rate among unskilled workers might result in the medium term. However, as regards the long run, one should also consider the challenge of retraining and education, as the share of unskilled workers in Europe – or the US – is not exogenous. This then, points to the issue of adequate policies, including tax policies that stimulate human capital formation and retraining.

The share of high technology imports (with the degree of technological sophistication assumed to correspond to skill intensity) in global imports increased from 18% in 1992 to 22.4% in 2003 – of which ICT represented 12.8% and 17.9%, respectively; the share of medium-high technology trade remained rather stable at around 37% (ECFIN, 2005, p.63). If one classifies global trade rather according to factor intensity, one finds that the share of R&D intensive goods has increased in global trade: the share of easy to imitate research goods stood at 14.3% in 1992, but at 18.3% in 2003. The share of difficult to imitate research goods was 24.6% in 1992 and 26.2% in 2003.

ICT goods production is not only technology intensive, it is also largely scale intensive so that the creation of the (enlarged) EU single market should reinforce the competitiveness of EU firms in this sector. One may measure the change in international competitiveness by regional or global indicators of revealed comparative advantage (RCA). Traditionally the Balassa-Samuelson RCA is used for RCA analysis where the definition of traditional RCA puts the focus on the sectoral export-import ratio relative to the aggregate export-import ratio. In this perspective, a ratio above unity indicates a comparative advantage ("positive specialization"). This indicator might be used in a trade-balance corrected form which takes into account any bias related to an aggregate surplus or deficit position (see, e.g., ECFIN, 2005). Alternatively one can focus on modified RCA, which is the ratio of sectoral exports to aggregate exports of country i relative to the same ratio for a benchmarking group of countries in the same target market (e.g., EU15 market). This concept has been developed by BORBÉLY (2005) who compares EU accession countries' normal sectoral export performance with various groups of sectors (e.g., labor intensive or technology intensive) in the EU15 market. Instead of focusing on the EU15 market, one could focus on the world market. Due to data problems, however, the more narrow EU15 single market is often considered.

While it is true that each country naturally is positively specialized in some sectors and negatively specialized in other sectors, one should note that the type of positive specialization is crucial with respect to economic growth, as was shown for the EU15 by JUNGMITTAG (2004; 2006):

- If a country is positively specialized in high-technology sectors ("Ricardian specialization"), this will significantly contribute to economic growth.

- Smithian specialization naturally will occur in the process of competition and trade in open economies, but it does not contribute to growth in EU15 countries. One should not rule out that in certain manufacturing sectors import competition could be a particular driver for productivity growth. (For positive evidence in the case of the US but negative for the case of Germany, see MANN, 2000.)

The EU Economy 2005 Review (ECFIN, 2005) emphasizes several important developments:

- there is a growing global tendency towards trade in intermediate products and hence to flexible international networked production
- the EU's trade position is rather weak in ICT, which is considered a high-technology sector; based on traditional RCA and with respect to the world market the EU15 has structural deficits in five of the 20 export groups which grow most quickly among the 3-digit product classification groups. In the five negative RCA sectors of the EU15, there are three ICT related industries (semiconductors, computers, parts and accessories for computers) as well as clothing and electrical machinery (ECFIN, 2005, p. 73). East Asian countries – including China and India – have gained considerable market shares in ICT.
- Across all sectors the EU(15) has lost ground in low- and medium-quality products but not in the top-of-the-range product groups; upmarket products accounted at the beginning of the 21st century for 48% of EU15 exports, for 52% of exports in the case of Japan and for 41% of exports in the case of the US (ECFIN, 2005, p. 74)
- ICT is facilitating the international fragmentation of the value-added chain, namely both in the manufacturing industry and services sector. The latter thus also raises new challenges for skilled labor (MANN, 2003) which so far has been under rather limited pressure from outsourcing and offshoring. The European Commission notes (ECFIN, 2005, p. 15): "ICT is affecting production structures: International specialization according to Ricardo's comparative advantage applies increasingly to segments of the product cycle rather than to complete products. The growing share of part and components in world trade…indicates the increasing fragmentation of manufacturing production. ICT has been a fundamental contributor to the dramatically changed tradability of goods and services…Services are affected: While modularity and fragmentation of manufacturing production is not a new phenomenon, it is now also applied to services. Many jobs previously considered as non-tradable are suddenly exposed to international competition and may risk being dislocated."

The fact that tradability has increased implies that the costs of international fragmentation have fallen, which has to be further explored in basic models of fragmentation. To the extent that services become more tradable – see the case of digital products and services – one may also expect economies of scale to become more important in the services sector.

Internationalization of industries is a consistent phenomenon of economic globalization which mainly suggests a rising role for both foreign direct investment and international trade, particularly since the expansion of the internet has increased the digital cross-border

diffusion of information and knowledge. Globalization and the above described developments have to be explained in theoretical terms, namely

- in order to get a better understanding of the international and national economic dynamics
- to develop rational policy options with the aim of increasing economic welfare, maintaining economic stability and reinforcing cooperation among partners in the EU integration club as well as outside the EU.

Globalization also concerns the aspect that more and more countries have opened up for trade and capital flows, which in turn has facilitated international outsourcing and trade with intermediate products on the one hand and with differentiated final products on the other, the latter being a crucial part of intra-industrial trade. In this perspective, the expansion of ICT and accumulation of ICT capital in Europe is crucial as it

- helps to create new markets and thus stimulates product cycle trade in ICT goods
- affects relative factor abundance (as measured by the share of ICT-capital in overall capital) and thus stimulates internationalization of goods and services along the lines of a modified Heckscher-Ohlin approach; countries which have relatively high ICT capital intensities will specialize in ICT-capital-intensive goods and record high shares of the respective export category
- creates new opportunities for outsourcing at the national level and the international level; international outsourcing is stimulated relatively strongly in industries with opportunities for digital outsourcing, since the liberalization of telecommunications markets in EU15 after 1998 has brought with it the steepest fall in prices in international telecommunications (as regards accession countries there are several special developments, including transition periods to full international liberalization in telecommunications which imply that digital international outsourcing opportunities will improve in EU25/Eastern European accession countries more slowly than in EU15); national long distance prices have also fallen considerably, while the decline of local prices was modest in the first stage of liberalization.
- ICT reduces firm internal transaction costs and thus facilitates management in large companies which in turn implies new opportunities for foreign direct investment (FDI); in the context of product cycle trade FDI can be expected to play a particularly strong role in scale intensive goods. The new tendencies towards fragmentation – facilitated by ICT – allow even for the possibility to relocate production of high-technology components so that offshoring-dynamics increase. To the extent that ICT-expansion creates larger markets, the typical positive correlation between market size and firm size also implies increased FDI and offshoring.

From an EU15 perspective, EU eastern enlargement has strongly risen interest in off-shoring – defined as international outsourcing involving foreign direct investment – as new low-wage countries have entered the EU single market. Assuming that not only cheap unskilled labor in eastern Europe is found but also relatively cheap skilled labor is available in accession countries, one may anticipate considerable pressure for off-shoring.

If there is off-shoring through a subsidiary abroad, rising management costs associated with a more complex (international) organization of the respective multinational company must be more than offset by a cost advantage in production or the provision of services – or by improved access to the host country markets. If there is off-shoring to a foreign firm there will be quality uncertainties, so that the cost savings should more than offset the increasing cost of quality verification in the buying of intermediate inputs of uncertain quality.

Policymakers are to some extent worried that international outsourcing could lead to considerable job losses. This fear is not only relevant with respect to (ICT) manufacturing but also with respect to services which typically are more skill-intensive than the manufacturing industry. Thus international outsourcing of services could mean that jobs requiring skilled labor (representing relatively high wages and incomes) may be relocated internationally. Taking into account that a considerable share of international outsourcing does indeed improve the global competitiveness of EU firms – say EU software firms outsourcing to Asia so that cost competitiveness of EU firms in US markets is improved – the basic equation could reveal that in a triangular trading perspective, one should not worry about outsourcing. The situation with ICT, however, is special to some extent since the ICT sector is a Schumpeterian sector with high innovation dynamics. Between 15-25% of patents from firms in leading EU countries concern the ICT sector in the early 21st century.

Section 2 takes a look at ICT characteristics and international outsourcing dynamics on the one hand and on ICT on the other to get a better understanding of the role of ICT for Europe. Section 3 considers the role of ICT and foreign direct investment in the context of a modified Dornbusch model to offer a better idea about the nature of overshooting problems in a digital economy with ICT. Section 4 puts the focus on some regulatory policy issues and key aspects of life-long learning in the EU.

2. Economic Development, Adjustment and Outsourcing

2.1 Traits of the ICT Sector and Economic Dynamics

The ICT sector has been part and parcel of the international outsourcing process. ICT sector dynamics have broad economic significance; they affect many sectors, as so many use ICT products or ICT services, which implies strong competition and in turn stimulates the cost-cutting reorganization of industries and national or international outsourcing dynamics – part of which concerns the ICT sector itself. Moreover, one may expect four impulses for rising internationalization in the sense of growing trade:

- the ICT sector is an expanding field in its own right, as novel digital products and services are created in a dynamic networked world economy; the internationalization of the ICT sector thus has to be analyzed not in the least from the perspective of the product cycle trade approach (VERNON, 1966); a special ICT issue concerns the question as to whether ICT contributes to an accelerated innovation race, possibly induced through faster diffusion of new knowledge in an increasingly networked world economy
- part of the ICT sector (e.g., software, a sub-sector of digital services) is characterized by network effects, which amounts to a kind of unusual endogenous growth impulse coming from the demand side. To the extent that this raises both output and per capita income, one faces a trade creation effect
- since part of the ICT sector expansion amounts to cutting international transaction costs – relative to domestic transaction costs – there is an indirect trade creation effect which will influence not only the ICT sector itself but other sectors as well
- since ICT is particularly characterized by high R&D intensity and since in technology-based ownership specific advantages are considered as the basis for successful international investment, one should expect that expansion of the R&D sector will stimulate foreign direct investment.

Since the 1990s information and communication technology (ICT) has been a major driver of economic growth in OECD countries. There is broad consensus in the literature that ICT production (mainly due to high rates of process innovations) is contributing to this growth. Moreover, there is also some support for the argument that ICT use contributes to increases in output (VAN ARK, 2001; AUDRETSCH/WELFENS, 2002 BARFIELD/HEIDUK/WELFENS, 2003). There is considerable evidence that ICT plays an important role for the growth differential US vs. EU15: JORGENSON/STIROH (2000), COLECCHIA/SCHREYER (2002), OLINER/SICHEL (2002), STIROH (2001), and INKLAR ET AL. (2003) have argued that ICT production and the use of ICT (that is, cumulated ICT investment) are important drivers of productivity growth. More cautious about the link between ICT and growth is GORDON (2004). As regards Eastern Europe, VAN ARK/PIATKOWSKI (2004) find some evidence that ICT significantly affects productivity and output growth. WELFENS/PONDER (2003) and PONDER/MARKOVA (2005) have shown that Eastern European countries have considerably caught up in the field of telecommunications, however Russia lags behind EU accession countries.

Comparing the periods 1995-2000 to 1979-1995, the INKLAAR ET AL. analysis of labor productivity growth in the US and EU-4 finds a rise of 1.25 percentage points in the US and a fall of 0.27 points in the EU. The growth accounting estimates show that labor quality changes have reduced labor productivity in both the US and the EU-4. The employment reallocation effect in the US was positive at + 0.05 points, but in the EU-4 the figure was -0.06 points. ICT producing industries generated similar impacts on productivity growth in the US and the EU, namely 0.04 and 0.03 percentage points. As regards the impact of ICT-using industries, the EU did not reach even half the increase of the US which was 0.29 points, the main effect stemming from financial services (0.17 in the US; 0.02 in EU-4). Non-ICT capital deepening contributed to 0.08 points in the US and -.45 points in the EU. Total factor productivity contributed 0.79 points in the US, but only 0.13 points in the EU-4. The impact from ICT producing industries was rather similar on both sides of the Atlantic (0.36 in the US vs. 0.24 in the EU), but in ICT using industries there were many larger differences; in particular wholesale trade, retail trade and financial services seem to be problem areas for Western Europe. Weak EU15 productivity increases and slow growth are all the more unsatisfactory, since Germany, France, Italy and Spain suffer from high unemployment rates and since slow growth from 2000 to 2005 seems to indicate that the ambitious goals of the EU Lisbon Agenda (aiming at higher growth and employment by 2010) will not be achieved. However, there is a range of reports from the European Commission which analyze the dynamics of the information society developments and suggest policy options for stimulating digital modernization in EU eastern accession countries (BOGDANOWICZ/CENTENO/BURGELMAN, 2004; BOGDANOWICZ//BURGELMAN/CENTENO/GOUROVA/CARAT, 2003; GOUROVA/BURGELMAN/BOGDANOWICZ/HERRMANN, 2002).

A growth accounting analysis by SAKELLARIS/VIJSELAAR (2005) for the Euro zone has tried to take into account the role of quality changes in capital formation and in output (unfortunately this SOLOW-type growth accounting exercise does not consider labor quality aspects – and the analysis might suffer from methodological problems since focus is on the Euro zone with its high unemployment figures, which would rather suggest relying on data envelopment analysis). This leads to an upward correction of output growth figures for 1982-1990 and for 1991-2000 by about 0.5 percentage points in both periods. The role of capital growth, based on quality adjusted figures, rises by 0.33 in the first period and by 0.45 points in the second period. Among the sub-categories IT hardware, software, communication equipment, other machinery and equipment, transport equipment and non residential construction, the combined contribution of IT hardware, software and communication equipment amounted to 0.26 percentage points in the first period and 0.2 percentage points in the second period (reflecting a modest upward revision from quality-unadjusted figures; as regards software, quality adjustment brought no change in the assessment). Total factor productivity growth accounted for 2.2 points in the first period and 1.46 in the second period which had shown a deceleration of growth (2.34 % growth of GDP compared to 2.97% in the first period; both quality-adjusted figures are 0.6 percentage points higher than the figures without quality adjustment). The increase in total factor productivity growth is decomposed in equipment and software as well as "rest"; equipment contributed 0.59 percentage points in the first period and 0.63 percentage points in the second period. This suggests that ICT dynamics have a triple importance for the Euro zone as well as for other countries:

- quality adjustment of output;
- contribution to capital growth;
- growth of total factor productivity growth;

In the 1990s, the overall contribution to growth in leading OECD countries was – according to OECD figures – between 0.5 and 0.8 percentage points, which is rather impressive for a sector which hardly accounted for 10% of aggregate output at the beginning of the 21st century (and for 15-35% of investment). ICT is a broad field which contains computers & software, telecommunications and modern digital services, all of which are inputs in every sector of the economy. ICT is also crucial for innovation since a rising share of R&D expenditures is accounted for by the ICT sector. Nevertheless one cannot argue that ICT expansion has stimulated growth in a rather homogeneous way across OECD countries, and indeed very few OECD countries have experienced a considerable increase in labor productivity or technological progress in the context of the growth of ICT. PILAT (2005) argues that only a few countries have witnessed an upsurge in labor or multi-factor productivity growth in those sectors that have invested most in ICT. Among the factors explaining this – according to PILAT – are differences in the countries' respective uptake of ICT (OECD, 2003; 2004). ICT investment rose from less than 15% of total non-residential investment in the early 1980s to a range of 15-30% at the beginning of the 21st century; the share of ICT investment was relatively high in the US, the UK, Sweden, the Netherlands, Canada and Australia (OECD, 2004), where the uptake of ICT is partly linked to differences in the direct costs of ICT (ICT equipment, telecommunications, installations of e-commerce systems etc.). These costs still differ across OECD countries despite rising ICT trade and the liberalization of telecommunications. Moreover, countries differ in the degree of competition in ICT markets and in their respective ability to absorb ICT and use this technology effectively, which in turn is related to the availability of know-how and skilled labor. There also could be some impediment on complementary process innovations in Europe which explains the relatively modest productivity gains in some continental EU countries, and a lack of new firm creation in ICT-using services could play a role.

HEMPELL (2006) has emphasized that ICT is not a panacea for productivity gains; rather ICT raises productivity mainly by acting as a catalyst of innovation and upgrading of skills. He basically suggests several conclusions based on a large sample of German firms and findings for the Netherlands (HEMPELL et al. 2004). ICT use stimulates productivity; a 10% increase in the firm's ICT capital stock raises company productivity by roughly 0.6%. Given relative factor endowments in the sample of firms considered, annual returns to ICT investment are likely to exceed its user costs for many years to come. A crucial element of ICT productivity reflects improved quality of output. Quality improvements are quite important. Productive ICT use is complemented by innovation dynamics and innovative activities. Successful use of computers and internet requires companies to introduce their own innovations. Innovation history is important; service firms that have introduced innovations in the past are found to be better in using ICT productively than firms that have not, and the empirical results point to a major role of process innovation as a basic source of experience for ICT use. ICT productivity is contingent on the skills of workers and employees: the higher the share of highly-skilled workers in firms, the greater the productivity contribution of ICT.

- For the medium term, HEMPELL (2006, p. 182) sees two partially-opposed ICT developments. ICT access will become simplified and ubiquitous and innovation opportunities more complex and expensive from ICT use.
- On the one hand, falling computer prices and increasingly standardized software will make ICT more ubiquitous and simpler so that ICT could become less important for the sustained competitive advantage of firms. This implies that ICT will diffuse in the world economy.
- Technological progress in ICT hardware and software imply new options for a growing range of ever more complex innovations, including novel types of knowledge management. This includes ICT-based new tools and broadband internet access, which will facilitate collaboration of R&D teams scattered around the world (FRAUNHOFER-GESELLSCHAFT, 2004). The implication is that the internationalization of ICT as a high-technology field will be concentrated in advanced countries endowed with highly skilled labor and which have made investments in modern broadband e-communications networks. North America, Europe, Japan and a few Asian countries will fall into this category.

With the economic opening up of China and the transformation of the former Soviet Union and east European countries, a large part of the world economy (richly endowed with labor in the case of China and with labor and human capital in the case of Eastern Europe and Russia) has become integrated into the global economy. Both growing trade and rising FDI flows – mainly inflows – play a role for Eastern Europe and China/Asean countries. China and East Asian countries have become a major export region for ICT goods; however, considering Asia a natural winner in the process of modern globalization would be an overstatement (ECFIN, 2005).

2.2 Financial Markets and ICT

Banks are top users of ICT and also are heavy users of digital services. For international banks, communication costs represent a high share of costs and with sustained competition in telecommunications and continuing technological digital progress, banks will be able to strongly benefit from ICT dynamics. One particular aspect is eBanking, which offers a broad range of new digital banking services to national and international customers. However, apparent security problems indicate that there is no easy way to achieve long term growth in eBanking and other digital financial services. At the same time, one may point out that the US has developed internet-based venture capital funds which create larger funds, offer better transparency and stimulate reputation building.

In a broader perspective, there are also other links between the financial market system and ICT; the most interesting are the following:

- Banks, insurance companies and other financial services firms are among the heavy ICT investors so that this sector has been characterized by high ICT-based

productivity growth. The financial services sectors in the UK and the US have been quite strong in pushing ICT.

- Prudential supervision in the Basel II framework eliminates most of the traditional continental European relationship banking and puts strong emphasis on computerized monitoring of clients and debtors. The expansion of digital networks will reinforce the ability of banks to put all major financial activities of clients permanently on the radar screen.
- Data protection in the financial and personal sphere becomes increasingly important with ICT expansion. Problems of government in effectively taxing transactions over the internet will generate pressure for tax authorities to increasingly peek into internet users' e-commerce transaction. Moreover, internet-based advertising will become more personalized, which leads to the issue of consumer protection and data protection in a sensitive area. While customers have certain benefits from getting personalized advertisement, there is also the problem that the consumer is relatively losing control over the advertisement presented to him or her. Digital bonus programs further reinforce some of the problems with firms generally being happy to exploit data mining in a broad form. (Customers who regularly spend lavishly on products might never see the cheapest offer of some internet services companies as the customer's profile points to low price sensitivity.)
- The expansion of ICT will create particular problems for the bank-dominated financial systems to finance the growth of ICT. Since ICT often is characterized by a high intensity of immaterial assets – or the use of assets whose price is falling rapidly – banks will find it rather difficult to finance the expansion of young ICT firms. This will generate pressure to reform the financial system in continental EU countries and to reinforce the role of stock markets. As the US is the global leader of the stock markets, the EU markets could become dominated by these markets.
- ICT expansion will affect adjustment parameters in goods markets and financial markets and thereby influence the equilibrium solution in any standard macro model; for example, price adjustment speed in all markets will increase and collecting, processing and storing information should become easier so that the formation of expectations is thereby influenced.

To the extent that ICT expansion helps to create greater transparency in markets and to reduce the risk of overshooting, there will be positive external effects from firms' ICT investment. If there should be reduced volatility of asset prices, this would reduce the effective costs of capital and could thus raise the investment-output ratio and hence the level of the growth path.

2.3 Growth, Competitiveness and Outsourcing Dynamics

Achieving sustained economic growth is a key challenge for industrialized countries which rely on the accumulation of capital, human capital formation, technological progress and positive spillovers to generate growth. Analytically, spillovers have played a prominent role in endogenous growth models which rely on constant returns to a sufficiently broad concept of capital accumulated over time (ROMER, 1986; 1987; LUCAS, 1988; REBELO, 1991). Complementary approaches to endogenous growth are the R&D based models of ROMER (1990) and GROSSMAN/HELPMAN (1991a, 1991b), who emphasize accumulation and product upgrading. The emphasis in AGHION/HOWITT (1997a, 1997b) is on combining R&D and capital accumulation. MARREWIJK (1999) presents an interesting and important extension as he integrates the expansion of product variety rather than quality improvements (vertical differentiation as opposed to horizontal differentiation). He then looks at knowledge spillovers as well as learning, before finally considering different production technologies in the R&D sector and in the final goods sector. He thus departs from the standard assumption of identical technologies in these two sectors (RIVERA-BATIZ/ROMER, 1991; BARRO/SALA-I-MARTIN (1995), AGHION/HOWITT (1997a, 1997b).

Rising trade (in intermediate products) will lead to different results if we consider neoclassical trade theory and modern trade theory (typically with a simple focus on two countries):

- Traditional neoclassical trade theory suggests that more trade should contribute to international price equalization and hence to factor price equalization, which in turn reinforces economic convergence.
- Modern trade theory offers models with skilled and unskilled labor (FEENSTRA, 2004) where introducing trade with intermediate products leads to a relative increase in the demand of skilled labor in both countries. If wages are not fully flexible in both countries, a key result will be unemployment in one of the countries or in both. If one country has full employment and the other structural unemployment of unskilled workers, it is clear that factor price convergence and hence convergence of real per capita income will slow down.

2.4 ICT, Outsourcing and R&D

The EU adopted a strong focus on ICT in the 6th and 7th framework programme, thereby stimulating cross-border ICT research in the EU. However, it is unclear whether the Community adequately emphasizes the ICT sector and if the interplay between national R&D policies and supranational R&D policy is optimal. R&D policy is optimal if positive external effects are internalized efficiently. National external effects can be internalized mainly at the national level. International external effects could be internalized through R&D policy in partner countries or through adequate supranational policy. If there is

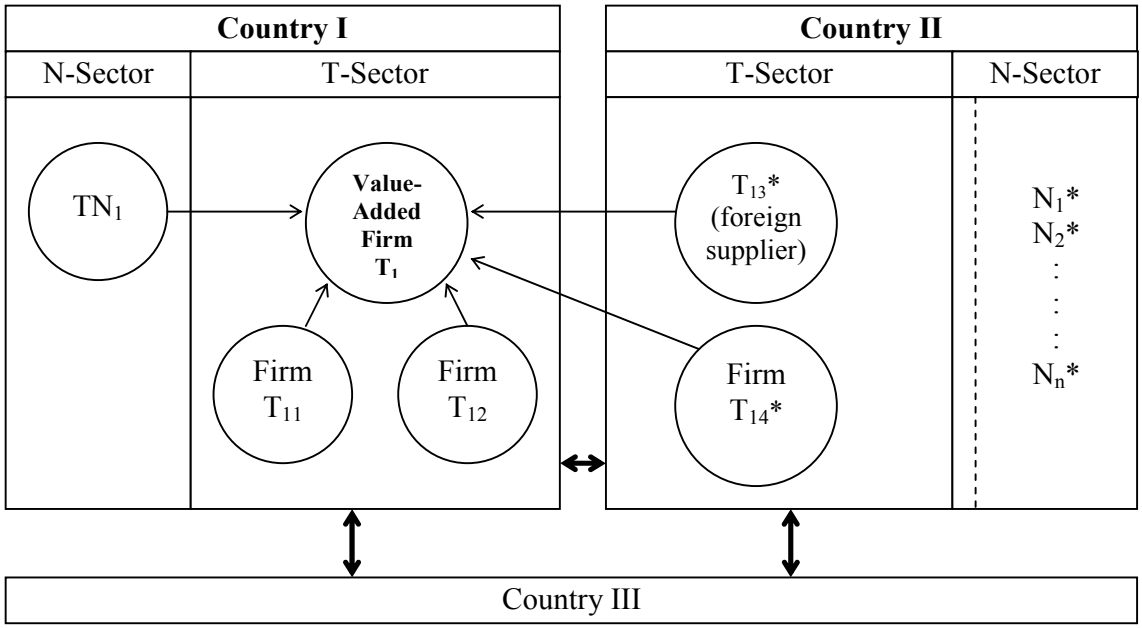
insufficient international cooperation (within the EU or within the OECD), the level of innovation policy will be sub-optimal. From the perspective of the respective government, it is clear that positive growth effects and the associated additional tax revenues provide an incentive for R&D promotion.

R&D intensities in the EU do not seem to converge across countries; only for a subgroup of early leading EU countries and Finland can a convergence be observed. At the same time, empirical evidence exists for a convergence of trade structure among EU15 (JUNGMITTAG, 2006). It is, however, unclear what convergence really means here. One may state the hypothesis that through increasing vertical trade – within industries – there is some structural convergence in the EU (or in the world economy). If convergence is to mean that intermediate products with low profit rates are more and more concentrated in Spain and Portugal while final goods production is in Germany, France, the UK and the Benelux group as well as Scandinavian countries and Ireland, one would not really expect economic convergence in terms of per capita income. The main reason for non-convergence or divergence is that final goods producers in technology-intensive industries will appropriate a Schumpeterian rent in their respective profit rates. In a Heckscher-Ohlin approach to international trade, technologies are the same across countries. For this reason, Schumpeterian profit differentials across countries cannot play a role. In reality Schumpeterian profits indeed play a crucial role; this holds not only for countries with high patent intensities but also for countries with a specialization in sectors shaped by high progress rates. ICT is such a sector; the OECD (2002) has emphasized that it is one of the most important fields of innovation dynamics in the US and other OECD countries.

2.4.1 ICT Dynamics: Outsourcing and Insourcing

ICT facilitates national and international outsourcing (WELFENS, 2005) and also raises the range of tradability in the services sector; the N-sector shrinks (see the figure: dashed line in country II) while the T-sector grows. The firm T_1 considered in country I can outsource tradable goods and services domestically – say to firms T_{11} and T_{12} – or to the domestic N-sector. As regards intermediate tradables, there is potential competition with suppliers abroad; the split between outsourcing to domestic suppliers and foreign suppliers typically will be determined along the lines of the Heckscher-Ohlin-Samuelson approach. As countries I and II differ in terms of relative factor endowment, international outsourcing will be favored with respect to those components which use the factors intensively which are relatively abundant in country II.

Figure 1: National and International Outsourcing / Fragmentation of ICT Production
(T is tradables sector; N is nontradables sector)

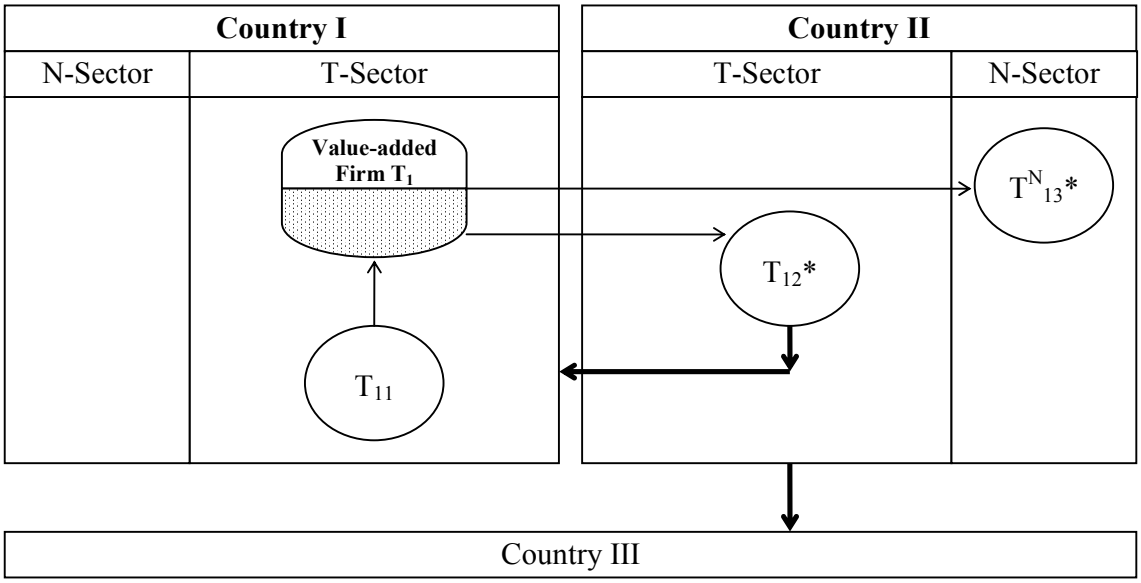


A large share of ICT is strongly technology intensive and therefore international outsourcing is often in the form of offshoring. Offshoring allows not only for cutting costs by importing from foreign subsidiaries in the tradables sector, but in principle there is also the option that ICT offshoring take place in the foreign non-tradables sector (case of special ICT services). Intermediate inputs from foreign subsidiaries go into production of firm T_1 in country I; however, part of valued-added in foreign subsidiaries could be sold directly on the world market (country III). As the R&D intensity of ICT is expected to grow over time, one should expect offshoring to increase in importance in the long run.

In some ICT sectors network effects are relevant; to the extent that those effects are international, outsourcing dynamics could be influenced. From a theoretical perspective, international network effects are of particular importance in ICT innovations in certain fields. Network effects are positive demand-side externalities, which are rather unusual. ICT R&D is likely to have positive cross-sector spillover effects. One also may anticipate considerable international spillovers, either in the ICT sector itself or through increasing use of ICT capital in other sectors. One should, however, carefully distinguish sub-sectors of ICT. For example, chip production is scale intensive and knowledge intensive (referring to the overall product not the rather simple chip production as such) as is software. However, many digital services have to be very customer specific so that economies of scale play a limited role. To some extent economies of scale can be exploited for the basic product – say the core algorithm – while customization requires specific adjustment involving the employment of skilled labor.

Figure 2: ICT and International Offshoring Opportunities

(including direction of sales from subsidiary ⟶)



While ICT facilitates international outsourcing, it is not true that leading OECD countries are natural losers from outsourcing. Indeed, international outsourcing can stimulate structural adjustment in a way which increases productivity, competitiveness and growth. Moreover, international outsourcing from the EU to Eastern Europe, Asia or elsewhere goes along with insourcing in the sense that firms from Asia and other regions of the world economy can conquer markets in EU countries/OECD countries only if they set up marketing centers and R&D facilities in those countries (which have a comparative advantage in relevant R&D fields). Two important studies can be found in this context:

- BAILEY/LAWRENCE (2005) have shown that the US software sector internationally outsourced some 100,000 jobs in the period from 2000 to 2003. However, the overall number of software personnel in the US increased in that period. Mostly, rather simple programming jobs were outsourced, often to Asian countries. This suggests that the international outsourcing of standardized services will allow advanced countries with a relative abundance of skilled workers to specialize increasingly in advanced services. The EU15 should also benefit in a similar way, as leading software firms become more globally competitive by outsourcing to Eastern Europe or Asia.
- As regards the outsourcing of services, a broader picture is obtained if one takes into account data on the largest absolute insourcers, the principal world relative insourcers (for business services and computer & information services) and the biggest surplus and deficit countries (AMITI/WEI, 2005a; 2005b). In 2002, the top insourcers in business services were the US, the UK, Germany, France, the Netherlands, India, Japan, China and Russia; as regards computer & information services No. 1 was Ireland followed – with the exception of Spain – roughly by the same list of countries.

As regards the outsourcing of services in Europe, the study by AMITI/WEI (2005a) is quite interesting. They follow the study of FEENSTRA/HANSON (1996, 1999) – their focus was on material inputs outsourcing of the US – in their definition of outsourcing. Defining Y, J and X as production, imports and exports, respectively, the outsourcing intensity Ω of sector i is defined as:

Ω_i = (Input purchase of service by i/total nonenergy inputs used by i) $(J_i/[Y_i+J_i-X_i])$

In the AMITI/WEI study, the denominator includes all non-energy material inputs as well as the five business service industries: communication, financial services, insurance, other business services, computing and information. The authors only report figures for the UK where the figures are rough estimates, as no sectoral data on imported services inputs are available; instead the economy-wide import share is applied to each industry (the UK imported 6.6% of business services in 2001; it thus is assumed that each industry – in manufacturing and services – imports 6.6% of the business services used in that year; as the ratio of business services to total non-energy material inputs is 15%, the outsourcing intensity of business services is 0.15*0.066 = 1%.). The authors aggregate across the five service inputs and thereby obtain the average service outsourcing intensity in each industry. Unfortunately AMITI/WEI do not provide a split of imports according to intra-EU service imports and extra-EU services imports. They also do not look into the topic of transfer pricing which, however, might be rather important in the context of outsourcing of services in countries with considerable inward or outward stocks of foreign direct investment. The figures for the UK for 1992 and 2001 show that there has been a modest increase in international outsourcing of services, except in the case of communications services. The latter finding can probably be explained through the fall of telecommunications prices in the 1990s triggered by increasing competition in EU countries and technological progress. This shows that it can be quite important to carefully split purchase figures into prices and quantities.

Figure 3: UK: Outsourcing of Services

Services	Share of Service		Import of service j
	Mean	Std Dev	
1992			
Communication	0.0153	0.0373	0.0587
Financial	0.0330	0.0247	0.0173
Insurance	0.0137	0.0103	0.0186
Other business service	0.1261	0.1615	0.0503
Computer and Information	0.0112	0.0185	0.0148
2001			
Communication	0.0158	0.0393	0.0547
Financial	0.0306	0.0198	0.0420
Insurance	0.0123	0.0060	0.0230
Other business service	0.1536	0.1872	0.0659
Computer and Information	0.0211	0.0302	0.0283

Source: AMITI/WEI, 2005a, p. 319

The average outsourcing of services – relative to GDP – has increased in the UK (from 1.4% in 1992 to 2.6% in 2001) and the US (0.6 and 0.9%, respectively) (AMITI/WEI, 2005a; 2005b). By contrast, material outsourcing intensities are much higher in both the US and the UK. At the beginning of the 21st century, it was about 27% in the UK and 11% in the US; the figure for the UK peaked in 1996. In the US, the outsourcing of material inputs is a sustained phenomenon, although in the period from 1992 to 2001 the growth rate was lower than in services.

The leading 10 exporters in the field of computer and information services are Ireland (14 bill. in 2003; this includes revenues from software sales), India, the US, the UK, Germany, Israel, Spain, Canada, Netherlands and Sweden (2 bill.); the global figure is 75.1 bill, to which the EU has accounted for an impressive 40.7 bill. (WTO, 2005). Israel and Spain are two interesting newcomer countries in the export of computer and information services. The "effective US surplus" of 2.4 bill. – defined not geographically but on a company basis – is certainly higher than the US figure indicates, as more than one-half of the Irish figure is likely to represent activities of US subsidiaries.

The relatively biggest insourcers of business services (relative to local GDP) were Vanuatu, Singapore, Hong Kong, Papua New Guinea and Luxembourg, which recorded business services outsourcing in the range of 17% to 10% of GDP; rank 21 is for India, 33 for the UK, 50 for France, 54 for Germany, 79 for China, 88 for Russia, 90 for the US, and 95 for Japan. The average share of the UK (2.35%), France (1.45%) and Germany (1.40%) was more than twice as high as the share of the US of 0.58% of GDP; hence even under the assumption that leading EU countries' insourcing represents one-half of the insourcing from other EU countries, the combined position of the UK/France/Germany is favorable. As regards computer and information services Ireland, Cyprus, Luxembourg, Costa Rica and Belgium were the top 5 (with a rang of 8.5% to 0.8%), rank 17 was for the UK, 24 for Germany, 42 for France, 49 for the US. Thus one may state that for some of the small open economies in the EU, there has been relatively successful insourcing which reflects a particular specialization in ICT services. As regards large countries, it is not surprising that insourcing figures are rather small relative to GDP, as most regional outsourcing in a large economy is regional insourcing; this is in contrast to small open economies.

Figure 4: Biggest Absolute Insourcers in the World Economy, (Business Services and Computer & Information Services), 2002

Rank	Country	Business services	Rank	Country	Computer and information services
1	United States	58.794	1	Ireland	10.426
2	United Kingdom	36.740	2	United Kingdom	5.675
3	Germany	27.907	3	United States	5.431
4	France	20.864	4	Germany	5.185
5	Netherlands	20.074	5	Spain	2.487
6	India	18.630	10	France	1.191
8	Japan	17.401	11	Japan	1.140
14	China, P.R.	10.419	12	China, P.R.	638
29	Russia	2.012	25	Russia	137

Source: Amiti / Wei (2005), p. 324

Figure 5: Biggest Relative Insourcers in the World Economy (Business Services and Computer & Information Services), 2002

Rank	Economy	Business services	Rank	Economy	Computer and information services
A. Ratio to Local GDP (%)					
1	Vanuatu	17,13	1	Ireland	8,54
2	Singapore	14,98	2	Cyprus	2,19
3	Hong Kong SAR	11,53	3	Luxembourg	1,09
4	Papua New Guinea	10,55	4	Costa Rica	0,91
5	Luxembourg	9,78	5	Belgium	0,76
21	India	3,79	17	United Kingdom	0,36
33	United Kingdom	2,35	24	Germany	0,26
50	France	1,45	42	France	0,08
54	Germany	1,40	49	United States	0,05
79	China, P.R.	0,82	51	China, P.R.	0,05
88	Russia	0,58	54	Russia	0,04
90	United States	0,56	59	Japan	0,03
95	Japan	0,44			
B. Ratio to Value-added of Local Service Sector (%)					
1	Papua New Guinea	32,92	1	Ireland	15,64
2	Vanuatu	23,85	2	Guyana	1,50
3	Singapore	21,93	3	Costa Rica	1,46
4	Swaziland	16,06	4	Luxembourg	1,40
5	Hong Kong SAR	13,46	5	Armenia	1,09
13	India	7,82	18	United Kingdom	0,51
44	United Kingdom	3,28	24	Germany	0,38
53	China, P.R.	2,45	38	China, P.R.	0,15
64	Germany	2,07	42	France	0,12
66	France	2,03	51	Russia	0,07
87	Russia	1,04	52	United States	0,07
91	United States	0,76	60	Japan	0,04
94	Japan	0,66			

Source: Amiti / Wei (2005), p. 325

Figure 6: Biggest Services Trade Surplus Countries (Business Services and Computer & Information Services), 2002

Rank	Economy	Business services	Rank	Economy	Computer and information services
Surplus countries			Surplus countries		
1	United Kingdom	20.555,96	1	Ireland	9.882,71
2	United States	17.864,30	2	United States	3.884,00
3	Hong Kong SAR	15.424,54	3	United Kingdom	3.072,72
4	India	6.813,44	4	Canada	1.077,12
5	Singapore	3.826,12	5	Spain	914,65
6	China, P.R.	2.462,05	9	France	41,39
10	France	1.752,32	10		
Deficit countries			Deficit countries		
135	Russia	-2.570,90	95	Russia	-454,30
139	Korea	-4.450,90	96	China, P.R.	-494,85
140	Japan	-7.313,51	97	Italy	-674,85
141	Indonesia	-7.985,71	98	Germany	-939,29
142	Germany	-11.205,43	99	Japan	-1.007,74
143	Ireland	-13.882,01	100	Brazil	-1.118,10

Source: Amiti / Wei (2005), p. 327

At the beginning of the 21st century, the largest global surplus countries in the field of business services were the UK ($ 20.6 bill.), the US, Hong Kong, India and Singapore (followed by China); in computer & information services, the leaders were Ireland, the US, the UK, Canada and Spain. The five largest deficit countries in the field of business information were Korea, Japan, Indonesia, Germany, Ireland; in the field of computer and information services, China, Italy, Germany, Japan and Brazil.

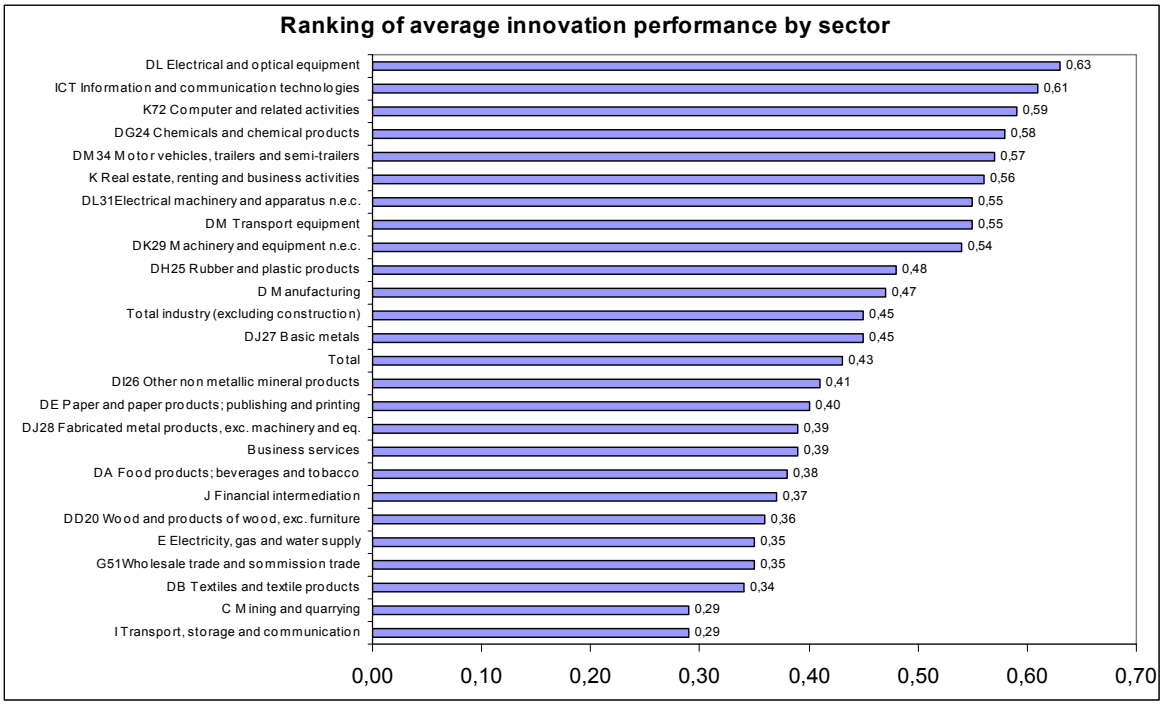
So the picture at the beginning of the 21st century is inconclusive, and one may draw only preliminary conclusions:

- Some EU countries are major insourcers of ICT services
- Some EU countries have a considerable sectoral deficit position in ICT services
- Some Asian countries seem to play a considerable role as successful net exporters of ICT services; from this perspective it will be interesting to observe whether subsidiaries of EU ICT multinationals are among the driving forces of those surpluses. If there were such a sustained phenomenon, one may assume that international ICT outsourcing of EU firms reflects a win-win international division of labor in the digital world economy.

2.4.2 ICT and R&D

ICT – broadly defined – is a strong driver of innovation dynamics in OECD countries. According to the European Innovation Scoreboard 2006, electrical and optical equipment and ICT information and communication technologies as well as computer and related activities show the highest ranking of average innovation performance by sector. This indicates a strong relevance of ICT for growth and structural change. R&D activities in ICT are strongly internationalized in some sub-sectors, including software development. (The US, the EU, China and India plus Japan are strong centers of software development; some of the US firms' and EU firms' activities in China and India partly reflect the search for comparative advantage and cost-cutting. There is, however, also pressure by governments of these big countries, namely to give access to markets only under the condition that firms establish a development center.)

Figure 7: Sectoral Innovation Performance in the EU



Source: European Innovation Scoreboard (2005), S. 23

As regards links between the US, the EU and Japan, one should emphasize the role of international R&D alliances, which became rather important in the 1980s and 1990s in OECD countries – not only in ICT. As regards international alliances, the emphasis is more on EU15 countries than on EU accession countries. Strategic R&D alliances played an increasing role in the EU in the late 1980s, as globalization and the run-up to the single market programme as well as higher EU funds for cooperative R&D projects stimulated the internationalization of European R&D (NARULA, 2000); the IT sector and biotechnology played a particular role in this respect. Moreover, there have also been renewed dynamics in R&D in the form of both asset-exploiting and asset-seeking FDI in the EU and the US. CRISCUOLO/NARULA/VERSPAGEN (2005) argue that R&D facility's capacity to exploit technological competences is a function not just of its own resources, but also of the efficiency with which it can utilise complementary resources

associated with the relevant local innovation system. The empirical analysis indicates that both EU (US) affiliates in the US (EU) rely strongly on home region knowledge sources, although they appear to exploit the host knowledge base as well. The crucial emphasis on home knowledge suggests doubts about a potential R&D strategy of the EU which would neglect the EU countries as prime locations for leading edge R&D in technologically dynamics sectors, in particular the ICT sector. One must also raise the issue as to which extent the expansion of ICT requires reforms of the innovation system and in particular a stronger role of virtual research networks and "Digital Universities." Optimal linkages between R&D facilities and firms in technology-intensive sectors are crucial, which will naturally include foreign investors.

Both the US and the EU belong to the group of major source countries and host countries while Japan is mainly a source country of FDI – at least if one is to believe Japanese statistics (note: according to US FDI outflow statistics, Japan should have high US FDI inflows). In the US and the EU, innovation plays a crucial role for economic growth. The US and several EU countries achieved rather high growth rates of per capita income and total factor productivity in the 1990s, and the expansion of information and communication technologies (ICT) played a particular role. From a theoretical perspective, one may emphasize the endogenous growth model of ZON/MUYSKEN (2005), who highlighted in a refined LUCAS-model the role of ICT in a modern growth model, where the ICT capital intensity has a positive impact on the knowledge accumulation process. ICT is important both in final goods production and in knowledge accumulation. The expansion of knowledge and the rise in ICT capital intensity contribute to higher steady state growth of output. Knowledge accumulation thus plays an important role in economic growth. The implication is that the long run increase in ICT capital intensity in OECD countries and NICs – fuelled by falling relative prices of ICT capital goods – will reinforce the role of knowledge in production. As regards long term dynamics one should, however, not overlook the problems of information markets themselves, which suffer from market imperfections. The special aspects of ICT and growth will not be analyzed here as many special aspects would have to be emphasized, including the considerable role of intangible assets, network effects as a dynamic demand side-effect and static as well as dynamic economies of scale in several sub-sectors. ICT seems to facilitate the outsourcing of services as it supports virtual mobility of the supply-side and the demand side. With the role of digital services increasing in modern economies, one might find that the macroeconomic production function is characterized by economies of scale at the aggregate level; however, there is no clear evidence on this.

The EU adopted the Lisbon Agenda in 2000, emphasizing the need for higher innovation, higher growth and higher employment. According to this agenda, the EU should become the most dynamic knowledge-based economy by 2010. Interim results are rather sobering according to the KOK (2004) report; with EU eastern enlargement the EU faces additional challenges. The EU is moving increasingly towards a digitally networked high technology knowledge society. Western Europe's high-wage countries particularly face the need to adjust to globalization and EU eastern enlargement in a way which requires an increased use of information and communication technology. ICT is one of the most dynamic fields in terms of technological progress in OECD countries and is therefore of prime importance for economic growth, productivity increases and employment. ICT

markets in Europe and worldwide are growing at a pace which exceeds both regional and global economic growth.

The ICT sector has also become a major driver of the innovation process and of productivity growth. High Schumpeterian dynamics are not only observed in ICT production but also in the use of ICT. Hence ICT investment relative to overall investment may be expected to grow continuously, not least because falling relative prices of software and hardware stimulate ICT investment. With digital (broadband and narrowband) networks expanding in Europe, North America, Asia and in other regions of the world, one may anticipate a further acceleration in digital knowledge creation and information as well as e-commerce – often associated with favourable network effects as well. With so many changes shaped by ICT, the question arises as to whether traditional economic systems, historically shaped by industry, should adjust in order to optimally support – digital – economic growth. The liberalization of EU telecommunications in 1998 (UK already in 1984) stimulated product innovations and possibly innovations in the overall telecommunications sector. The picture for telecommunication network operators is inconclusive as one finds some firms with rising R&D-sales ratios and other with falling R&D-sales ratios. One cannot, however, overlook that the R&D-sales ratio of the equipment industry has increased, which suggests that in the course of restructuring of telecommunications network operators – in the post-1998 period – R&D activities were effectively shifted to a considerable extent to the equipment industry, which is both knowledge-intensive and scale-intensive. The more competition drives e-communication towards global technological standards, the higher the pressure in the equipment industry to consolidate. It is noteworthy that R&D-sales ratios of telecommunications operators are lower than in the continental EU, where the liberalization of the telecommunications sector occurred only 14 years after the opening of the market in the US.

Taking a broader look at R&D expenditure in ICT – relative to overall business R&D expenditure – one can observe considerable differences across countries. Ireland and the Scandinavian EU countries were leaders at the beginning of the 21st century. The three top OECD countries – Ireland, Finland and Korea – spent 70, 64 and 50% of total business R&D expenditures on ICT in 2003. Canada, the Netherlands, the US and Japan followed with an ICT share of about 35%; France had 31%, the UK 24 and Germany, Italy and Spain about 22%. Ireland, the UK, Norway, Denmark, Australia, Spain and the Czech Republic had a relatively high share of R&D ICT expenditures in the service sector. The ranking in terms of ICT patents looks rather similar to that in ICT R&D expenditures. The top countries are Singapore, Finland, Israel, Korea, Netherlands and Japan, Ireland the US, Canada and Sweden, which recorded an ICT patent share of close to or above 40% (top scorers Singapore and Finland close to 60%) based on figures at the European Patent Office. These countries were followed by the UK, Chinese Taipei, China, Australia, Hungary France, EU, Russia, Germany, Norway, Switzerland, Denmark, New Zealand, South Africa, Belgium Spain, Austria, Italy, India and Brazil. It is clear that the ICT patent position of US firms – with subsidiaries in many of the top countries – is much stronger than that of the US as a country. Moreover, taking a look at US figures shows a clear US lead even if one assumes that there is a home bias (in the US in favour of US firms, in the EU in favour of EU firms). As regards ICT goods, Japan is very strong in global markets.

This also becomes apparent from the fact that Japan's share in EPO patents was very close to the share of the US (see subsequent figures/tables).

As regards ICT employment – narrowly defined – an increase can be seen in most OECD countries in the period from 1995 to 2003. Ireland is a negative example. The share of ICT-related occupations in the total economy was in a range of 3-5%. Sweden was the OECD leader in 2003, and the US was ahead of the EU by almost 1 percentage point. This finding points to a transatlantic lead on the part of the US, which is well ahead of the EU in terms of patenting, R&D-sales ratio and employment. Given the relatively small employment shares, it is impressive to see how important ICT patents are in comparison with other sectors. As regards EU innovation dynamics, one might want to consider a broader coordinated R&D effort in the ICT sector, in particular some form of coordinated international R&D program. The latter should not mean that all EU countries or very many are embarking upon coordinated projects under the heading of EU programmes. Rather it would be desirable for several countries to team up under the heading of a multi-country ICT R&D programme of excellence. The typical EU R&D programme, which effectively requires involving countries/partners from Western Europe, Eastern Europe and the Cohesion countries, makes ICT projects unnecessarily complex and often undermines efficiency. The EU might well want to subsidize employment of R&D researchers from relatively poor countries in leading EU R&D countries. There could be a particular role for EU-funded R&D projects, but overemphasizing EU projects is damaging for European innovation dynamics. Political control of EU R&D policy is rather weak and implies inefficiency risks. The EU might want to consider a special role for the supranational policy level in stimulating diffusion and in financing R&D centres of excellence in the Community. Finally, there is a major inconsistency in the EU R&D projects, which typically require 50% co-financing.

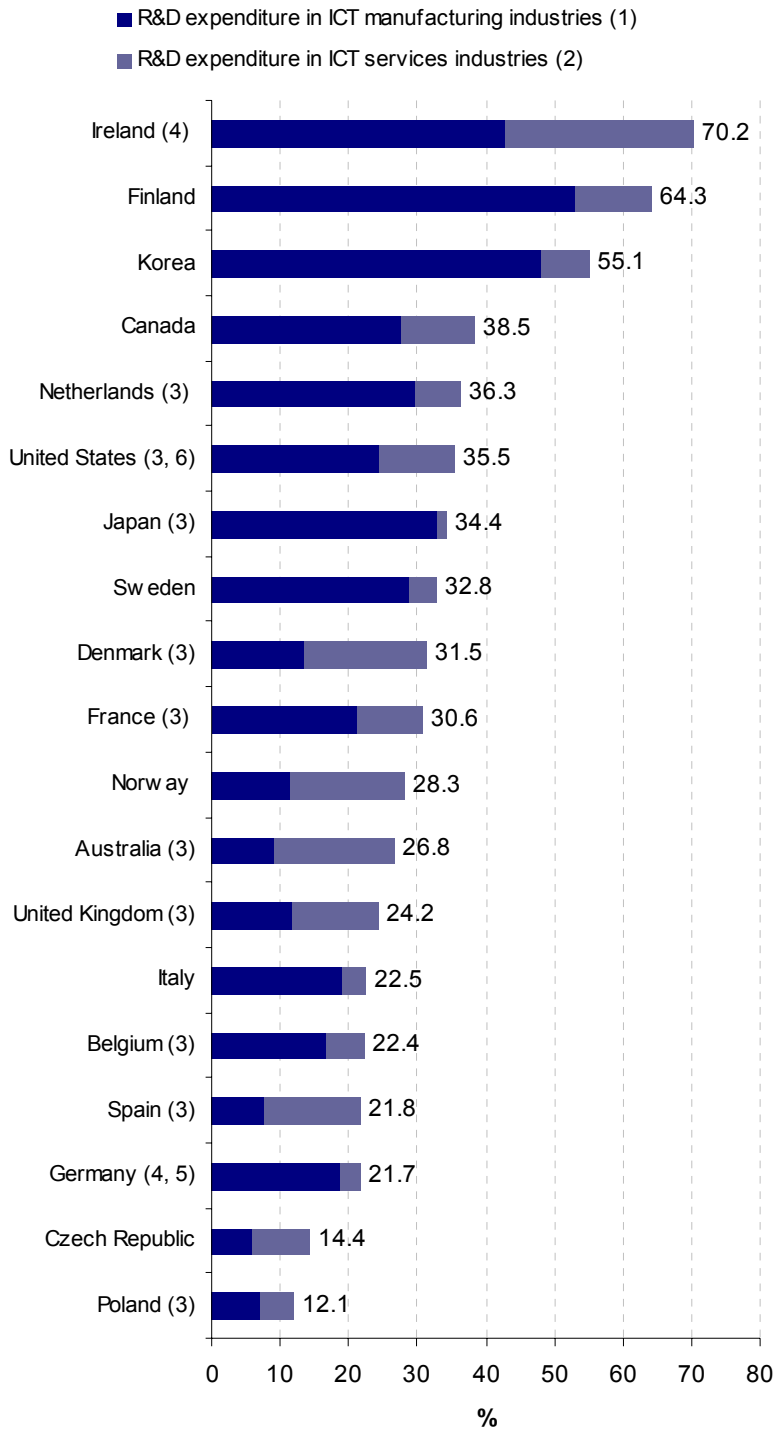
As regards university research institutes, one should expect that national government or special R&D funds with partial government funding would provide the co-financing for successful bidders. This is not the case and indeed is adequate for industrial R&D consortia. However, only a rather limited number of R&D projects are dominated by the business community, namely in applied R&D. Fundamental R&D should be financed mainly by government. In Germany and several other EU countries – including eastern European accession countries – there is no adequate co-financing from governments for projects in fundamental research. Moreover, the broad lack of private universities in most EU countries means that there is insufficient funding of higher education and insufficient R&D activities at the same time (e.g., Germany spends only 1% of its national income on university funding and has very few private universities, which are all very small).

The ICT sector has a special feature which makes adequate financing of innovation projects difficult in the continental EU countries. Many sub-sectors of ICT are characterized by a high share of intangible assets which undermines bank financing. The typical bank will always want collateral, and neither intangible assets (e.g., software) nor computer equipment – whose price absolutely falls over time – can serve as collateral for bank financing. This implies for many Eurozone countries that one has enormous problems in financing innovative young ICT firms. Interestingly, there are some big companies such as Siemens, SAP and Deutsche Telekom which have set up special venture capital funds. However, the general conclusion is that the Euro zone countries should move more

towards a capital market system and thus become more Anglo-Saxon in terms of the financial market system. Financial markets are important for growth and structural change (WELFENS/WOLF, 1997). *Mutatis mutandis* this also holds for university financing, where continental EU countries have underdeveloped banking markets for students. Part of EU underfunding of the university system is actually due to a lack of private universities on the one hand and of adequate financing for university study on the other. As one may argue from a theoretical perspective, adequate financial market deepening will contribute to a higher level of growth and potentially to a higher trend growth rate (namely to the extent that the structure of financial markets influences R&D intensity and human capital formation and hence contributes to endogenous growth dynamics). One should make serious efforts in the new EU knowledge society to develop financial institutions that are up to the challenges and opportunities of the digital age. These arguments, however, do not imply that one should underestimate the risks from volatile stock markets.

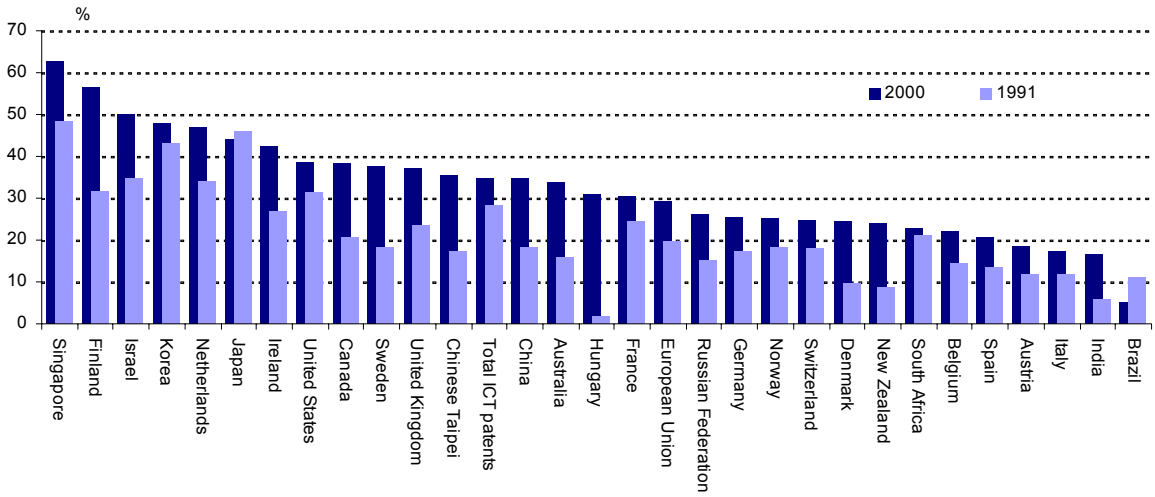
Slow growth in the Eurozone over many years – in particular in Germany and Italy – should be a wake-up call for many continental EU countries to modernize the innovation system and to put more emphasis on R&D funding; this must at the same time become more efficient. Conditional tax credits should play a larger role than traditional subsidies, which effectively favour large firms that can afford to spend considerable sums of money on active lobbying. R&D tax credits would be less distorting in the sense that large countries and SMEs would act on a more level playing field. Since innovative SMEs are so important in R&D in the ICT sector – and since Germany/the Eurozone is lagging behind the US – one should seriously consider the reform proposals made here (and others made subsequently).

Figure 8: R&D expenditure in selected ICT industries, 2003 or latest year available as a percentage of business enterprise sector R&D expenditure



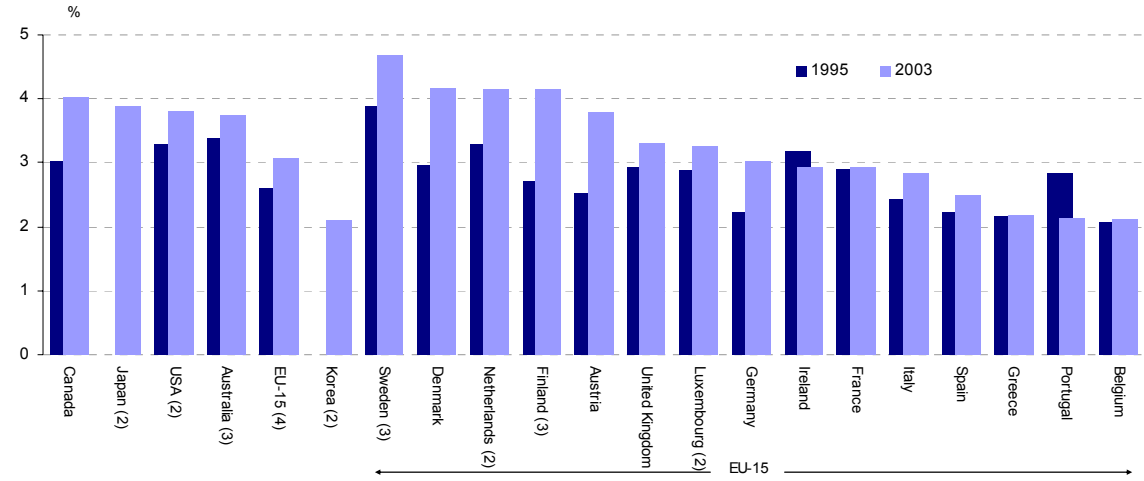
Source: OECD, ANBERD database, March 2005.

Figure 9: ICT patents1 as a percentage of national total (EPO) in selected countries2. According to the residence of the inventors, by priority year.



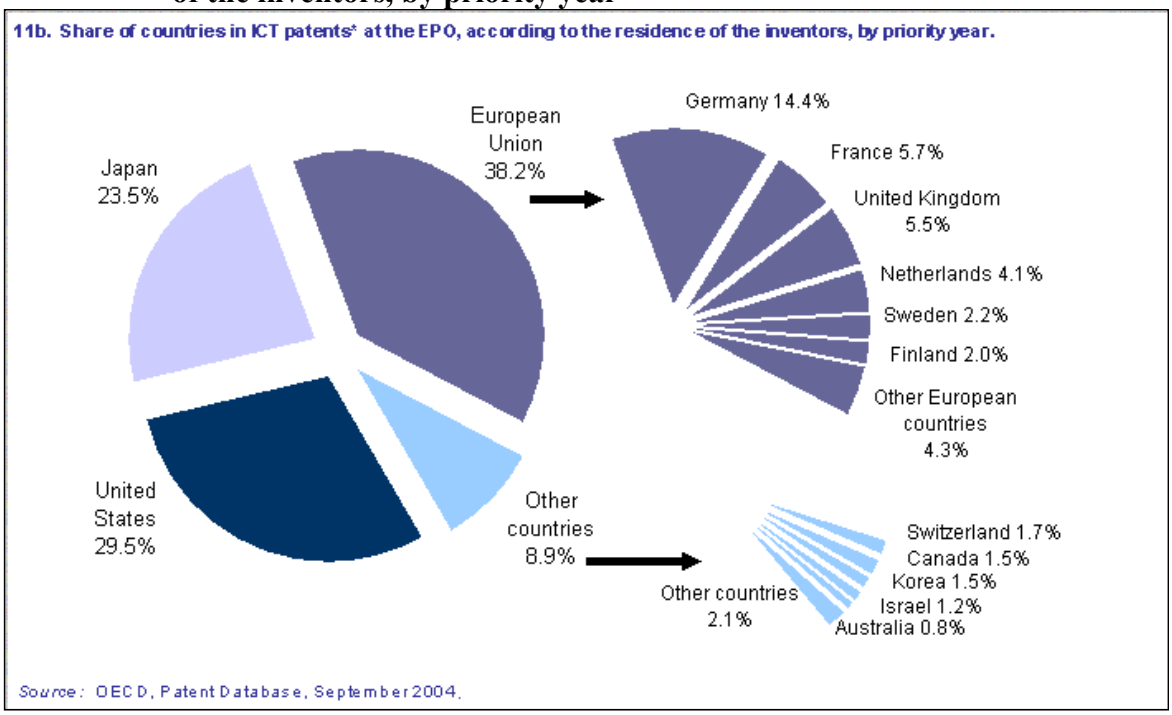
1. The provisional definition of ICT patents is presented in Annex B of the OECD compendium
2. Cut-off point: countries with more than 100 EPO applications in 2000
Source: OECD, Patent Database, September 2004

Figure 10: ICT employment across the economy- Share of ICT-related occupations in the total economy in selected countries, 1995 and 2003, narrow definition (1).



Based on methodology developed in chapter 6 of the Information Technology Outlook 2004. See also van Welsum, D., and G. Vickery (2004), New perspectives on ICT skills and employment, Information Economy Working Paper DSTI/ICCP/IE(2004)10, OECD.
2. 2002 instead of 2003
3. 1997 instead of 1995.
4. Estimates.
Source: OECD Information Technology Outlook 2004

Figure 11: Share of countries in ICT patents' at the EPO, according to the residence of the inventors, by priority year



The provisional definition of ICT patents is presented in Annex B of the Compendium of patent statistics 2004.
Note : See table for footnote
Source: OECD, Patent Database, September 2004

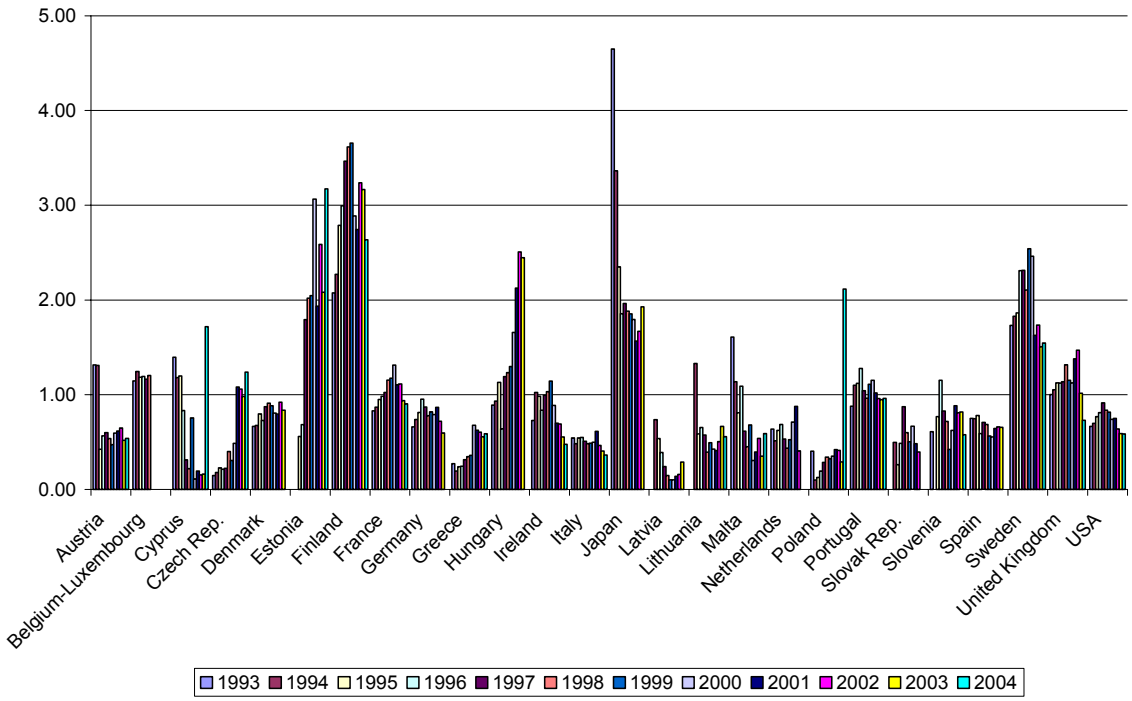
2.5 Regional Integration Dynamics

The international division of labor is changing at a global scale, and changes in competitiveness in ICT sector are of particular interest. This is also an important issue in the context of EU eastern enlargement, namely whether new member countries can reinforce the Community's competitiveness in global ICT markets. This topic can be analyzed by examining the development of RCAs (sectoral export-import balance relative to country's total global export-import balance) in relevant fields, here telecommunications industry and office machinery & computers. An RCA exceeding unity is considered a favorable sign of competitiveness. Those countries with an RCA exceeding unity over a considerable time period are strong competitors in world markets. With respect to RCAs, there is, however, one caveat, namely that the RCA is a sectoral trade ratio relative to an overall export-import ratio where overall exports and imports might reflect rather low technology products; this aspect in turn should be visible in the weighted absolute export unit value for all exports (and import unit value for all imports), which naturally will be much lower than in a high income country in which trade is more concentrated on medium-technology and high-technology products which carry relatively high absolute prices (both export unit values and import unit values). Thus, one may suggest defining a relative price weighted RCA where the respective sectoral RCA is weighted with the

relative sectoral export unit value (country I relative to country II in a model or relative to the rest of the world in reality). One could first identify the RCAs exceeding unity and then multiply those with the relative export unit value in order to get an economic weighting of the RCA; in practice relative export unit value could simply mean comparing the sectoral export unit value of country i to that of the respective value of the US. In the perspective suggested here, an RCA in a high income country (with relatively high export unit values) slightly exceeding unity is more impressive than an RCA strongly exceeding unity in an economy with a small relative export unity value. In this perspective, economic catching up requires economic upgrading leading to a long term increase in the weighted export unit value and a increased role of RCAs exceeding unity in those sectors where high Schumpeterian economic rents are earned, namely in scale intensive, technology-intensive and knowledge-intensive goods.

In the following paragraphs, we use "modified" RCA which is the ratio of a countries export share in a sector (for certain relevant markets) to the export share of the competitor's countries in the same market. Here the relevant market is the EU15. An indicator above unity shows a comparative advantage in the respective sector. As regards the telecommunications industry, one may note that the RCA of Japan declined considerably in the decade from 1993 to 2004, yet in 2004 Japan still had a positive RCA. The US has a "negative" RCA (RCA below unity), with its position having deteriorated at the beginning of the 21st century.

Figure 12: RCAs in the Telecommunications Industry

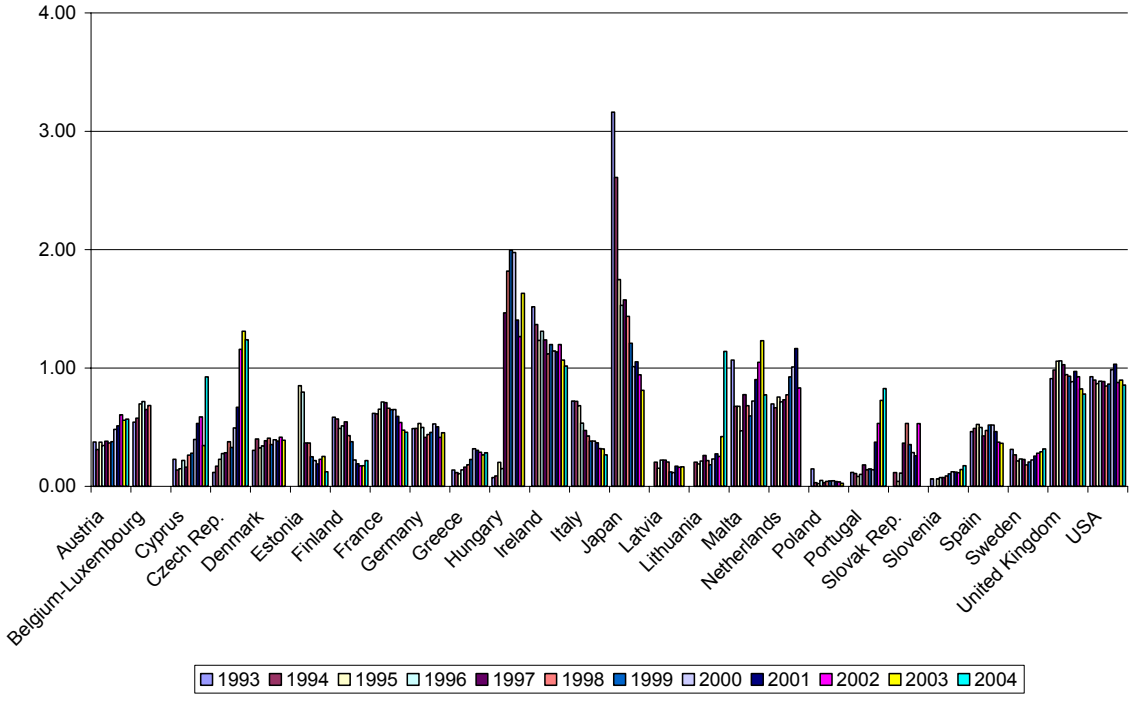


Thus it is noteworthy that the Czech Republic, Hungary and Estonia have developed an RCA exceeding unity in the early 21st century. This reinforces the particular strength of leading EU15 countries, namely of the UK, Finland and Sweden, to some extent also of France. As regards office machinery and computers, one may emphasize that this sector

has become more price competitive in the early 21st century. Japan's favorable RCA position has strongly eroded in the period 1993-2004, and the country was below an RCA of unity in 2004. The US had a rather stable RCA index which was slightly below unity. Hungary and the Czech Republic have joined Ireland and the UK in their favorable RCA position among EU countries.

The more interesting field here certainly is software whose role is rising relative to that of computers. Software development involves, by and large, much human capital. This statement does not, however, suggest that one could not find useful steps in software development which can be outsourced internationally. Standardized relatively simple tasks in programming can be outsourced conveniently in the internet age. However, the final testing and the high end programming are typically made in advanced OECD countries.

Figure 13: RCAs in the Office Machinery and Computers Industry



3. Economic Stability: ICT and FDI in a Modified Dornbusch Model

Information & Communication Technology and the Dornbusch Model

A standard model for medium-term exchange rate analysis is the Dornbusch model, which emphasizes the interplay of rapidly reacting financial markets (the nominal interest rate and the exchange rate adjust instantaneously) and the macroeconomic goods market in which the adjustment speed (i.e., the change of the price level) is rather slow. A key feature of the model is an overshooting of the exchange rate, namely that the short-term reaction of the exchange rate is stronger than the medium term equilibrium adjustment would require. In the Dornbusch model (1976), the interest elasticity of the demand for money and the type of exchange rate expectations are crucial for the overshooting problem. Regional monetary integration – as exemplified in the Euro zone – and technological dynamics, particularly the expansion of information and communication technology, signify interesting developments whose implications for economic stability can be highlighted through in the context of the Dornbusch model. How will the expansion of information and communication technology affect exchange rate dynamics and the overshooting/undershooting effects? The speed of price adjustment in the goods market is likely to increase, as the global supply side elasticity in an internationally networked society will be relatively large, in particular in the field of digital services whose share in aggregate demand is likely to increase over time. However, the relative adjustment speed of "digital financial markets" is likely to increase even faster than in the goods markets. To understand the basic problems we consider a modified Dornbusch model, namely a setup which includes foreign direct investment and thus implies a modified interest parity condition (WELFENS, 2006).

Subsequently we consider a simple system of six equations: Equation (1) is a kind of Phillips curve, where Y# is full employment long run equilibrium output: an excess in demand will lead to an increase in price level. Equation (2) is a logarithmically-stated specification of aggregate demand. Though partly following GÄRNTER (1997), we insert several extensions including the impact of product innovations which are assumed to raise net exports; in the original formulation of GÄRTNER there is also a term related to real income, lnY (and a term related to trade and the exchange rate). However, the sign of the parameter of lnY is negative – as we will show – and not positive; this is in spite of hundreds of articles using ad hoc logarithmically stated demand curves where the elasticity of lnY is positive while it actually is negative as the relevant parameter reflects the impact of a change in lnY on real net exports and imports. Moreover, lnG is often in the aggregate demand as well, but we will replace lnG by the ratio G/Y, which is more consistent as will be argued subsequently.

It is assumed that the foreign price level P* is constant and equal to unity so that $\ln(eP^*/P) = \ln e - \ln P$; we define $q^*=eP^*/P$. To the extent that we consider a model with foreign direct investment, the parameter ψ' does not only reflect the link between trade balance (ψ) and the real exchange rate but also the impact (ψ'') of the real exchange rate on foreign direct investment and hence on the overall investment-GDP ratio. A real depreciation will bring about higher net foreign direct investment inflows – relative to

GDP – and hence higher overall investment according to the theoretical arguments and empirical findings of FROOT/STEIN (1991). The perspective suggested here implies that ψ'=ψ+ψ". The variable e is the current nominal exchange rate, and e# denotes the long run exchange rate.

Capital market equilibrium is given by two interacting factors (i is the nominal exchange rate), namely the impact of portfolio investors guided by the interest rate parity (i=i* + E(dlne/dt)) and foreign investors who focus on long run differences in the marginal product of capital. As we assume that both the home and the foreign country (* denotes foreign variables) produce according to a Cobb Douglas function $Y=K^{ß}(AL)^{1-ß}$ and $Y^*=K^{*ß^*}(A^*L^*)^{1-ß^*}$, respectively, the relevant variable for foreign investors is the difference in marginal products of capita ($Y_{K\#}$,, Y_K*#), namely ßY#/K minus ß*Y#*/K#* where # denotes long run values. From a portfolio-theoretical perspective, real capital and bonds are complementary in terms of risk, as risks faced by holders of K are negatively correlated with that of holding bonds. Hence we state the rather simple equilibrium condition $i+\zeta(ßY\#/K\# - Y_K^*\#)= i^*+E(dlne/dt)$. Thus a positive international differential of marginal products in favor of the home country requires that domestic interest rates fall for a given sum i* +E(dlne/dt). To put it differently, given the domestic and the foreign interest rate the required expected exchange rate depreciation rate E(dlne/dt) must rise along with a positive differential of marginal products since bond investment abroad would otherwise be insufficiently attractive now that holding domestic bonds has become more attractive.

The expected devaluation rate is assumed to be proportionate to the difference between the equilibrium exchange rate e# and the actual exchange rate e; expressed in logarithms, we have equation (6).

Goods Market

(1) $dlnP/dt= \pi'(lnY^d - lnY\#)$

(2) $lnY^d= c+\psi'[lne-lnP]-\Omega lnY\#+[1+\omega]\gamma-[c+\omega']\tau+\eta"lnv+ \Omega^*lnY^*$

Money Market

(3) $lnM^d = lnP + \varphi lnY - \sigma'i$

(4) $lnM^s = lnM^d = lnM$

International Capital Market

(5) $i+\zeta(ßY\#/K\# - Y_K^*\#)= i^* + E(dlne/dt)]$

(6) $E(dlne/dt) = \theta(lne\#-lne)$

Note that in the very long run (defined by equality of marginal products of capital across countries), equation (5) results in the standard interest rate parity condition. Here we focus on the short term and the long run, whereby the latter is defined by a response in the price level P.

The long run change of the equilibrium exchange rate lne# with respect to a change of the money supply dlnM is unity. The short run reaction of the exchange rate can be obtained from the following equation (WELFENS, 2006)

(I) $lne=lne\#+[lnM–lnP-\varphi lnY\#]/(\theta\sigma')+i^*/\theta -[\zeta/\theta][(\beta Y\#/K\#–Y^*_{K^*}\#)$

Therefore, we have in the short run the following result which confirms exchange rate overshooting:

(II) $dlne/dlnM = dlne\#/dlnM +1/(\theta\sigma') = 1 +1/(\theta\ \sigma')>1.$

Thus we see that the adjustment parameters relevant for overshooting are θ – the learning speed in the formation of exchange rate expectations – and the semi-interest elasticity of the demand for money (σ'); the smaller both parameters are, the higher the overshooting effect. Both parameters also play a role with respect to the adjustment speed for nominal exchange rate and price level. The adjustment speed is given by the expression $\pi'(\psi'/\sigma'\theta + \psi')=:\alpha$". ICT will affect some or all of the parameters.

Since ICT facilitates access to various kinds of financial market instruments – as does the creation of the Euro zone (from an EU perspective) –, the interest elasticity of the demand for money may be expected to increase. Monetary overshooting problems should thus be reduced unless the learning speed in the field of exchange rate expectations should decrease. Moreover, ICT might indeed facilitate the learning process in markets and hence ICT expansion will go along with a higher adjustment parameter θ (concerns formation of exchange rate expectations). This implies that ICT will lead to reduced overshooting problems; at the same time, the adjustment speed to the new long run exchange rate equilibrium will slow down. From this perspective, the opportunities of an activist monetary policy have improved, namely in the sense that exchange rate overshooting problems are less severe than in the traditionally industrialized OECD countries. This holds all the more since one has to take into account that ICT expansion is equivalent to a positive supply shock which itself implies a dampening exchange rate movement.

As regards a positive supply-shock we get as a short-term impact:

(III) $dlne/dlnY\# = dlne\#/dlnY\# - [\varphi/(\theta\sigma')] - [\zeta\beta/\theta K\#]Y\# =$

$-\varphi[1+(1/\theta\sigma')] + [(1+\Omega)/\psi'] - [\zeta\beta/\theta K\#]\ Y\#$

A positive supply-side shock is all the more likely to cause a real appreciation in the short term, the larger the income elasticity of the demand for money is and the higher the output

elasticity of capital is (and the lower the capital stock is). A positive supply shock is reinforced by the impact of foreign direct investment which reinforces the tendency towards a short term appreciation.

Moreover, note that the long run exchange rate reaction of a supply-side shock is given by:

(IV) $d\ln e^{\#}/d\ln Y^{\#} = -\varphi + [(1+\Omega)/\psi']$

The short-term reaction of the nominal exchange rate is more towards a nominal appreciation than the long term reaction. The long term real exchange rate ($q^*=:eP^*/P$) will depreciate as a consequence of a supply-side shock – whose nature is similar to a process innovation.

(V) $d\ln q^{*\#}/d\ln Y^{\#} = [(1+\Omega)/\psi']>0$

However, the impact of product innovations (v) imply a real appreciation ($q^*=:eP^*/P$):

(VI) $d\ln q^{*\#}/d\ln v = -\eta''/\psi'<0$

Hence the impact of ICT on the long run real exchange rate is ambiguous: If product innovations dominate sufficiently there will be a real appreciation; if process innovations are dominant there will be a depreciation of the exchange rate.

Exchange rate overshooting depends on several parameters, including the learning dynamics of exchange rate expectations and the interest elasticity of the demand for money; the adjustment speed to the new equilibrium is influenced by the responsiveness of the trade balance and foreign direct investment. ICT and FDI will affect the nominal and real exchange rate dynamics. There are several arguments why FDI could reduce the problem of overshooting. From this perspective, economic globalization – in the sense of a rising share of FDI in overall investment – is likely to contribute to less exchange rate instability. If ICT for technological reasons leads to an increase in the learning speed in the foreign exchange market, the size of overshooting is reduced. At the same time, one might expect that ICT raises the price adjustment speed in the goods markets, which reinforces the speed of adjustment towards the new equilibrium. Monetary policy would then generate less overshooting than in the time of the Old Economy so that a more activist monetary policy could be considered.

From an empirical perspective it would be important to find out more about the effect of the exchange rate regime on innovation dynamics. A fixed exchange rate regime basically transmits the domestic price level to those countries which have pegged the currency to the anchor country. If a fixed exchange rate regime helps to diffuse price stability worldwide – under the assumption that the anchor country pursues a stability-oriented monetary policy leading to a low inflation rate – firms in all countries might find it relatively easy to conduct R&D policies which require a long term perspective; bond

maturities (as a proxy for the representative time horizon) are known to be relatively long in periods of low inflation rates. The counter-argument in favour of a flexible exchange rate regime is that it establishes full individual responsibility in monetary policy in each country so that the weighted world inflation rate could be lower under flexible exchange rates than in a system with a fixed exchange rate. However, there are other aspects which are rather unclear: will multinational companies be more active innovators in a system of fixed exchange rates than in a system of flexible exchange rates? More research is needed here.

As regards regional integration several parameters of the (modified) Dornbusch model will be affected. The price adjustment parameter in the goods markets should increase, as this would be natural to expect in a single market – and to the extent that monetary union reinforces this adjustment speed, the argument is even more valid. From a Eurozone perspective there is the crucial issue of whether dollar exchange rate volatility in the sense of overshooting risks will be reduced. Indeed, less overshooting problems should be expected if regional integration – in particular monetary integration – raises the interest elasticity of the demand for money. (In a monetary union one should expect more liquid alternatives to holding money than in fragmented national markets.) Moreover, the learning speed (parameter θ) in the foreign exchange market should also increase. The main problem which arises in a monetary union involving countries with high sustained budget deficits is that there is a considerable risk that tax rates will go up. If such tax increases are not mainly invested in the form of higher public investment – relative to GDP – and higher R&D expenditure-GDP ratios, the impact on GNP could be negative in the long run, not least because an increasing share of GDP will accrue to foreign investors (from country II) who will benefit from a real depreciation through cheaper access to the stock of capital abroad.

Finally, one should notice that the expansion of ICT is likely to reinforce the role of foreign direct investment as firm-internal transaction and management costs are reduced. Thus the findings with respect to FDI are reinforced through the expansion information and communication technology. The logarithmic formulation of the aggregate demand side suggested here should encourage new options to consistently develop macro models. Supply side shocks and product innovations will affect the exchange rate in the long run. In a world economy with increased innovation dynamics, the respective topics need to be further explored and also require additional empirical analysis. While the context of the modified Dornbusch model suggests a reduced risk of overshooting in a digitally networked economy with FDI, this does not rule out that other mechanisms relevant for exchange rate instability could become more relevant through the expansion of ICT. Indeed, if there are two groups of speculators in the foreign exchange market or the stock market – namely group 1, for which expectations are guided by fundamental variables while expectations of group 2, the chartists, follow current market trends –, a temporary dominance on the part of the chartists could bring about instability. With many financial market actors from newly industrialized countries active in a globally networked financial market, one cannot rule out that the influence of chartists could become quite important during periods of market turbulence.

4. Challenges: Regulatory Policy and Life-long Learning

There are three basic challenges for policymakers in a digitally networked European economy:

- actively shaping the global rules for digital trade (this points to the role of the WTO);
- defining adequate rules for competition in telecommunications; national regulatory approaches in combination with the EU framework regulation should bring about sustained competition and a high intensity of innovation in the EU single market;
- maintaining leadership in key fields of ICT, which requires not only adequate R&D government programmes and new initiatives to modernize the university system in a way which combines solid education with innovativeness; it will also be necessary to fully exploit the digital learning opportunities in an ageing EU society.

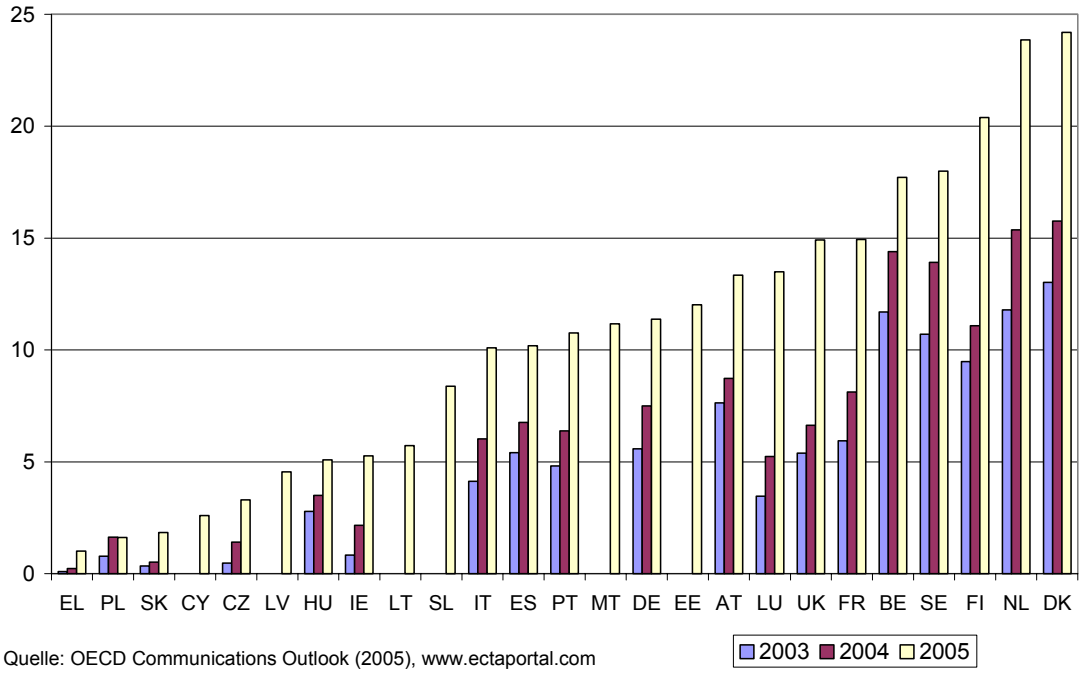
While the WTO process is a long term challenge whose dynamics are difficult to anticipate, the adjustment of eCommunications rules is a more medium-term challenge for which the European Commission has started a Review Process on the 2002 framework regulation based on market analysis of 18 pre-defined markets and a broad set of rules ranging from universal services to access regulation.

As regards the period 2010-2020, one may anticipate that three major drivers will shape eCommunications:

- digital convergence which already is visible in triple play services (fixed line telecommunications, TV and internet) or quadruple play (triple play plus mobile services);
- mobile telecommunications will increasingly become a substitute for fixed line telecommunications; the majority of calls in EU25 will be from mobile telecommunications. Moreover, there are new options for mobile internet-based phone calls. VoIP – internet-based telephony – will become rather common by 2010 in the business community which is likely to use hybrid network configurations. At the bottom line, international communication costs will continue to fall which should stimulate trade and foreign investment;
- broadband density will increasingly matter for digital modernization of the economy. Here Germany and Italy are two laggards among EU countries, and most Eastern European member countries are rather weak.

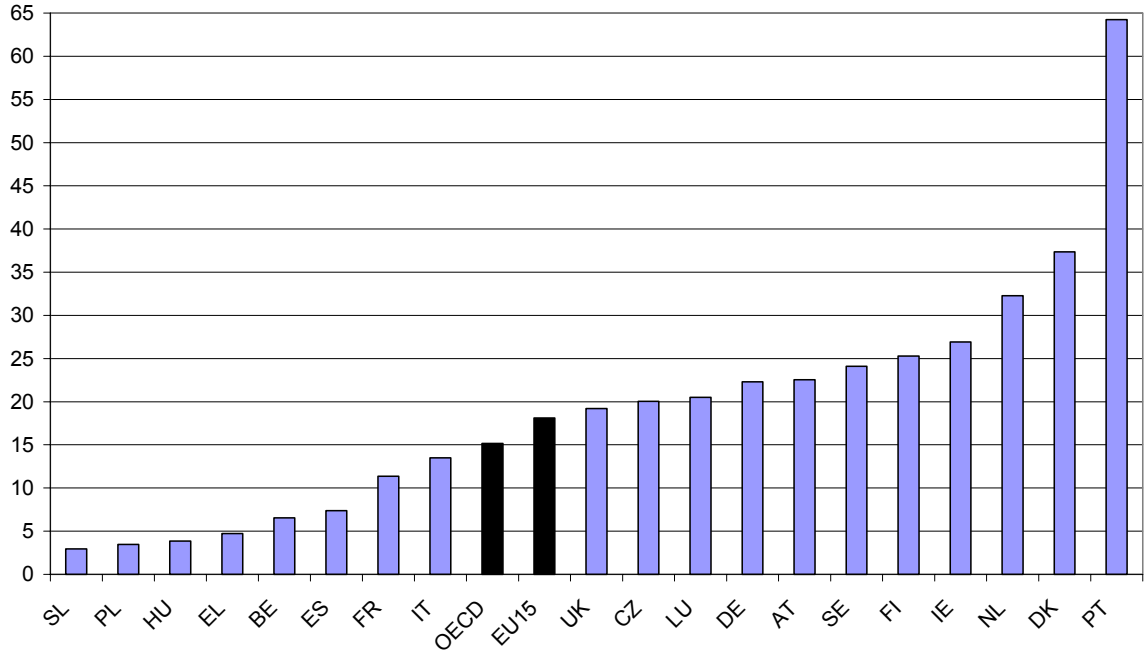
As the following graphs illustrate, the cross-country differentials in broadband density are rather large in the EU. If such differentials should be sustained, it will be rather difficult to fully develop a modern digital single EU market – and the innovative applications and productivity improvements that should go along with advanced digital networks and their respective services.

Figure 14: Broadband Density in Selected EU Countries, 2003-2005 (density is per 100 workers)



Quelle: OECD Communications Outlook (2005), www.ectaportal.com

Figure 15: Narrowband Densities in EU Countries (per 100 inhabitants)



Quelle: OECD Communications Outlook (2005)

From an EU single market perspective, it will be quite important for consolidation in the EU telecommunications market to be facilitated. Compared to the US – with three major fixed network operators and four mobile operators in 2006 – the EU has an amazing

number of operators which act in nationally, rather fragmented markets. Anticipating true globalization of communications markets through VoIP services, the EU seems not to be well positioned in comparison to the US. Moreover, it is strange that the European Commission has emphasized in the Lisbon Agenda 2010 the aim of making the EU the most dynamic competitive knowledge-based society by 2010 while the Commissioner responsible for eCommunications is undermining the incentives for telecommunications network operators to invest in innovative networks (e.g., VDSL which is an advanced broadband network). The EU-imposed requirement to give competitors access to the VDSL network on cost-based prices is absolutely inconsistent not only with incentives for innovations in advanced networks and digital product innovations; it also is contradictory to the European Commission's own principle that new markets should not be regulated. Achieving the goals of the Lisbon Agenda without strong national and supranational support for ICT innovation dynamics in general and for modern telecommunications in particular is not possible. If commercial ICT dynamics in the EU are not be fully exploited and national governments are unable to reallocate more funds to complementary higher education, the economic and social opportunities of modern ICT will remain unexploited in critical areas. The traditionally strong role of public universities in Europe lets one expect that even in the university sphere innovative digital opportunities for networked education – teaching and learning – will be exploited rather slowly. The mixed US system – with many private and public universities eager to develop a new digital profile –is apparently better positioned to explore new ICT-related options.

Digital Learning in the Networked Society

If the Community is interested in stimulating economic growth and economic cohesion, the availability of broadband internet access is crucial. The Community might well consider defining broadband universal services and leaving member countries responsible for organizing efficient provision of such services. For the academic community and the business community, Internet 2 – already tested in the US on a large scale in 2006 – will be a major innovation which not only means much more rapid transmission of data but also facilitates national and international cooperation of research institutes. Universities and schools will look different in 2010+, since distance learning and other elements of digital teaching will become a natural element of life-long learning (LLL).

LLL presents four major challenges:

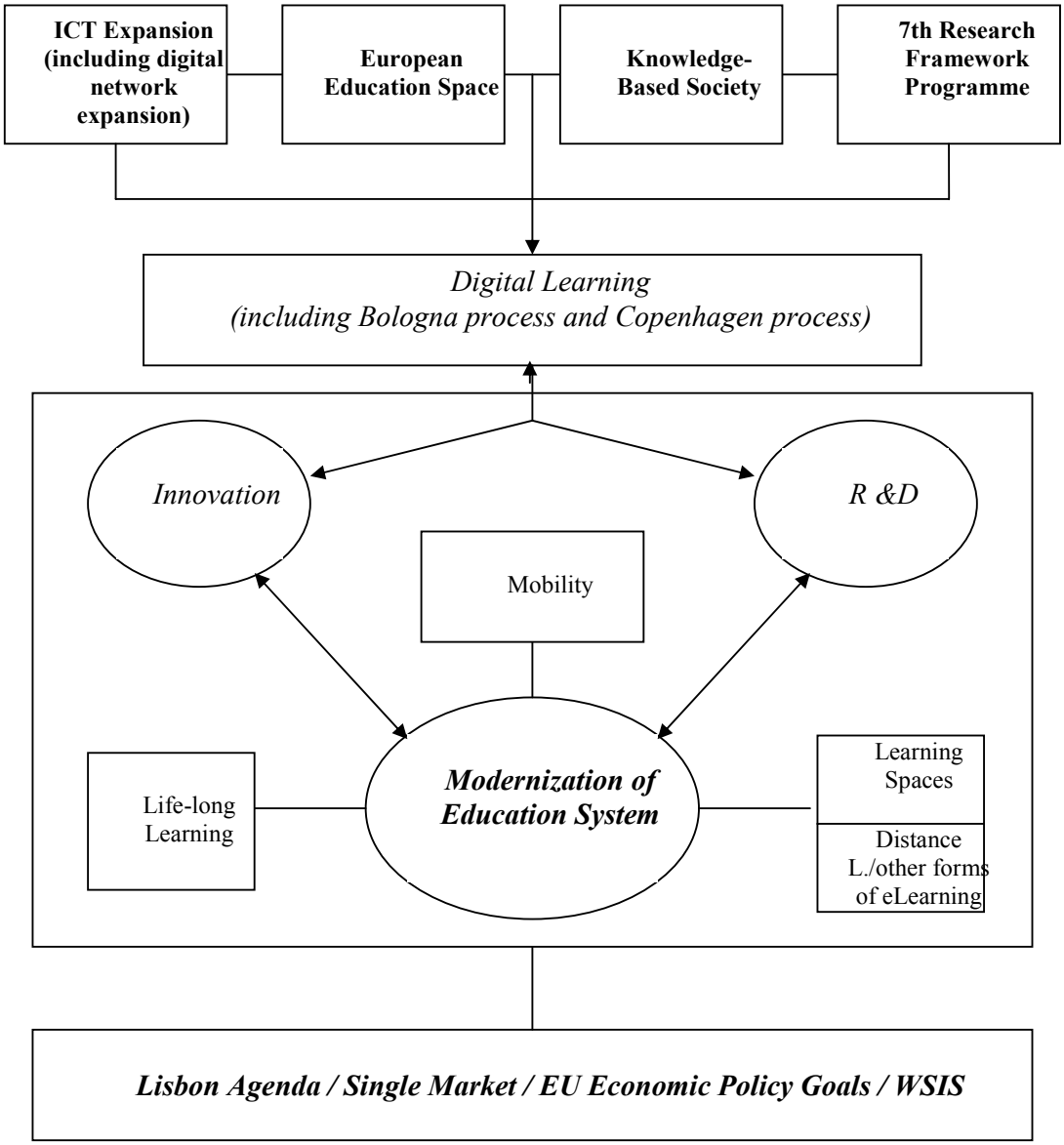
- ageing societies coping with adjustment needs, technological progress and economic globalization can raise the stock of human capital efficiently by including new digital learning features;
- as economic globalization brings with it a tendency towards higher labor market flexibility and reduced tenure in firms, there is a clear need for governments to support retraining and training in firms. With tenure falling in all EU countries, the incentive for firms to invest in human capital formation is reduced – to the extent that training and retraining generate external effects, and governments should provide financial incentives for training and retraining in firms;

- EU member countries show relatively heterogeneous indicators in the field of LLL and it is remarkable that Germany and Italy – two core countries of the Euro zone – are among the relatively weak performers
- LLL will be a particular problem in the context of economic globalization which will not only erode the tax base (in particular with respect to corporate taxation), but also brings pressure towards more flexibility in the labour market which implies – among other things – shorter tenure of workers. In such an environment, the incentive for firms to invest in training and retraining is declining over time. For example, while it is still slightly above ten years in German industry, some of Germany's leading ICT firms have average tenure of workers of less than five years.

Assuming that there are positive external effects from training and retraining, governments should consider subsidizing modern efficient forms of digital learning and teaching.

Drivers of digital learning is ICT expansion, the initiatives in the European education space, the dynamics of the knowledge based society – including the growth of the (digital) services sector – and EU framework programme effects. The Bologna process and the Copenhagen process bring new impulses for digital learning. At the same time, the interaction of innovation, research and development (R&D) as well as the modernization of the education system are crucial drivers of digital learning. The modernization of the education system is largely driven by the increasing need for life-long learning, the rising mobility of people (workers/managers/students/apprentices) and the dynamics in creating new learning spaces. If the interaction of these elements is carefully organized, well managed and to some extent integrated into market mechanisms, the resulting developments would help the EU in meeting the goals of the Lisbon Agenda, reinforce single market dynamics, help in reaching EU policy goals and contribute to avoiding a digital divide within Europe and possibly also beyond the EU (as the EU is an influential actor in many regions of the world – not only in other integration areas such as ASEAN or MERCOSUR); the latter would be in the spirit of the WSIS, the World Summit of the Information Society meeting held in 2006.

Figure 16: ICT, Innovation and eLearning



The internationalization of ICT will continue as falling intra-firm transaction costs coincide with an increasing R&D intensity within the ICT sector. Governments in EU countries should investment more in R&D support. Given the relative innovation differentials within the EU (JUNGMITTAG, 2004), however, the optimum R&D-GDP ratio will certainly differ across countries. Special projects and programs related to the ICT sector could be useful; this approach is particularly valid if positive external effects from ICT innovation projects are relatively large. Encouraging the networking of SMEs in knowledge-intensive and science intensive sectors could also be a crucial policy element. Given the growth of the global knowledge society it will also be important for regulatory policy to encourage the modernization of telecommunications networks. More labor market flexibility in many countries of the Eurozone might also be a requirement to fully exploit the benefit of the digital economy.

Growing internationalization of the ICT sector (including outsourcing) is a natural element of structural change and economic growth. There is hardly a reason for sounding an alarm bell over a hollowing out of German (or EU15) industry; indeed, there is no simple bazaar effect which would be dangerous for economic development and employment. Rather there are imported intermediate products in exports goods, but there are also exported intermediate products in import goods.

As regards Eastern European accession countries it would be desirable for national governments and collective bargaining actors to find ways to reduce the unemployment rates. At the same time, governments would be wise to stimulate both economic modernization and innovation. This should include adequate incentives not only for FDI inflows but also for developing multinational companies which are able to actively use foreign sources of innovation and knowledge abroad. EU structural policies should take some of these aspects into consideration in the future.

Comparing the Eurozone to the US (or ASEAN countries), there might be problems of optimum outsourcing as the resistance of trade unions in countries with high unemployment rates will impair outsourcing which reduces profitability and hence the ability of finance innovation and international marketing campaigns. At the same time one should emphasize that for high wage EU15 countries it will naturally become important in the medium term to specialize more on services which are less exposed to price competition. However, such specialization will indeed require not only flexible outsourcing but also higher expenditures on education in order to have a well-educated workforce. Here the problems of ageing societies will avert increases in the public education budget; ageing societies in Europe might place priority on spending more taxpayers' money on social security, in particular retirement benefits. Globalization at the same time means that the average tenure of workers at the firm is decreasing so that the incentive for firms to invest in human capital upgrading is on the decline. Thus the EU is facing serious risks of losing (relative to the US) two traditional advantages relevant for productivity and growth.

For prosperity, stability and growth, the expansion of ICT will be crucial for the EU in the 21st century. Since EU25 is relatively well positioned in terms of human capital, R&D activities and broadband network expansion, the Community will be able to benefit strongly from ICT. Moreover, the Community should exploit the new democratic opportunities of digital networks and introduce internet-based referenda; this is not to suggest the introduction of a spontaneous political snapshot. Rather, both ICT and the internet make it possible to indeed pose the same question at least twice (say at the beginning and the end of a three-month-period) to the electorate and thereby generate a solid political feedback mechanism which could help to combine a more efficient government with a new digital invisible hand mechanism in the market place.

The global expansion of ICT and particularly of the internet is not without risks. In a political perspective, the internet creates a global public for certain issues. Conflicts which would have remained regional in the 18th or 19th century could quickly expand to a global scale if the respective issue becomes a priority theme in the internet. Speeches of politicians, business leaders or religious leaders that would have received only national attention a century ago – being thus imbedded in a well-known cultural context – will receive global attention in the future in many cases. With information/words absorbed in a

heterogeneous global cultural context, the risks of (intended and unintended) misunderstandings are increasing. Thus there is an additional source of conflict with respect to a potential clash of civilizations. This calls for more careful communication policies on the part of politicians and business leaders as well as religious leaders.

From an EU perspective, ICT is quite important not only in economic terms but also in political terms. The internet – as well as mobile communications – allow for the creation of integration in a new manner from below. Digital flexible networking should thus be encouraged through not only adequate infrastructure policies in EU countries, but also through an active digital integration policy by the Commission and the European Council. Making the diversity of the Community more visible and encouraging creative and innovative actors from various member countries to flexibly cooperate through modern networks should be an essential goal of the EU. Finally, considering the opportunities of cooperation among integration areas (e.g., Mercosur, Asean or Nafta), digital global networks create new options not only for policymakers but for cooperation among civil societies as well.

Appendix: Modified Dornbusch-Model (Welfens 2006)

As regards the logarithmic formulation of aggregate demand ($\ln Y^d$) it is not easy to reconcile the commonly used formulation (e.g. GÄRTNER, 1997) $\ln Y^d = a\ln q^* + a'\ln Y + a''\ln G$ (the parameters a, a', a'' all are positive) with the standard expression of the uses side of GDP: $Y = C + I + G + X - q^*J$ where C is consumption, I investment, X exports and J imports (τ is the tax rate, v product innovations, * for foreign variable). One may, however, consider a consistent setup where $C = cY(1-\tau)$, $G=\gamma Y$, $I=\lambda Y$; and $\lambda=\lambda(\ln q^*, \gamma, \ln v, \tau)$, the net export function is $X' = x'(\ln[eP^*/P], \ln Y, \ln Y^*, \ln v)Y^*$; we then will use the function $\ln x'(\ldots)$. The investment output ratio λ is assumed to be a positive function of the real exchange rate as we follow FROOT/STEIN (1991), who argue that in a world with imperfect capital markets, foreign firms will find it easier to take over companies in country I (host country) since a real depreciation of country I's currency will increase equity capital expressed in terms of the potential host country so that leveraged international takeover will become easier; hence we assume that the overall investment-GDP ratio is a positive function of the real exchange rate eP^*/P (or $\ln q^*$); the partial derivative of λ with respect to $\ln q^*$ therefore is positive ($\psi''>0$). With respect to the government expenditure-GDP ratio, γ the partial derivative ω is ambiguous (will be positive if a rise of γ mainly falls on investment goods), with respect to product innovations v the partial derivate is positive ($\eta>0$), and with respect to the income tax rate it is negative (in absolute term ω'). We also define $1+\omega=:\omega''$. Furthermore, we assume that $\ln x'$ is a function of all the four arguments shown in the function $x(\ldots)$. Thus we can write a consistent version of the aggregate demand side:

(2') $Y^d\{1- c[1-\tau] - \gamma - \lambda(\ln q^*, \gamma, \ln v, \tau)\}= x'(\ldots)Y^*$

Assuming for simplicity that $c[1-\tau]+\gamma+\lambda$ is rather small so that we can use the approximization $\ln(1+z)\approx z$, we can rewrite the equation as:

(2'') $\ln Y^d - c[1-\tau] - \gamma - \lambda(\ln q^*, \gamma, \ln v, \tau) =$

$=\{\ln x'(\ln q^*, \ln Y, \ln Y^*, \ln v)\}+ \ln Y^*$

Using linearized functions $\lambda(\ldots)$, $\ln x'(\ldots)$ we can write – with three positive derivatives $\partial\ln x'/\partial\ln q^*=:\psi''$, $\partial\ln x'/\partial\ln Y^* =:\Omega'$, $\partial\ln x'/\partial\ln v =:\eta'$and $\partial\ln x'/\partial\ln Y=: -\Omega<0$ – the equation as follows:

(2''') $\ln Y^d= c -c\tau + \gamma + \psi''\ln(\ln e-\ln P) + \omega\gamma + \eta\ln v$

$+\omega'\tau + \{\psi(\ln e-\ln P) -\Omega\ln Y + \Omega'\ln Y^* +\eta'\ln v\} + \ln Y^*$

This then leads to subsequent equation (2) where $\psi'=: \psi''+\psi$, $\eta''=\eta+\eta'$ and $\Omega^*=1+ \Omega'$; we also define $1+\omega=:\omega''$.

The money market is characterized (with φ denoting the income elasticity of the demand for money, $\sigma'$the interest semi-elasticity and e' the Euler number) by nominal money demand $M^d= PY^{\varphi} e'^{-\sigma' i}$ which implies for equilibrium $\ln M = \ln P + \varphi\ln Y - \sigma' i$. While money market equilibrium is fairly standard, the subsequent capital market equilibrium condition is rather unusual as it modifies the interest rate parity condition by taking into account portfolio-theoretical considerations relevant in a setup with foreign direct investment – the latter is not considered in the Dornbusch model. Note that an

alternative way to express the aggregate demand in a logarithmically-stated function is based – with j denoting the import –output ratio (imports J=jY) - on $Y^d([1-c-\gamma-\lambda(\ldots)+q^*j(lnq^*)] = x(lnY, lnq^*, lnv^*)Y^*$ where we have assumed in the spirit of the gravity equation that exports are not only a positive function of real income abroad but of domestic real output or actually of lnY as well (in an empirical context the assumption that $c+\gamma+\lambda-j$ is close to zero is more convincing than assuming that $c+\gamma+\lambda$ is close to zero). Some key equations in the modified Dornbusch model are:

(A1) $dlnP/dt = \pi'[\psi' (lne - lne\#) - \psi'(lnP-lnP\#)]$

(A2) $lne - lne\# = (lnP\# - lnP)/[\theta\sigma'] -(\zeta/\theta) [\beta Y\#/K\# - Y^*_K\#)$

If we assume that the foreign marginal product of capital is equal to the domestic marginal product we get:

(A3) $dlnP/dt = - \pi'(\psi'/\sigma'\theta + \psi') (lnP - lnP\#) = -\alpha''(lnP - lnP\#)$.

Here we have simply defined $\pi'(\psi'/\sigma'\theta + \psi')= \alpha''$; the parameter α'' is crucial subsequently. The above equation is (setting P#=1) a homogeneous differential equation of first order and has the solution

(A4) $lnP(t) = C_0\, e'^{-\alpha''t}$

This implies (having solved for C_0 by considering t=0):

(A5) $lnP(t)= lnP\# + (lnP(0) - lnP\#) e'^{-\alpha''t}$

Note that

(A6) $lne(t) = lne\# +[\theta\sigma']^{-1} (lnP\# - lnP) e'^{-\alpha''t}$

Thus we can state

(A7) $lne(t) = lne\# + (lne(0) - lne\#) e'^{-\alpha''t}$

The adjustment speed for the exchange rate variable is therefore the same as for the price level. Obviously, the adjustment speed α'' is faster the higher π' and ψ' are (i.e., the faster goods market react to excess demand and the stronger trade and (foreign direct) investment react to the real exchange rate). The lower the semi-interest elasticity of the demand for money (σ) and the slower the foreign exchange market reacts to divergences between the long run equilibrium value and the current exchange rate (parameter θ), the faster the adjustment process of the price level towards the equilibrium price level. However, we have seen that low parameters θ and σ' imply a large overshooting in case of a monetary supply shock so that these two parameters are ambivalent. If they are low, the overshooting effect will be large, but adjustment to the new equilibrium value will be fast. Foreign direct investment raises the adjustment speed.

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