

UNIVERSITY OF WUPPERTAL  
BERGISCHE UNIVERSITÄT WUPPERTAL

EUROPÄISCHE WIRTSCHAFT  
UND  
INTERNATIONALE MAKROÖKONOMIK



Andre Jungmittag  
Paul J.J. Welfens

**Telecommunications Dynamic, Output and Employment**

Diskussionsbeitrag 195  
Discussion Paper 195

*Europäische Wirtschaft und Internationale Wirtschaftsbeziehungen*  
*European Economy and International Economic Relations*

ISSN 1430-5445







Andre Jungmittag  
Paul J.J. Welfens

**Telecommunications Dynamics, Output and Employment**

September 2013

*Herausgeber/Editor: Prof. Dr. Paul J.J. Welfens, Jean Monnet Chair in European Economic Integration*

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@eiiw.uni-wuppertal.de](mailto:welfens@eiiw.uni-wuppertal.de)

[www.eiiw.eu](http://www.eiiw.eu)

JEL classification: E0, L96, O0

Keywords: Telecommunications, Employment, Growth, Knowledge Society, Regulation



**Summary:** In EU countries, opening up of telecommunications markets and regulations have helped to reduce the price of digital services which is an important quasiinput factor in all firms. Integrating the use of telecommunications in a macroeconomic production function is the analytical starting point for our interdependent analysis of output, use of telecommunications and employment. Based on unit root and co-integration analysis as well as an error correction three-equation model which is estimated simultaneously, we present results both on long run links and short run links between telecommunications, output and employment. Considering various scenarios suggests that a fall in the relative price of telecommunications can generate a cumulated employment increase of 760,000 within seven years in Germany. The institutional setup for regulating telecommunications could be improved in Germany and other EU countries; investor-friendly regulation is required.

**Zusammenfassung:** In den EU-Ländern haben die Öffnung der Telekommunikationsmärkte sowie Regulierungen zu einem Rückgang der Preise für digitale Dienstleistungen beigetragen, die einen wichtigen Quasi-Faktoreinsatz in allen Unternehmen darstellen. Die Einbeziehung der Verwendung der Telekommunikation in die makroökonomische Produktionsfunktion ist der analytische Ausgangspunkt für unsere unabhängige Analyse des Outputs, der Telekommunikationsverwendung und der Beschäftigung. Auf der Grundlage der Einheitswurzel und der Kointegrationsanalyse sowie des Drei-Gleichungsfehlerkorrekturmodells, das simultan geschätzt wurde, präsentieren wir Ergebnisse hinsichtlich sowohl der langfristigen als auch kurzfristigen Verbindungen zwischen Telekommunikationen, Output und Beschäftigung. Unter Berücksichtigung verschiedener Szenarien lässt sich schließen, dass ein Rückgang der relativen Telekommunikationspreise einen kumulierten Beschäftigungsanstieg von 760.000 innerhalb von sieben Jahren in Deutschland bewirken kann. Der institutionelle Aufbau zur Regulierung der Telekommunikation könnte sich in Deutschland und in anderen EU-Ländern verbessern lassen; eine investorfremdliche Regulierung ist erforderlich.





*Prof. Dr. Paul J.J. Welfens, Jean Monnet Chair for European Economic Integration, European Institute for International Economic Relations (EIIW) at the University of Wuppertal, Rainer-Gruenter-Str. 21, D-42119 Wuppertal, Phone: +49-202-4391371, Fax: +49-202-4391377*

[welfens@eiiw.uni-wuppertal.de](mailto:welfens@eiiw.uni-wuppertal.de), [www.eiiw.eu](http://www.eiiw.eu)

*Andre Jungmittag, BFB 3: Buisness and Law, University of Applied Sciences Frankfurt am Main, Nibelungenplatz 1, 60318 Frankfurt am Main, Germany*

[jungmitt@fb3.fh-frankfurt.de](mailto:jungmitt@fb3.fh-frankfurt.de)

## **Telecommunications Dynamics, Output and Employment**

Discussion Paper 195

### **Table of Contents**

<b>Table of Contents</b> .....	<b>I</b>
<b>List of Tables</b> .....	<b>II</b>
<b>List of Figures</b> .....	<b>II</b>
<b>1. Introduction</b> .....	<b>1</b>
<b>2. Telecommunications, employment and output: model and emperical analysis</b> ...	<b>3</b>
2.1 Estimation of the long run relationships.....	4
2.2 Estimation of the dynamic simultaneous error correction model.....	6
2.3 Selected scenarios.....	7
<b>3. Policy Implications</b> .....	<b>13</b>
<b>References</b> .....	<b>16</b>

## List of Tables

Table 1: Results of the ex ante simulations (percentage growth rate of the endogenous variables) .....	12
Table 2: Employment effects in alternative ex-ante simulations (absolute derivations from scenario 3: <i>PTEL</i> constant) .....	13

## List of Figures

Fig. 1: Dynamic ex post forecasts and simulations (scenario 1) for the endogenous variables .....	9
Fig. 2: Scenario 2: Effects of a permanent cut in <i>PTEL</i> by 20 % (percentage deviations from dynamic ex post forecasts) .....	9

# 1. Introduction

Economic developments and innovations are influenced by the interplay of competition and technological dynamics. The growth of information and communication technology (ICT) has strongly contributed to investment and growth in the US and many EU countries (e.g. Audretsch and Welfens 2002). There is considerable evidence that telecommunications and the use of ICT, respectively, are drivers of economic growth (Röller and Waverman 2001; Zhen-Wei Qiang and Pitt 2003); as regards the long term diffusion of the internet in turn is linked to growth of real income and other variables (Andres et al. 2010) However, so far there is no clear evidence on the links between the use of telecommunications, regulation - and the effects of competition on relative prices - and the demand for labour. The following analysis gives a first empirical analysis on these dynamics for the case of Germany and the results for the EU's biggest economy certainly are quite interesting with respect for the broader e-communication approach adopted by the European Commission.

The European Commission has emphasized in its policies and particularly in its Lisbon Agenda of 2000 that developing a dynamic EU knowledge society in which information is a distinct element of the production function will be important; telecommunications services are relevant in this perspective. The EU has opened up telecommunications markets in 1998 and thus reinforced competition in this sector. In a more general approach the theoretical and empirical analysis of Bayoumi et al. (2004) indicates that Europe would benefit from more competition, and more competition in network industries including telecommunications is of key importance here. More intensive competition in telecommunications which is capital intensive could help in enjoying efficiency gains in investment, but it would also stimulate sector growth through network effects and would simultaneously reduce costs in sectors using telecommunications services as an input.

Telecommunications services are a key element of ICT. Innovative services help to reduce transaction costs and stimulate networking in the business community. Digital goods also offer many options for product differentiation. Falling relative prices generate additional demand. Volume growth, which partly benefits from network effects on the demand side – endogenous growth of demand –, in turn, raises investment needs. There is broad consensus that ICT production stimulated growth in the US and Europe in the 1990s, but growth accounting (Van Ark and Piatkowski 2004) also suggests that the use of telecommunications is important for output expansion in Europe, both in Eastern and in Western Europe.

Moreover, as information is an input in all sectors, the cheaper use of telecommunications and the launching of advanced digital services will stimulate output growth. From a macroeconomic perspective, one may argue that broader and faster communication networks including mobile telecommunications stimulates output growth through faster diffusion of knowledge. Indeed there is empirical evidence for Germany (Jungmittag and Welfens 1996) which shows that not only capital and labour inputs in addition to technology inputs - proxied by patents and real expenditures for imported licences - contribute to output growth, but the number of telecommunications calls does so as well. The authors estimate a long run production function for the period 1970–1990 for

Germany. Röller and Waverman (1996a; 1996b) and Canning (1999) have used telecommunications density as one of the inputs in explaining growth for a panel of countries in the period 1970–1990 and 1960–90, respectively. Other authors have also provided some empirical evidence on the link between telecommunications and growth (Cronin et al. 1993a; Cronin et al. 1993b; Karunaratne 1997; Meijers et al. 2008). An important issue in modern growth analysis is the explanation of technological progress, whereby a standard reference is Mankiw et al. (1992); more sophisticated approaches have been presented by several authors (Budd and Hobbis 1989a; 1989b; Coe and Moghadam 1993; Jungmittag and Welfens 1996; Jungmittag et al. 1999). Subsequent analysis is partly based on this work, in particular Jungmittag and Welfens 1996; Röller and Waverman 1996a and 1996b and Canning 1999. A dynamic, simultaneous, multi-equation approach for Germany is presented so that we can analyze the links between telecommunications, growth and employment; simulations can also be run. The basic idea is that telecommunications stands for diffusion of information which – at least partly – is an input in the aggregate production function; if the relative price of telecommunications (e-communications) is falling the amount of information used in the overall economy is rising. This will raise labor productivity and thus increase the demand for labor. Thus there is a dynamic interaction between the liberalization of telecommunications, output and employment; while the sectoral employment effects of liberalization of telecommunications might be neutral (read the employment effect in the telecommunications sector) the overall employment effect can be expected to be positive since information is an input in all sectors of the economy.

Based on unit-root analysis and cointegration analysis, we can analyze both long run dynamics and short-run dynamics. As a first step – based on cointegration analysis – we present a long run production function and demand functions for labour and telecommunication calls. In a second step, we present a simultaneous dynamic, three-equation model for the short run dynamics while taking into account the deviations from long run equilibrium values (error correction model). Basically the spirit of the model is neoclassical, which is in a similar vein as Hansen (1992, 1993); it, however, puts its focus on the interdependence between exogenous technological progress, innovation output indicators and telecommunication calls as a proxy for information and communication. As such, it explicitly considers technological progress.

From a theoretical perspective, it is clear that the relative price of telecommunications services determines the use of information as an input variable in the production process. Price dynamics in turn depend in the case of fixed line networks on regulatory policies. Price caps have been adopted in most EU countries after the start of EU-wide liberalization in 1998. In network industries, government can indeed affect investment and innovation in many ways as has become obvious in the context of the deregulation of fixed network telecommunications in the EU. RPI minus X has become a standard price cap approach in the regulation of telecommunications in many OECD countries. That is, regulation estimates sector productivity growth  $X$  and requires a bundle of services – basically the use of essential facilities by other operators – that the dominant firm must not exceed with its regulated basket of prices, the inflation rate (as measured by the retail price index) minus  $X$ . This is an incentive regulation since the firm can appropriate any profits stemming from productivity growth beyond  $X$ . These regulation-induced price reductions are in line with

the more general trend of falling relative prices in information and communication technology.

There is no doubt that technological progress in the production of ICT goods is high, which implies high productivity and output growth in the ICT producing sector. The high rate of technical progress in the ICT producing sector reduces the relative price of ICT investment goods and therefore stimulates accumulation of such investment goods. The relative price fell by about 8 % p.a. in the US and France in the period from 1970 to 1991. From 1991 to 1999, relative price fell by about 15 % in the US but only by about 10 % in France during the same period. In Germany, the producer prices of the OCM industry (OCM=office, computing and accounting machinery) fell by only 1.2 % p.a. in 1970–91 and 4.4 % p.a. in 1991–99 (Falk and Koebel 2004). This might partly explain the relatively modest IT-investment-GDP ratio in Germany as compared to leading EU countries and the US. In the US, the total stock of quality-adjusted computer equipment in constant prices increased with a growth rate of 20 % over several years with its peak of about 30 % p.a. in the 1990s (Jorgensen and Stiroh 2000; Jorgensen et al. (2002)).

In the following analysis we first present the modelling approach (Section 2) before we turn to the key policy conclusions which concern regulatory policies in telecommunications at both the national level and the EU level. At the bottom line, it can be shown that output, aggregate labour demand and the use of telecommunications are interdependent and that the institutional setup in the field of regulations can strongly influence the use of telecommunications. Given Germany's weakness in terms of output growth and employment dynamics, one may argue that careful regulation of telecommunications with clear emphasis on an institutional setting that gives incentives for digital innovations and investment is a key element for raising aggregate real income and employment.

## **2. Telecommunications, employment and output: model and empirical analysis<sup>1</sup>**

The model developed here carefully considers long term and short term interdependencies between aggregate output, employment and the use of telecommunications. As endogenous variables we consider real income ( $Y$ ; GDP in constant prices of 1995), the number of gainfully employed ( $L$ ) and the number of telecommunication calls ( $TC$ ), whereas data for the latter are based on data from Germany's Federal Statistical Office or from Deutsche Telekom AG. The number of telecommunication calls is considered to be an adequate indicator variable for the diffusion of digital information. While one might want to consider alternative indicator variables, it is clear that only the number of telecommunication calls is available over an extended period. With respect to future modern telecommunications services, one may raise doubts that the number of

---

<sup>1</sup> A comprehensive presentation of the methodology used and the empirical results can be found in Welfens et al. (2005), *Internet Economy 2010/Internetwirtschaft 2010*, Heidelberg: Springer (study for the German Ministry of Economics and Labor).

telecommunications calls is an ideal indicator since the increasing use of the internet protocol in data transmission and voice telephony (VOIP) suggests that the intensity of digital information exchange could be better covered by some other measure for data traffic. We use as exogenous variables the net capital stock ( $K$ ; in constant prices of 1995) as well as indices for nominal wage costs per capita ( $WAGE$ ) and the price index of GDP ( $PGDP$ ). Wage costs as well as the price for telecommunications are considered relative to the GDP deflator with data being derived from the EU's AMECO data bank. Moreover, we use the "average stock of patents" at the German Patent Office as an exogenous indicator for the level of technology. The stock at year end is defined as:  
 stock at beginning of year + granted (basic) patents + granted additional patents - cancelled patents - lapsed patents<sup>2</sup>.

The average stock of patents is one-half the stock of patents in the previous year and the stock at the end of the current year. Using patents registered as an indicator of innovativeness can be justified on various grounds (Grupp 1997; Jungmittag 2002); it can be considered for a number of reasons as a superior indicator compared to R&D expenditures.

## 2.1 Estimation of the long run relationships

Before the estimation of the long-term relations, we checked whether the considered time series are integrated by the order of 1 (i.e., the series are characterised by unit roots) or whether they follow deterministic trends by ADF tests. The null hypothesis of a unit root cannot be rejected for any of the seven variables. For the first differences ( $\Delta$  is the differences operator), the null hypothesis must be rejected at a significance of at least 1 %. So, it can be concluded that all individual time series are I(1).

The estimation of the long-term production function for Germany from 1960 until 2000 is based on a Cobb-Douglas function, augmented by the number of telephone calls and the patent stock:

$$Y_t = A \cdot K_t^\alpha \cdot L_t^\beta \cdot TC_t^\gamma \cdot PAT_t^\delta, \quad (1)$$

where  $Y_t$  represents the output,  $K_t$  the capital stock,  $L_t$  labour,  $TC_t$  the number of telephone calls and  $PAT_t$  the stock of patents granted at the German Patent Office. The parameters  $\alpha$  and  $\beta$  represent the partial production elasticities of capital and labour. Furthermore, the interplay of  $A$ ,  $TC_t$  and  $PAT_t$  can be interpreted as a technical progress function, explaining the increase of efficiency. The efficiency parameter  $A$  measures exogenous technical progress, while the indicator variables  $TC_t$  raised to the power  $\gamma$  and  $PAT_t$  raised to the power  $\delta$  measure the degree of efficiency due to knowledge diffusion and the stock of results from research and development activities (innovations). In logarithmic form the production function can be written as

---

<sup>2</sup> The patent data from 1963 to 2001 were taken from the Statistical Yearbook of the Federal Statistics Office and from the „Blatt für Patent-, Muster- und Zeichenwesen“. The previous non-available values were calculated on the basis of a linear trend estimate.

$$y_t = a + \alpha \cdot k_t + \beta \cdot l_t + \gamma \cdot tc_t + \delta \cdot pat_t, \quad (2)$$

with lower case letters denoting logarithms.

For the OLS estimation, the production function was supplemented by some dummy variables and a stochastic error term  $u_{1t}$ . The first three dummy variables are *DOC*, which captures the shock due to the first oil price crisis, and *D80* as well as *D81*, which capture a structural break starting in 1980 and reinforcing in 1981 following the second oil price crisis. Furthermore, a dummy variable *DGU* is added to catch the effects of German unification, and *D99* for a renewed structural break subsequent to 1999. Then, we get the following long-term production function for Germany from 1960 to 2000:

$$y_t = -0,590 + 0,620 k_t + 0,867 l_t + 0,095 pat_t + 0,119 tc_t - 0,019 DOC - 0,040 D80 \\ - 0,029 D81 - 0,192 DGU - 0,039 D99 + u_{1t} \\ R_{adj.}^2 = 0,999 \quad DW = 1,864 \quad EG = -6,558 \quad (3)$$

The  $t$ -values shown in brackets are only for information and cannot be used for statistical inferences about the significance of the individual variables, because the OLS estimates of the cointegration parameters are generally not normally-distributed. However, the adjusted  $R^2$  of 0,999 indicates a very good fitting of the model to the observed data. The *DW* statistics suggest that there is no first order autocorrelation. Furthermore, the null hypothesis of no cointegration relation of the *EG* test can be rejected a significance level of 1 %, indicating that this equation can be interpreted as a long-term production function. The magnitudes of the coefficients of the indicator variables for the innovation output and the use of information and communication as well verify that the factors approximated by the indicator variables make contributions to real GDP that cannot be neglected. In a long-term view, output grows by roughly 0.1 % if the patent stock increases by 1 %, and by roughly 0.12 % if the effects captured by telephone calls increase by 1 %.

For the specification of the long-term labour demand function, we use a standard formulation whereby the number of persons employed depends on real GDP, real labour costs per person employed and a time trend (cf. e.g. Hansen 1992 and 1993). Including the already mentioned dummy variables and an error term  $u_{2t}$ , the OLS estimation for the logarithmic form yields:

$$l_t = -4,429 + 0,719 y_t - 0,482 \ln((WAGE_t / PGDP_t) * 100) - 0,007 t + 0,021 DOC + 0,030 D80 \\ + 0,182 DGU + 0,015 D99 + u_{2t} \\ R_{adj.}^2 = 0,997 \quad DW = 0,931 \quad EG = -3,442 \quad (4)$$

The adjusted  $R^2$  indicates a very good fitting for this model as well. Furthermore, based on the *EG* statistic it can be concluded at a significance level of 5 % that the employment demand function is also a cointegration relation. As expected, real GDP has a positive impact on employment, while the influence of real wages is negative. The negative sign of the trend coefficient is in accordance with other estimations of labour demand functions for Germany (cf. again Hansen 1992 and 1993).

We also used a standard specification of a demand function for the long-term demand for telephone calls, with the number of telephone calls depending positively on income and negatively on the real price of telecommunication services. Again after the inclusion of some dummy variables and an error term  $u_{3t}$ , OLS estimation of the logarithmic form gives:

$$\begin{aligned}
 tc_t = & -18,267 + 2,095 y_t - 0,216 \ln((PTEL_t / PGDP_t) * 100) + 0,136 D81 - 0,190 DGU \\
 & \quad (-12,03) \quad (28,98) \quad (-1,80) \quad (2,85) \quad (-6,44) \\
 & + 0,128 D99 + u_{3t} \\
 & \quad (2,49) \\
 R_{adj.}^2 = & 0,996 \quad DW = 1,031 \quad EG = -4,118 .
 \end{aligned} \tag{5}$$

The explanatory power of this equation is also very high. Moreover, the EG statistics show a cointegration relation at a significance level of 1 %. The high income elasticity of the demand for telephone calls is especially conspicuous. If real income grows by 1 %, the demand for telephone calls increases by roughly 2.1 %. Furthermore, the positive sign of the dummy variable D99 shows that telecommunication liberalisation has positive effects on demand, which go beyond a pure price effect.

## 2.2 Estimation of the dynamic simultaneous error correction model

Subsequent to the determination of economically well-founded long-term relationships, a dynamic simultaneous-equations model was specified, which, on the one hand, captures short-term dynamics, and, on the other hand, includes error correction terms to take the long-term relations into account. Therefore, each equation for the first differences of the endogenous variables – real GDP, number of persons employed and number of telephone calls – contains deviations from the long-term equilibrium relationships lagged for one year in addition to the – partly lagged – first differences of the explanatory variables (i.e., the lagged residuals of the respective cointegration relation). Three-step least squares is applied to estimate the simultaneous-equations model subject to all available information. This gives the following model, which forms the basis for the further analyses and simulations:

Production function:

$$\begin{aligned}
 \Delta y_t = & 0,002 - 0,864 ecm_{t-1}^y + 0,346 \Delta y_{t-1} + 0,448 \Delta k_t + 0,317 \Delta l_t \\
 & \quad (0,42) \quad (-2,61) \quad (1,86) \quad (1,98) \quad (3,43) \\
 & - 0,164 \Delta l_{t-1} + v_{1t} \\
 & \quad (-1,63) \\
 R_{adj.}^2 = & 0,753 \quad DW = 1,864
 \end{aligned} \tag{6}$$

Labour demand:

$$\begin{aligned}
 \Delta l_t = & -0,008 - 0,312 ecm_{t-1}^l - 0,101 \Delta l_{t-1} - 0,513 \Delta \ln((WAGE_t / PGDP_t) * 100) + \\
 & \quad (-2,84) \quad (-2,16) \quad (-2,33) \quad (-3,72) \\
 & 0,538 \Delta y_t + 0,256 \Delta y_{t-1} + 0,020 \Delta D80 + 0,198 \Delta DGU + v_{2t} \\
 & \quad (3,597) \quad (3,02) \quad (2,93) \quad (7,05) \\
 R_{adj.}^2 = & 0,978 \quad DW = 1,289
 \end{aligned} \tag{7}$$



Demand for telephone calls:

$$\begin{aligned} \Delta tc_t = & 0,034 - 0,487 \text{ } ecm_{t-1}^{tc} + 0,311 \Delta tc_{t-1} + 0,522 \Delta y_t - 0,305 \Delta y_{t-1} \\ & (3,23) \quad (-4,20) \quad (2,62) \quad (3,12) \quad (-1,62) \\ & - 0,258 \ln((PTEL_t / PGDP_t) * 100) + v_{3t} \\ & (-2,76) \\ R_{adj.}^2 = & 0,476 \quad DW = 2,163 \end{aligned} \quad (8)$$

The fit of the equations of the error correction model to the observed data is also good, or for the demand function for telephone calls at least at the usual level. Furthermore, the error correction terms are in all three equations highly significantly different from zero, as the  $t$ -values within the brackets indicate, and they show a negative sign. Thus, there is actually an adjustment to their respective long-term equilibrium path. The explanatory variables in first differences, which capture the short-term dynamics, show the expected signs. In the production function, increases in the capital stock as well as in employment (the sum of the coefficients for the change of the number of persons employed is positive) also lead in the short run to an increase of GDP. Analogously, a rise in real GDP also leads in the short run to an increase of labour demand as well as an increase in the demand for telephone calls. Conversely, price variables (real wages and the real price for telecommunication services) also have negative effects on these respective equations in the short run. It is obvious that the indicator for the innovation output – the stock of patents – and the number of telephone calls as a proxy variable for the whole indication field for the use of information and communication (i.e., knowledge diffusion) mainly have long-term effects, since their first differences do not appear in the production function. However, this can be expected intuitively as well as from the viewpoint of economic theory (e.g., on the basis of new growth theory).

## 2.3 Selected scenarios

The dynamic, simultaneous macro model presented above can be used for ex-post analyses on the one hand and for ex-ante simulations on the other. The simplest form of an ex-post analysis (i.e., an analysis within the estimation period) is a dynamic ex-post forecast, which provides information about the dynamic properties of the model. For such a forecast, the historical values of the exogenous variables are used, but the values of lagged endogenous variables are taken from the previous forecasts. If there is already a stronger deviation between the actual and forecasted values of the endogenous variables at the beginning of the observation period or at a later point in time as well, the ex-post forecasts will drift apart more and more from the actual values over the whole further observation period, because these errors will multiply due to the dynamics taken into account. Then the model is unsuited for ex-ante forecasts as well as simulations.

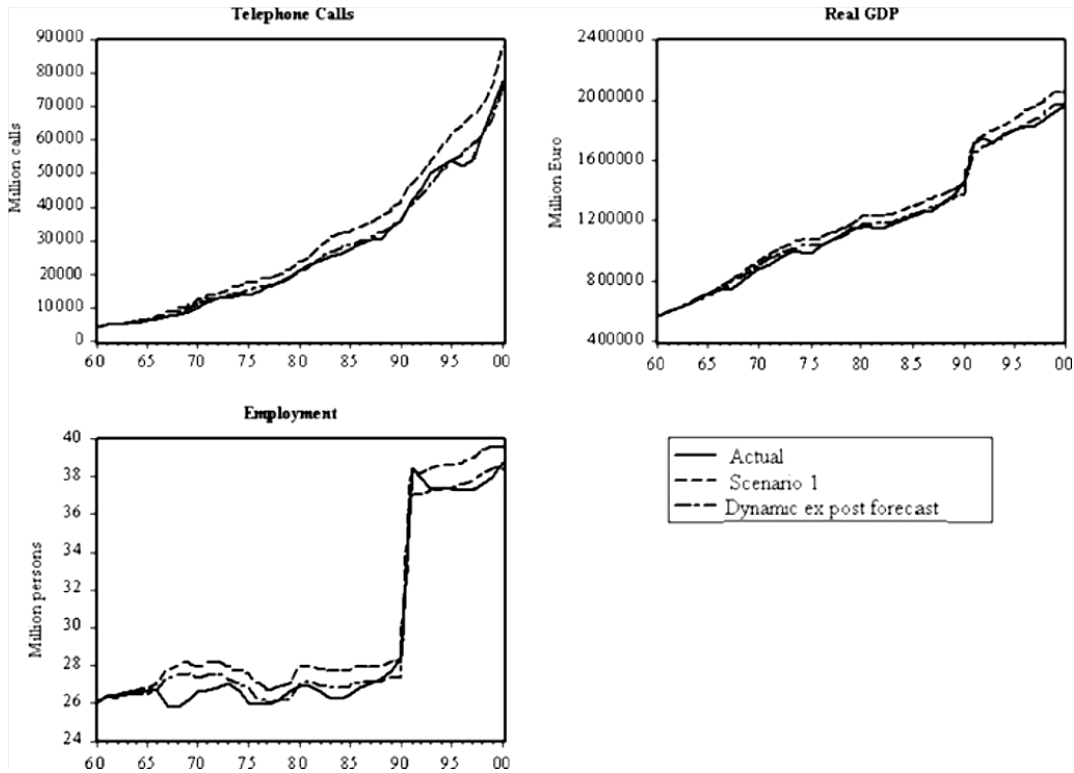
Scenario 1 From 1960 to 2000, the nominal price index for telecommunication services (PTEL) was permanently below 20 % of the actual values.

In addition to the ex-post forecast, a simple ex-post scenario was carried out, in which it is assumed that the nominal price index for telecommunication services (*PTEL*) from 1960 to 2000 was permanently below 20 % of the actual values. Figure 1 shows the development of the actual and forecasted values as well as the results from the simulation run. Comparing the actual values and the forecasts, there is clearly a very good fit for the telephone calls and real GDP, which points to the good dynamic properties of the model. Basically, the trend in development of employment is also reproduced adequately. However, temporary events like the first German crisis of 1967 and the fall of employment after German unification in the second and third quarter of the nineties are not recognized in this variable. Scenario 1 shows that permanently lower telecommunications costs would have been an important impulse for higher real income and more employment.

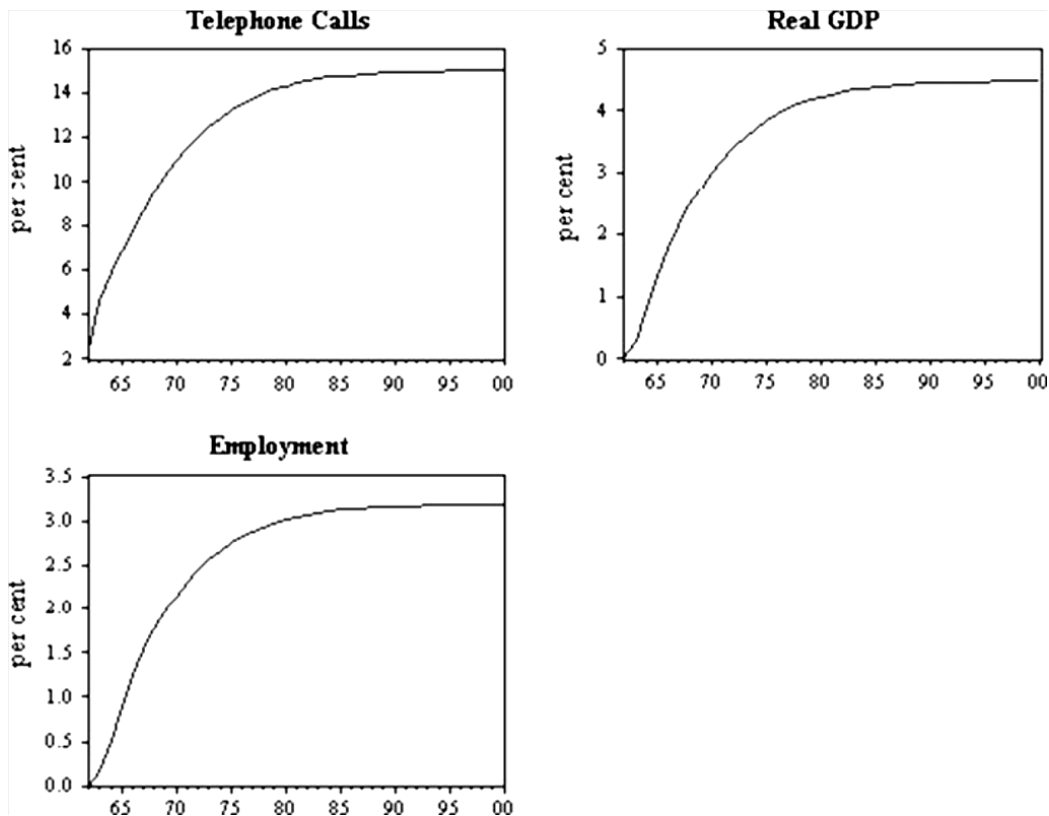
Figure 2 shows the percentage deviations between the dynamic ex-post forecasts and scenario 1. According to that, a permanent decrease of the price for telecommunication services by 20 % leads to faster growth in the number of telephone calls, real GDP and employment in the early stages. However, this growth effect declines continually and converges towards zero, so that there is finally only a level effect, which is however considerable with respect to its magnitude. Since the mid-nineties, the number of telephone calls has been 15 % higher than for the dynamic ex-post forecasts, real GDP 4.47 % and the number of persons employed 3.18 %.

Ex-post simulations can lead to interesting conclusions for economic policy, and they show the magnitude of the effects of the measures of economic policy, but in the centre of the analysis is the simulation of alternative development paths for the future up through 2010. For not taking the assumptions on which the scenarios are based arbitrarily, expert opinions are used for their justification.

**Fig. 1: Dynamic ex post forecasts and simulations (scenario 1) for the endogenous variables**



**Fig. 2: Scenario 2: Effects of a permanent cut in *PTEL* by 20 % (percentage deviations from dynamic ex post forecasts)**



Five ex-ante scenarios were developed in this manner. For all these scenarios, we assume that the other exogenous variables follow rather conservative development paths based on their trend development within the last available 10 years (partly taking into account the forecasts for 2004 of DG II of the European Commission. Thus, the capital stock increased on average by 1.83 % from 1995 to 2004. This development was prolonged until 2010. We proceeded analogously for the wages, which grew on average yearly by 1.51 % from 1994 to 2003, and the price index of GDP, which increased yearly on average by 0.86 % from 1995 to 2004. Since the patent stock as a further exogenous variable shows no clear trend and stays roughly – after a clear decrease in the first half of the nineties – on the same level, we assume zero growth for this variable through 2010. Furthermore, the development of real GDP was exogenised for the years 2001 until 2003 in all ex-ante simulations, because the exogenous shocks in this period would lead to a clear overestimation of actual growth within a model immanent forecast – as in all other econometric models as well.

Based on these fundamental assumptions which hold for all ex-ante simulations, we have looked at the following scenarios based on expert opinions:

Scenario 2 The price index for telecommunications services (PTEL) increases by 2 % p.a. between 2003 and 2010.

The background for scenario 2 is that there was a slight increase in the price index for telecommunication services in 2002, for the first time since 1996. A continuation of this pessimistic trend is considered possible based on the following arguments:

Prices for user access are used to cross-subsidize digital services. It is true that pure transmission costs for telecommunications are falling, but the respective cost reductions are not fully passed on to the user. Rather there is a tendency to combine increased access prices with lower per minute or per bit prices. Thus one should not overlook that voice services – partly already based on the internet protocol (naturally in the case of UMTS) – have increasingly become a commodity while voice telephony remains the cash cow of leading operators.

Scenario 3 The price index for telecommunications (PTEL) stays at the level of 2002.

This scenario can be considered as a neutral point of reference: The nominal price stays constant but as there is a rise of the general price level, the real price of telecommunications falls by 0.86 % p.a.

Scenario 4 The price index for telecommunications (PTEL) will fall by 4 % p.a. in the period between 2003 and 2010.

This assumption seeks to extend the development observed since 1998 while ignoring the slight rise of telecommunications costs in 2002 (i.e., that is the price development of 2002 is considered as an irrelevant outlier). The argument for this scenario is basically the opening up of markets in local telecommunications (as of 2003). This should lead to intensified price competition which translates into falling prices for users. Hence the potential for cost reductions associated with new technologies (e.g., VOIP/internet-based telecommunications) is passed on to the user. This scenario also takes into account the potentially growing role of newcomers in telecommunications and the associated

intensification of price competition. Voice services will become a quasi-commodity once several players become active in the market. The rising role of mobile communications also puts pressure on operators in the fixed-line business.

The two other scenarios are not based on the assumption of an exogenous variable price index for telecommunications services but on exogenous pre-determined adjustment paths for the endogenous variable, 'number of telecommunications calls'. We are looking here at a pessimistic and an optimistic variant.

Scenario 5 The number of telecommunication calls (TC) increases by 3 % p.a. in the period from 2001 to 2010.

This rather pessimistic case assumes a rather modest rise in the number of calls. Arguments for such a scenario are based on the assumption that the use of both broadband access and of flat rate online offers are not taken up on a broad scale. Moreover, there are substitution effects in the sense that online users switch to broadband offers whereby pricing is often based on a flat rate. Such users – exploiting a flat rate – will not show up in the form of a rising number of calls.

Scenario 6 The number of telecommunication calls (TC) will rise by 7 % in the period from 2001 to 2010.

This optimistic scenario assumes that the number of telecommunication calls will rise strongly, including a rising number of online users. Broadband and flat-rate dynamics cannot keep pace with the fast growth of new online users. Hence a large number of online users will use the internet via a standard model or ISDN channels even in 2010. As a critical caveat, one should consider that a long run growth rate of 7 % is an extreme assumption as saturation processes are not taken into account (approaching a saturation point implies a decline of growth rates over time).

The results of the simulations for all ex-ante scenarios are shown in Table 1. We indicate the annual growth rates for the three endogenous variables of the model. As regards the number of telecommunication calls, the pessimistic and the relatively neutral scenarios for price dynamics of telecommunication services will only translate into either low or modest growth, approaching roughly the exogenous growth rate of 3 % after 2006/2007. The dynamics are different for the case of a fall of prices by 4 %. Over time there will be a strong increase in the number of calls with the growth rate reaching 5.6 % in 2010. However, even this strong fall in the telecommunications price does not translate into a similar case as the exogenously-given 7 % in the number of calls.

As regards the growth of the real GDP, all scenarios except for scenario 6 – meaning exogenous growth of calls by 7 % p.a. – amount to achieving a growth rate of 2 % in 2004. This figure is consistent with the projection of DGII of the European Commission which also foresees gains of 2 %. As regards the pessimistic and the relatively neutral scenario, the growth of real GDP would decline slightly up through 2007 but would thereafter increase until 2010 (not having achieved the growth rate for 2004). A different perspective holds in scenario 4. Here we can see that output growth dynamics at the end of the decade are slightly higher than in 2004 with an interim period of modest growth rate.

The scenarios with exogenous growth of telecommunication calls show that a growth rate of 3 % will not suffice in the long run to maintain the growth rate of 1.8 % in 2004. An

exogenous growth rate of calls by 7 % would result in higher growth which, however, would reduce in the second half of the decade. As a caveat, one should point out that such high growth rates are plausible only if the share in residential phone calls would rise over-proportionately, a case which is not unlikely given the enormous dynamics of mobile telecommunications. However, such a structural change would violate the implicit assumption of the model, namely that there is a constant ratio of residential calls to business calls. It also is noteworthy that the scenarios indicate that after a slight increase in the price of telecommunications services, there will be – after a slight employment growth in 2005 – slightly negative employment effects after 2006. A constant telecommunications price index implies a slight increase in employment, while a fall of the telecommunications price index corresponds with higher employment growth. A fall of the (relative) price index by 4 % p.a. would therefore translate into considerable cumulated employment growth: 200,000 by 2006; 450,000 by 2008 and 760,000 by 2010 (Table 2).

**Table 1: Results of the ex ante simulations (percentage growth rate of the endogenous variables)**

Scenario	2004	2005	2006	2007	2008	2009	2010
<b>Telephone calls</b>							
2. <i>PTEL</i> +2 % p. a.	0.4	1.5	2.5	2.8	2.8	2.6	2.6
3. <i>PTEL</i> konstant	1.1	2.1	3.2	3.6	3.6	3.5	3.6
4. <i>PTEL</i> -4 % p. a.	2.5	3.6	4.7	5.3	5.4	5.5	5.6
5. <i>TC</i> +3 % p. a.	3.0	3.0	3.0	3.0	3.0	3.0	3.0
6. <i>TC</i> +7 % p. a.	7.0	7.0	7.0	7.0	7.0	7.0	7.0
<b>Real GDP</b>							
2. <i>PTEL</i> +2 % p. a.	1.9	1.6	1.2	1.2	1.3	1.4	1.4
3. <i>PTEL</i> konstant	2.0	1.7	1.4	1.4	1.5	1.6	1.7
4. <i>PTEL</i> -4 % p. a.	2.1	2.0	1.8	1.9	2.0	2.2	2.3
5. <i>TC</i> +3 % p. a.	1.8	1.8	1.6	1.6	1.5	1.6	1.5
6. <i>TC</i> +7 % p. a.	3.2	3.5	3.2	3.0	2.9	2.8	2.8
<b>Employment</b>							
2. <i>PTEL</i> +2 % p. a.	0.0	0.2	-0.1	-0.2	-0.1	-0.1	0.0
3. <i>PTEL</i> konstant	0.0	0.3	0.0	0.0	0.0	0.1	0.2
4. <i>PTEL</i> -4 % p. a.	0.1	0.5	0.3	0.3	0.4	0.5	0.6
5. <i>TC</i> +3 % p. a.	-0.1	0.3	0.1	0.1	0.1	0.1	0.1
6. <i>TC</i> +7 % p. a.	0.7	1.5	1.3	1.2	1.1	1.0	1.0

**Table 2: Employment effects in alternative ex-ante simulations (absolute derivations from scenario 3: *PTEL* constant)**

Scenario	2004	2005	2006	2007	2008	2009	2010
Employment (in mill. Persons)							
2. <i>PTEL</i> +2 % p. a.	-0.01	-0.05	-0.10	-0.15	-0.22	-0.29	-0.36
4. <i>PTEL</i> -4 % p. a.	0.03	0.10	0.20	0.32	0.45	0.60	0.76
5. <i>TC</i> +3 % p. a.	-0.04	-0.05	0.00	0.05	0.06	0.03	-0.01
6. <i>TC</i> +7 % p. a.	0.25	0.72	1.24	1.71	2.12	2.47	2.79

### 3. Policy Implications

The empirical analysis suggests that a long run fall of the telecommunications prices will stimulate the use of information as an input in the production function and hence stimulate the diffusion process. At the bottom line, one may expect higher output and higher employment which would be important not only for Germany but for other OECD countries with high unemployment as well. From this perspective, it is important to focus on key issues in the regulation of telecommunications. Sustained competition can be expected to bring about both static and dynamic efficiency gains. However, the dominant position of the incumbent telecommunications operator, the former national monopoly operator, raises some doubts about the viability of competition (Welfens 2003; 2005; Knieps and Vogelsang 2007). While it is true that regulators in some countries (e.g., Germany and Austria) have introduced preselection options as a means to open up competition in fixed line telephony in the late 1990s, it also is true that the incumbent operators have reacted. By offering bundled services, incumbent operators have tried to shift market power from the local access market in which they strongly dominate towards other market segments such as long distance calls and international calls. At the same time broadband technology is expanding in the US and Europe so that the quality of digital services will improve while relative prices could continue to fall; fixed-mobile substitution and the high growth rate in the use of smart mobile phones also will contribute to falling relative prices for basic communication services. From the perspective of the macroeconomic production function one should emphasize that only part of the digital services provided stand for factor inputs; a considerable share has to be classified as household consumption.

Market opening up – as required by the European Commission – and privatization of the respective incumbent operator in most EU countries have stimulated the expansion of fixed network telecommunications services. Fixed-line telecommunications indeed should be regulated to the extent that newcomers in the market face the problem that the incumbent operator can get access to customers only through its local network; only in countries or regions with cable TV as an alternative network one may consider competition problems as

rather small – e.g. the case of the Netherlands. The regulator should make sure that there is reasonable access to the network of the incumbent operator and that prices for the respective services are based on long run costs. Adequate bottleneck regulation (i.e., cost-oriented regulation of essential facilities) is crucial for sustained competition in all network sectors in which falling average and marginal costs are combined with a considerable role of sunk costs (The latter impair market entry and thus reduce prospects for potential competition). As local access prices have increased in 2004 for the first time in the post-1998 market in Germany, there is evidence that there might be no sustained fall in the price of telecommunications services.

It will remain an important challenge for the regulator that sustained competition be enforced and that digital innovation dynamics be reinforced (Welfens and Weske 2006). The tendency of product bundling which has gained importance after a first liberalization stage makes market entry for new firms more costly and more risky so that potential competition is losing significance. At the same time there is a doubtful tendency of the German regulator to inflate the number of prices which are subject to ex-ante regulation. From a theoretical perspective, one should only have strict ex-ante price regulation in the field of essential facilities. All other areas should be fully liberalized. There is, however, the problem that the bundling of various services – those which are regulated and those which have not been regulated so far – raises difficult problems for the regulator. To the extent that bundling is considered a normal element of competition (hence the type of bundling indeed could have occurred under competition), the regulator should not impair bundling. Yet there is an issue when the dominant operator uses high profits from the regulated markets to cross-subsidize non-regulated other digital services markets. Predatory pricing and dumping thus could be temporary problems.

Regulatory institutions and rules matter for economic policy and for investors. The EU has established a rather consistent framework regulation which imposes broad guidelines for various sub-markets in fixed-line telephony. National regulators still have considerable autonomy and have pursued different approaches in digital regulation which to some extent reflect national policy preferences, size of the market and willingness to accept market forces in a field where there is still a role for universal services. In the case of the telecommunications sector, it is important that the regulator not impose artificial costs/risks on market actors, since a rise in services prices would follow. The regulator should indeed limit itself to a strict bottleneck regulation and not impose restrictions which undermine the incentive for market entry on the part of domestic or foreign newcomers.

Even if the regulator adopts an efficiency-enhancing regulatory policy, positive employment effects require complementary institutional elements. As regards the link between output dynamics and employment, it is well known that labour markets in Germany and some other EU countries are relatively inflexible. If fear of accelerated structural change should encourage trade unions to even more strongly emphasize the protection of insiders in collective bargaining, the link between potential output growth and employment growth could weaken. It is obvious that modern digital technology offers a broad array of new options for organizing research & development, production, financing and marketing more flexibly, but more flexibility will require organizational changes in most firms. If resistance against such organizational learning is high, the potential benefits



of accelerated diffusion in the digital economy cannot be reaped. Measures which further tighten adjustment options in the labour market are inadequate.

Finally, one may notice that the digitization of the economy creates new opportunities for both digital international trade and for new forms of digital international outsourcing. To the extent that cheaper international telecommunications calls as well as the internet mainly stimulate trade in Europe, one should not anticipate new complications for countries with employment problems. However, if digitization should stimulate net foreign direct investment outflows, the combination of a slowdown in capital accumulation in the source country and the faster international diffusion of knowledge could impair high wage countries' prospects for positive output and employment effects from falling (national and international) telecommunications prices.

## References

- ANDRES, L.; CUBERES, D.; DIOUF, M.; SEREBRISKY, T. (2010), The diffusion of the internet: a cross-country analysis. *Telecommunications Policy* 34:323-340.
- AUDRETSCH, D.; WELFENS, P.J.J. (eds) (2002), *The new economy and economic growth in Europe and the US*. Springer, Heidelberg and New York.
- BAYOUMI, T.; LAXTON, D.; PESENTI, P. (2004), Benefits and spillovers of greater competition in Europe: a macroeconomic assessment, Federal Reserve Bank of New York Staff Paper No. 182, New York.
- BUDD, A.; HOBBS, S. (1989), Output growth and measure of technology, Discussion paper, London Business School Centre for Economic Forecasting, July 1989.
- BUDD, A.; HOBBS, S. (1989a), Cointegration, technology and the long-run production function, Discussion paper, London Business School Centre for Economic Forecasting, July 1989.
- CANNING, D. (1999), Telecommunications and aggregate output, CAER II Discussion Paper No. 56, Harvard Institute for International Development, Cambridge, MA.
- COE, D.T.; MOGHADAM, R. (1993), Capital and trade as engines of growth in France. *IMF Staff Pap* 40:542–566.
- CRONIN, F.J.; COLLERAN, E.K.; HERBERT, P.L. et al (1993a), Telecommunications and growth: the contribution of telecommunications infrastructure investment to aggregate and sectoral productivity. In: *Telecommunications policy.*, pp 677–690.
- CRONIN, F.J.; PARKER, E.B.; COLLERAN, E.K. et al (1993b), Telecommunications infrastructure investment and economic development. In: *Telecommunications policy.*, pp 415–430.
- FALK, M.; KOEBEL, B.M. (2004), The impact of office machinery, and computer capital of the demand for heterogeneous labour. *J Labour Econ* 11(2004):99–117.
- GRUPP, H. (1997), *Measurement and explanation of technological change/messung und erklärung des technischen Wandels*, Berlin.
- HANSEN, G. (1992), Macroeconomic modelling: an update/makroökonomische modellierung heute. *RWIMitteilungen* 43:287–300.
- HANSEN, G. (1993), *Quantitative economic analysis/quantitative Wirtschaftsforschung*, Munich.
- JORGENSEN, D.W.; STIROH, K. (2000), Raising the speed limit: U.S. economic growth in the information age, *Brookings Papers on Economic Activity* (2000), U.S. economic growth and development at industry level, *American Economic Review*, Vol. 90, No. 2.
- JORGENSEN, D.W.; HO, M.S.; STIROH, K.J. (2002), *Growth of US Industries and Investments in Information Technology and Higher Education*, Harvard University, mimeo.
- JUNGMITTAG, A. (2002), Innovation dynamics in the EU: Convergence or divergence—A cross-country panel data analysis, Paper presented at the international conference, Dynamics, Economic Growth, and International Trade, VII (DEGIT-VII) in Cologne, May 24–25, 2002, Discussion Paper No. 96, EIIW.
- JUNGMITTAG, A.; WELFENS, P.J.J. (1996), Telecommunications, Innovation and the Long-term Production Function/Telekommunikation, Innovation und die langfristige Produktionsfunktion: Theoretische Aspekte und eine Kointegrationsanalyse für die Bundesrepublik Deutschland, .Discussion Paper No. 20, Europäisches Institut für internationale Wirtschaftsbeziehungen (EIIW), University of Potsdam.

- JUNGMITTAG, A.; BLIND, K.; GRUPP, H. (1999), Innovation, standardisation and the long-term production function: A cointegration analysis for Germany 1960–1996, in: *Zeitschrift für Wirtschafts- und Sozialwissenschaften*, Vol. 119, 205–222.
- KARUNARATNE, N.D. (1997), High tech innovations, growth and trade dynamics in Australia. *Open Econ Rev* 8:151–170.
- KNIEPS, G.; VOGELSANG, I. (2007), Digital economy and regulatory issues. Introduction. *IEEP* 4:101–107.
- MANKIW, N.G.; ROMER, D.; WEIL, D.N. (1992), A contribution to the empirics of economic growth. *Q J Econ* 107:407–438.
- MEIJERS, H.; DACHS, B.; WELFENS, P.J.J. eds (2008), *Internationalization of European ICT Activities*, Heidelberg and New York: Springer; study for the European Commission/IPTS.
- RÖLLER, L.H.; WAVERMAN, L. (1996a), Telecommunications infrastructure and economic development: A simultaneous approach, WZB discussion paper FS IV 96–16.
- RÖLLER, L.H.; WAVERMAN, L. (1996b), The impact of telecommunications infrastructure on economic development, In: Howitt P (ed). *The implications of knowledge-based growth for micro-economic policies*, Calgary.
- RÖLLER, L.H.; WAVERMAN, L. (2001), Telecommunications infrastructure and economic development: a simultaneous approach. *Am Econ Rev* 91:909–923.
- VAN ARK, B.; PIATKOWSKI, M. (2004), Productivity, innovation and ICT in Old and New Europe. *IEEP* 1:215–246.
- WELFENS, P.J.J (2003), *Internet economics.net*, Heidelberg and New York.
- WELFENS, P.J.J; WESKE, M. (eds) (2006), *Digital economic dynamics, innovations, networks and regulations*. Springer, Heidelberg.
- WELFENS, P.J.J; ZOCHÉ, P.; JUNGMITTAG, A., et al (2005), *Internet Economy 2010/Internetwirtschaft 2010* (study for the German Ministry of Economic Affairs).
- ZHEN-WEI QIANG, C.; PITT, A. (2003), *Contribution of information and communication technologies to growth*. World Bank, Washington DC.

## EIIW Discussion Papers

### ISSN 1430-5445:

Standing orders (usually 13 issues or more p.a.): academic rate 95 Euro p.a.; normal rate 250 Euro p.a.

Single orders: academic rate 10 Euro per copy; normal rate 20 Euro per copy.

Die Zusammenfassungen der Beiträge finden Sie im Internet unter:

The abstracts of the publications can be found in the internet under:

<http://www.eiiw.eu>

- No. 100 **Gavrilencov, E.**: Macroeconomic Situation in Russia - Growth, Investment and Capital Flows, October 2002
- No. 101 **Agata, K.**: Internet, Economic Growth and Globalization, November 2002
- No. 102 **Blind, K.; Jungmittag, A.**: Ausländische Direktinvestitionen, Importe und Innovationen im Dienstleistungsgewerbe, February 2003
- No. 103 **Welfens, P.J.J.; Kirn, T.**: Mittelstandsentwicklung, BASEL-II-Kreditmarktprobleme und Kapitalmarktperspektiven, Juli 2003
- No. 104 **Standke, K.-H.**: The Impact of International Organisations on National Science and Technology Policy and on Good Governance, March 2003
- No. 105 **Welfens, P.J.J.**: Exchange Rate Dynamics and Structural Adjustment in Europe, May 2003
- No. 106 **Welfens, P.J.J.; Jungmittag, A.; Kauffmann, A.; Schumann, Ch.**: EU Eastern Enlargement and Structural Change: Specialization Patterns in Accession Countries and Economic Dynamics in the Single Market, May 2003
- No. 107 **Welfens, P.J.J.**: Überwindung der Wirtschaftskrise in der Eurozone: Stabilitäts-, Wachstums- und Strukturpolitik, September 2003
- No. 108 **Welfens, P.J.J.**: Risk Pricing, Investment and Prudential Supervision: A Critical Evaluation of Basel II Rules, September 2003
- No. 109 **Welfens, P.J.J.; Ponder, J.K.**: Digital EU Eastern Enlargement, October 2003
- No. 110 **Addison, J.T.; Teixeira, P.**: What Have We Learned About The Employment Effects of Severance Pay? Further Iterations of Lazear et al., October 2003
- No. 111 **Gavrilencov, E.**: Diversification of the Russian Economy and Growth, October 2003
- No. 112 **Wiegert, R.**: Russia's Banking System, the Central Bank and the Exchange Rate Regime, November 2003
- No. 113 **Shi, S.**: China's Accession to WTO and its Impacts on Foreign Direct Investment, November 2003

- No. 114 **Welfens, P.J.J.:** The End of the Stability Pact: Arguments for a New Treaty, December 2003
- No. 115 **Addison, J.T.; Teixeira, P.:** The effect of worker representation on employment behaviour in Germany: another case of -2.5%, January 2004
- No. 116 **Borbély, D.:** EU Export Specialization Patterns in Selected Accession Countries, March 2004
- No. 117 **Welfens, P.J.J.:** Auf dem Weg in eine europäische Informations- und Wissensgesellschaft: Probleme, Weichenstellungen, Politikoptionen, Januar 2004
- No. 118 **Markova, E.:** Liberalisation of Telecommunications in Russia, December 2003
- No. 119 **Welfens, P.J.J.; Markova, E.:** Private and Public Financing of Infrastructure: Theory, International Experience and Policy Implications for Russia, February 2004
- No. 120 **Welfens, P.J.J.:** EU Innovation Policy: Analysis and Critique, March 2004
- No. 121 **Jungmittag, A.; Welfens, P.J.J.:** Politikberatung und empirische Wirtschaftsforschung: Entwicklungen, Probleme, Optionen für mehr Rationalität in der Wirtschaftspolitik, März 2004
- No. 122 **Borbély, D.:** Competition among Cohesion and Accession Countries: Comparative Analysis of Specialization within the EU Market, June 2004
- No. 123 **Welfens, P.J.J.:** Digitale Soziale Marktwirtschaft: Probleme und Reformoptionen im Kontext der Expansion der Informations- und Kommunikationstechnologie, Mai 2004
- No. 124 **Welfens, P.J.J.; Kauffmann, A.; Keim, M.:** Liberalization of Electricity Markets in Selected European Countries, July 2004
- No. 125 **Bartelmus, P.:** SEEA Revision: Accounting for Sustainability?, August 2004
- No. 126 **Welfens, P.J.J.; Borbély, D.:** Exchange Rate Developments and Stock Market Dynamics in Transition Countries: Theory and Empirical Analysis, November 2004
- No. 127 **Welfens, P.J.J.:** Innovations in the Digital Economy: Promotion of R&D and Growth in Open Economies, January 2005
- No. 128 **Welfens, P.J.J.:** Savings, Investment and Growth: New Approaches for Macroeconomic Modelling, February 2005
- No. 129 **Pospiezna, P.:** The application of EU Common Trade Policy in new Memberstates after Enlargement – Consequences on Russia’s Trade with Poland, March 2005
- No. 130 **Pospiezna, P.; Welfens, P.J.J.:** Economic Opening up of Russia: Establishment of new EU-RF Trade Relations in View of EU Eastern Enlargement, April 2005
- No. 131 **Welfens, P.J.J.:** Significant Market Power in Telecommunications: Theoretical and Practical Aspects, May 2005
- No. 132 **Welfens, P.J.J.:** A Quasi-Cobb Douglas Production Function with Sectoral Progress: Theory and Application to the New Economy, May 2005
- No. 133 **Jungmittag, A.; Welfens, P.J.J.:** Institutions, Telecommunications Dynamics and Policy Challenges: Theory and Empirical Analysis for Germany, May 2005

- No. 134 **Libman, A.:** Russia's Integration into the World Economy: An Interjurisdictional Competition View, June 2005
- No. 135 **Feiguine, G.:** Beitritt Russlands zur WTO – Probleme und Perspektiven, September 2005
- No. 136 **Welfens, P.J.J.:** Rational Regulatory Policy for the Digital Economy: Theory and EU Policy Options, October 2005
- No. 137 **Welfens, P.J.J.:** Schattenregulierung in der Telekommunikationswirtschaft, November 2005
- No. 138 **Borbély, D.:** Determinants of Trade Specialization in the New EU Member States, November 2005
- No. 139 **Welfens, P.J.J.:** Interdependency of Real Exchange Rate, Trade, Innovation, Structural Change and Growth, December 2005
- No. 140 **Borbély D., Welfens, P.J.J.:** Structural Change, Innovation and Growth in the Context of EU Eastern Enlargement, January 2006
- No. 141 **Schumann, Ch.:** Financing Studies: Financial Support schemes for students in selected countries, January 2006
- No. 142 **Welfens, P.J.J.:** Digitale Innovationen, Neue Märkte und Telekomregulierung, März 2006
- No. 143 **Welfens, P.J.J.:** Information and Communication Technology: Dynamics, Integration and Economic Stability, July 2006
- No. 144 **Welfens, P.J.J.:** Grundlagen rationaler Transportpolitik bei Integration, August 2006
- No. 145 **Jungmittag, A.:** Technological Specialization as a driving Force of Production Specialization, October 2006
- No. 146 **Welfens, P.J.J.:** Rational Regulatory Policy for the Digital Economy: Theory and EU-Policy Options, October 2006
- No. 147 **Welfens, P.J.J.:** Internationalization of EU ICT Industries: The Case of SAP, December 2006
- No. 148 **Welfens, P.J.J.:** Marktwirtschaftliche Perspektiven der Energiepolitik in der EU: Ziele, Probleme, Politikoptionen, Dezember 2006
- No. 149 **Vogelsang, M.:** Trade of IT Services in a Macroeconomic General Equilibrium Model, December 2006
- No. 150 **Cassel, D., Welfens, P.J.J.:** Regional Integration, Institutional Dynamics and International Competitiveness, December 2006
- No. 151 **Welfens, P.J.J., Keim, M.:** Finanzmarktintegration und Wirtschaftsentwicklung im Kontext der EU-Osterweiterung, März 2007
- No. 152 **Kutlina, Z.:** Realwirtschaftliche und monetäre Entwicklungen im Transformationsprozess ausgewählter mittel- und osteuropäischer Länder, April 2007
- No. 153 **Welfens, P.J.J.; Borbély, D.:** Structural Change, Growth and Bazaar Effects in the Single EU Market, September 2008
- No. 154 **Feiguine, G.:** Die Beziehungen zwischen Russland und der EU nach der EU-Osterweiterung: Stand und Entwicklungsperspektiven, Oktober 2008

- No. 155 **Welfens, P.J.J.:** Ungelöste Probleme der Bankenaufsicht, Oktober 2008
- No. 156 **Addison J.T.:** The Performance Effects of Unions. Codetermination, and Employee Involvement: Comparing the United States and Germany (With an Addendum on the United Kingdom), November 2008
- No. 157 **Welfens, P.J.J.:** Portfoliomodell und langfristiges Wachstum: Neue Makroperspektiven, Portfolio Modelling and Growth, November 2008
- No. 158 **Welfens, P.J.J.:** Growth, Structural Dynamics and EU Integration in the Context of the Lisbon Agenda, November 2008
- No. 159 **Welfens, P.J.J.:** Portfolio Modelling and Growth, December 2008
- No. 160 **Islami, M.:** Interdependence Between Foreign Exchange Markets and Stock Markets in Selected European Countries, December 2008
- No. 161 **Welfens, P.J.J.:** Portfolio Modelling and Growth, January 2009
- No. 162 **Bartelmus, P.:** Sustainable Development – Has It Run Its Course?, January 2009
- No. 163 **Welfens, P.J.J.:** Intégration Européenne et Mondialisation: Défis, Débats, Options, February 2009
- No. 164 **Welfens, P...J...J.:** ЭКОНОМИЧЕСКИЙ РОСТ, ИННОВАЦИИ И ПРИРОДНЫЕ РЕСУРСЫ, February 2009
- No. 165 **Welfens, P.J.J.; Vogelsang, M.:** Regulierung und Innovationsdynamik in der EU-Telekommunikationswirtschaft, February 2009
- No. 166 **Welfens, P.J.J.:** The International Banking Crisis: Lessons and EU Reforms, February 2009
- No. 167 **Schröder, C.:** Financial System and Innovations: Determinants of Early Stage Venture Capital in Europe, March 2009
- No. 168 **Welfens, P.J.J.:** Marshall-Lerner Condition and Economic Globalization, April 2009
- No. 169 **Welfens, P.J.J.:** Explaining Oil Price Dynamics, May 2009
- No. 170 **Welfens, P.J.J.; Borbély, D.:** Structural Change, Innovation and Growth in the Single EU Market, August 2009
- No. 171 **Welfens, P.J.J.:** Innovationen und Transatlantische Bankenkrise: Eine ordnungspolitische Analyse, August 2009
- No. 172 **Erdem, D.; Meyer, K.:** Natural Gas Import Dynamics and Russia's Role in the Security of Germany's Supply Strategy, December 2009
- No. 173 **Welfens P.J.J; Perret K.J.:** Structural Change, Specialization and Growth in EU 25, January 2010
- No. 174 **Welfens P.J.J.; Perret K.J.; Erdem D.:** Global Economic Sustainability Indicator: Analysis and Policy Options for the Copenhagen Process, February 2010
- No. 175 **Welfens, P.J.J.:** Rating, Kapitalmarktsignale und Risikomanagement: Reformansätze nach der Transatlantischen Bankenkrise, Februar 2010
- No. 176 **Mahmutovic, Z.:** Patendatenbank: Implementierung und Nutzung, Juli 2010
- No. 177 **Welfens, P.J.J.:** Toward a New Concept of Universal services: The Role of Digital Mobile Services and Network Neutrality, November 2010
- No. 178 **Perret, K.J.:** A Core-Periphery in Russia – Twin Peaks or a Rat's Tail, December 2010
- No. 179 **Welfens, P.J.J.:** R&D Employment, Golden Rule and Hybrid Welfare, December 2010

- No. 180 **Welfens, P.J.J.:** European and Global Reform Requirement for Overcoming the Banking Crisis, December 2010
- No. 181 **Szanyi, M.:** Industrial clusters: concepts and empirical evidence from East-Central Europe, December 2010
- No. 182 **Szalavetz, A.:** The Hungarian automotive sector – a comparative CEE perspective with special emphasis on structural change, December 2010
- No. 183 **Welfens, P.J.J.; Perret, K.J.; Erdem, D.:** The Hungarian ICT sector – a comparative CEE perspective with special emphasis on structural change, December 2010
- No. 184 **Lengyel, B.:** Regional clustering tendencies of the Hungarian automotive and ICT industries in the first half of the 2000's, December 2010
- No. 185 **Schröder, C.:** Regionale und unternehmensspezifische Faktoren einer hohen Wachstumsdynamik von IKT Unternehmen in Deutschland; Dezember 2010
- No. 186 **Emons, O.:** Innovation and Specialization Dynamics in the European Automotive Sector: Comparative Analysis of Cooperation & Application Network, October 2010
- No. 187 **Welfens, P.J.J.:** The Twin Crisis: From the Transatlantic Banking Crisis to the Euro Crisis?, January 2011
- No. 188 **Welfens, P.J.J.:** Green ICT Dynamics: Key Issues and Findings for Germany, March 2012
- No. 189 **Erdem, D.:** Foreign Direct Investments, Energy Efficiency and Innovation Dynamics, July 2011
- No. 190 **Welfens, P.J.J.:** Atomstromkosten und -risiken: Haftpflichtfragen und Optionen rationaler Wirtschaftspolitik, Mai 2011
- No. 191 **Welfens, P.J.J.:** Towards a Euro Fiscal Union: Reinforced Fiscal and Macroeconomic Coordination and Surveillance is Not Enough, January 2012
- No. 192 **Irawan, Tony:** ICT and economic development: Conclusion from IO Analysis for Selected ASEAN Member States, November 2013
- No. 193 **Welfens, P.J.J.; Perret, J.:** Information & Communication Technology and True Real GDP: Economic Analysis and Findings for Selected Countries, February 2014
- No. 194 **Schröder, C.:** Dynamics of ICT Cooperation Networks in Selected German ICT Clusters, August 2013



## **EIIW Economic Policy Analysis**

- No. 1 **Welfens, P.J.J.:** Globalisierung der Wirtschaft und Krise des Sozialstaats: Ist die Wirtschaftswissenschaft am Ende?, April 1997
- No. 2 **Welfens, P.J.J.:** Nach der D-Mark kommt die E-Mark: Auf dem Weg zur EU-Währungsunion, Juli 1997
- No. 3 **Welfens, P.J.J.:** Beschäftigungsförderliche Steuerreform in Deutschland zum Euro-Start: Für eine wachstumsorientierte Doppelsteuerreform, Oktober 1998

Fordern Sie den EIIW Newsletter an: [www.eiiv.eu](http://www.eiiv.eu)

Please subscribe to EIIW Newsletter: [www.eiiv.eu](http://www.eiiv.eu)

### **Weitere Beiträge von Interesse: Titels of related interest:**

Most recent books also see the last page.

PERRET, J.K. (2013), Knowledge as a Driver of Regional Growth in the Russian Federation, Heidelberg: Springer.

WELFENS, P.J.J. (2013), Nachhaltige Überwindung der Euro-Krise, Stuttgart: Lucius & Lucius.

SCHULZ, M. (2013), Der gefesselte Riese – Europas letzte Chance, Reinbek: Rowohlt Verlag.

WELFENS, P.J.J. (2012), Die Zukunft des Euro, Berlin: Nicolai Verlag.

WELFENS, P.J.J., HENNICKE, P. (2012), Energiewende nach Fukushima, München: Oekom Verlag.

WELZER, H.; WIEGANDT, K. (2012), Perspektiven einer nachhaltigen Entwicklung: Wie sieht die Welt im Jahr 2050 aus?, Frankfurt am Main: Fischer Verlag.

WELFENS, P.J.J. (2011), Cluster- und Innovationsdynamik in Europa: Neue Perspektiven der Automobil- und IKT-Wirtschaft, Stuttgart: Lucius & Lucius.

- WELFENS, P.J.J.; EMONS, O.; SCHRÖDER, C. (2011), Europäische Innovations- und Spezialisierungsdynamik im Gesundheitssektor, Stuttgart: Lucius & Lucius.
- ISLAMI, M. (2010), Interdependenz zwischen Devisen- und Aktienmärkten in ausgewählten EU-Ländern: Theorie und empirische Analyse, Hamburg: Verlag Dr. Kovac.
- VOGELSANG, M. (2010), Digitalization in Open Economies, Heidelberg: Springer.
- WELFENS, P.J.J.; et al. (2009), A Europe of achievements in a Changing World, European Commission.
- WELFENS, P.J.J.; BORBÉLY, D. (2009), Europäische Integration und Digitale Weltwirtschaft, Band 4: EU-Ostererweiterung, IKT und Strukturwandel, Stuttgart: Lucius & Lucius.
- BLEISCHWITZ, R.; WELFENS, P.J.J.; ZHANG, Z. (2009), Sustainable Growth and Resource Productivity, Sheffield: Greanleaf.
- WELFENS, P.J.J.; ADDISON, J.T. (2009), Innovation, Employment and Growth Policy Issues in the EU and the US, Heidelberg: Springer.
- WELFENS, P.J.J.; RYAN, C.; CHIRATHIVAT, S.; KNIPPING, F. (2009), EU-ASEAN, Facing Economic Globalisation, Heidelberg: Springer.
- WELFENS, P.J.J. (2009), Transatlantische Bankenkrise, Stuttgart: Lucius & Lucius.
- WELFENS, P.J.J.; WOLF, H.C.; WOLTERS, J. (eds., 2008), International Economics and Economic Policy, Heidelberg: Springer.
- WELFENS, P.J.J.; WALTHER-KLAUS, E. (eds., 2008), Digital Excellence, University Meets Economy, Heidelberg: Springer.
- WELFENS, P.J.J. (2008), Digital Integration, Growth and Rational Regulation, Heidelberg: Springer.
- WELFENS, P.J.J. (2007), Innovation in Macroeconomics, Heidelberg: Springer.
- WELFENS, P.J.J.; WESKE, M. (eds., 2007), Digital Economic Dynamics, Innovations, Networks and Regulations, Heidelberg: Springer.
- WELFENS, P.J.J., WESKE, M. (eds., 2006): Innovations, Digital Economic Dynamics and Regulatory Policy, Heidelberg: Springer.
- WELFENS, P.J.J., KNIPPING, F., CHIRATHIVAT, S., RYAN, C. (eds., 2006): Integration in Asia and Europe: Historical Dynamics, Political Issues and Economic Perspectives, Heidelberg: Springer.
- BROADMAN, H.G., PAAS, T., WELFENS, P.J.J. (eds., 2006): Economic Liberalization and Integration Policy Options for Eastern Europe and Russia, Heidelberg: Springer.
- BORBÉLY, D. (2006): Trade Specialization in the Enlarged European Union, Heidelberg/Berlin: Springer.
- JUNGMITTAG, A. (2006): Internationale Innovationsdynamik, Spezialisierung und Wirtschaftswachstum in der EU, Heidelberg: Physica.
- WELFENS, P.J.J., WZIATEK-KUBIAK, (eds., 2005): Structural Change and Exchange Rate Dynamics – The Economics of EU Eastern Enlargement; Heidelberg: Springer.

WELFENS, P.J.J., ZOCHE, P., JUNGMITTAG, A. (et al. 2005): Internetwirtschaft 2010 (final Report for the German Federal Government; joint study EIIW and Fraunhofer Institute for System Dynamics and Innovation, Karlsruhe), Heidelberg: Physica.

GRAHAM, E., ODING, N., WELFENS, P.J.J., (2005): Internationalization and Economic Policy Reforms in Transition Countries, Heidelberg: Springer.

GAVRILENKOW, E., WELFENS, P.J.J., (2005): Infrastructure, Investments and Economic Integration: Perspectives for Eastern Europe and Russia, Moscow: HSE.

APOLTE, T.; CASPERS, R.; WELFENS, P.J.J. (2004), Ordnungsökonomische Grundlagen nationaler und internationaler Wirtschaftspolitik, Stuttgart: Lucius & Lucius.

GAVRILENKOV, E.; WELFENS, P.J.J.; WIEGERT, R. (2004), Economic Opening Up and Growth in Russia, Heidelberg and New York: Springer.