RWI : Schriften

Jochen Dehio, Roland Döhrn, Rainer Graskamp,
Klaus Löbbe, Hans Dietrich von Loeffelholz,
Waike Moos and Michael Rothgang

New Economy

The German Perspective

Heft 70

RWI
ESSEN

Vincit Veritas D&H

Duncker & Humblot · Berlin

RWI : Schriften
Heft 70

Schriftleitung: Prof. Dr. Christoph M. Schmidt, Ph.D.
Redaktionelle Bearbeitung: Joachim Schmidt

Jochen Dehio, Roland Döhrn,
Rainer Graskamp, Klaus Löbbe,
Hans Dietrich von Loeffelholz,
Waike Moos and Michael Rothgang

New Economy – The German Perspective

RWI : Schriften

Heft 70

Jochen Dehio, Roland Döhrn, Rainer Graskamp,
Klaus Löbbe, Hans Dietrich von Loeffelholz,
Waike Moos and Michael Rothgang

New Economy

The German Perspective

RWI
ESSEN

Duncker & Humblot · Berlin

Bibliografische Information Der Deutschen Bibliothek

Die Deutsche Bibliothek verzeichnet diese Publikation in
der Deutschen Nationalbibliografie; detaillierte bibliografische
Daten sind im Internet über <http://dnb.ddb.de> abrufbar.

Fotoprint: Berliner Buchdruckerei Union GmbH, Berlin
Printed in Germany

ISSN 0720-7212
ISBN 3-428-11327-6

Gedruckt auf alterungsbeständigem (säurefreiem) Papier
entsprechend ISO 9706 ♾

Preface

For many observers the beginning of a dynamic economic and stock market upswing in the U.S. in the mid 1990s marked the start of a new era, the times of the *new economy*. This phenomenon has been under intense discussion ever since – both in the political arena as well as among scientists. Thereby the somewhat glamorous term *new economy* reflects the conviction held by its proponents that the use of new technologies will lead to a never ending acceleration of technological progress and economic welfare.

The origins of this development date back a long time: More than 30 years ago, the starting point was the basic innovation "digitilization". Production as well as application of information and communications technologies (ICT) are based on this principle. At the beginning of the seventies, the first microprocessor was produced. Some ten years later, the first personal computer was brought onto the market. The commercial use of the Internet has begun in the mid nineties. In view of the economic boom in the U.S. accompanying the introduction of the Internet, the question arises as to what extent the *new economy* actually has exerted lasting positive effects on productivity – not only in the United States, but also worldwide.

Inspired by these developments, the Federal Ministry of Economics and Technology commissioned RWI, Essen, to study the driving forces of the *new economy*. In this report, the trends of the ICT sector and of the use of ICT products are analyzed with respect to the overall economic effects in Germany in comparison to the U.S. Further analyses were carried out regarding the intensity and effects of *e-business*. Finally, the influence of different methods of price measurement on productivity was analysed, since this is important for international comparisons of total factor productivity. The study culminates in a growth accounting calculation separating the contributions to economic growth by capital, labor, and technological progress.

The study was conducted by RWI's research group "Industrial Organisation and Industry Studies" in close co-operation with Prof. *Robert J. Gordon* (NBER and Northwestern University). Professor Gordon is one of the most eminent experts in matters of the *new economy*. The project was directed by Klaus Löbbe. Preliminary results were presented and discussed by experts on November 9, 2001 during a workshop organized by the Federal Ministry of Economics and Technology in Berlin. The study was finished in 2002. Prof. *Francesco Daveri* (University of Parma), an acknowledged scientist in the empirical analysis of the effects of the *new economy*, provided useful comments in the course of this publication's preparation. We heartily thank him, as we do Professor Gordon and all other researchers involved in this study.

Essen, June 2003

Rheinisch-Westfälisches Institut
für Wirtschaftsforschung

Christoph M. Schmidt

Contents

List of Tables

List of Figures

List of Schedules

Introduction

Already since the beginning of the year 2001, and even more so since the terror attacks in the United States in early September, economic growth has been declining in most parts of the world. The decline ends, at least temporarily, a long lasting phase of accelerated growth. This protracted growth had contributed to a rapidly rising real income and the creation of a great number of attractive jobs in the U.S. and some other countries for several years. The associated combination of accelerated growth and monetary stability was often addressed as the emergence of a "new economy" (see, e.g., Bosworth, Triplett 2000; Bryson 2001; David 2001; Jorgenson, Stiroh 2000b; Nordhaus 2001a; Oliner, Sichel 2000). This new era was supposed to lead the U.S. to yet another "golden age" of growth and full employment, making the stagflation of the seventies and the productivity slowdown of the eighties as a forgotten historical episode. Many observers assumed that the driving force of this "new economy" – primarily the development and the increasing diffusion of new technologies, especially the information and telecommunications technology (ICT) – would lead to an ever accelerating factor productivity and the creation of new jobs, to low inflation and increasing "sustainable" real income.

However, the existence of a "new economy" in the U.S. is not an undisputed fact. In the U.S.-American literature there is an intensive discussion about the role of cyclical components and capital deepening on the one hand, and the contribution of technical progress (or total factor productivity) and falling ICT prices on the other hand (see, e.g., Blinder 2000; Davies et al. 2000). Lower restrictions regarding trade in goods and capital, an investment-friendly environment and a willingness to foster intensive competition, the associated adaptations of corporate structures, a skilful macroeconomic policy (a good mix between fiscal consolidation and countervailing monetary policy) and singular events (so-called peace bonus, drop in raw materials prices) are also important for the existence of the "new economy". Last but not least there was a debate in the U.S. economic literature about the appropriate calculation and statistical determination of labor and total factor productivity, qualifying the large growth figures to some extent (see, e.g., Boskin et al. 1996; Gordon 1999d; Triplett 2001).

From the European, and especially the German perspective, further factors that could have contributed to economic growth and employment should be pointed out. One can refer to the extension and more intense implementation of the European Community, the reunification of Germany and some structural reforms, such as the deregulation of several sectors, the privatization of public enterprises, reforms in public procurement and the creation of new instruments for business finance (Neuer Markt and venture capital, e.g.). These changes in the legal and institutional framework and structural reforms might also have contributed to the accelerated change in sectoral structures, numerous mergers and acquisitions and the creation of new enterprises. All this resulted in a higher degree of competition and a greater share of small and medium- sized enterprises. Nevertheless, during the nineties economic growth in most European countries was modest – and proved not sufficient in reducing the high unemployment rate. Under these conditions, the debate about the "new economy" in the U.S. was observed more and more carefully in most European countries.

At first glance, the attractiveness of the "new economy" concept has decreased markedly since the bursting of the speculative bubble on the stock markets (especially the Nasdaq Market and the Neuer Markt). But one should bear in mind that the connection between both phenomena is weak: While at the micro-economic level the valuation of individual companies is at issue, at the macro-economic level it is the development of total factor productivity which is of interest. Yet, up- and downswing of the NASDAQ or the Neuer Markt since 1997 reflect at least the changing role of technical progress.

For these reasons, a detailed analysis of the "new economy" and its components is still necessary. This requires – first of all – a theoretically sound, but practicable definition of the term "new economy". Following the recent literature (OECD 2001b), this study classifies an economy as a "new economy", if there is a remarkable acceleration of real growth in total output, value added, employment and/or labor productivity that can be mainly attributed to

- an improved quality of labor measured as an increase in educational attainment or in the level of post-secondary skills,
- an extended use of physical capital, above all ICT capital, and
- a rising multi-factor productivity (MFP), that is an increase in production and/or productivity which exceeds the gains resulting from intensified utilization of intermediate inputs or production factors (labor or capital).

Empirically, the MFP is usually calculated as the residual of a production function estimate. This procedure requires numerous, and partly restrictive, assumptions. Its main focus is necessarily on the long-run development of the economy, over and above its cyclical up- and downswings. The factors that may have caused an increase in MFP are (1) an accelerating technological progress, (2) a higher degree of competition which pushes prices closer to marginal costs, or (3) a rising efficiency in the overall production and distribution process, either by the introduction of new organizational methods in management or by the use of new techniques (e.g., ICT techniques).

Against this background a comparative study is conducted on the importance of the phenomenon of the "new economy" and its driving forces in the United States and in Germany. In this context, the following questions need to be answered:

- Does the recent acceleration in the growth of U.S.-productivity really imply a fundamental change in the long-lasting trend of a protracted productivity slowdown? Which differences exist between the United States and Germany, with respect to long-term economic growth and employment, factor productivity and inflation? Which U.S.-German differences can be observed across the different sectors of the economy?

- How can these differences be explained? What is the importance of technological, cyclical and statistical (new methods for price measurement, calculation of nominal or real input and output figures etc.) factors for this change?

- Is ICT really a basic technology in the sense that it fundamentally alters the production process in the overall economy? Alternatively, are the production and productivity effects only confined to the ICT-sector?

- Do the general and sector-specific economic advantages arising from ICT correspond to those experienced during earlier technological revolutions (rise of the railways, widespread use of electricity and the automobile)? Based on historical experience, how long does it usually take for new technologies to diffuse into the German economy? What is the realistic time scale for catching up with the U.S. economy in terms of ICT penetration?

- Are there spillover effects from the ICT-sector into the remaining sectors of the economy? In which way do ICT-technologies change the internal production processes and the organization of work in the various sectors and/or firms? Which role do the new technologies play in the optimization of production processes as well as for the reduction in transaction costs (B2B, B2C)?

- What is the structural framework and which are the supporting macroeconomic policies that will foster the further development of the "new economy"? Could more intense efforts by economic, social, educational and research policy help Germany to catch up to other economies, particularly to the United States?

To take the U.S. American experience in this field into consideration appropriately, RWI has carried out this study in close co-operation with Prof. Robert J. Gordon (NBER and Northwestern University). The study is organized as follows: in Chapter 1 the long- term development of production and value added, employment and labor productivity in the U.S. and the German economy are described. Following this, an overview is given about the importance of open markets and an efficient fiscal policy as pre-conditions for a new economy. Chapter 2 gives a chronology of fundamental technological revolutions in the past. The following questions are asked: What can be learned from these earlier revolutions? To what extent can ICT technologies be regarded as such a fundamental revolutionary technology? Chapter 3 analyses the volume and the industrial structure of the ICT-sector in the U.S. and Germany and calculates the direct contribution of ICT production to economic growth and employment. In Chapter 4, the role of the economy-wide adoption and use of ICT technologies and the future perspectives regarding their utilization are discussed based on general indicators of ICT use and with respect to e-commerce. Chapter 5 analyses and compares the contributions of ICT capital accumulation to growth in Germany and the U.S. In this context, the special role of different methods used to deflate economic time series data in both countries is explored. A summary and some implications for economic policy in Chapter 6 complete the study.

Chapter 1

Economic Development in Germany and the U.S.

1. Long-Term Trends

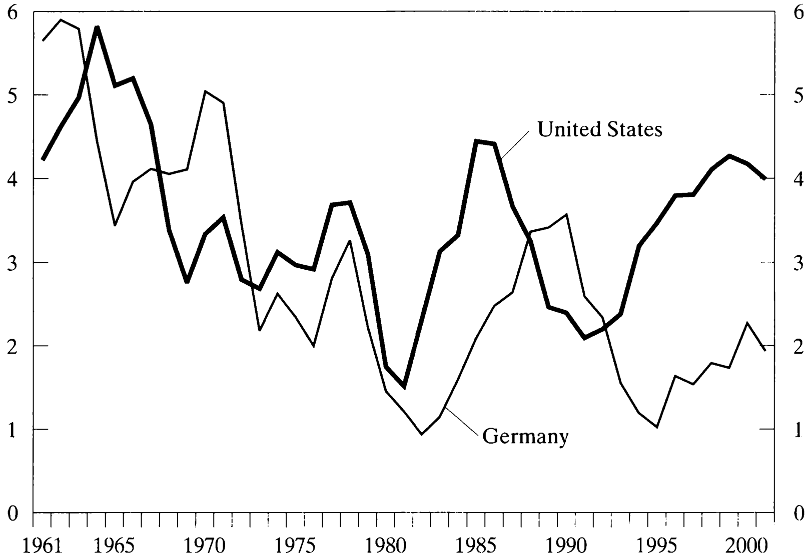
In this section the different developments in the U.S. and in Germany are analyzed with the aim of identifying the most important correlates of recent economic growth. Thus, in a first step a general survey of the important macroeconomic aggregates in the U.S. and in Germany is provided. In a second step, because of the distinct developments of the German and U.S. aggregates, further insights preparing the detailed analysis will be provided as well.

In Figure 1, the long-term development of GDP (in constant prices) in Germany and the U.S. is shown. The time series (annual percentage changes with respect to the previous year) are smoothed with a five-year moving average, to moderate the short-term cyclical fluctuations. Until 1990 the German growth rates refer to the former Germany, since 1991 they refer to Germany. The structural break associated with German re-unification in the year 1991 is smoothed by using an imputed growth rate between 1990 and 1991. For this purpose, the parallel reporting of GDP-data for former Germany as well as for unified Germany was used to calculate the "missing" growth rate between 1990 and 1991.

Until 1980 the German and the U.S. growth rates were fluctuating tightly together. Since 1981 this pattern has changed. First of all, cycles have decelerated their frequency. Even more important, until 1988 the U.S. growth rate was lying above the corresponding German rate by more than 2 percentage points. After the brief episode 1989 to 1992, the U.S. growth rates have surpassed the German rates significantly again. During the nineties, the U.S. GDP growth accelerated strongly. Recently, however, this acceleration has come to an end and the growth rates have reduced slightly. The German GDP growth has also decelerated since the middle of the year 2000, suggesting that the turning point has already been passed in both countries.

Figure 1

Long-Term Development of GDP[1] in Germany and the United States
1961 to 2001; five-year moving average of growth rates in %



Authors' own calculations. – [1]In constant prices.

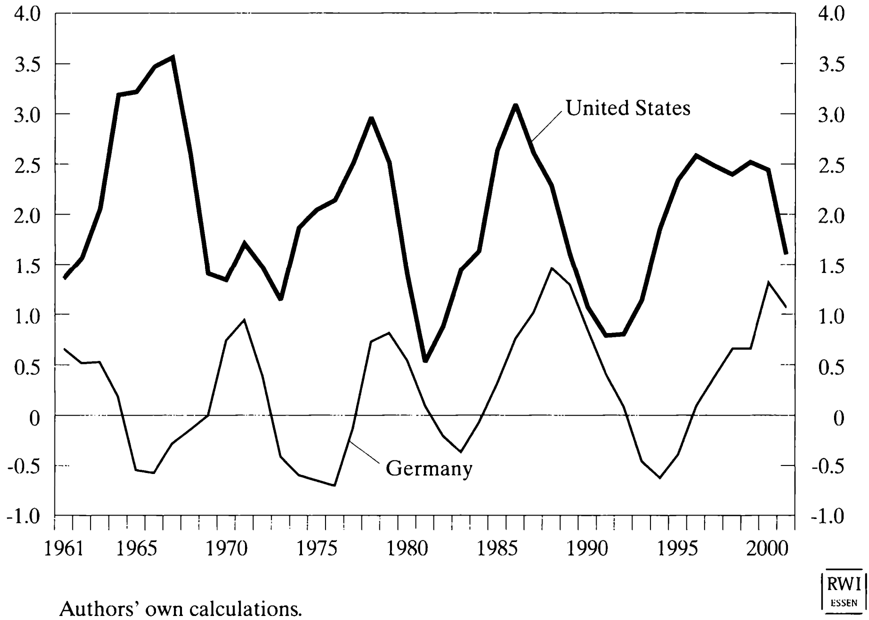
Figure 2 documents the long-term development of the employment figures, also as five-year moving averages. Similar to the imputation of the missing GDP growth rate, the employment growth rates for Germany are connected to the growth rates for former Germany. The U.S. employment growth is lying significantly above the corresponding rates for the former Germany and unified Germany, respectively. In Germany, in the middle of the sixties and seventies, between 1982 and 1984 and between 1993 and 1996 the level of total employment even decreased. In contrast, the U.S. employment growth rates accelerated during the early nineties, and since the middle of the nineties remained on a high level. However, the maximum growth rates of employment of the years 1967, 1978 and 1986 were not achieved again. Currently, the employment growth in the U.S is decelerating. However, it is still significantly higher than in Germany although here employment growth has also accelerated since the middle of the nineties and has nearly reached the high rates of the end of the eighties.

Smoothing the time series with moving averages is only one method to eliminate the different short-term fluctuations and to concentrate on the long-term components. Different smoothing procedures, however, lead to different pat-

Figure 2

Long-Term Development of Employment in Germany and the United States

1961 to 2001; five-year moving average of change rates in %



Authors' own calculations.

terns of the smoothed time series because they focus on different features of the original series. A well-known method to identify the trend path of the potential growth rate of economic aggregates, while neglecting the cyclical fluctuations, is smoothing the corresponding time series with the Hodrick-Prescott filter (HP filter). Using this filter, enables the analyst to identify the long-term trend component of a time series. If one assumes that a trend in a time series only changes, if there are structural changes in the economy and in the technology, the HP filter is an appropriate instrument to find out whether the U.S. time series since 1991 has been driven by other structural forces than in former times.

The HP filter is especially used for estimating the trend component of aggregate output, because in this context it can be interpreted as potential output. With an estimated potential output, the output gap and the different rates of capacity utilization can be calculated as differences between actual and potential output. In this study, however, the HP filter is not only used for estimating the trend growth of the potential output and for answering the question, whether there was a secular change in GDP growth rates. It is also used for estimating the trend component of employment growth and factor productivities.

More formally, the trend component of a time series is estimated by minimizing the target function

$$\sum_{t=1}^{T}\left\{\left(y_t - y_t^p\right)^2 + \lambda\left[\left(y_t^p - y_{t-1}^p\right) - \left(y_{t-1}^p - y_{t-2}^p\right)\right]^2\right\}$$

with y^p being defined as potential output, with a given smoothing parameter λ. The first term in brackets "punishes" a deviation between the unknown trend component and the actual value of the time series. The second term in the brackets punishes any variation of the trend growth rates. The value of the parameter λ determines the weight of the two – usually contradictory – elements of the total objective function. The larger λ is chosen, the smoother is the estimated trend time series.

For Germany one has to bear in mind the structural break in the data between 1990 and 1991 because of German re-unification. To overcome this break, the two different parts of the series are linked. This linkage is possible because between 1991 and 1997 the Federal Statistical Office has published separate data for the former Germany, based on the former statistical concepts and definitions, as well as for the whole of Germany, based on the new concept of the European System of National Accounts (ESVG 1995). For the missing value between the fourth quarter of 1990 and the first quarter of 1991 a weighted average of the earlier and later growth rates is calculated to eliminate the special economic effects of re-unification. Based on the time series of growth rates between 1960 and 2000 and using the imputed level in the year 2000, the corresponding time series of levels can be calculated backwards. The levels between 1991 and 2000 refer to unified Germany; however, those between 1960 and 1990 refer to a hypothetical unified Germany, without any missing values. As a smoothing parameter for the quarterly data a value of $\lambda = 6{,}400$ is used. This choice exceeds the default value of most statistical software packages by factor four, and therefore leads to a stronger smoothing of the trend time series with nearly complete elimination of cyclical fluctuations.

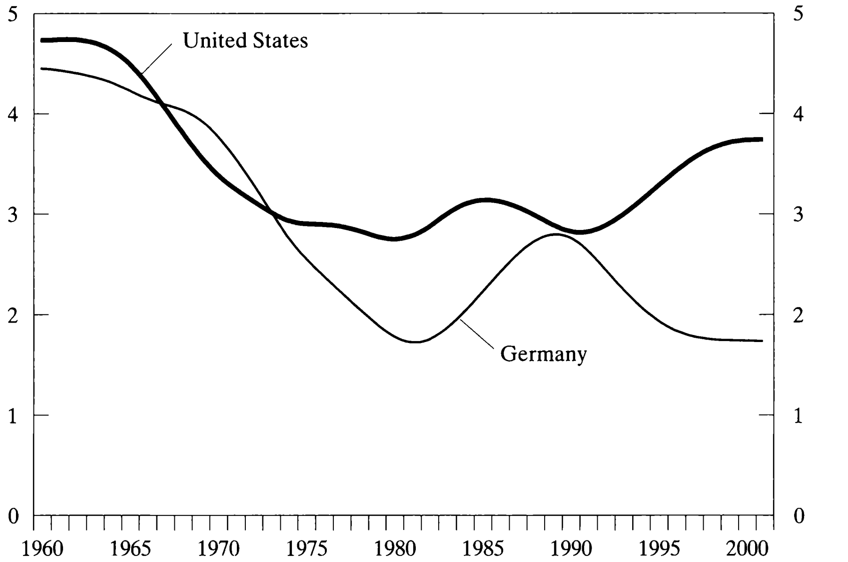
Figure 3 displays the corresponding trend growth rates (annual percentage changes relative to the previous year) of GDP in constant prices for Germany and the U.S. With the exception of the period between 1968 and 1974, the U.S. trend growth rates of GDP are always higher than the German rates. However, in the end of the eighties the German growth rates were closer to the American. During the nineties the trend growth rates in the U.S. and in Germany were divergent. In the last two years this divergence seems to have come to an end, though.

The pattern of the time series differs with the smoothing strategy, either the moving average method or the HP filter. For example, the U.S. expansion in the end of the seventies cannot be observed in the HP filtered series because

Figure 3

Estimated Trend Growth Rate[1] of GDP[2] in Germany and the United States

1960 to 2001; percentage change relative to the previous year



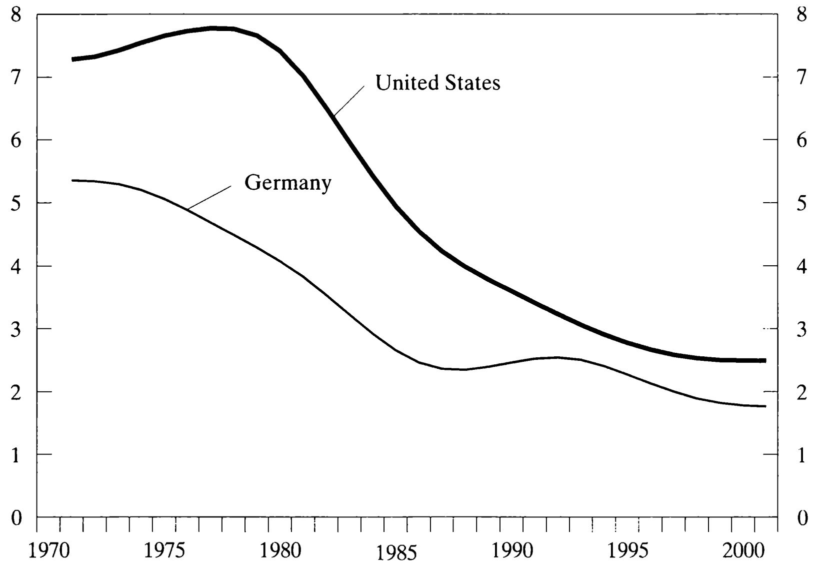
Authors' own calculations. – [1]Estimates by a HP filter of the original time series, see text. – [2]In constant prices.

they are smoothed more severely. This suggests that the expansion could be caused by short-term cyclical fluctuations rather than by a structural change of the growth path. Significant changes of the growth path for the U.S. can be seen in the first half of the eighties, during the Reagan administration. Thereafter the growth rates declined until the year 1991, where the long-term expansion has begun. As discussed above, the increase in the estimated trend growth rates in the HP filtered time series represents structural or technological changes. Therefore, a structural change in the U.S. growth path seems to have taken place in the early eighties and in particular since 1991. A high potential growth could possibly be interpreted as an indication for the existence of the so-called "new economy".

On the other side, in Germany one can observe a continuous reduction of the trend growth rates from about 4 percent in 1970 to 1.8 percent in the year 1982. During the eighties and until the beginning of the nineties the trend growth has accelerated to 2.6 percent. This acceleration was even stronger than the U.S. expansion of the nineties. German re-unification and the structural break induced by the economic burden of re-unification have stopped this trend growth. Since then, the trend growth rates have declined, and have recently

Figure 4

Estimated Trend Growth[1] Rate of Consumer Price Index in Germany and the United States
1970 to 2001; percentage change relative to the previous year



Authors' own calculations. – [1]Estimates by a HP filter of the original time series, see text.

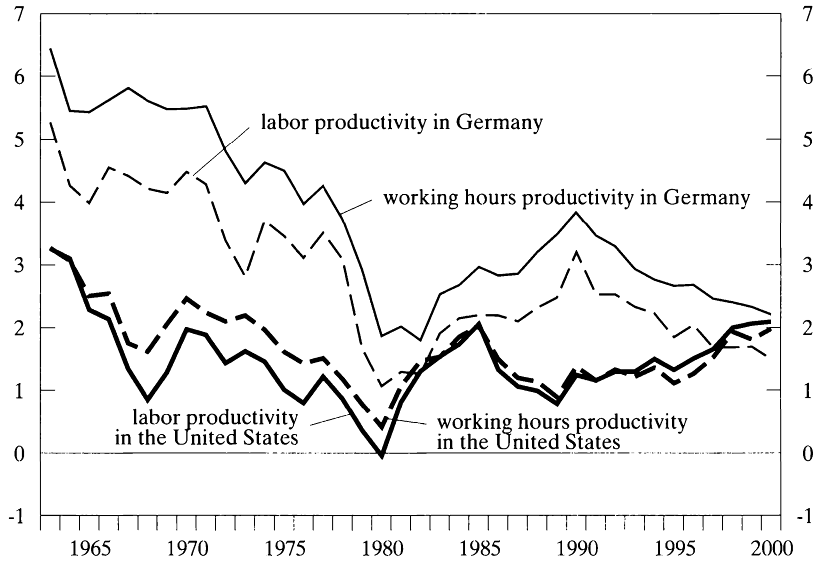
RWI ESSEN

stabilized to low, but constant growth rates of potential GDP. Also in the U.S. the trend growth rates are stabilizing, albeit, on a much higher level than in Germany.

Figure 4 shows the HP filtered growth rates of the consumer price index. During the whole observed period between 1970 and 2000, the German CPI change rates were beneath the corresponding U.S. rates. This result reflects the high importance given to price stability in Germany. Since the middle of the eighties, this political target was achieved. An inflation rate of about 2 percent still counts as price stability. Since the middle of the nineties, the CPI growth has even decelerated to below 1.8 percent. In the U.S., the CPI growth rate has decelerated, too. This deceleration of inflation started ten years later, in the end of the seventies. Since the beginning of the nineties, the fast decline of CPI growth faded into a slower deceleration. With 2.4 percent the level of the CPI change rate in the U.S. is significantly higher than the corresponding German rate. The higher CPI growth in the U.S. emerged with a higher GDP growth, without any indication for serious inflationary pressure.

Figure 5

Labor Productivity[1] in Germany and the United States
1963 to 2000; five-year moving average of growth rates in %



Authors' own calculations. – [1]Gross value added and GDP respectively in constant prices per employed worker (per hours worked) in the non-farm private business sector.

RWI ESSEN

2. Labor and Capital Productivity

Against this background the analysis of the driving forces of the "new economy", especially of productivity trends, is of great importance. On the one hand, there has been a direct increase in productivity in the manufacturing sector by producing ICT. On the other hand, during the nineties there was also a continuous growth of labor productivity, possibly caused by a broader diffusion of ICT. A rise in labor productivity can be caused by capital deepening or by an increase in total factor productivity. Capital deepening took place in the U.S. during the nineties. There was a great amount of investment spending in hardware and software. However, while capital deepening is only a substitution between the two input factors labor and capital, the increase of total factor productivity reflects a more efficient combination of the input factors, leading to a higher output with the same input (Chapter 5).

Figure 5 and Table 1 document the moving averages of the growth rates of labor productivity in the non-farm private business sector. The rates in Germany have always been – there was a short exception in the beginning of the

Table 1

Productivity in the Non-Farm Private Business Sector
1970 to 2000; annual average growth to the previous year in %

	Germany		U.S.	
	per hour	per employed	per hour	per employed
1970 – 1980	4.0	2.9	1.9	1.2
1980 – 1990	2.9	2.1	2.0	1.3
1990 – 2000	2.7	2.0	2.0	1.6
1995 – 2000	3.0	2.1	3.2	2.5

Author's own calculations. RWI ESSEN

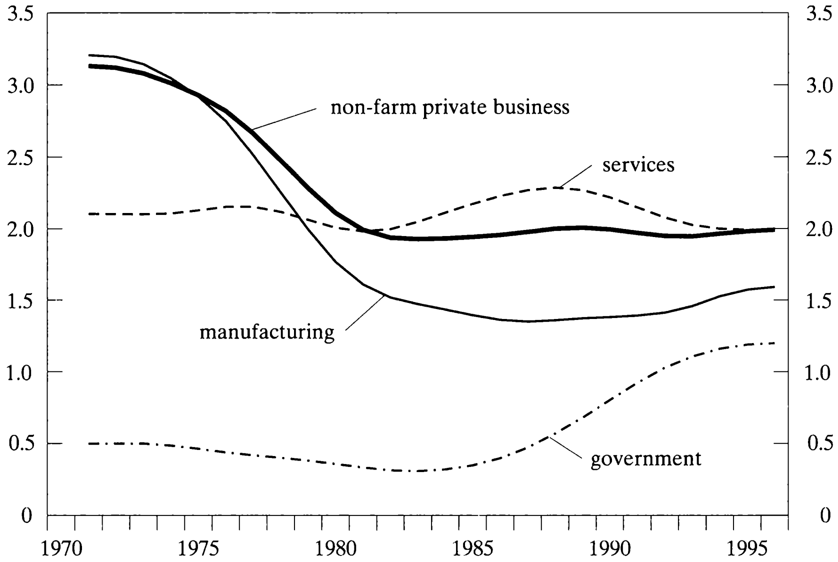
eighties – higher than in the U.S. In Germany the growth of labor productivity between 1960 and 1980 fell from more than 5 percent to 1 percent. Thereafter, labor productivity increased to a growth rate of 3 percent in 1990. Until then, growth was decelerating again. The continuous and long-term deceleration since 1960 can be explained by the phase of the reconstruction after World War II. This period started in a situation of a nearly totally destroyed capital stock and an abundant supply of labor. After the end of the reconstruction phase, the velocity of labor productivity growth naturally had to decelerate again.

In the U.S., a completely different development can be observed. In the first half of the sixties, a deceleration of the growth of labor productivity occurred as well. Yet, since the middle of the sixties, productivity growth has been fluctuating around 1 percent. In the first half of the eighties, productivity accelerated, slowing down again in the second part of the eighties. Since 1990 the labor productivity growth has increased again, at first with a slow, and then with an increasing velocity. The acceleration of productivity growth led to the situation of a divergent development between Germany and the U.S.; for the first time the U.S. growth rates of labor productivity have surpassed the corresponding German rates. Furthermore, by contrast to Germany for the U.S. one can see a rather parallel development between the local maxima and minima of the three time series (GDP, employment and labor productivity growth; Figures 1, 2 and 5). Possibly factors other than market forces might influence the economic development in Germany.

This analysis was confined to the overall economy. Figure 6 displays the HP filtered growth rates of sectorally disaggregated labor productivities (gross value added in constant prices per employed) for various important sectors. In addition to the structural break in the data because of German re-unification, the data suffer from another structural break. Sectoral data reflect the harmonization of the national statistics in ESVG 1995, which is based on the SNA

Figure 6

Estimated Trend Growth Rates[1] of Sectoral Labor Productivity[2] in West-Germany
1970 to 1996; percentage change relative to the previous year



Authors' own calculations. – [1]Estimated by a HP filter of the original time series. – [2]Gross value added in constant prices per employed worker.

RWI ESSEN

(System of National Accounts) and the ISIC Rev. 3[1]. As the definition of the different economic sectors based on the NACE Rev. 1 for Europe and the NACE is comparable to the ISIC Rev. 3, the disaggregated German and U.S. data are comparable, after all.

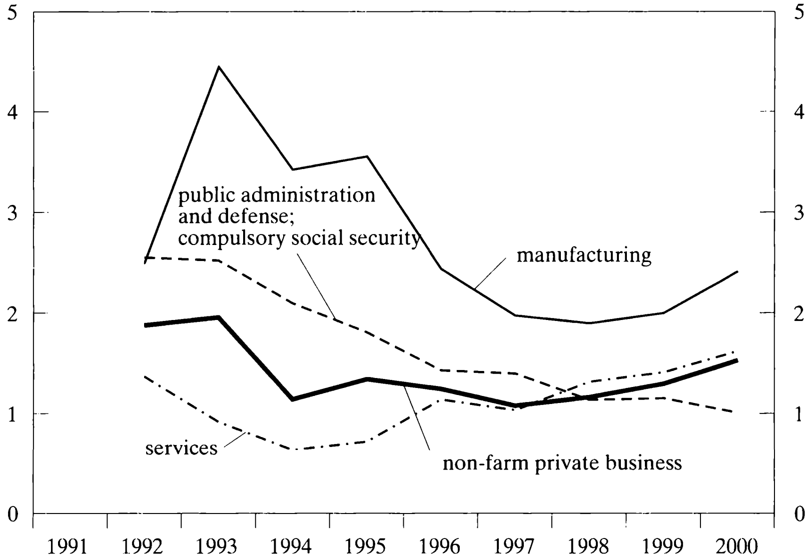
For Germany there are backward projections of the data of the new statistical concept (ESVG 1995) since 1991. Consequently, for the former Germany there are data between 1970 and 1990 and for unified Germany between 1991 and 2000. Linking of the time series on a sectorally disaggregated level is not possible, because the discrepancies induced by the conceptual changes are more serious than on the aggregate level. Furthermore, a comparison between the results based on the old concept for former Germany and those of the U.S. have to be taken with a grain of salt.

The trend growth rates of labor productivity of both the non-farm private business sector and the manufacturing sector in former Germany have decreased

[1] ISIC: United Nations International Standard Industrial Classification of all Economic Activities. The third revision of the ISIC is used in the SNA.

Figure 7

Sectoral Labor Productivity[1] in Germany
1991 to 2000; three-year moving average of growth rates in %



Authors' own calculations. – [1]Gross value added in constant prices per employed worker.

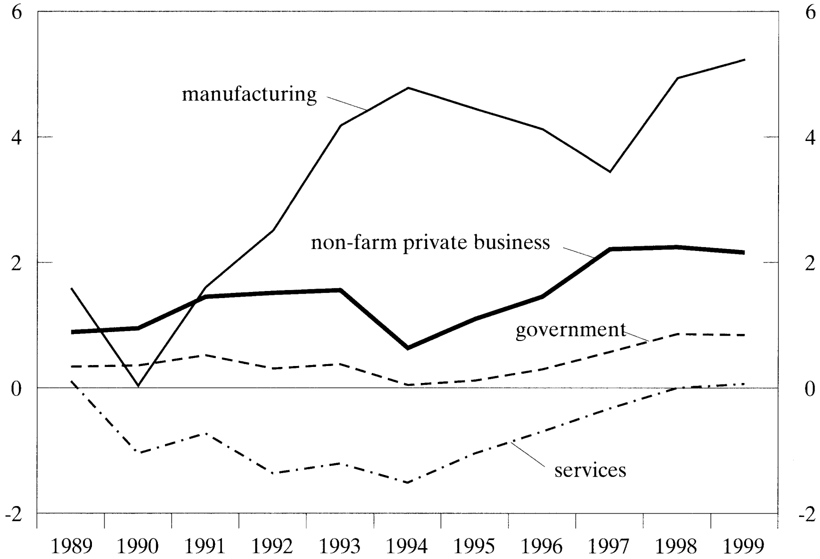
RWI ESSEN

from 1970 to 1980 from more than 3 percent to 2 (1.5) percent. Since the eighties until the end of the observed period for the former Germany in 1997, the trend growth rates are developing on a constant level. The trend growth of labor productivity in the service sector is also fluctuating on a constant level of about 2 percent. Only the government sector could raise its growth rate of productivity by 0.5 percent, however, the growth velocity is still low.

Figure 7 documents the three-year moving averages of sectoral labor productivity for Germany. The definition of the sectors is based on the WZ93 rsp. ISIC classification. The manufacturing sector corresponds to the ISIC category "D" (manufacturing) and is directly comparable to the U.S. manufacturing sector. Within the new classification system on the two-digit level, the government sector cannot be identified exactly any longer. As an approximation for the definition of the government sector, the two-digit figure "75" (public administration and defence, compulsory social security) is used. The service sector contains the two-digit figure "50" (sales, maintenance and repair of motor vehicles), "51" (wholesale trade and commission trade), "55" (hotels and restaurants), "60" to "67" (transport, storage and communication; financial intermediation), "70" to "74" (real estate, renting and business activities),

Figure 8

Sectoral Labor Productivity[1] in the United States
1989 to 1999; three-year moving average of growth rates in %



Authors' own calculations. – [1]Gross value added in constant prices per employed worker.

RWI ESSEN

"80" (education), "85" (health and social work), "90" to "93" (other community, social and personal services activities).

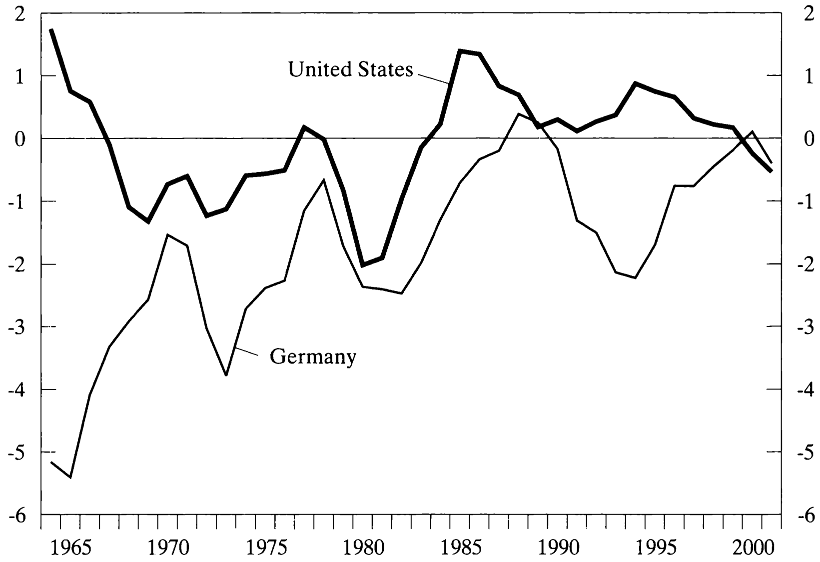
During the nineties, in Germany in all sectors there is a tendency for a decreasing velocity of labor productivity growth. In the non-farm private business sector it moves permanently below the 2 percent line. The productivity growth of the service sector is even beneath this line. Yet, it has accelerated slightly during the last five years, so that the rate has reached the non-farm private business growth rate. A significant deceleration in labor productivity growth from 2.5 percent in the beginning and 1 percent in the end of the nineties can be observed for the government sector. Also in the manufacturing sector, there was a deceleration of labor productivity growth from more than 4 to 2 percent in the observed period. The slight acceleration during the year 2000 is hardly a sign of the emergence of a "new economy".

Figure 8 reports the corresponding growth rates of U.S. productivities as three-year moving averages. The manufacturing sector, with 4 percent, displays the highest growth rates. They have even accelerated during the nineties. Also in the non-farm private business sector growth has accelerated or dou-

Figure 9

Capital Productivity[1] in Germany and the United States

1964 to 2001; five-year moving average of growth rates in %



Authors' own calculations. – [1]Gross value added divided by net capital stock (both 1995 prices) and GDP, respectively, divided by net capital stock (both 1996 prices) in the private sector without dwellings.

RWI ESSEN

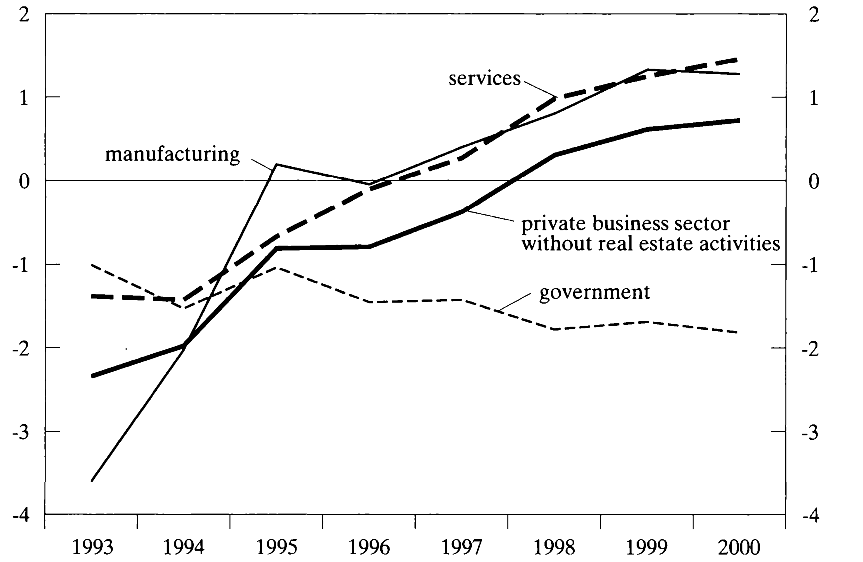
bled from 1 percent to more than 2 percent, however, the acceleration took mainly place in the second half of the nineties. This acceleration can also be observed, albeit on a much lower level, in the government sector. In the service sector deceleration diminished.

To analyse the different capital productivities in Germany and the U.S., a comparable definition of "capital productivity" has to be chosen. For the U.S., the published data refer to the net capital stock; capital productivity is approximately calculated as gross value added in constant prices divided by net capital stock in constant prices. We use this definition for Germany as well.

The rate of change of the U.S. capital productivity was always lying above the corresponding German rate (Figure 9). Since the middle of the eighties, in Germany there has been a trend of decreasing capital productivity, whereas in the U.S. there was a growth in the same period. Because of the capital deepening in the U.S., the growth rates have declined since the middle of the nineties. The decreasing trend growth rate of capital productivity may possibly give an indication for over-investment and under-utilized capacities.

Figure 10

Sectoral Capital Productivity[1] in Germany
1993 to 2000; three-year moving average of growth rates in %



Authors' own calculations. – [1]Gross value added divided by net capital stock (both 1995 prices).

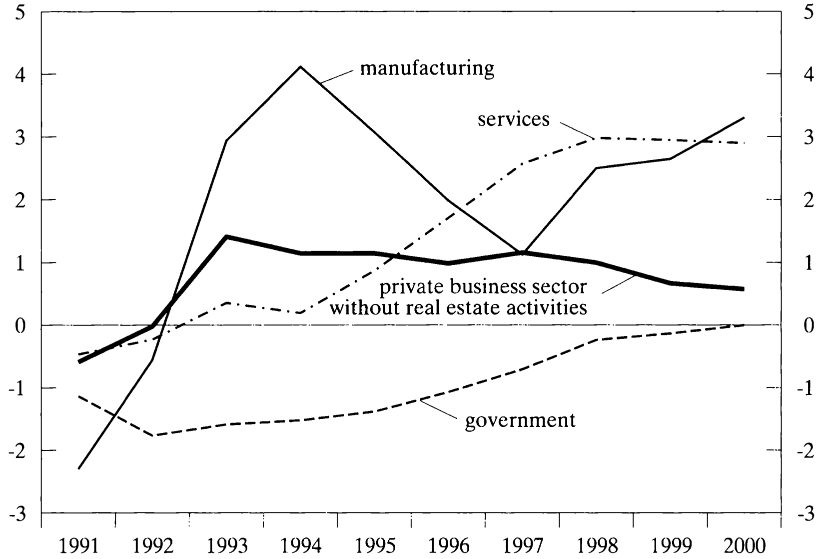
Figure 10 reports change rates of sectoral capital productivity in Germany as three-year moving averages[2]. Until the middle of the nineties, sectoral capital productivities declined more slowly from year to year. In 1997 these rates crossed the zero line, and have been increasing since, leading to an absolute increase in the level of capital productivity. An exception is capital productivity of the government; its change remained negative during the nineties, consequently, capital productivity is declining here with 2 percent per year.

Figure 11 documents the corresponding sectoral capital productivities in the U.S., also as three-year moving averages of change rates. Similar to Germany, all rates are accelerating. However, the increase in capital productivity has started already at the beginning of the nineties. Only the capital productivity of the government sector is declining. For the last three years at least constant productivities have been achieved.

[2] Because of the short observation period, three-year instead of five-year moving averages are used.

Figure 11

Sectoral Capital Productivity[1] in the United States
1991 to 2000; three-year moving average of growth rates in %



Authors' own calculations. – [1]GDP divided by net capital stock (both 1996 prices).

Summarizing we draw the following conclusions:

- Since 1991 there is a diverging development in the trend growth of GDP between the U.S. and Germany; the average trend growth rate in the U.S. has accelerated from 2.8 percent in 1990 to 3.8 percent in 2000, whereas the German trend growth rate has started on nearly the same level in 1991, but has slowed down to 1.8 percent.

- The U.S. trend growth rate of employment (between 1.5 and 2 percent) has always been higher than in Germany (below 0.5 percent). At the same time, the working-age population in the U.S. was growing more slowly, leading to a decline in the NAIRU and in the unemployment rate.

- The trend growth rate of labor productivity has always been higher in Germany than in the U.S. Since 1995 for the first time the velocity of U.S. productivity growth has – now with 2.5 percent – surpassed the corresponding German rate with 1.3 percent.

- In Germany sectoral labor productivities are growing with different constant rates – the highest in manufacturing, the lowest in the service sector.

By contrast, in the U.S. the growth rates are accelerating with a different acceleration rate in each sector.

- Although German inflation was higher than in the U.S. for the period of 1992 to 1995, and was considerably lower in 1996 to 2000, there is a long-term tendency of a decrease in the CPI-growth rates in both countries. The German growth rate is slightly lower; yet, there is some convergence over time.

Clear differences in economic development between Germany and the U.S. emerge in the nineties. Explaining this divergence is difficult, not only because of German re-unification. Attributing it only to ICT is certainly inappropriate. After all, the application and diffusion of ICT is not a special feature of the nineties, it already started 30 years ago. What is new in the nineties, is the Internet, but its effects have not yet been reflected by the data.

3. External Trade and Foreign Direct Investment

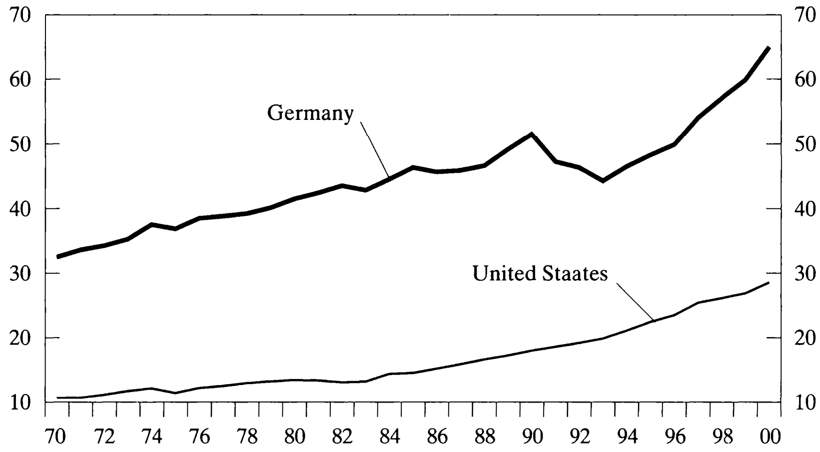
One of the neglected factors that contributed to the "lucky" combination of high growth, low unemployment and low inflation that the U.S. achieved in the nineties, is the growing openness of the U.S. economy. Despite of being one of the world's most important exporters and importers, external trade of the U.S. was always low when measured as a percentage of GDP. An often-used indicator of openness, expressed by the sum of exports and imports of goods and services (in 1996 prices) relative to GDP, was 10.7 percent in 1970, having increased marginally in the years after World War II. Since then, the indicator rose, at first slightly to around 13 percent at the beginning of the 1980s, then at a higher pace to 18 percent at the beginning of the 1990s. Finally, it jumped to 28.6 percent in 2000.

Germany, on the other hand, always has been an open economy after World War II, especially when compared to other European countries of similar size such as Italy, France or the UK. Even if the indicators for Germany have to be taken with a pinch of salt, as it is difficult to obtain consistent long time series on a comparable price base to the U.S. data due to German re-unification, the openness index was clearly above 30 percent at the beginning of the 1970s and it climbed to 50 percent at the end of the 1980s. However, German re-unification changed the situation: Germany became less outward oriented; the openness index decreased for some years and it remained below its historic high until 1997. Since then, it rose sharply similar to the development in the U.S. (Figure 12).

It is not the difference in the level of the openness indices between the two countries that matters. It is quite obvious that larger countries are less "open" than smaller ones due to the size of their internal markets. Furthermore, Ger-

Figure 12

Openness of the Economy[1]
1970 to 2000



Authors' own calculations from national sources. – [1]Sum of exports and imports of goods and services to GDP in 1995 (Germany) resp. 1996 (U.S.) prices.

RWI ESSEN

man economy was, and is, highly integrated with its neighbouring countries, whereas U.S. companies had to bridge larger distances to the relevant markets in high-income economies. This also led to differences in the companies' strategies. U.S. enterprises were much more inclined to invest abroad to get access to foreign markets than German enterprises. In 1980, the relation of outward investment stocks to GDP was 8.1 percent in the U.S. compared to 4.7 percent in Germany.

Essential for the characterisation of the differences between the two countries are the changes of the ratios: Becoming more open means to the U.S. economy nothing else than increasingly using foreign production capacities to meet excess demand and to overcome shortages in indigenous production. Furthermore, it might be argued that more openness might have helped to keep U.S. wages and thus inflation down, especially through setting low skilled labor under pressure. However, this effect is highly disputed (see, e.g., Freeman 1995; Mann 1999: 47–60).

It is the conclusion of Mann (1999: 58-59), that the impact of globalisation on wages does not differ much from the impact of technological progress and productivity growth, but the two work hand in hand. Following from this, growing openness of the U.S. economy may be considered as one source of the "new economy", as it signals a more efficient division of labor spurring productivity growth, and it helped to ease inflationary pressure and contributed to inflation-free growth (Dhrymes 2001). In Germany, integration into the international division of labor was temporarily reduced in the beginning of the 1990s, but in recent years, the impact of unification on external trade has receded.

Another aspect that has to be taken into account in this context, are differences in the organisation of trade. A good deal of U.S. exports and imports is intra-firm trade, between U.S. mother companies and subsidiaries in the Maquiladora industries in Mexico, but also in China and South East Asia. Trading within the same company necessitates a high capacity to optimise production processes and to reduce costs, which enhanced the productivity effects of trade on the U.S. economy. In Germany, on the other hand, intra-firm trade seems to have not played an important role in the past, partly due to unfavourable location conditions, as a low labor cost hinterland had been missing as long as the iron curtain existed[3]. However, during the 1990s, the situation changed inasmuch as German companies increasingly used production facilities in Eastern Europe. In this field, Germany's comparative disadvantage against the U.S. appears to become smaller.

4. Public Finance

The fundamental fiscal trends in the German as well in the U.S. economy can be characterized by a change of paradigm in the late 1970s and early 1980s. From the postwar period up to the recessions in the wake of the first oil crisis fiscal policies in both countries were more or less expansionary. Their major aim was the stabilization of the business-cycle. Yet, these measures were typically unsuccessful, leading to large public deficits and debts. Between 1965 and 1985, public debt more than doubled in Germany as a percentage of GDP, to 42 percent. In the U.S., the relation soared from 35 percent in 1970 to about the same level by 1985 (Tables 2 and 3). The public sector in the U.S. is smaller than in Germany, since it does not provide a comprehensive old age and health care social security system. Yet, in both the U.S. and Germany, during the recent decades, fiscal indicators rose dramatically. The expenditure share, for instance, rose in Germany from 37 percent of GDP in 1965 to 49 percent in 1980 and in the U.S. from 23 to 29 percent. This increase was not caused by larger tax revenues. Tax receipts did not increase remarkably as share of GDP. In the U.S. these additional expenditures were funded via deficits and, consequently, the accumulation of public debt (Figure 13).

In Germany the expansion of the educational and social security systems was partly financed by increasing social security contributions and partly by debt. This development restricted the potential of fiscal policy for stabilizing the

[3] Figures on intra-firm trade are missing in the case of Germany.

Table 2

Fiscal Indicators in Germany[1]
1950 to 2001; percentage of GDP

	current receipts			current expenditures			surplus or deficit (–)	public debt	interest-tax-ratio[2]
	total	of which taxes	of which contri-butions	total	of which interest	of which invest-ment			
1950	32.2	21.3	8.7	31.6	0.6	2.1	0.6	.	2.7
1955	35.1	23.1	8.7	30.4	0.8	2.7	4.7	.	3.4
1960	36.0	23.0	10.3	32.9	0.7	3.2	3.0	17.4	3.1
1965	36.5	23.5	10.6	37.1	0.7	4.5	–0.6	18.2	3.0
1970	39.3	24.0	12.6	39.1	1.0	4.6	0.2	18.6	4.0
1975	44.0	24.8	16.3	49.6	1.4	3.9	–5,6	25.0	5.6
1980	46.1	25.9	16.9	49.0	1.9	3.6	–2.9	31.8	7.5
1985	46.9	25.2	17.6	48.0	3.0	2.4	–1.2	41.7	12.0
1990	44.0	23.6	16.9	46.1	2.6	2.3	–2.1	43.4	11.1
1991	44.2	22.4	17.2	47.1	2.8	2.7	–3.0	40.3	12.7
1992	45.5	22.8	17.6	48.1	3.3	2.6	–2.5	43.1	14.3
1993	46.1	22.9	18.2	49.3	3.4	2.8	–3.1	47.1	14.6
1994	46.5	22.9	18.6	49.0	3.3	2.7	–2.4	49.4	14.6
1995	46.1	22.5	18.8	49.3	3.7	2.3	–3.2	57.1	16.3
1996	46.8	22.9	19.4	50.3	3.7	2.1	–3.4	59.8	16.1
1997	46.5	22.6	19.6	49.2	3.6	1.9	–2.7	60.9	16.1
1998	46.6	23.0	19.2	48.6	3.6	1.8	–2.1	60.7	15.6
1999	47.2	24.1	18.9	48.9	3.5	1.8	–1.4	61,1	14.7
2000	47.0	24.5	18.7	48.1[a]	3.3	1.8	–1.0[a]	60.3	13.5
2001	45.9	23.3	18.6	47.6	3.2	1.7	–1.7	59.0	13.8

1950 to 2000 offical data, 2001 authors' own estimations. – [1]1950 to 1990 former FRG, 1991 and thereafter Germany. – [2]Interest expenditures as percentage of tax revenues. – [a]Without UMTS-license-auction proceeds (99.4 bn DM).

RWI ESSEN

economy, providing public goods and improving the income distribution. In addition, it endangered generational equality, the provision of private investment and, consequently, the economic growth. In both countries the growth of the public sector is often implicated as the main reason for the slow-down of economic growth since the mid of the 1970s.

Reaching a balanced budget has therefore gained more and more importance in the public and scientific discussion. The allocative function of fiscal policy – as one of its three fundamental tasks besides stabilization and redistribution – has gained more and more importance in the U.S. and in Germany since the end of the 1970s. However, the countries set different courses: Whereas the U.S. tried to strengthen economic incentives by considerable reductions of about one third in (personal and corporate) income tax rates, German fiscal policy concentrated on a reduction of expenditure growth.

Table 3

Fiscal Indicators in the United States[1]
1950 to 2000; percentage of GDP

fiscal year	current receipts total	of which taxes	of which contri-butions	current expenditures total	of which interest	of which invest-ment	surplus or deficit (–)	public debt	interest-tax-ratio[2]
1950	22.5	20.6	1.9	20.2	.	3.3	2.3	.	.
1955	23.7	21.5	2.2	21.1	.	5.4	2.6	.	.
1960	24.9	21.8	3.1	22.7	2.0	5.6	2.1	.	9.1
1965	24.4	21.2	3.1	23.0	1.9	4.8	1.3	.	9.0
1970	26.9	22.1	4.5	27.6	2.3	4.3	–0.7	35.5	10.0
1975	26.3	20.9	5.5	30.4	2.4	3.9	–4.1	32.5	11.7
1980	27.4	21.5	5.9	29.0	3.2	3.6	–1.6	32.4	14.8
1985	27.0	20.3	6.7	30.6	5.0	3.8	–3.7	43.2	24.8
1990	27.7	20.6	7.1	30.6	5.1	3.7	–2.9	55.3	24.9
1991	27.7	20.5	7.2	31.4	5.3	3.7	–3.7	61.2	25.7
1992	27.6	20.4	7.2	32.4	5.0	3.5	–4.8	64.3	24.5
1993	28.0	20.8	7.2	32.1	4.8	3.3	–4.1	66.4	22.9
1994	28.3	21.0	7.2	31.1	4.6	3.2	–2.9	66.5	22.0
1995	28.6	21.4	7.2	31.0	4.8	3.2	–2.4	80.4	22.6
1996	29.0	21.9	7.1	30.5	4.7	3.2	–1.5	66.8	21.4
1997	29.3	22.3	7.1	29.6	4.4	3.2	–0.3	65.0	19.9
1998	29.8	22.7	7.1	28.7	4.2	3.2	1.0	62.8	18.5
1999	30.0	22.9	7.1	28.1	3.8	3,3	1.9	60.7	16.8
2000	30.6	23.5	7.1	27.5	3.6	3.4	3.1	.	15.2

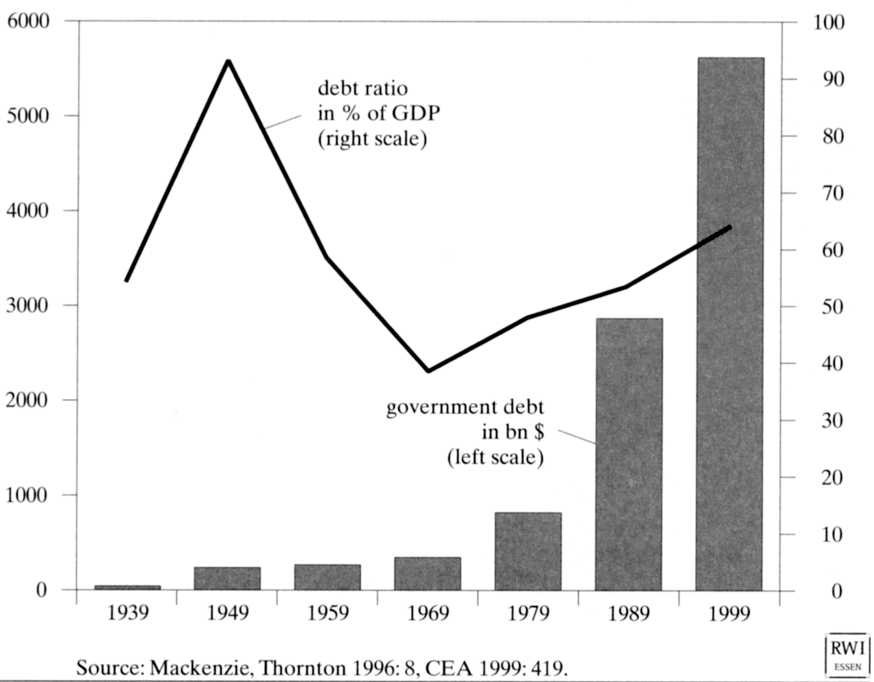
Authors' own calculations, based on CEA, U.S. Census Bureau and BEA data. – [1]Definitions in line with the National Income and Production Accounts (NIPA). – [2]Interest expenditures as percentage of tax revenues.

RWI ESSEN

Between 1982 and German re-unification each (Christian-liberal) government co-ordinated with the state and local authorities to increase the annual growth rate of all government outlays (discretionary and entitlements and other mandatory spending) by 2 percent on average. The idea was that with respect to a "normal" GDP-growth-rate of 5 percent per year the deficits in the public budgets would soon be history. In fact in 1989, on the eve of the German re-unification, the federal, state and local governments together with the social security sector reached a slight budget surplus (0.2 percent of GDP) for the first time since 1969/70. This was the more noteworthy because the so-called "great" tax reform took place stepwise between 1986 and 1990 and relieved the taxpayers by 1 ½ percent of GDP. By cutting the (personal and corporate) income tax rates and broadening the corresponding tax bases, the tax system has been simplified.

Since then, fiscal policy in Germany has been committed, at least on paper, to balance the budgets by a restrictive expenditure policy. This commitment not

Figure 13
Gross Federal Debt in the United States
1939 to 1999



Source: Mackenzie, Thornton 1996: 8, CEA 1999: 419.

only concerns public consumption (purchases and recruitment as well as remuneration of personnel in the public sector), but also the transfers for interpersonal and -generational income redistribution, particularly in the old-age social security system, and payments for social aid and assistance. However, due to the extraordinary event of German re-unification this policy approach had to be adjusted to the new challenges. Massive transfers had to be shifted from the western to the eastern part of the "new" Germany.

This necessity to transfer about 5 percent p.a. of the western economic resources to the eastern part of Germany ended restrictive fiscal policy for half a decade until about 1995. Public debt rose from around 40 percent of GDP – a level which reached Germany 5 years (1990) and the United States 10 years ago (1985) – to almost 60 percent in this short time. In effect, re-unification was financed by increasing public debt and by increasing social contributions, instead of raising taxes. But higher social contributions implied higher labor cost and, consequently, higher unemployment of unskilled workers. Since the middle of this decade we have seen intensified expenditure cuts and increases of direct and indirect tax contributions. This policy contributed to the weak

Table 4

Federal Outlays by Major Spending Category in the United States
1991 to 2000

Fiscal year	Total		Discretionary spending		of which entitlements and other mandatory spending		Interest	
	bn $	% of GDP	bn $	% of GDP	bn $	% of GDP	bn $	% of GDP
1991	1,324.4	22.6	533.0	9.1	702.6	12.0	194.5	3.3
1992	1,381.7	22.5	534.0	8.7	716.6	11.7	199.4	3.2
1993	1,409.4	21.8	540.4	8.3	736.8	11.4	198.8	3.1
1994	1,461.7	21.3	543.3	7.9	784.0	11.4	203.0	3.0
1995	1,515.7	21.1	545.1	7.6	818.2	11.4	232.2	3.2
1996	1,560.5	20.3	533.8	7.1	857.5	11.4	241.1	3.2
1997	1,601.2	19.5	548.3	6.9	896.3	11.2	244.0	3.1
1998	1,651.4	19.1	553.6	6.6	938.6	10.8	241.2	2.8
1999	1,703.0	18.6	575.0	6.3	976.8	10.7	229.7	2.5
2000	1,789.0	18.2	617.0	6.3	1,029.8	10.5	223.2	2.3
1991/2000[a]	3.3	.	1.2	.	4.3	.	1.5	.

Authors' own calculations based on CBO data. – [a]Annual growth rate in %.

RWI ESSEN

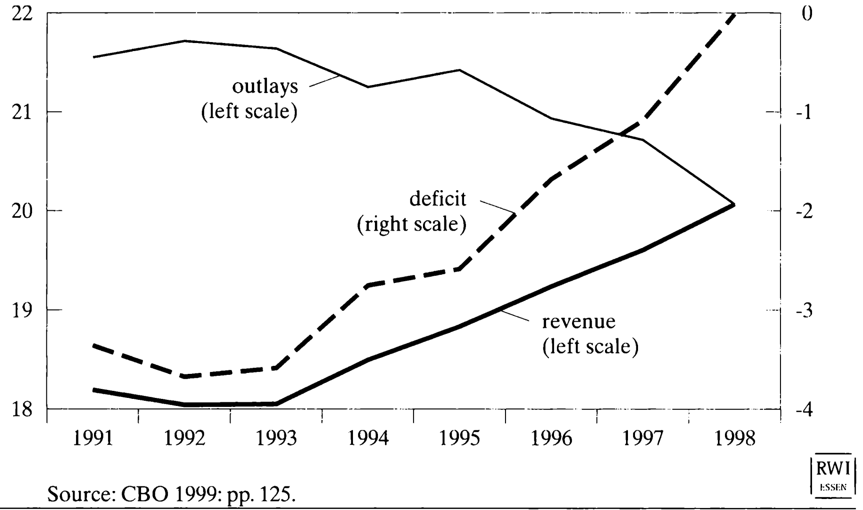
macroeconomic performance of Germany in the past 10 years: real GDP-growth did not surpass the rate of 1½ percent p.a. on average, and unemployment remained high at 4 mill. or one tenth of the workforce.

U.S. fiscal policy in the past decade can be characterized as a reversal of the unsustainable expenditure and tax policy of the 1980s which had led to considerable public debt. The restrictive fiscal policy enabled the monetary policy to reduce the interest rates below the level of the 1980s, to induce private investment and consumption. Between 1991 and 1998, the GDP share of public expenditures, particularly discretionary spending (Table 4) has been cut by 2 percentage points. The share of revenues rose to the same extent, particularly by the tax increases of 1991–1993 (Figure 14). The deficit vanished in 1998 and has been replaced by a surplus of 1 percent of GDP (Table 3); two years later (2000) the revenues outweighed the expenditure by almost 3 percent of GDP. It is noteworthy that not only the expenditure side of the federal budget has been used to balance it, but also considerable tax increases. This seems to be the more remarkable with respect to possibly unfavorable incentives to work, save and invest, because the American tax system is heavily more based on direct levies.

From a macroeconomic perspective this fiscal policy was restrictive for economic growth and employment. Our calculations suggest that the dampening

Figure 14

Federal Budget in the United States
1991 to 1998; % of GDP



Source: CBO 1999: pp. 125.

effect of these tax and expenditure policies can be associated with a loss of GDP-growth of ½ percentage point p.a. each. All in all, economic growth has been 1 percent lower annually due to fiscal policy. However, monetary policy countered the dampening effects by lowering interest rates. The federal funds rate has been on average 2 percentage points lower than in the 1980s. Econometric studies for the U.S. point out that a reduction of 1 percentage point in the interest rate typically leads to an additional economic growth of more than 1 percent. Thus, the lower interest level has been a strong countervailing force against the restrictive course of fiscal policy. What it meant for the development of the "new economy" in the U.S. will be analyzed in the following section of this report.

Chapter 2

ICT and Earlier Technological Revolutions

One of the main issues of the study refers to the question whether the general and particular economic advantages of the new ICT correspond to those of earlier technological revolutions. According to the experience of the past, the focus will be on the following questions:

- To what extent can ICT be regarded as fundamental in the sense that they fundamentally change the type of industrial production and require far-reaching changes in corporate organisation and working processes?

- To what extent do ICT differ from earlier fundamental technologies (e.g., the steam engine, the railway, the combustion engine, electricity, and the automobile; David 1990; Gordon 2000a) with regard to the range of their effects and the speed of diffusion?

- How long does it usually take for new technologies being widely used? Thus, when technical and scientific innovations are integrated in the production and the working processes and when do they show spill-over effects that influence the interplay between the economic units?

- If there is a time lag in the diffusion of a technology in Germany, what is a realistic timescale for convergence?

To find out if the characteristics of the ICT and use of such technologies in the economy are comparable to earlier technological revolutions, historical time series for Germany and the U.S. are analysed. For Germany, time series exist since 1850 for the net domestic product in current and in constant prices (Mitchell 1980). However, there are missing data between 1914 and 1924 as well as between 1939 and 1949. Between 1950 and 1990 the time series covers Western Germany. Yet, until 1960 West Berlin and the Saarland are not included. By contrast, the time series for the U.S. is not affected by structural breaks. However, between 1869 and 1917 there are no annual values; the data were only collected in five-year or three-year cycles.

1. Fundamental Technological Revolutions in Historical Perspective

Economic growth is not a continuous, but rather a stepwise phenomenon. The corresponding structural change itself is induced by innovations. The concept of innovation comprises the transformation of scientific knowledge into new products and production processes, but also new organisational forms of firms, institutions, and labor. Life-cycle theory explains the sequence starting from innovation, and leads over its diffusion, to the maturity of the product and its descent. The rise and fall of new products or processes are reflected by the rise and decline of industries and sectors.

Inspired by this insight, some observers have suggested the existence of long swings in economic development. They argue, in particular, that the economic development of the past 200 years can be divided into five large cycles, the so-called Kondratieff cycles. Each of them is viewed as being caused by different fundamental technologies. Those fundamental innovations induce changes in the methods of production in the overall economy which are accompanied by changes in the structure of value added. These changes are in turn supported by the tendency to substitute new, more information intensive products for traditional products.

The fundamental innovations are often followed by incremental or derivative innovations which induce a "bandwagon effect". The derivative innovations refer to the application and diffusion of the new products, production processes, or institutions. If those incremental innovations are complementary, they can cause a sustainable upward shift of the growth path of an economy until their benefits are exhausted. The five Kondratieff cycles implicated by this literature (see Nefiodow 1990) are:

- The first cycle ranges from the end of the 18th to the middle of the 19th century based on the use of the stationary steam engine. The steam engine caused the industrial revolution, as well as the existence of firms as institutions and a shift from agricultural to industrial workers. The regional impacts were concentrated in England.
- The second cycle spans from the middle to the end of the 19th century and was based on the mobile steam engine. In combination with the knowledge of steel processing, the formation of the railway system totally changed the existing infrastructure. Coal mining, the steel industry and the manufacturing of machinery have gained by the application of the steam engine. The regional impacts were concentrated on the U.S. as well as on Europe.
- The third cycle started at the beginning of the 20th century and ended in World War II. This period can be characterized by the widespread application of electricity, the electric motor, radio and telephone, and by mass production as a new production process. In connection with mass production

DOI https://doi.org/10.3790/978-3-428-51327-7 | Generated on 2025-09-03 17:43:25

the purchasing power of the private households increased, too. Alongside pure production processes, planning processes, administration and product marketing gained in importance as additional fields of economic activity. In the U.S., the diffusion of electricity and the development of the automobile occurred simultaneously. The electrification of manufacturing, the widespread use of the automobile reached their peaks in the 1920s. In Europe, however, the diffusion of the automobile was delayed in comparison to the U.S. until after World War II. Nevertheless, electricity had, too, become widespread even at the time of the third cycle.

- The fourth cycle started after World War II and was mainly based on improvements of existing technologies. Important innovations are petrochemicals followed by innovations in plastic materials and textiles based on mineral oil. Finally, the first computer and the microchip were developed. The fourth cycle was ended by the oil crisis in the early seventies.
- Since the end of the fourth cycle there has been a fundamental structural change in the economy. This change was mainly driven by an increasingly international division of labor, the globalisation process, and the increasing importance of information as both a production factor and a technology. Furthermore, there has been enormous technical progress in biotechnology and genetics which have led to new and growing markets. Those changes are often interpreted as a fifth Kondratieff cycle (Nefiodow 1990) based on telecommunications. Because of the international division of labor and the globalisation process, the impact of this fifth cycle is no longer regional but global.

However, at best the exact date of the beginning and end of such cycles within the economic development can be identified ex-post on the basis of income and price elasticities. Furthermore, a fundamental technological innovation does not cause a new growth path of the economy directly after the date of invention. It is more the sufficient diffusion and application of a new product, process or institution which accelerates the growth path. The exact date of this sufficient diffusion cannot be determined ex-ante. Finally, it must be taken into account that normally a fundamental innovation is followed by further incremental innovations and developments, which are, on the one hand, influenced by the technology and, on the other hand, by market conditions. The interplay between the fundamental innovation and the follow-up innovations influences the time lag before the innovation reaches marketability and widespread application. If there are no supporting factors which increase the absorption of the market for the innovation, it will take a long time between the innovation and its diffusion.

For example, the widespread application of electricity, which is characteristic for the third cycle, has its roots in proceeding technological innovations. Already in 1866, *Werner Siemens* invented the generator principle, which is still valid today for the production of electricity. In connection with the invention of the light bulb by *Thomas Edison* (1879), and the gradually emerging electrification of the cities because of the decentralization of the energy sources, at the end of the 19th century mass production became the prevailing production method. Industrial mass production changed existing production and working processes and the organization of firms. Those induced changes were the preconditions for further innovations and raised the standard of living significantly. This in turn had repercussions on the purchasing power of consumers. According to our estimations, the time lag between the fundamental technological innovation and the widespread use of electricity, with its derivative and incremental innovations, took about half a century.

A further important technological innovation is the automobile and the combustion engine as its core element. The third and the fourth Kondratieff cycle are both influenced by the use and widespread dispersion of the automobile. The automobile influenced regional structures, for example, by the formation of suburbs. The regional delivery and supply interlinkages were influenced by the formation of supermarkets. The satisfaction of the demand for mobility raised the standard of living. Nevertheless, the innovation of the automobile in a strict sense took place in 1885 by *Karl Benz* and *Gottlieb Daimler*. Thus, as for electricity, it took half a century until the widespread use of the automobile as a mass transportation system induced a sustainable change in the economic and regional structure. As a complementary innovation, the formation of the necessary infrastructure and a national road network – especially in the U.S. with its long distances – in the first half of the 20th century boosted the diffusion of the automobiles. *Henry Ford* started the production of automobiles using assembly lines. Annual output increased between 1910 and 1920 from 19,000 to 1.25 million units, confirming *Henry Ford*'s expectation of an increasing demand for automobiles. In Germany, *Adam Opel* introduced the assembly line production in 1924. In the year 1935, for the first time, the annual output of automobiles, exceeded 100,000 units. The widespread diffusion of the automobile in Germany took place about 20 years later than in the U.S.

Also, in the area of audiovisual technological developments and entertainment facilities, the first innovations have their roots firmly in the past. Important audiovisual innovations were the photography by *Daguerre* in the year 1839 and film projection by the *Lumière* brothers in the year 1896 in France. In 1877, *Thomas Edison* invented the phonograph, and around 1887 *Berliner* developed the vinyl record which has been used until recently. In the year 1897 the first cathode-ray tube was developed by *Braun*, and in 1898 *Poulson* invented a magnetic tape recorder for recording sounds. All of these innovations took place in the second Kondratieff cycle, however, they did not determine this cycle owing to the lack of diffusion to that time. In the twenties, the widespread diffusion of radio broadcasts began, so that in the third Kondratieff cycle, the information and communication structure changed significantly. The first radio station, with a regular radio programme started in the year 1920 in Pittsburgh in the U.S., and in 1923 in Berlin in Germany.

With the widespread use of television in the fifties, the information and communication possibilities were coined to a great extent by mass media. Again, it took nearly half a century between the fundamental technological innovation and its widespread diffusion. Only this diffusion facilitated a sustainable and significant change of the conventional communication structure.

Concerning the development of the telephone as a communication medium there was a slightly faster diffusion: In the year 1876 the patent for the first telephone in the U.S. was granted to *Bell*, and only four years later there were about 50,000 telephone connections in the U.S. By contrast, in Germany, this number was reached not until ten years later. In the year 1920, there were 21 million telephone connections in the world: 64 percent in the U.S., 9 percent in Germany, and 27 percent the rest of the world. In spite of the fast increase in the number of telephone connections in such a short time, the communication structure only started to have a sustainable influence on society in the seventies. The time lag between the technological innovation and the widespread supply with telephone connections was less than 50 years. However, the significant impact of the communication structure on the society and economy, because of the widespread application and use of this medium, did not occur until 70 years later.

The technological development of the computer can be subdivided into different periods: the first transistor was invented in 1948. At this time *Zuse* and *Turing* also developed the first computer. At the end of the fifties, for the first time, electronic semiconductors began to be mass-produced. In the year 1971, the first microchips with more than 100,000 transistors were developed. In the following year the Arpanet in the U.S. – a pioneer of the Internet – was built-up for military reasons. Since the beginning of the eighties, videotext as a basis for multimedia data processing was implemented. The first personal computers were developed by *Wozniak* and *Jobs* in the year 1976. The first cheap personal or home computers were supplied in the beginning of the eighties. They formed the basis for multi-media data processing. During the nineties, the world wide web was developed and, until now, the number of connected computers on the Internet has been increasing enormously.

Similarly to the telephone, the time lag between the first innovation and a broad market diffusion, in the form of automation of manufacturing and administration processes was less than fifty years for the computer. However, the diffusion of computers happened within a framework of an increasing importance of administration and management of production and market processes and an increasing service intensity. Thus, there has already been a demand for the new abilities of computers. Furthermore, the high velocity of diffusion was boosted by the very fast decrease in prices. The impact of the computer as an information and communication medium on economic structure and growth has not been seen until recently. Computers have widely been used in the economy ever since the seventies, and their spread continues.

Besides the application of computers as single calculation machines, the past ten years have brought the additional effects of the network computer, via the Intranet or Internet, as a derivative innovation of the computer. Bearing in mind the long time horizons between the first innovation, the widespread application and the repercussion of the application on the economic structure, it seems to be plausible that the influence of the use of ICT on the economic structure has not emerged in its entirety. In particular, the impact of the Internet is not fully reflected in the existing data because the observed period since the formation of the Internet is too short. A possible long-term consequence could be a higher market transparency because of an easier accessibility of information. Higher transparency might lead to lower prices and, therefore, to higher consumer welfare.

Comparing all of the fundamental technological innovations and driving forces of economic growth during the past 200 years, one can find the tendency towards an increasing service intensity and a qualitative change in communication structures, connected with the dispersion and application of the innovations in the economy. However, the productivity effects within the service sector are more difficult to evaluate than in the manufacturing sector because the input and the output in the former are more difficult to define than in the latter.

Furthermore, accelerated growth in connection with fundamental innovation, its diffusion, and the emerging structural change can take place more easily, if there is an innovation-friendly economic and social framework, and the different interest groups are open-minded and willing to adopt the innovations. For this reason the U.S. might have had the better preconditions for the diffusion and adoption of ICT, while in Germany, especially during the nineties, the challenges of re-unification had to be mastered. Besides the special effects of German re-unification, during the nineties some further structural changes dominated: During the second part of the nineties in Germany a lot of structural reforms and deregulation took place, while in the U.S. those reforms had already been carried out earlier. So in the nineties the diffusion of ICT in the U.S. took place in highly competitive and quickly changing markets. This structural framework was less volatile and easier to predict than in Germany.

Table 5

Growth of GDP and Labor Productivity in Historical Perspective
1871 to 2000; annual average growth rate in %

Innovation	Period	GDP		Labor Productivity	
		Germany	U.S.	Germany	U.S.
Total period	1871[1]–2000	2.7	3.7	2.3	1.4
Kondratieff cycle:					
mobile steam engine	1871–1900	2.5	4.8	0.9	1.7
electricity, automobile	1900–1945	1.8	3.6	2.0	1.1
petrochemicals, television	1945–1970	4.9	2.9	3.9	1.8
information	1970–2000	2.1	3.1	1.7	1.2
Computer with vacuum tubes	1950–1959	7.7	3.6	6.0	2.1
Substitution of vacuum tubes by transistors	1959–1965	6.3	4.5	5.5	2.5
IBM Computer	1965–1975	3.1	3.0	3.4	1.1
Microchips	1975–1985	2.2	3.4	2.0	1.2
Decentralisation with PCs and workstations	1985–1990	3.4	3.2	1.9	0.9
WWW	1991–1995	1.3	3.1	2.0	1.3
Increasing diffusion with ICT	1995–2000	1.8	4.1	1.1	1.7

Authors' own calculations. – [1]Due to data restrictions the calculation of labor productivities was started in 1891. RWI ESSEN

2. Analysis of Historical Time Series

During the whole period between 1871 and 2000, GDP in the U.S. grew with an annual average rate of 3.7 percent. That is much faster than in Germany with a rate of "only" 2.7 percent[1] (Table 5). However, on the other hand, the average growth rate of labor productivity in Germany was 2.3 percent – higher than in the U.S. (with only 1.4 percent).

Also across the various phases of long-term economic development average growth rates of GDP differed. In addition to the particular fundamental innovations, other factors have had an important impact. For example, the extraordinary growth rate in Germany (4.9 percent) in the fourth cycle, between 1945 and 1970, was more the result of the reconstruction phase correcting for the low level of GDP after the war than of innovations in petrochemical production processes and television production, the main innovations in this period. In the U.S., during this time the average GDP growth rate (2.9 percent) was just below the long-term average, so that the innovations of the fourth cycle did not augment the growth path. However, the GDP had already reached a very high level and high growth rates in the U.S. before the war, so that a slight deceleration of growth was not unusual.

[1] To take into account the variations in the regional coverage by Germany, the average growth rates are not calculated from the original levels. Rather, they represent the geometric means of the corresponding growth factors, and the missing values for the years where structural breaks occurred are replaced by imputed values.

The GDP growth rates of the second and third cycles can be interpreted in a similar way. Both fundamental innovations and additional factors have influenced the growth path. The fundamental innovations of both of these cycles changed the supply of mobility possibilities. Because of the great distances and the different regional settlement structures in the U.S., this supply had met a greater demand, so that the market conditions for the diffusion of those new mobility concepts were better in the U.S. In the fifth cycle, with information as an important resource, the GDP growth rate in the U.S. has accelerated again to 3.1 percent and has surpassed the corresponding German rate (2.1 percent). Nevertheless, by interpreting this difference as solely a backlog of Germany, one has to take into account – besides the different country-specific influencing factors – the very high level from which the German growth rates were calculated. After World War II, in the period of reconstruction German growth was very fast. Consequently, the growth rates of the period after the end of this reconstruction process had to be lower.

Concerning labor productivity, the German growth rates have been higher than the U.S. rates since the third Kondratieff cycle. The highest growth rate of labor productivity in Germany was in the post-war period during the fourth cycle. Thereafter, the rate declined to 1.7 percent. However, the reason for those high rates was the very low capital stock installed directly after World War II, and the fast increase of capital employed in the years after the war. In the U.S., the growth rates have not fluctuated strongly between the different cycles. Regarding the whole period of the fifth cycle, the U.S. growth rate of labor productivity (1.2 percent) was lying 0.5 percentage points below the corresponding German rate (1.7 percent).

The fifth cycle, which is characterized by information as important economic resource, has neither led to significantly higher growth rates of GDP nor to higher growth rates of labor productivity yet, so that the computer as a fundamental innovation has not caused such greater effects on the economy than other fundamental innovations. Further insight might be gained by analysing sub-periods of the fourth and fifth Kondratieff cycle (which are defined by important innovations in the field of computer technology). In the first two sub-periods in Germany until 1965, the growth rates were very high. Yet, the reason was the economic boom after World War II rather than the invention of vacuum tubes or transistors. Nevertheless, in the U.S., the growth rate (4.5 percent) in the second sub-period 1959 to 1965 accelerated compared to the first sub-period. The growth in the U.S. was nearly as fast as during the invention and diffusion of the mobile steam engine at the end of the 19th century.

The invention of transistors in the first half of the sixties, which led to smaller computers making them more robust, made a broader diffusion of the computers possible. The broad employment of computers changed the production processes and led to a capital deepening. The growth rate of labor productivity reached its maximum during this sub-period in the U.S. Also, in Germany, the high growth rates of labor productivity between 1950 and 1965 have not been reached again until now. However, the high rates in Germany were caused by the post-war capital deepening rather than by the increasing diffusion of computers and microchips in conventional production processes. Between 1965 and 1990, in the U.S., the growth rates of labor productivity were between 0.9 and 1.3 percent, which was relatively low in comparison to earlier periods or in comparison to Germany.

During the nineties, German growth rates were significantly lower than in the U.S., which enjoyed a solid expansion. The German deficit of growth became more obvious in the second part of the nineties than in the first part. Since 1995, in the U.S., there was a significant acceleration of both the GDP growth and the growth of labor productivity. Furthermore, the U.S. has outstripped Germany concerning labor productivity. For the first time in the 20th century, the U.S. growth rate of labor productivity was, at 1.7 percent, higher than the corresponding German rate of 1.1 percent. However, the U.S. rate does not match the average of the fourth Kondratieff cycle (1.8 percent) between 1945 and 1970. They have also fallen behind the high-labor productivity growth between 1950 and 1965. Nevertheless, in the long term, the average growth rate of labor productivity in Germany has always been higher than in the U.S.

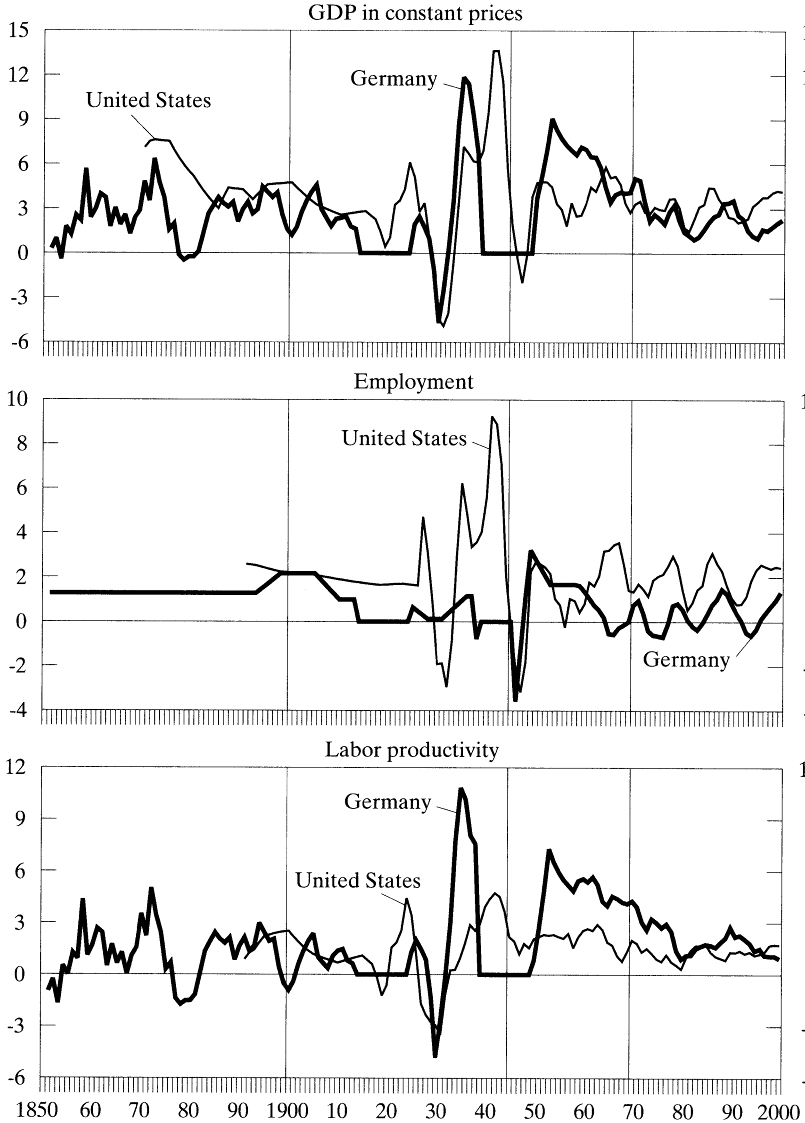
Furthermore, the increase in economic productivity was mainly caused by increased productivity in the manufacturing sector, which was induced by the application of computers in those industries. However, in many industries outside the manufacturing sector, no significant productivity gains could be seen, which is reflected in the famous statement of Solow in 1987 concerning the productivity paradox of computer use. Reasons for the pretended low productivity growth outside the manufacturing sector are the limited possibilities of an increase in production. For example, several working processes such as the management functions and personal consulting cannot be carried out by computers.

Because the nineties are characterized by a widespread formation of computer networks, it seems to be plausible that the intensive use of the Internet has induced a positive impulse on growth and productivity. However, in the U.S. many positive factors came simultaneously into operation and supported the expansion. As a necessary, but not sufficient condition, the technological opportunities had to be available. However, the combination of innovations in hardware (computing power) and software could be interpreted as complementary incremental innovations which strengthened each other. Furthermore, in the U.S., there was a strong demand for information as well as com-

Figure 15

Long-term Development in Germany and the United States

1850 to 2000; five-year moving average of growth rates in %



Authors' own calculations.

RWI ESSEN

munication products and services from the service sector. This demand was supported by the firms' strategies of concentrating on core competencies and outsourcing parts of their operations. This situation was similar to the diffusion of automobiles in the first part of the 20th century, where also a strong demand for mobility met a new supply. A further positive factor for the diffusion of ICT was the strong competition in a stable political framework, because the deregulation processes of the regulated markets had already taken place in the eighties.

The backlog concerning German GDP growth, however, should not be interpreted in such a way that there appears to be a ten-year time lag in the use of ICT and the Internet in Germany. There are, rather, completely different starting positions. In Germany, during the nineties, a special situation prevailed: Firstly, the economic effects of the German re-unification have led to a structural break in the existing growth path, which prevailed during the beginning of the nineties. Secondly, a lot of markets were deregulated, which led to a political and economical framework which could not be predicted as easily as in the U.S. Furthermore, because of the high unemployment rate and the discussion about the feasibility of the social welfare system, the future expectations were – compared to the U.S. – rather pessimistic, which led to a more unfavorable framework for the diffusion of innovations and for investment in general. The combination of those extraordinary factors has hampered the positive economic effects of an intensive Internet use, so that for Germany one has to wait until the impact of those extraordinary effects has faded out to prove the effects of ICT use on economic performance.

The graphical comparison of the five-year moving average growth rates (Figure 15) confirms the frequent changes of the leading positions in the velocity of the German or U.S. GDP growth. Generally, the strong declines in growth were caused by wars and by the world depression. During the period of the economic miracle in Germany (in the fifties and sixties), the Germany GDP growth was significantly higher than those in the U.S. The advantage of the U.S. concerning the growth rates, however, began in the nineties. Nevertheless, in none of the periods can any permanent upward shift of the level of the growth rates be seen. Therefore, in the long run, none of the fundamental technological revolutions have resulted in a permanently faster growth path. Every acceleration of growth is followed by phases of deceleration and is only partly caused by the fundamental innovations. Additional factors, which may support or hinder the economic performance, have also played an important role.

Concerning the employment figures, the time series for both Germany and the U.S. display several missing values. The data result from different censuses, which were carried out in different years with periods of data collection every five or ten years[2]. The missing values for the employment data between two particular collection periods are interpolated linearly, so that constant annual change rates are assumed. The growth rates of employment in the U.S. have nearly always been higher than in Germany. An exception is the period around the time of the world depression and at the beginning of the fifties. Since the sixties, the employment growth in the U.S. has been faster than in Germany, regardless of the particular situation of the business cycle.

3. Historical Trend Growth of the Production Potential

To find out if the technological innovations concerning ICT have changed the growth path of the economy, one has to cancel out the cyclical fluctuations and concentrate on trend growth. For this reason, the historical time series of GDP, employment and labor productivity are smoothed by the HP filter (see Chapter 1), so that only the development of the trend component remains as residual. Figure 16 reports the rates of estimated trend growth[3].

Since the fifties, the German trend growth of labor productivity has decelerated, while in the U.S. the growth rate was around 1.5 percent. However, one can also see, that the U.S. productivity growth during the nineties with 1.3 to 1.7 percent is higher than in the seventies and eighties. This may give a weak indication for the increased diffusion of the economy with ICT which has led to a positive production effect. Nevertheless, the currently growth can hardly be compared with the high growth rates of labor productivity at the beginning of the twenties and the forties.

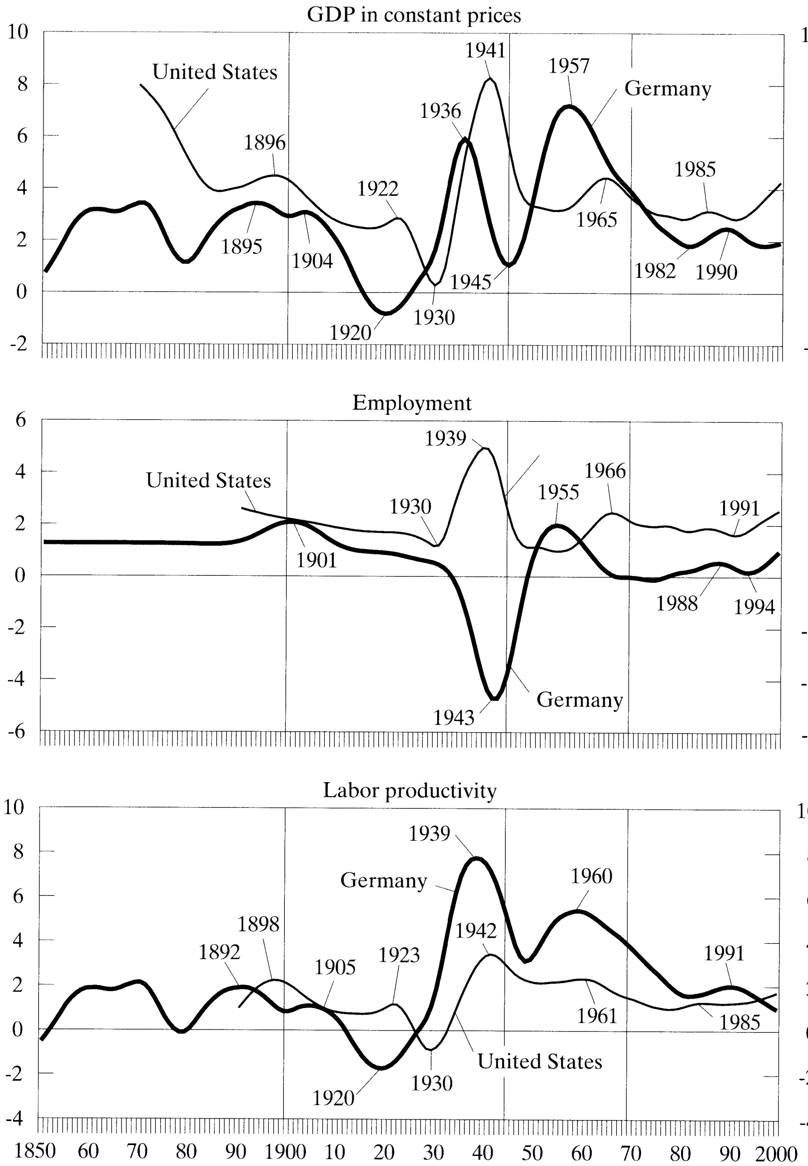
Until the world depression, the trend growth rate of the production potential in the U.S. was higher than in Germany. Reasons for the backlog in growth in Germany were, on the one hand, the impacts of the German-French war (1870/71) and World War I. On the other hand, the automation in the U.S. had started ten years earlier than in Germany. To which degree the earlier automation in the U.S. and the impact of the wars in Germany have caused the higher growth path in the U.S. cannot be identified on the basis of the data. However, one can see that in the U.S., in the first half of the 20th century, there was a slight acceleration of the GDP trend growth. This acceleration occurred in a

[2] For Germany the collection periods are 1882, 1895, 1907, 1925, 1933, 1939 (in borders of 1937), 1946, and 1950; the missing values between the collection periods are interpolated. Since 1960 there are annual data. For the U.S., there exist data for the labor force only for several years (1890, 1900, 1920, and 1930). With interpolation and estimates for the unemployed, the number of employed are estimated. Since 1929 there exist time series without missing values. The structural breaks in the data of employment because of the different borders of Germany are handled like the GDP data. The average growth rates are calculated as geometric means of the growth factors; missing values because of the structural breaks were estimated.

[3] The missing values during the World Wars were smoothed by interpolating because only the long-term trend development is of interest.

Figure 16

Estimated Trend Growth Rates[1] of Historical Time Series in Germany and the United States
1850 to 2000; change rate relative to previous year in %



Authors' own calculations. – [1]HP filtered, see text.

period of capital deepening due to automation and the introduction of assembly lines in the production process (especially in the automobile production). The world depression, however, interrupted this development and led to a sharp decline in the U.S. growth.

In the second part of the twenties, Germany had caught up to U.S. GDP and productivity trend growth rates. GDP and productivity growth accelerated significantly during the thirties, a period in which the capital stock was built up and automation gained in importance in Germany. However, acceleration in Germany was also influenced by the fiscal stimulation of demand because of the preparations for the World War II. In Germany, the maximum trend growth rate of GDP (6 percent) was reached a long time before the beginning of World War II (in the year 1936). During the war, the German trend growth rate declined sharply. The maximum trend growth of GDP in the U.S. was reached later on in the year 1941. Thereafter, the trend growth rates decelerated to below 4 percent.

In the following years of the economic upswing, German production potential growth has outstripped the growth rate of the U.S., reached its maximum in the year 1957 and then decelerated continuously until 1982. After the 1972/73 oil crisis, the U.S. surpassed German production potential growth rates again. Until now, the U.S. growth rates have always been higher than the German rates, and the difference is even widening. Since the nineties one has been able to see a significant acceleration of trend growth, which can at least partly be attributed to the higher diffusion with ICT. Furthermore, one can see that in the post-war period, the U.S. trend growth rate of production has fluctuated less than in Germany. Focusing on the post-war period, neglecting the special influence factors of governmental demand stimulation because of the war, one can see that the recent growth rates in the U.S. are even higher than the growth rates of the boom in the sixties.

The differences between Germany and the U.S. are reflected especially in employment. Even in the past, until the end of the forties, the U.S. employment trend growth rates were higher than in Germany. World War II reduced the number of the employed people in Germany significantly. In the U.S., however, the trend growth rate of employment accelerated. At the beginning of the fifties the rate reduced to 1.7 percent, a figure which was also reached at the end of the thirties. In the middle of the fifties, the German trend growth rate of employment had surpassed the rates of the U.S. for the first time. However, in the beginning of the sixties in the U.S. one can see a significant change in the growth path of the employed people from 1.7 to more than 2 percent. A further acceleration of the growth path of employment emerged during the nineties. However, also in Germany, one again can see – after the decline of the employment growth rates after the re-unification – an acceleration, although on a much lower level.

The estimated trend growth of labor productivity was more stable in the U.S. Furthermore, since the end of the twenties the trend growth of productivity has always been higher in Germany than in the U.S. There is a coincidence in the time between the widespread use of ICT in the economy, the beginning of the Internet and the acceleration of the trend growth rate of labor productivity. In Germany the trend growth rate of labor productivity is still declining, a slight acceleration of the trend growth of GDP, however, can be observed in the last years. Also for Germany, there are weak indications for an impact on growth coming from the "new economy".

4. Concluding Remarks

The velocity of GDP growth since the nineties in the U.S. has not been higher than in some time intervals of the past, for example after 1930 and in the fifties. Intervals of high long-term economic growth have always been followed by intervals of lower growth, so until now the pattern of the recent development is not unusual. However, the recent upswing in the U.S. looks similar to upswings in the past, which were induced by fundamental innovations. However, until now, ICT has seemingly not caused greater, but rather smaller effects on the economy than earlier technological revolutions.

In Germany the recent trend growth rates of GDP are far away from those which can be connected with an upswing because of a fundamental technological innovation. Nevertheless, at the end of the observed time series there is a turning point which has changed the direction of the trend growth upwards.

Concerning labor productivity, since the end of the twenties, the trend growth rate in the U.S. has, for the first time, surpassed the corresponding German rate. The U.S. growth rate is characterized by a downward tendency since the beginning of the forties. Yet, in the eighties there was a turning point with increasing rates from this time on. In Germany, the deceleration of the trend growth rate of labor productivity started in 1960 and – ignoring the short-term effects of re-unification – is still continuing. However, the long-term deceleration of German productivity growth since 1960 is not unusual because it could not be expected that the extraordinarily high productivity growth of the past caused by the restructuring process after World War II would last forever.

The usual time lag between the date of the technological innovation and the widespread application of this innovation, which induces a structural change of the existing economic situation, typically takes about half a century.

The invention of the computer took place more than fifty years ago, and the widely spread application began not until the seventies and eighties. Thus, on the one hand a large part of the productivity effects already occurred in the past. On the other hand, a lot of effects will only arise in the future, because many problems concerning information technology have still to be solved; for example the efficient transformation of information into useful knowledge.

The Internet can be interpreted as an incremental innovation which has followed the technical innovation of computers. The economic effects of the Internet, however, have not shown up until now because the time interval is too short.

Chapter 3

Volume and Growth of the ICT Sector

After the historical perspective described in the previous chapter, this section provides an empirical analysis of volume and growth of the ICT sector both in Germany and the U.S. In addition, the direct contribution of the ICT sector to overall economic growth and employment will be estimated. For this reason, a practicable definition of the ICT sector and a number of indicators have to be chosen which represent the volume and quality of production and – as far as possible – some characteristics of the production process. For a detailed analysis of the ICT sector, information is required about factor input, production, and distribution up to final demand (Shedule 1). Unfortunately, the statistical basis for this issue is very weak: The available indicators are mainly focused on physical output (e.g., production, market volume, value added), whereas input factors are restricted especially to employment and R&D. Further input factors, such as physical and/or human capital spending, business start-ups (and closures) are not available. In addition, the time horizon for the analysis is limited to the years from 1990 to 2000.

1. Definitions and Data Base

A crucial condition for the analysis is finding the appropriate definition of ICT products. One question is to what extent traditional information products like newspapers and books should be included, too. We propose to focus on the use of digitized signals and miniaturized techniques as a main criterion. Obviously, the OECD's well known definition was guided by the same criterion: As a result of the April 1998 meeting of the "Working Party on Indicators for the Information Society" (WPIIS) and subsequently endorsed at the September 1998 meeting of the "Committee on Information, Computer and Communications Policy", the OECD presented a detailed proposal of ICT producing industries, expressed in terms of the International Standard Classification (ISIC rev. 3) (OECD 2000c: 7; OECD 2001f: table B.7.1, B.7.2). According to this definition, the ICT sector comprises seven industries of the manufacturing sector, and four industries of the service sector:

Schedule 1

Framework for Data Collection: ICT Production and Demand

Value added creation chain/ Industry	Input factors		Market volume		Intermediary demand		Final demand	
	Labor	Capital	Production	Imports	Investment	Inputs	Export	Consumption
Hardware Computers Cables, Wires Components								
Software Wholesaling Retailing Telecommunications Data Services								
Total								
Ref. NBE								
Other Sectors								

RWI ESSEN

(1) Manufacturing
- 3000 Office, accounting, and computing machinery,
- 3130 Insulated wire and cable,
- 3210 Electronic valves and tubes and other electronic components,
- 3320 Televison and radio transmitters and apparatus for line telephony and line telegraphy,
- 3230 Television and radio receivers, sound or video recordings or reproducing apparatus, and associated goods,
- 3312 Instruments and appliances for measuring, checking, testing, navigating, and other purposes, except industrial process equipment,
- 3313 Industrial process control equipment,

(2) Services
- 5150 Wholesaling of machinery, equipment and supplies,
- 7123 Renting of office machinery and equipment (including computers),
- 6420 Telecommunications,
- 7200 Computer and related activities.

In the publications cited above, the OECD provides – on the basis of national and international data available – an estimate of total volume of ICT sector in the OECD-countries for 1997 and 1999 (and in some cases for an earlier year). In this study, we have tried

- to calculate comparable figures for the years 1990 and/or 1995 to 2000 for the U.S. and Germany and

- to decompose them by industries on the 4-digit level of the ISIC or the German GP 95 code.

These calculations are based on published data[1]. Due to remaining differences between the international ISIC and the different national classifications (SIC for the U.S. vs. WZ 93 or GP 95 for Germany), the results are not fully comparable. For this reason, in the following tables the direct international comparison is provided only for the aggregated figures. Concerning the breakdown by 4- or 3-digit levels of SIC and WZ93, there are separate tables for the U.S. and Germany. In addition, there are two slightly different definitions for the ICT sector: It can be shown that the definition cited above seems quite broad, because it also includes "traditional" products such as "Insulated cables and wires" (ISIC 3130), "Instruments for meausuring air pressure, water flows or electric capacity" (ISIC 3312; 3320 GP 95), and „Industrial process control equipment" (ISIC 3313; 3330 GP 95).

Due to this and to the lack of reliable data, in some parts of the study a more narrow definition is used; it is defined as "ICT sector (RWI)" and excludes the items ISIC 3130, ISIC 3312 and ISIC 3313[2]. Besides the OECD, several national and international institutions use diverging definitions and only in few cases they allow the analysis over time. In the following tables some of theses calculations are quoted, too (see, e.g., EITO 2001; Eurostat 2001a, b; WITSA 2000). The differences between these definitions and the OECD definition will be explained as far as possible.

2. International Comparison

According to recent OECD publications, the ICT sector is of substantial importance for overall economic value added and employment primarily in the U.S. and the UK and in some smaller countries like Finland and Sweden, but only of limited importance in Germany, Italy, France, and Japan. With the exceptions of Finland, Japan and Sweden, all selected countries are net importers of ICT products (Table 6).

Another well-known source for the volume and the perspectives of the ICT sector is EITO, a joint organization of leading enterprises of the ICT sector. Due to a more narrow definition and the exclusion of exports, the EITO fig-

[1] In the case of Germany, the main sources were the current surveys of the Federal Statistical Office in the manufacturing industry, the value added tax statistics and the the national account statistics; in the case of the U.S. the Current Population Survey (CPS) conducted by the U.S. Bureau of Labor Statistics (BLS), the BEA Survey of Current Business, and the U.S. Census Bureau's Annual Survey of Communication Services (ASCS). Additional information resulted from EITO 2001 and OECD 2000c, 2001f.

[2] In a recent study, RWI used a broader definition, including "old" information technologies (paper production, printing products, advertising, libraries, news services, and others; RWI 2000).

Table 6

Size and Growth of the ICT Sector in International Comparison
1998 to 2000

	Germany	Finland	France	Italy	Sweden	UK	U.S.	Japan
Value added, employment and trade in the ICT sector, 1999								
ICT as % of total business								
Value Added	7.0	13.2	9.8	7.1	11.5	10.7	10.5	8.1
Employment	4.5	9.4	9.0	4.7	8.7	7.7	5.8	6.9
Trade balance	–0.4	3.0	–0.2	–0.9	2.1	–0.4	–0.4	1.3
ICT as % of total goods trade								
Average exports/imports	12.5	21.7	12.8	8.4	19.5	20.7	22.7	24.6
Market volume of ICT products in bn $, 2000								
Total	108	7	80	58	17	94	683	208
Information	52	4	41	19	10	50	429	115
Telecommunications	56	4	40	38	7	44	254	93
Annual growth rate, 1998/00								
Total	10.2	11.0	12.8	14.6	10.9	12.4	.	.
Information	9.9	12.2	11.6	11.5	11.1	11.9	.	.
Telecommunications	10.5	9.9	14.1	16.3	10.6	13.1	.	.
As % of GDP, 2000								
Total	5.0	5.6	5.5	4.8	7.2	6.7	7.8	5.3
Information	2.4	2.6	2.8	1.6	4.2	3.5	4.9	2.9
Telecommunications	2.6	3.0	2.7	3.2	3.0	3.1	2.9	2.4

Source: OECD 2000c, 2001f; WITSA 2000; EITO 2001 and authors' own calculations. RWI ESSEN

ures for the market volume of ICT products and services are significantly lower than the OECD calculations, but they show the same differences between the selected countries. Judged by the growth rates in 1998/2000, the use of ICT goods and services is continuously rising whereby especially France and Italy seem to catch up slightly[3]. In most of the countries, the developments in the field of telecommunication services have made progress; only the information goods in producer countries like Finland and Sweden are gaining disproportionally from the growth of hardware production (12.2 percent and 11.1 percent, respectively).

The RWI has made some efforts to implement the ICT definition of the OECD on the basis of official datasets. Time series for the development of the different product groups and service categories in Germany and the U.S. were calculated. The results are presented in Tables 7 and 8. However, a comparison

[3] The forecasted values for the years 2001 and 2002 are not reported here because they had been already worked out at the beginning of the year 2001. At that moment in time no one was able to expect the abrupt decline in the development of the "new economy" and the following cyclical slowdown as well as the events which happened in September 2001.

Table 7

Contribution of the ICT Sector[1] to Economic Growth and Employment
1995 to 2000

	Value added at current prices[2]			Employment		
	2000		1995/2000	2000		1995/2000
	value, bn	share[3]	growth[3]	mill.	share[3]	growth[4]
Germany						
Hardware	50	1.8	7.3	355	1.2	–2.2
Software	131	4.8	5.1	703	2.3	3.3
ICT total	181	6.6	5.6	1.058	3.4	1.2
Non-farm private business	2.729	100.0	2.4	30.831	100.0	0.9
excluding ICT	2.548	93.4	2.2	29.770	96.6	0.9
United States						
Hardware	205	2.8	8.9	1.677	1.5	2.9
Software	612	8.3	11.2	4.005	3.6	7.4
ICT total	817	11.0	10.6	5.682	5.1	5.9
Non-farm private business	7.404	100.0	6.3	112.450	100.0	2.5
excluding ICT	6.588	89.0	5.8	106.768	94.9	2.4

Authors' own estimations. – [1]OECD definition. – [2]In national currencies. – [3]In % of non-farm private business. – [4]Annual average growth rate in %; excluding housing. RWI ESSEN

with the U.S. is only possible on the basis of nominal value added and people employed (Table 7). Due to different methods of inflation measurement (Paasche indices vs. hedonic prices) it is not possible to compare the level and growth of real GDP. The analysis period focuses on the years 1995 to 2000 because of data restrictions. Therefore, a desirable cyclical adjustment, which had also to reflect the largely diverging cyclical patterns of both countries, could not be carried out here. The results emphasize the concurrent findings of the OECD and EITO that Germany, with a 6.6 percent share in the ICT sector on the value added of all private companies (excluding agriculture, forestry and dwellings[4]) is far behind the U.S. (11.0 percent), both in manufacturing goods (hardware 1.8 percent, compared with 2.8 percent) and services (software 4.8 percent, compared to 8.3 percent). Yet, the nominal value added of hardware producers in Germany rose much more briskly than that of software providers from 1995 to 2000. Contrary to this, the U.S. trend was more strongly driven by service companies. All in all, the ICT sector, with nominally 5.6 percent per year, grew significantly faster than the average for all companies. The situation was similar to the U.S. However, because of the lower share, the direct contribution of the ICT sector to overall economic growth in Germany is estimated at just 0.2 percentage points per year (this means, at this margin,

[4] Besides commercial accommodation agencies, to the housing industry belongs the ownership and use of flats and/or of single and two-family houses.

overall economic growth would be less if there were no ICT sector). By contrast, in the U.S., the direct impact is estimated at just a half percentage point[5].

In Germany, changes in employment of the ICT sector turned out to be decidedly disappointing. Even in the field of hardware there were job cuts. Mainly two reasons are responsible for this trend: On the one hand, until the recent past, industrial production in the field of office and data processing machines is characterized by "classical" typewriting and calculating machines, copiers, cash registers, and postage meters. In the following years this sector had to cut jobs to a great extent and to close down manufacturing plants. The capacity and employment cuts could not be compensated by the producers of mainframe computers and desktop computers or peripheral devices. Additionally, the leading suppliers have carried out outsourcing of parts of their production to legally and economically independent enterprises of the service sector.

On the other hand, the framework conditions and organizational structures changed decisively in telecommunications in Germany in recent years. As a consequence of liberalization and far-reaching privatization, the need to rationalize has increased considerably. Although numerous suppliers entered the market and established companies expanded their product scope, the number of employed people declined markedly. Many activities in fields like premium rate services, broad radio and broad band cable services, information and innovation management or asset management were outsourced to companies in other sectors.

All in all, according to this data, in the year 2000 in Germany only 1.1 million people or 3.4 percent of private business sector employment worked in the field of ICT. The ICT sector of the U.S. employed 5.7 million people (5.1 percent)[6]. In Germany, like in the U.S., the ICT sector contributed directly only a little (by at most 0.1 percentage point) to the overall economic employment growth.

By coupling different German special statistics with the national accounts one can gain further data for the ICT sector. Additionally, with these data, a narrower definition "ICT sector (RWI)" is possible. Thus, table 8 illustrates that production in this sector has increased in the last years more rapidly than

---

5 In such hypothetical calculations those growth effects are neglected, which are caused by a more intensive ICT use in other sectors (for that cf. Chapter 4).

6 For the narrow RWI definition, there are 930,000 employees. In a comparison with the EITO figures often cited in economic and political discussions, it should be considered that statements are made there on the supply and/or demand for ICT skills. Thus, in Germany, for example, there was a demand for skills (including e-business and call center skills) of 2.95 million people. Therefore, this not only involves employees of the ICT sector, but also of engineering sector, building and construction industry, credit institutions and insurance companies (see chapter 4 for a comparison).

Table 8

Production, Value Added and Labor Productivity in the German ICT Sector
1995 to 2000; annual average growth rates in %

	ICT sector		Non-farm private business[1]	
	OECD	RWI	total	excl. ICT (OECD)
Production, at current prices	7.9	8.1	3.4	3.2
Value added, at current prices	5.6	5.6	2.4	2.2
in % of production	47.7	47.8	47.3	47.3
Value added, at 1995 prices	9.5	10.1	2.5	2.0
Employment	1.2	1.6	0.9	0.9
Labor productivity	8.2	8.3	1.6	1.1
in 1 000 DM per employee	204.9	218.5	89.1	85.0
GDP deflator	–3.5	–4.1	–0.1	0.1

Authors' own estimations. – [1]Excluding housing. RWI ESSEN

the value added. This suggests an intensified inter-sectoral and inter-regional division of labor. The share of output produced within this sector fell from 53 percent in 1995 to 48 percent in 2000 – and thus more briskly than other businesses on average. With the increasing ratio of inputs to gross output, the companies of the ICT sector must have tried to alleviate the strong pressure on profits. This pressure came from rising miscellaneous costs (wages, energy, raw materials and depreciation) on the one hand and declining producer's prices for semi-finished and finished products on the other hand. All the same, the price index of ICT value added in the ICT sector fell by an average of 3.5 percent per year, especially in the software industry with 4.2 percent, but less so in the hardware industry, where the decline of value-added prices was approximately that of producer prices[7].

Resulting from these changes in the backward linkages on the one hand, and the relative position of prices on the other hand, there was a well-above-average increase of real value added (at 1995 prices) by 9.5 percent in the broader (OECD) and by 10 percent in the narrower (RWI) definition. Thus, the contribution of the ICT sector to the overall economic growth can be estimated: Without the ICT sector, the German economy would not have risen by 2.5 percent in the years from 1995 until 2000, but by only 2 percent per year. From the employment trend it was to be expected that real labor productivity has risen less slowly than the real value added: The direct productivity stimulus is estimated at 0.5 percentage points as well.

[7] According to RWI's calculations, the decline in prices of ICT goods and services is even underestimated to some extent, because the index weights are held constant for some years so that new, cheaper, and generally more efficient goods become established in the official price statistics only with a time lag of several years. Other methods of calculation (for example, on the basis of hedonic techniques) take those quality and substitution effects immediately into account (see Chapter 5).

3. ICT Sector by Industry

3.1 United States

Based on the BEA statistics about gross output and gross domestic product at the 3-digit-SIC level on the one hand, and shipments of manufacturing industries at the 4-digit level on the other hand, RWI has calculated the volume and the structure of the ICT sector in U.S. for the years 1990 to 1995. The results are presented in Tables 9 and 10.

They confirm that in the nineties, the ICT sector expanded much more quickly than did other sectors of the U.S. economy. This holds especially for the second half of the decade. Responsible for this growth was, above all, the production of electronic components and accessories and of telephone communication products, followed by cable and pay-TV services as well as of computer and data-processing services. Expressed at current dollar estimates, the total gross output of ICT producing sectors during the period 1990/2000 expanded by 10.1 percent per year – with an acceleration of 8.8 percent in the first to 11.3 percent in the second half of the decade. This was nearly twice as fast as the growh rate of the private non-farm business sector. If one excludes hypothetically all ICT producing sectors, the remaining sectors would have grown by an annual rate of 5.9 percent per year. This implies a direct growth contribution of the ICT sector of about a half percentage point. Similarly to Germany, the share of value added to gross output has fallen significantly.

Far more impressive was the growth rate of gross output, expressed in 1996 dollars. Due to the use of hedonic methods in the calculation of price indices especially for ICT products (see Chapter 5 for details), the annual growth rate of "real" production reached 16.1 percent, with an acceleration of 10 percent in the first to 22 percent in the second half; the growth impetus is calculated to an annual growth rate of nearly 2 percentage points. This acceleleration may have arisen, since in the last years semiconductors experienced strong quality improvements, leading to a substantial increase in the quality-adjusted growth of production, labor, and total factor productivity. According to Moore's law, the number of transistors that manufacturers can fit on a single computer chip doubles every 18 months. Furthermore, the reduction of product life cycles through increased competition in semiconductor manufacturing has led to an increased supply of new computer chips. These factors have led to high productivity growth rates for the semiconductor sector during the last years. Since the production of semiconductors takes place almost exclusively in the U.S. and only to a small fraction in Europe, these productivity effects are more pronounced in the U.S.

An alternative interpretation of the sharp fall in (hedonic) prices for computers and – correspondingly – the rapid growth of real product and value added

Table 9

Gross Output and Gross Domestic Income in the U.S. ICT Sector[1]
1990 to 2000

SIC		1990	1995	2000	90/00	90/95	95/00
			bn $		average annual growth, %		
	Gross Output, current dollar estimates						
357	Computer and office equipment	65.3	91.3	136.7	7.7	6.9	8.4
366	Communications equipment	38.6	58.5	105.0	10.5	8.7	12.4
367	Electronic components and accessories	62.6	120.1	181.9	11.3	13.9	8.7
3699	Electric machinery, equipment, n.e.c.	5.8	5.9	7.0	1.9	0.4	3.5
382pt.	Laboratory apparatus, analyt. instruments	19.7	27.4	30.5	4.5	6.8	2.2
481	Telephone communications	156.3	217.9	343.0	8.2	6.9	9.5
482	Telegraph a.o. message communications	3.8	5.3	13.0	13.0	6.6	19.7
483	Radio and TV broadcasting stations	31.0	35.3	52.0	5.3	2.7	8.1
484	Cable and other pay TV services	20.9	34.3	64.5	11.9	10.4	13.5
489	Telephone and telegraph communications	.	.	.	.	.	.
5045pt.	Computers a. pheriph…wholesale sales	43.0	63.9	110.2	9.9	8.2	11.5
5734pt.	Computers and computer software stores	2.3	3.8	5.3	8.8	10.6	7.0
737	Computer programming, data processing	88.0	155.2	352.3	14.9	12.0	17.8
ICT industries total		537.2	818.9	1 401.6	10.1	8.8	11.3
% of Private non-farm business[2]		6.7	7.9	10.0	5.8	5.2	6.4
excluding ICT industries					5.4	5.0	5.9
	Gross Domestic Income, current dollar estimates						
357	Computer and office equipment	24.2	31.0	46.3	6.7	5.1	8.3
366/99	Communications equipment	21.6	30.8	51.8	9.1	7.3	11.0
367	Electronic components and accessories	30.4	61.8	85.6	10.9	15.3	6.8
3699	Electric machinery, equipment, n.e.c.	.	.	.	.	.	.
382pt.	Laboratory apparatus, analyt. instruments	7.9	8.6	19.4	9.4	1.9	17.5
481/82	Telephone communications	118.8	145.5	199.1	5.3	4.1	6.5
482	Telegraph a.o. message communications	.	.	.	.	.	.
483	Radio and TV broadcasting stations	13.0	18.4	26.6	7.4	7.2	7.6
484	Cable and other pay TV services	11.3	21.8	35.2	.	.	.
489	Telephone and telegraph communications	3.8	8.0	12.9	13.1	16.5	9.8
5045pt.	Computers a. pheriph…wholesale sales	34.4	51.1	88.2	9.9	8.2	11.5
5734pt.	Computers and computer software stores	1.7	2.9	4.0	8.8	10.6	7.0
737	Computer programming, data processing	63.4	108.5	239.7	14.2	11.3	17.2
	Other	2.1	2.9	5.9	10.9	6.6	15.5
ICT industries total		332.4	491.3	814.7	9.4	8.1	10.6
% of Private non-farm business[2]		7.9	9.0	11.0	5.8	5.3	6.2
excluding ICT industries					5.4	5.1	5.8
	Gross Domestic Income as % of Gross Output						
357	Computer and office equipment	37.0	34.0	33.9	.	.	.
366/99	Communications equipment	48.7	47.8	46.2	.	.	.
367	Electronic components and accessories	48.5	51.4	47.1	.	.	.
3699	Electric machinery, equipment, n.e.c.	.	.	.	.	.	.
382pt.	Laboratory apparatus, analyt. instruments	40.0	31.6	63.6	.	.	.
481/82	Telephone communications	74.2	65.2	55.9	.	.	.
482	Telegraph a.o. message communications	.	.	.	.	.	.
483	Radio and TV broadcasting stations	42.0	52.2	51.0	.	.	.
484	Cable and other pay TV services	54.0	63.5	54.6	.	.	.
489	Telephone and telegraph communications	.	.	.	.	.	.
5045pt.	Computers a. pheriph…wholesale sales	80.0	80.0	80.0	.	.	.
5734pt.	Computers and computer software stores	75.0	75.0	75.0	.	.	.
737	Computer programming, data processing	72.0	69.9	68.0	.	.	.
	Other	.	.	.	.	.	.
ICT industries total		61.9	60.0	58.1	.	.	.
% of Private non-farm business[2]		52.8	53.0	52.7	.	.	.

Source: BEA and authors' own estimations. – [1]3-digit Standard Industrial Classification. – [2]Exluding dwellings. RWI ESSEN

Table 10

Gross Output of the U.S. ICT Sector[1], in Chained 1996 Prices
1990 to 2000

SIC		1990	1995	2000	90/00	90/95	95/00
			bn $		average annual growth, %		
	Gross Output in chained 1996 dollars						
357	Computer and office equipment	28.3	70.5	403.0	30.4	20.0	41.7
366	Communications equipment	36.1	57.6	123.3	13.1	9.8	16.4
367	Electronic components and accessories	40.3	96.0	551.1	29.9	19.0	41.8
3699	Electric machinery, equipment, n.e.c.	6.1	5.9	7.0	1.3	–0.8	3.5
382pt.	Laboratory apparatus, analyt. instruments	21.9	27.6	29.5	3.0	4.8	1.3
481	Telephone communications	160.5	216.6	365.0	8.6	6.2	11.0
482	Telegraph a.o. message communications	4.0	5.2	13.8	13.3	5.8	21.4
483	Radio and TV broadcasting stations	38.4	38.6	38.3	0.0	0.1	–0.1
484	Cable and other pay TV services	27.7	35.9	55.1	7.1	5.4	8.9
489	Telephone and telegraph communications	.	.	.	.	.	.
5045pt.	Computers a. pheriph…wholesale sales	22.9	56.7	183.8	23.1	19.9	26.5
5734pt.	Computers and computer software stores	1.3	3.0	11.0	23.8	18.2	29.6
737	Computer programming, data processing	89.2	157.4	335.2	14.2	12.0	16.3
ICT industries total		476.5	771.1	2,116.2	16.1	10.1	22.4
% of Private non-farm business[2]		5.3	7.4	15.7	4.1	3.1	5.2
excluding ICT industries		.	.	.	2.9	2.6	3.2
	Chain Type Price Index, 1996 = 100						
357	Computer and office equipment	230.7	129.6	33.9	–17.4	–10.9	–23.5
366	Communications equipment	106.9	101.6	85.2	–2.2	–1.0	–3.5
367	Electronic components and accessories	155.5	125.2	33.0	–14.4	–4.2	–23.4
3699	Electric machinery, equipment, n.e.c.	94.4	100.0	100.2	0.6	1.2	0.0
382pt.	Laboratory apparatus, analyt. instruments	90.0	99.0	103.3	1.4	1.9	0.9
481	Telephone communications	97.4	100.6	94.0	–0.4	0.7	–1.4
482	Telegraph a.o. message communications	96.8	100.6	94.0	–0.3	0.8	–1.4
483	Radio and TV broadcasting stations	80.7	91.6	135.8	5.3	2.6	8.2
484	Cable and other pay TV services	75.5	95.4	117.0	4.5	4.8	4.2
489	Telephone and telegraph communications	.	.	.	.	.	.
5045pt.	Computers a. pheriph…wholesale sales	187.7	112.6	60.0	–10.8	–9.7	–11.8
5734pt.	Computers and computer software stores	176.0	126.4	48.4	–12.1	–6.4	–17.5
737	Computer programming, data processing	98.7	98.6	105.1	0.6	0.0	1.3
ICT industries total		112.7	106.2	66.2	–5.2	–1.2	–9.0
Private non-farm business[2]		88.9	98.8	104.3	1.6	2.1	1.1

Source: BEA and authors' own estimations. – [1]3-digit Standard Industrial Classification. – [2]Exluding dwellings. RWI ESSEN

would be that the quality improvement is less intensive than it is indicated by hedonic methods. In this context, it is often pointed out that much of the higher quality (and speed) of the hardware is rendered useless by more sophisticated software and that a substantial proportion of computers installed in private households and enterprises is used inefficiently. The important question, whether the falling prices for computers reflect more than a statististical artefact or an increase in the real value of production (and welfare), cannot be discussed in detail here[8].

3.2 Germany

Based on the National Account Statistics, the value added tax statistics, and the current statistical reports on the manufacturing sector (German Federal Statistical Office), the following calculations characterize the German ICT sector. This sector is defined both in terms of the OECD definition and the RWI classification, respectively (Table 11)[9]. In the recent past, telecommunications and computer services became the dominant sub-areas, which received the far-highest share of value added and employment. They were the driving forces behind the increase in growth of the whole sector.

In contrast, the industrial areas of the ICT sector are starting to fall behind. In particular, the cuts in employment are much greater (by 2.2 percent) than they are compared to the average of the manufacturing industry (by 0.8 percent). Labor productivity valued at 1995 prices fluctuated between just under 368,000 DM in telecommunications and 96,000 DM in the industrial-process-control equipment. The reasons for these considerable differences are undoubtedly the different potentials for rationalization and capital deepening as well as differences in the qualitative factor input relations (human capital, technical progress etc.). Further reasons are the different input structures and – last but not least – the respective market position of the enterprises involved. Unfortunately, the information provided by official as well as by non-official statistics still displays a lot of deficiencies.

Some more insights can be gained by analyzing the National Account Statistics (Table 12), because this source also provides information about prices and international trade since 1991. Concentrating on the 2-digit classification of the National Account Statistics, the German ICT sector (OECD) is represented by the sum of "Office, accounting and computing machinery (30)", "Electrical machinery & apparatus (31)", "Radio, TV and communication equipment (32)", "Telecommunication and postal services (64)" and "Computing and data services (72)". This definition includes all electrical machinery and electronic components and the postal sector, but excludes insulated cables and wires, instruments and appliances for measuring etc., industrial process control equipment and wholesaling and renting of electric and electronic equipment.

---

[8] Besides that, it is to be assumed that the use of hedonic methods in Germany would have a far less important influence on the observed inflation rate than in the U.S., because in Germany the index weights are updated in considerably shorter intervals than in the U.S. (see Chapter 5).

[9] WZ 93 is used in value added tax statistics since 1994 and in the monthly and annual statistical reports on manufacturing sector since 1995. For this reason, it is not possible to calculate values for 1990 or 1991.

Table 11

Value Added and Employment in the German ICT Sector by Industry
1995 to 2000

		2000		1995/2000
		value	share	average annual growth, %
		Value added, at 1995 prices, bn DM		
3000	Office, accounting & computing machinery	12.4	5.7	10.1
3130	Insulated cables and wires	2.5	1.1	–1.8
3200	Electronic component., Radio, TV & telephone	27.1	12.5	13.0
3320	Instruments & appl. for measuring etc.	11.5	5.3	4.1
3330	Industrial process control equipment	0.8	0.4	3.9
ex 5164	Wholesaling of machinery etc.	6.6	3.0	11.9
ex 5248	Retailing of office machinery and equipment	3.9	1.8	11.9
6420	Telecommunications	84.5	39.0	7.6
7200	Computer and related services	62.5	28.8	12.6
ex 5-9	Other ICT service	5.0	2.3	7.5
Total ICT (OECD)		216.8	100.0	9.5
Total ICT (RWI)		202.0	.	10.1
Non-farm private business (excluding housing)		2,747.3	.	2.5
		Employment, 1 000		
3000	Office, accounting & computing machinery	43.0	4.1	–9.0
3130	Insulated cables and wires	21.8	2.1	–3.5
3200	Electronic component., Radio, TV & telephone	178.3	16.9	–0.7
3320	Instruments & appl. for measuring etc.	103.3	9.8	–1.1
3330	Industrial process control equipment	8.7	0.8	3.7
ex 5164	Wholesaling of machinery etc.	39.9	3.8	7.8
ex 5248	Retailing of office machinery and equipment	23.9	2.3	7.8
6420	Telecommunications	229.9	21.7	–3.7
7200	Computer and related services	379.0	35.8	8.5
ex 5-9	Other ICT service	30.5	2.9	3.6
Total ICT (OECD)		1,058.4	100.0	1.2
Total ICT (RWI)		924.5	.	1.6
Non-farm private business (excluding housing)		30,831.4	.	0.9
		Labor productivity, 1 000 DM per employee		
3000	Office, accounting & computing machinery	278.5	140.3	21.0
3130	Insulated cables and wires	112.9	55.1	1.7
3200	Electronic component., Radio, TV & telephone	151.8	74.1	13.8
3320	Instruments & appl. for measuring etc.	111.8	54.6	5.2
3330	Industrial process control equipment	95.9	46.8	0.2
ex 5164	Wholesaling of machinery etc.[1]	164.8	80.5	3.7
6420	Telecommunications	367.6	179.4	11.8
7200	Computer and related services[2]	164.8	80.5	3.7
Total ICT (OECD)		204.9	100.0	8.2
Total ICT (RWI)		218.5	.	8.3
Non-farm private business (excl. housing)		89.1	.	1.6

Source: OECD and authors' own estimations. – [1]Incl. retailing. – [2]Incl. other services. RWI ESSEN

Table 12

Production and Value Added in the ICT Sector in Germany
1991 to 2000

	Absolute	Total = 100		Annual average growth, %		
	2000	1991	1999	1991/ 2000	1991/ 1995	1995/ 2000
Production, at current prices, bn DM						
ICT-sector						
OECD	485	7.59	8.40	4.5	1.8	6.8
RWI	313	4.57	5.43	5.4	2.7	7.6
Total	5,773	100.00	100.00	3.4	3.3	3.4
Value added, at current prices, bill. DM						
ICT-sector						
OECD	249	8.93	9.13	3.2	0.8	5.2
RWI	181	5.99	6.62	4.1	2.5	5.4
Total	2,729	100.00	100.00	3.0	3.7	2.4
Value added, at 1995 prices, bn DM						
ICT-sector						
OECD	293	8.28	10.65	4.8	0.2	8.6
RWI	231	5.44	8.41	6.9	2.4	10.7
Total	2,747	100.00	100.00	1.9	1.1	2.5
GDP-Deflator, 1995 = 100						
ICT-sector						
OECD	85.2	107.7	85.75	–1.5	0.6	–3.2
RWI	78.3	110.1	78.77	–2.6	0.1	–4.8
Total	99.3	100.00	100.00	1.0	2.5	–0.1
Employment, 1 000						
ICT-sector						
OECD	1,670	6.99	5.42	–2.6	–5.1	–0.6
RWI	1.116	4.54	3.62	–2.3	–4.8	–0.2
Total	30,831	100.00	100.00	0.2	–0.7	0.9
GDP per employee, 1 000 DM						
ICT-sector						
OECD	175.2	118.49	196.61	7.6	5.5	9.2
RWI	206.9	119.79	232.19	9.4	7.6	10.9
Total	89.1	100.00	100.00	1.7	1.8	1.6

Source: Statistisches Bundesamt, National Account Statistics, and authors' own calculations. RWI ESSEN

As a result, the ICT sector (OECD) seems much greater than that in Tables 7 and 8: It accounts for a production of 485 bn DM (8.4 percent of total, i.e. non-farm private business sector, excluding real estate), a value added at current prices of 249 bn DM (9.1 percent of total) and an employment of 1.7 mill. people (5.4 percent of total) in 2000. Since 1991 the ICT sector (OECD) has grown significantly faster than the total economy – especially with respect to real GDP (value added at 1995 prices). It rose by 4.8 percent (total: 1.9 per-

Table 13

Production and Market Volume in the ICT Sector in Germany
1991 to 2000

	Absolute	Total = 100		Annual average growth, %		
	2000	1991	1999	1991/ 2000	1991/ 1995	1995/ 2000
Production, at current prices, bn DM						
ICT sector						
OECD	485	7.59	8.40	4.5	1.8	6.8
RWI	313	4.57	5.43	5.4	2.7	7.6
Total	5,773	100.00	100.00	3.4	3.3	3.4
Exports, at current prices, bn DM						
ICT sector						
OECD	178	9.59	13.53	10.4	7.3	12.9
RWI	117	4.82	8.88	13.7	10.4	16.4
Total	1,316	100.00	100.00	6.2	2.8	9.0
Share of exports to production, %						
ICT sector						
OECD	36.7	126.34	161.11	–	–	–
RWI	37.3	105.43	163.64			
Total	22.8	100.00	100.00	–	–	–
Market volume, at current prices, bn DM						
ICT sector						
OECD	516	7.8	9.00	5.0	1.8	7.6
RWI	356	5.1	6.21	5.7	2.6	8.3
Total	5,735	100.00	100.00	3.4	3.2	3.5
Imports, at current prices, bn DM						
ICT sector						
OECD	209	11.02	16.37	11.0	6.5	14.7
RWI	160	7.77	12.48	12.0	7.5	15.7
Total	1,278	100.00	100.00	6.2	2.1	9.7
Share of imports to market volume, %						
ICT sector						
OECD	40.6	140.72	181.97	–	–	–
RWI	44.8	152.85	201.07			
Total	22.3	100.00	100.00	–	–	–

Source: Statistisches Bundesamt, National Account Statistics, and authors' own calculations. RWI ESSEN

cent) on average between the years 1995 and 2000. This reflects partly the sharp and well-known decline in product prices (especially for computers and related components) and – as a consequence – the pressure on GDP prices and nominal profits. This development resulted in a further increase in the traditionally high labor productivity and, finally, contributed to a reduction in employment[10]. But since 1995 there was an acceleration of real growth and a remarkable reduction in the lay-off of employment in Germany as well. Real growth rates of GDP accelerated from 0.8 percent per year in the period 1991/95 to 5.2 percent in the period 1995to 2000, labor productivity growth rose from 5.5 percent to 9.2 percent per 5 years. Nevertheless, the reduction in employment has much been smaller in these years (–0,6 %) than in the previous years (–5,1 %).

These tendencies are emphasized when the sector "Electrical machinery and apparatus (31)" is excluded from this analysis, because a great proportion of its products can be seen as part of the "old economy" (electric motors, household appliance etc.). This exclusion results in the so-called "ICT sector (RWI)" that contributed to 5.4 percent of production and to 3.6 percent of employment of the total economy. The labor productivity growth from 1991 to 2000 and its acceleration from the second half of the nineties were significantly sharper, and GDP-prices were reduced faster.

It is the major advantage of National Account Statistics that they provide consistent data for different economic transactions (production and consumption, intersectoral deliveries and purchases, international trade and investment): Their main disadvantage is – as pointed out before – the very low level of sectoral disaggregation. Therefore, the following analysis of production, imports and exports of ICT products is based on National Account Statistics as well as on specific data from the production surveys (Table 13).

On the basis of National Account Statistics, the German ICT sector can be characterized as an extremely international sector: In 2000, exports of the ICT sector (OECD) reached the amount of 178 bn DM or 37 percent of sectoral production. Thus, the export share was 50 percent higher than the average share for all industrial and service sectors of the German economy. At the same time, the import of ICT products (OECD) accounted for 209 bn DM, the import ratio (imports as percentage of market volume[11]) was 41 percent or 182 percent of the overall economic average. Similar relations can be observed for the ICT sector (RWI) that is in general more service-oriented than the ICT (OECD) sector. An assessment of these facts under long-term aspects must remain somewhat ambivalent: On the one hand, it may be criticized that in Germany the surplus in international trade with respect to these fast growing products is negative. On the other hand, it may be welcome that the market volume – that means the use of ICT for consumption and/or investment – exceeds the national production level. This might strengthen the total factor pro-

[10] In addition, employment was sharply reduced in more "traditional" ICT sectors such as office machines, cash machines, and mechanical calculators.

[11] Market volume is defined as production plus import minus export and represents the use (consumption or investment) of the relevant products in the home economy. Market volume (and other indicators) will be discussed in detail in Chapter 4.

ductivity in other sectors and the efficiency of the overall economic production performance (see Chapter 4).

Since 1991, however, Table 13 shows that the mutual dependencies of home and foreign ICT markets have further increased: Exports of ICT products (OECD) have grown with an average rate of 10.4 percent, imports with 11.0 percent per year. A significant acceleration is to be seen in both demand components in the last years. At the same time there was an increase in the overall imports and exports of "only" 6.2 percent, so that export and import shares of the ICT sector exceeded the overall economic average more than ever before.

4. Concluding Remarks

All in all, the results confirm that the ICT sector was a dynamic factor of the economy in the U.S. as well as in Germany, at least in the nineties. The production of ICT products was obviously connected with rapid technological and organizational progress. This has contributed considerably and directly to the acceleration – at least to stabilization – of overall economic output and productivity growth. But our results also suggest that the ICT sector was driven by a long-lasting cyclical upswing especially in the U.S., and by the corresponding investments. These investments occurred last, but not least in ICT hardware and software and in an unidentified factor with little relation to the "new economy" and computer use. These insights lead to the conclusion that the substantial growth differences between the U.S. and the German economy cannot be attributed to the different shares of ICT production alone.

Unfortunately, further conclusions about the reasons underlying the fluctuations characterizing the ICT sector are impossible, due to restricted data availability. It would be welcome if there were, e.g., data about the input structure by kind of goods as well as by domestic or foreign suppliers in order to be able to estimate the cross-border impacts of the ICT sector. For instance, while imports of the German ICT industry concentrate more heavily on the West European region, U.S. producers are obviously connected to a greater extent with the suppliers from abroad; e.g., from Ireland or the Asian-Pacific region. These connections may have contributed to the fact that U.S. ICT producers are more successful than their German competitors and to the fact that the Asian emerging economies could surmount the Asian crisis in 1997/98 very quickly.

Considerable information would also be needed on capital inputs. A carefully conducted accounting exercise could contribute to the explanation of the observed high productivity in the ICT sector. This accounting would also uncover to what extent excess capacities have been built up. After the bursting of the speculative bubble on the "new market" these excess capacities were detected to be unprofitable investments and, consequently, were written off.

Chapter 4

ICT Use

A comprehensive and cost-efficient supply of ICT products and services is generally regarded as one of the most important economic infrastructure elements for today's highly internationally networked economies (Bangemann et al. 1994; Heilemann, Loeffelholz 1994: 85; Müller 1999: 16; Röller 2000; P. Schreyer 2000). The decrease in costs of the international transfer of goods and information which could be observed in the last years is not only a consequence of technical progress in the areas of transport and logistics – which themselves would not have been imaginable without the supply of ICT technologies – but also of the dramatically increased capacity of computer hardware and standardized software. Also, the deregulation of the markets for telecommunications played an important role in this development. As theoretical and empirical analyses have shown, the extensive regulation of telecommunications markets has been counterproductive in respect to economic performance (Schmidtchen 1973; RWI 1987; Vogelsang 1992; Klodt 1995). Therefore, the ICT infrastructure is regarded as having a crucial, locational advantage in international competition.

Against this background, in the manufacturing and service sectors, two central, and closely interrelated economic aspects arise with respect to ICT use:

- effects on output, production, productivity, and consumer welfare: existing knowledge on these important topics is, unfortunately, still rudimentary.
- indicators: judgement of the actual scale of the "new economy" requires appropriate indicators, which allow a comparison of the developments that have taken place in the U.S. and Germany during the last years.

In this chapter, both aspects of ICT use will be discussed. The analysis is based on two hypotheses about the effects of ICT use on the economy and two hypotheses about the extent of ICT use in Germany:

(1) The productivity increases in manufacturing during the nineties were directly attributable to the accumulation of ICT capital.

(2) ICT is the leading factor behind innovation performance in the service sector.

(3) Germany lags behind the U.S. and some European countries with respect to ICT use.

(4) This tendency can also be observed for e-commerce, but there the gap is becoming closer over time.

1. Economic Effects of ICT Use

1.1 Framework for the Analysis

Although the assertion is often made that ICT use is a crucial factor for economic welfare and, at the same time, personal computers are used everywhere in the economy, we do not know very much yet about the effects they have on the processes in which value added is created. This is true for microeconomic analysis as well as the industry level and from the macroeconomic perspective. The central question is whether there is something special in the accumulation of ICT capital, which has consequences for the way in which firms produce goods and services, or whether we are – on each level of analysis – dealing with just the usual process of capital accumulation. How far do characteristics of ICT use, like network effects and increasing returns to scale due to knowledge accumulation, matter for the analysis of the effects of digitilization on economic activities?

As illustrated Schedule 2, the effects of ICT use on production and final demand do not only depend on ICT investment itself, but also on complementary investments in innovative activity, R&D, and human capital, which aim at the implementation of new business processes. These changes in the creation of value added partly occur on the firm level but do also go beyond. They include:

- redesign of production processes;
- changes in knowledge management (information flows within and between firms; internationalisation of R&D, increasing importance of research networks between firms and with universities and research institutions);
- new industry-level supply chains for goods and services, including supplier-customer relationships;
- changing costs of conducting certain processes within or outside the firm: Data interchange and connecting different firms becomes much less expensive. This allows the outsourcing of business processes and concentration on core competencies;
- outsourcing of activities and concentration on core activities together with service creation; and

Schedule 2

Framework for Data Collection: ICT Use, Productivity and Final Demand

Value creation chain/ industry	Manufacturing	Services	Total	Other countries
ICT Investment				
Hardware				
Software				
Input factors				
Complement investment				
Human capital				
Innovation				
R&D				
Business processes				
Teleworking				
E-business				
E-commerce				
other				
Other				
Other				
Capital				
Labour				
Production				
Value added				
Gross production				
Productivity				
Final Demand				
Quantities				
Quality of goods and services				

Grey fields are in the center of the analysis.

RWI ESSEN

– increasing home-production as a consequence of decreasing cost of information transmission of all kinds (tele-working).

These new business processes trace out the field where the "new economy" is to be located. However, a consistent terminology and systematic accounting of the "new economy" (which is based on clear definitions of the underlying elements and processes) is still missing: The term "electronic business" (e-business) – as one possible common denominator for the "new economy" – is often widely used in the sense of all economic activity on the basis of electronic connections. This general definition is not easily to realize empirically. In order to get statistically useful indicators, restrictions have to be made. In addition to restrictions in the regarded business procedures, electronic processes can be characterized by the media that serve for electronic transactions. There are new media for interactive communications like the Internet but also traditional electronic media like TV. From the aspect of the business transactions that are supported or realized by electronic media, electronic offers (e.g., through the Internet, but also through TV-spots) can be separated from – on the other extreme – an integration of the whole purchasing process into the Internet.

E-commerce is one term that is often used, but for which a wide variety of different definitions has been proposed, from very wide ones that correspond to e-business as just defined (Picot et al. 1996) to very narrow definitions (Coppel 2000). The latter require nearly all business transactions to take place in the Internet and preclude other media which are more or less probable in the future, such as interactive TV. In Schedule 2, e-commerce is not shown as merely being a mode of trade as one could think of it, but as a kind of business process that changes the interactions between firms.

One central question for economic research is how internal business processes and market behavior of firms change as a result of these developments. The other central question is how these effects add up to aggregate effects – especially productivity. The aggregates of these micro processes lead to industry-level and macro-effects, therefore the understanding of micro behavior is very important in understanding the whole economy.

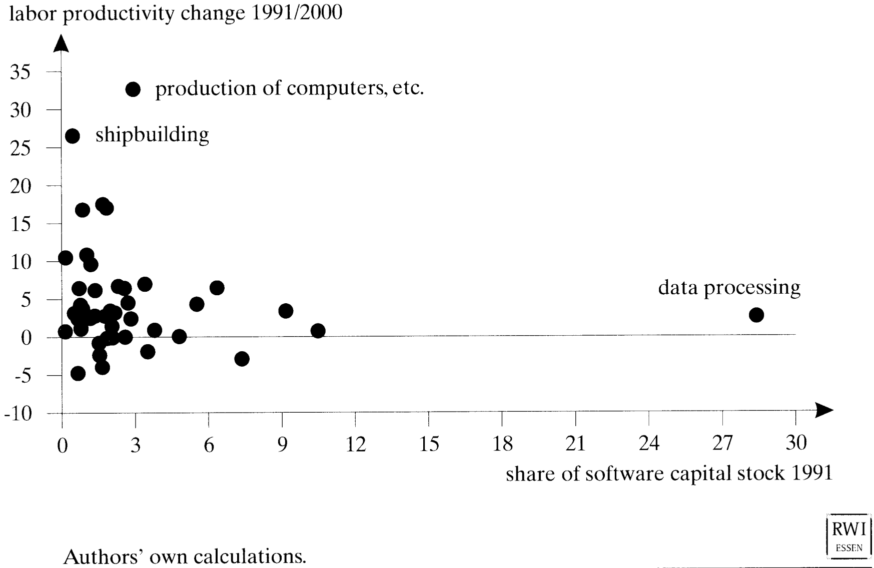
1.2 Effects on Industry Level Productivity

Productivity effects of ICT production and use can be analysed on the macroeconomic, the industry, and the firm level. Up to now, most studies have focused on the macro effects of ICT on productivity. However, industry-level and microeconomic analyses are important for understanding the overall economic effects of the ICT production and use.[1]

On the industry level, a big share of the productivity effects can be attributed to the production of ICT. Stiroh (2001a, b) analysed the interdependence between ICT use and productivity growth in the second half of the nineties at the industry level and came to the result that in sectors with a higher IT capital stock, productivity grew faster. This result was challenged by a study from McKinsey Global Institute (MGI 2001), which found that nearly all of the productivity growth on the industry level in the nineties was to be attributed to only six industries and that other industries that also invested heavily in ICT did not experience any significant increase in productivity. The data for Germany also do not reveal a correlation between the size of ICT capital stock and sectoral productivity growth. Figure 17 shows a scatter plot of the estimated 1991 share of the software capital stock in relation to the overall capital stock for 44 industries for Germany against the productivity growth from 1991 to 2000. The lesson that can be learned from these results seems to be that the

[1] For an analysis of the macroeconomic consequences see Chapter 5.

Figure 17
Software Capital Stock and Labor Productivity Change
%



Authors' own calculations.

sectoral and microeconomic analysis of the effects of ICT has to be intensified in order to get a better understanding of the circumstances under which productivity effects of ICT use and production occur.

In order to understand the productivity effects of ICT, one has to take a closer look at the different interdependencies with technical progress in the sectors using ICT. Microeconometric studies (Brynjolfsson, Hitt 2000b) show that the long-term effects of ICT use are much greater than the immediate effects on which macroeconomic growth accounting relies on. Thus, it seems that complementary follow-up-investments that accompany the ICT investment and the following restructuring of business processes determine the resulting productivity growth. This time lag between the adoption of a new technology and the resulting productivity growth is not a new fact that can be mainly attributed to ICT goods, but could also be observed for innovations in the past (David 1990, 2000). Further evidence of this assertion is given by a case study from MGI for the retail sector in the U.S. In that sector, productivity increase resulted from newer, managerial innovations in Wal-Mart (big box format, every-day low pricing, increased efficiency in logistics), which had improved business processes by applying ICT mainly in the eighties. This efficiency increase spread in the market by the adoption through competitors which was forced by increased competition.

An analysis of productivity changes at the sectoral level also has to take into account measurement problems that mainly concern the output of the service sector. It is very difficult to measure the consumer surplus that emerges from the convenience and increased quality of services as a result of the adoption of ICT technologies correctly (one example for this effect is the convenience that results from home-banking). In retail and wholesale trade, the value of the services is calculated on basis the value of the sold goods. As better quality goods are sold (e.g., more powerful computers), also the computed value added for the related services increases.

To draw a first conclusion, sectoral analyses and microeconometric calculations show that there is no simple, linear connection between ICT investment and productivity growth. Firms in different sectors behave differently and are differently successful in the application of ICT to increase productivity. Thus, the effect of ICT use on productivity is characterized by the following features:

- By the use of ICT in firms, potentials for productivity increases are created. Only if these potentials are realized – by the adoption of new business processes, complementary investments – they lead to increases in efficiency.
- In the service sectors using ICT, the application of ICT can result in an improved service quality, which in many cases is difficult to measure. It depends on the market situation whether the improved service quality is associated with price increases.

From the unclear evidence on the effects of ICT use on productivity, different questions arise concerning the statistical effects of the "new economy" and the relating measurement problems:

(1) Is it some sort of productivity increase in the traditional sense of factor augmenting technical progress that we are talking about? Does ICT capital have the characteristics of "normal" capital goods or do different quality characteristics matter? Are there increases in total factor productivity related to the use of ICT capital?

(2) Does the use of ICT lead to quality improvements connected with the production of goods and services?

From the economic interpretation of these effects one might ask:

(1) Is the assumption of the growth accounting studies right in that ICT capital is used efficiently by firms?

(2) Under which circumstances do the economic effects of ICT use occur? Are there other factors that have to be right in order to enhance productivity? Are there instances of sectoral over-investment?

(3) When does ICT capital use lead to increased productivity (time scale)?

From the measurement point of view of the effects of the "new economy" the corresponding questions are:

(1) Do the official data capture the productivity effects of ICT use correctly? Or are there certain microeconomic aspects that cannot be explained?

(2) If they are measured correctly, where are the effects measured?

1.3 ICT Use in the Service Sectors and Innovative Activity

As industry-level data show, the service sectors are, by far, the most important users of ICT products. Thus, for understanding the effects of ICT use on economic performance, it is straightforward to take a look at the service industries. Complementary investments seem to be a key for understanding the effects of ICT use. One important complementary factor is the inputs which lead to new products and production processes.

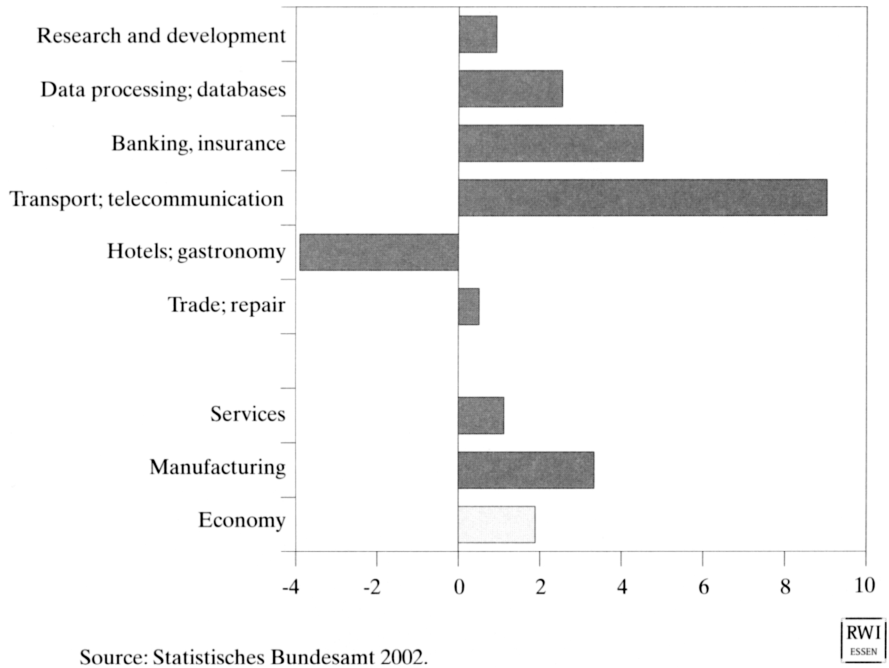
According to the traditional view, economic activities in the service sector are not very innovative. As a result of the intensified use of ICT technologies in some service sectors, this has changed in the last years. Meanwhile, certain service sectors are characterized by productivity increases comparable to manufacturing industries (Figure 18). While yearly average productivity growth was 3.33 percent in the manufacturing sector, in the services sector it was only 1.12 percent. However, some services such as transport and communications, finance, and insurance and data processing experienced considerable productivity increases. Furthermore, the use of IT technologies allows to adapt new products better to consumer needs.

The role of services for technological development has changed considerably. R&D becomes more and more important in some branches of the service sector. While service sector R&D still sums up to only a relatively small fraction of business sector R&D, this fraction has increased in all industrial countries during the last years. This tendency reflects, on the one hand, the growing importance of R&D in some service industries. On the other hand, it reflects the increasing efforts to measure service sector R&D.[2]

Despite these improvements, the innovative activities in the service sector are not well characterized by the R&D statistics. This becomes clear in a comparison with the statistics on innovative activities (Figure 19). The service sectors are much more innovative than the R&D statistics would indicate. Many innovative activities in the service sector are not directly connected to R&D; a

[2] Also in Germany, the measurement of service-sector R&D was improved by adding 8,000 firms to the survey that belonged to the very dynamic IT sector, banks and insurance, and waste disposal. Additionally, the survey used was improved to reflect better the R&D-efforts of the service sector (Wissenschaftsstatistik 1999). With this improved survey, the data for the year 1999 display substantially higher R&D expenditures for some service sectors like business-related services.

Figure 18
Productivity Change in Service Sectors
1991 to 2000; annual average change in %

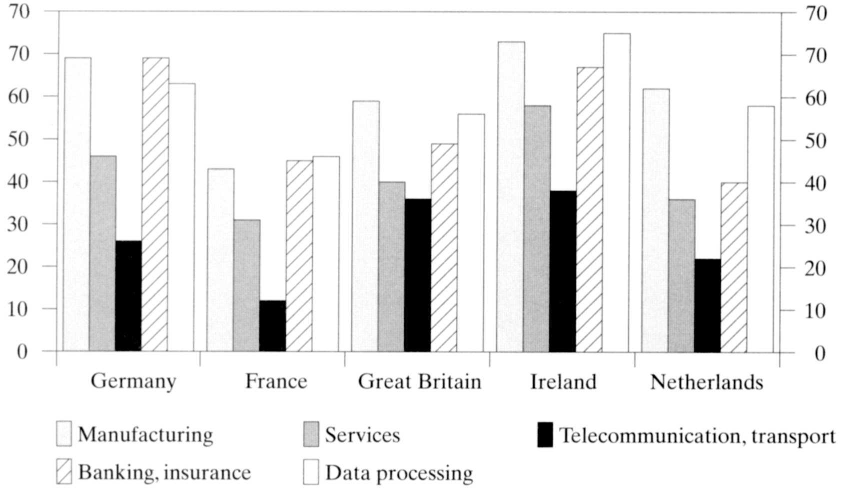


Source: Statistisches Bundesamt 2002.

well-known theory (Barras 1986) assumes a reverse life cycle of the adoption of innovations in the service sector: First of all, a new ICT developed in the manufacturing (computer) sector is adopted. This aims at a cost reduction in the delivery of a service and an increase in labor productivity. Later on, when the technology is used routinely, it is followed by development and quality improvement of existing products. In a third phase, new products are developed that would not have been imaginable without adoption of the new ICT ("normal" product life cycle).

These considerations show the close relationship between ICT use and innovations in the service sector. In order to understand the effect of ICT on the service sector, the patterns of innovative activities need to be understood. For this, one has to analyse the effect of ICT use on the process of production of services. The right measurement of innovative activities and R&D in the service sectors is an important research topic that also requires a better understanding of the role of ICT for innovative activities. Two important questions on the role of the service enterprises arise that go beyond the scope of this study: Firstly, apart from case studies, very little is known about the effects of

Figure 19
Share of Innovative Business Firms
%



Source: Eurostat 1999.

the ICT use on the business processes in the service sector. Secondly, quality improvements in service delivery are a central effect of the adoption of ICT in the service sector; therefore, the right measurement of the output of service sectors (especially innovations) will remain a central topic.

2. ICT Use in Germany

2.1 General Indicators

Various publications and statistical sources provide information on central aspects of ICT use on the aggregate level (EITO 2001; OECD 2000e, 2001f; WITSA 2000). These aspects include indicators like ICT expenditures, the stock of PCs in firms and private households, market structure and competition in the markets for telecommunications. These indicators have been analyzed in respect to the economic competitiveness of Germany (e.g., Löbbe et al. 2002). The assessment of the relative situation with respect to ICT use in Germany is based on indicators on ICT equipment and use (Table 14), telecommunications infrastructure (Table 15), and telecommunications charges and revenues (Table 16).

ICT expenditures allow a first and crude evaluation of the intensity of ICT use in the U.S., Germany, and other countries (Table 14). Expenditures in percent

Table 14

ICT Equipment and Use

		Germany	Finland	France	Italy	Sweden	UK	U.S.	Japan
ICT expenditure total									
per resident, DM	2000	2,737	3,001	2,828	2,083	4,028	3,343	5,090	3,406
percentage of GDP	2000	5.7	6.0	6.1	5.3	7.4	6.5	6.8	4.3
ICT investment, percentage of non-residential gross fixed capital formation[1]									
Hardware	1999	10.5	36.0	9.8	11.4	.	.	16.7	12.2
Software	1999	5.7	11.9	6.2	4.9	.	.	15.0	3.8
Total	1999	16.2	47.9	16.0	16.3	.	.	31.7	16.0
Schools									
PCs per 100 pupils									
Primary level	2001	4	13	6	5	10	9	.	.
Secondary Level	2001	7	15	11	11	23	16	.	.
Schools with internet access, %									
Primary level	2000	56	90	30	75	57	86	97	.
Secondary Level	2000	81	95	84	90	99	98	100	.
Private households									
PCs per 100 inhabitants (BITKOM)	2000	34	38	29	16	63	36	65	32
	92/00[a]	19,8		20.2	20.2	21.5	19.6	14.4	23.2
PCs per 100 households (OECD)	2000	47	47	27	28	60	46	51	38
Households having a PC, %									
Desktop	2000	32	45	29	35	56	36	51	.
Laptop	2000	5	7	5	1	11	8	.	.
Personal Organiser	2000	2	1	3	2	4	6	.	.
Firms									
PCs per 100 employees	1997	59	.	44	28	105	34	82	.
e-commerce usage by enterprise	1999	53	.	35	25	62	47	70	40

Source: OECD 1999, 2000e, 2001f; WITSA 2000; EITO 2001. – [1]In firms (excl. agriculture and housing). – [a]Annual average growth rate in %. RWI ESSEN

of GDP seem to indicate a backlog of Germany: ICT goods are used more widely in other European countries and in the U.S. Especially ICT investments play a much more prominent role in capital formation in the U.S. than in Germany. While in 2000, ICT expenditures amounted to 5.7 percent of GDP, they were 6.8 percent for the U.S. (WITSA 2000). Also, most of the other major European countries lie above Germany in respect to this ratio. The distance to the U.S. is even bigger when it comes to ICT investment figures. ICT investment made up 16.2 percent of non-residential fixed capital formation in Germany in 1999, while they made up 31.7 percent in the U.S. The other European countries lie very close to Germany with respect to this indicator.

Not only the aggregate use of ICT goods determines their economic effects, but also whether they are used in schools, private households, or firms. The

Table 15

Telecommunications (TC) Infrastructure Equipment and Use

		Germany	Finland	France	Italy	Sweden	UK	U.S.	Japan
Telecommunications channels per 100 residents	1999	58.8	55.1	57.8	46.4	73.8	56.5	69.8	54.6
	85/99[a]	4.2	5.0	2.4	3.0	1.2	3.1	2.6	2.7
ISDN-channels per 100 residents	2000	23	.	7	8	.	7	5	11
DSL-Connections per 100 households	2000	1.1	.	0.5	0.4	.	0.4	3.5	0.2
TV-Cable connections per 100 househouls	2000	55	.	13	2	.	14	54	18
Cellular mobile subscribers per 100 res	2000	58.6	72.8	50.5	73.2	74.2	67.2	40.9	47.0
	95/00[a]	19.9	9.5	26.9	18.4	8.7	14.7	8.6	12.3
Internet access per 100 residents	2000/J	21.7	12.0	15.3	20.1	50.7	32.7	53.7	21.4
Internet access per 100 households	2000/O	27.1	43.5	19.0	23.7	53.8	40.9	41.5	.
Internet users per 100 residents	2001	33.2	56.1	16.8	24.3	62.6	41.7	61.1	31.5
	97/01[a]	52.7	30.2	77.3	80.3	29.0	54.6	42.1	35.7
Enterprises with Internet access	1999	69	95	69	66	75	62	68	78
Internet hosts per 100 residents	2001	2.9	14.1	2.0	1.5	6.4	2.8	29.8	3.7
	97/01	29.6	20.0	39.6	42.1	16.3	15.6	51.5	44.9
Web sites per 100 inhabitants	2000/J	2.2	0.7	0.4	0.6	1.9	2.4	4.7	0.2
Secure Web servers per 100 000 residents	2000/J	4.6	6.6	2.2	1.4	9.2	7.4	24.0	2.3
	98/02[a]	176.3	94.2	140.1	118.9	136.3	147.3	110.4	159.5

Source: OECD 1999, 2000e, 2001f; WITSA 2000; EITO 2001. – [a]Annual average growth rate in %. RWI ESSEN

ICT equipment in schools indicates the efforts to integrate training in new technologies into the overall educational system. Germany lags behind other – especially the Nordic – countries with respect to PC use and the Internet access both in the primary and the secondary levels of education. This situation seems to be worse than in the Nordic countries both at the primary level with 4 PCs per 100 pupils (13 in Finland and 10 in Sweden) and at the secondary level with 7 PCs per 100 pupils (15 in Finland and 23 in Sweden). Furthermore, while nearly all schools in the U.S. have access to the Internet, in Germany only 56 percent in the primary and 81 percent in the secondary level can use the Internet in teaching.

The indicators on PC use in private households give contradictory information. While BITKOM data show 34 PCs per 100 residents for Germany and 65 for the U.S., and also Eurostat data indicate Germany lagging behind with 32 desktops per 100 households compared to 51 for the U.S., OECD (2001f) comes to 47 PCs per 100 households for Germany and 51 for the U.S.

Differences in ICT use in the business sector do not necessarily reflect a lag in technical development. Different sectors in the economy use PCs with differ-

Table 16

Telecommunications Charges and Revenue of TC Enterprises

		Germany	Finland	France	Italy	Sweden	UK	U.S.	Japan
OECD Basket of telephone charges, PPP p.a.									
Business telephone charges	2000	1,177		1,076	1,443	722	1,067	1,215	1,566
Leased lines (2 MB/sec; OECD = 100)	2000	66	19	65	119	26	63	63	148
Residential telephone charges	2000	509		499	646	349	392	609	611
Internet access for residents[1]	2000	34		34	32	35	41	21	35
Internet access for residents[2]	2000	51	45	60	46	58	60	24	49
Fixed telephone charge	2000	14	14	11	13	10	14	14	10
Telephone usage charge	2000	0	31	0	33	46	0	5	28
Internet service provider charge	2000	37	0	48	0	2	47	5	11
Revenue of TC-Enterprises									
Telecommunication revenue, $									
per mainline	1999	725		605	528	638	884	1,091	1,032
per capita	1999	634		561	523	838	854	1,105	1,027
annual average change	89/99[a]	9.8		7.4	8.0	6.3	8.9	7.7	11.7
Telecommunication revenue	1985	1.9		1.7	1.5	1.8	2.4	2.8	1.6
percent of GDP	1999	2.5		2.3	2.6	3.1	3.5	3.3	3.0
Mobile revenue, in $									
per mobile subscriber	1999	699		310	410	322	393	564	1,037
per capita	1999	199		108	215	184	160	175	466

Source: OECD 1999, 2000e, 2001f; WITSA 2000; EITO 2001. – [1]20 hours/month. – [2]40 hours/month at peak rates. – [a]At constant prices and exchange rates. RWI ESSEN

ent intensity and, thus, economies in which the sectors using them very widely are concentrated – like some service sectors – should also have a higher PC density. Still, firms in the Nordic countries and the U.S. use PCs more widely than in Germany. While the numbers of PCs per 100 employees is 53 in Germany, it is 62 in Sweden and 70 in the U.S. This tendency can also be observed in e-commerce-usage: 53 percent of the German enterprises used e-commerce in 1999, while this share was 62 percent for Sweden and 70 percent for the U.S.

The increasing utilization of ICT infrastructure in all industrial nations can be attributed to multiple factors like market deregulation and decreasing prices for TC-services, the ongoing changes in business processes, but also new consumption patterns of private households. These developments influence the use of conventional telephone networks, but also lead to an increasing utilization of mobile communications and the Internet (Table 15).

The supply of (traditional) telecommunications channels has not been affected largely by this trend. With respect to this indicator, Germany is in the middle of the countries with a value of 58.8 channels per 100 residents. The number of channels per 100 residents increased by 4.2 percent between 1985 and 1999. This increase can mainly be attributed to German re-unification.

Since that time a considerable decrease in the number of channels could be observed. This can be associated with a substitution of traditional channels by cellular mobile connections the number of which increased strongly during the last years. While the number of mobile subscribers per 100 residents was 40.9 in the year 2000 for the U.S., it amounted to 58.5 for Germany. Also the growth of mobile communication from 1995 to 2000 for Germany was higher than for the U.S. (19.9 vs. 8.6 percent). However, some of the other European countries experience still a higher diffusion of mobile phones.

On Internet use, a variety of low-quality data from different sources exist. Like the data source used in Table 15, most surveys find the highest number of Internet users in the U.S. (61.1 per 100 residents for the year 2001). Germany experienced a much lower share with 33.1 per 100 residents. The difference in the available statistics on Internet hosts per 1000 residents is still higher (2.9 for Germany vs. 29.8 for the U.S.). However, one has to be careful with the interpretation of these figures, because, especially for this indicator, it is not sure whether the same criteria were used for the calculations in different countries. Secure web servers are important for e-commerce transactions. These servers comply with certain operating requirements that shall enable, e.g., the codification of credit card numbers. In January 2000, 4.6 secure web servers per 100,000 residents existed in Germany. This number amounts to only one fifth of the U.S. number (24) . However, the estimated growth between 1998 and 2002 indicates that Germany is catching up with respect to this indicator.

During the last years, the deregulation of the telecommunications market has led to a substantial decrease in the charges for telephone usage and Internet access. This has supported an increased use of electronic media (Statistisches Bundesamt 1999, 2001b; DIW 2000). This tendency can also be observed in the basket of telephone charges that is calculated on a regular basis by the OECD. In that basket, the fixed and variable costs of telephone usage are summarized for a representative user. Table 16 uses Dollar in PPP for the comparison in order to avoid a distortion of the results through the exchange rates.

The basket for business telephone charges is typical for small firms that do not have the possibility to negotiate special rates like big firms. It shows substantially lower rates for Sweden (722 $ per enterprise) than for Japan (1,566 $), Italy (1,443 $) and the U.S. (1,215 $). Also in Germany (1,177 $), the charges are substantially higher than in Sweden. Similarly, the annual residential telephone charges do have their lowest value in Sweden (349 $ per household), while Germany takes a medium value (508 $), somewhat lower than the U.S. (609 $). The charge for Internet service provision (20 hours per month) amounts to 34 $ in Germany. This value is in the same range as the other countries, but substantially higher than for the U.S. (21 $).

2.2 E-commerce

2.2.1 Internet Use

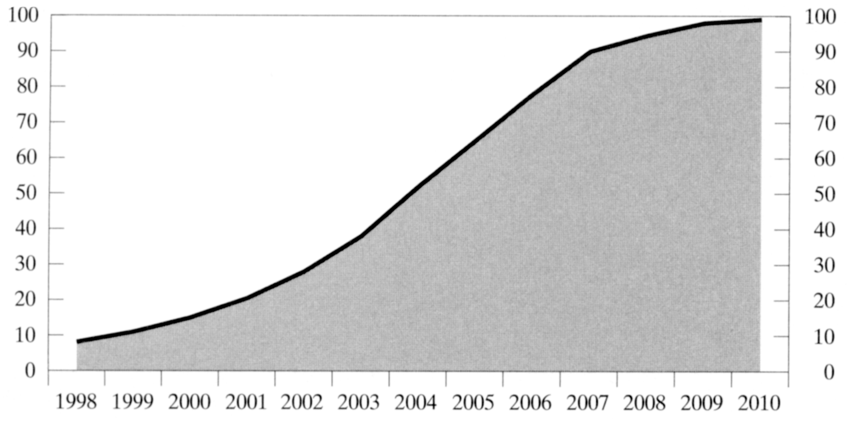
The precondition for a comprehensive extension of e-commerce is the supply of the appropriate infrastructure for Internet use and the provision of easy Internet access. The market penetration of modern ICT has accelerated considerably. In the year 2001, 300 mill. users throughout the world have already had access to the Internet (eMarketer 2000 cited by NFO Infratest 2001a: 148); this corresponds to approximately 5 percent of the world population. At the same time, the proliferation of telephone connections, PCs, and mobile phones contributes to the rapid expansion of Internet use. Prices in the field of hardware have been decreasing for years. Consequently, in the U.S. as well as in Germany available PC equipment has risen considerably. The price cuts stated in the German official statistics may be underestimated because quality effects have not been taken into account sufficiently up to now (in the U.S. the hardware prices are quality-adjusted by hedonic price indices; see Chapter 5).

The technical performance of PCs has risen significantly in terms of processor efficiency, memory, and other performance parameters. A similar development can be seen in the market for mobile means of communication. The new mobile communication standards, GPRS and UMTS, will lead to a considerable expansion of Internet use via cellular phone as well as other mobile means of communication. In the field of mobile communications Germany has a great competitive advantage in comparison to the U.S. because of the well-developed mobile communications network. Consequently, the expansion of the mobile telecommunications services may be accompanied by a reduction of the currently existing gap to the U.S. with respect to Internet use.

Furthermore, the Internet can also be used via television (Pricewaterhouse Coopers 2000). By means of so-called set-top boxes, it is possible to browse on the one hand, and to send e-mails on the other, as well as to use other Internet services. It is to be expected that in the future such set-top boxes will be an integral part of TV-sets so that the Internet use via TV will become the standard. Perhaps, the interactive television (iTV) will even become the most popular type of Internet use because it gives Internet access to the consumers who have neither a PC nor a cellular phone available.

In the years to come, the equipment of German households with Internet connections is likely to be characterized by a fast increase which levels off. Eventually, the share of the households with Internet connections will asymptotically approach the maximum equipment level of 100 percent (Figure 20). By the year 2007, according to this projection, the share will, in fact, be over 90 percent; by the year 2010 at the latest about 100 percent (RWI 2000: 71).

Figure 20
Households with Internet Access in Germany
1998 to 2010; share in %



Source: RWI 2000: 71.

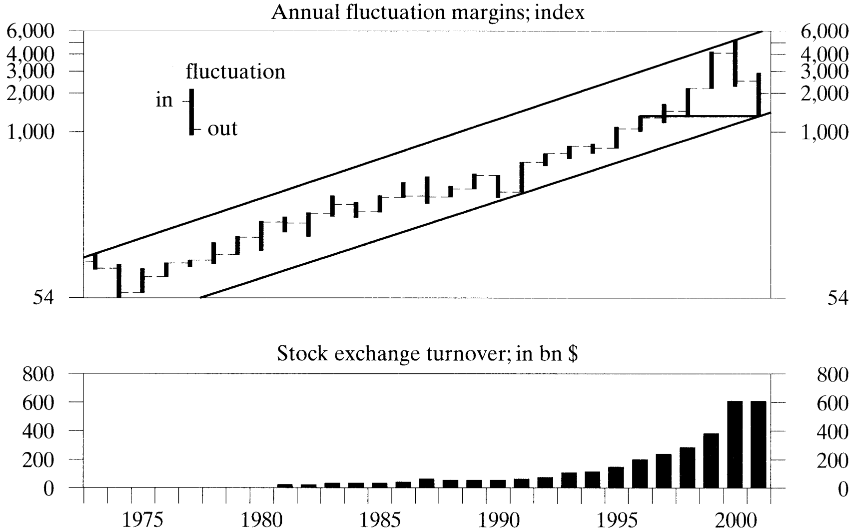
The share of households having Internet access available, is also influenced by socio-economic factors (RWI 2000: pp. 69): It rises significantly with household income as well as the number of people per household. One has also to take into consideration the age of the main income recipients: The older this recipient, the lower the share of households with Internet access tends to be. Nevertheless, at the individual level the share is highest in the group of 25 to 35 year-old people and, therefore, higher than in the group under 25 year-old people. This may mainly be the result of their lower income. From the occupational perspective, the self-employed show by far the highest share. Furthermore, the shares of civil servants and white-collar workers are above average.

2.2.2 Internet and e-commerce in Light of the Stock Markets

Doubts about the efficiency of capital-spending in the field of e-commerce, such as the spending on the Internet infrastructure, are nourished by the recent trends in the stock markets, especially with regard to high-tech stocks. The price losses on the technology stock exchange are not only an indication of the burst of an irrational speculative bubble, but possibly also for exaggerated growth expectations. These have apparently led to over-investments which have consequently carried low rates of return. Therefore, any unrealistic growth expectations should be adjusted downwards. Yet, it seems also not advisable to underestimate the positive effects accompanied by e-commerce.

Figure 21

Annual Fluctuation Margins and Stock Exchange Turnover of the NASDAQ Composite Index
1973 to 2001



Source: BigChart 2001, Internet: http://bigcharts.marketwatch.com, visited April 5, 2001. RWI ESSEN

In any case, experience suggests that short-term fluctuations of the stock markets alone should not be taken as a clear indication of long-term trends. For example, Figure 21 shows a development of the NASDAQ Composite Index since the beginning of the seventies. The NASDAQ (National Association of Securities Dealers Automated Quotations) is the computerized stock exchange of the dealers in unlisted securities in New York. It is the worldwide leading technology stock exchange for fast-growing high-tech assets. The price trend of stocks of several thousands of technology assets are reflected in the NASDAQ Composite Index, which are, first and foremost, the assets of U.S. enterprises. The diagram demonstrates that the stock market crash in 1987, the Gulf Crisis and the Gulf War in the years 1990 and 1991, the Asia Crisis in 1998 as well as the Internet-hype together with the following adjustments in the years from 1999 to 2001, find expression only in relatively greater annual fluctuation margins (depicted logarithmically). However, the long-term trend of the development of this index has not been significantly affected by these events.

The long-term upward trend channel, which lies currently between the lower limit of 1,000 points and the upper limit of 6,000 points, seems to be still in operation[3]. On closing-price basis, the bottom was reached in the year 2001 at 1,400 points and touched, therefore, the lower limit of the uptrend channel. After reaching this limit, the NASDAQ index moved in an upward direction again. Actually, this means that the index at the bottom fell temporarily back to the level that was reached at its peak five years ago. During this five-year period the greatest economic upswing in history of the U.S. occurred. It was followed by a decline that led – at least for a short time – to a recession. Furthermore, there was an extremely rapid rise followed by a breakdown of many Internet companies in this period.

The considerable adjustments of the stock market valuation since the spring of the year 2000 seems to be, first and foremost, the result of a prior exaggeration. This behavior is not unusual and can often be observed on stock markets. This exaggeration was primarily caused by the expansion of the Internet and the investors' speculations regarding the tremendous growth prospects emerging from this expansion. Moreover, the world-economic cyclical situation, and the accompanying reluctance to invest in the field of IT, may have played a role in the downturn. Indeed, the decline of the technology stock exchanges had already begun a long time before the first signs of an upcoming economic downturn were perceptible.

The stock price movements of the last years – which were also accompanied by a strong increase in stock exchange turnover (Figure 21) – are therefore anything else than exceptional. These long-term developments suggest that the stock exchange has both made it possible to set up the Internet infrastructure rapidly and to correct any misallocation of resources subsequently. In all likelihood, in the long run the technology stock markets will carry on with their upward trends. Regarding the investments in the field of e-commerce infrastructure, at most, the growth has turned out to be slightly lower than expected in optimistic scenarios. Since the beginning of the year 2000, until the middle of the year 2001, the number of Internet hosts increased worldwide by over 70 percent. Despite the considerable fluctuations on the technology stock markets, the Internet is still expanding rapidly.

Furthermore, the spectacular price movements in Internet stocks can be explained by the characteristics of an emerging market. The Internet is a relatively new medium. It only became a mass market with the development of the web-browser at the beginning of the nineties. In the following years a plethora of new Internet companies attempted to secure a market niche within the Internet economy. Some of their business models, such as those of *Yahoo* or *Amazon*, were extraordinarily successful. Consequently, these "dot. com"

[3] This trend channel results from a connection of the local minima of the years 1990/91 and 2001 respectively, as well as a parallel shift of this straight line upwards, to be precise, to the local peaks of the years 1973 and 2000.

companies were highly valued by the stock exchange. Yet, many other new companies did not rely on similarly ingenious business concepts. For many of those companies, analysts were unable to justify their stock market valuation on the basis of classical valuation methods (such as the price-earnings ratio). Instead of prudent assessment, valuation criteria were used to justify the astronomically high market capitalization (e.g., growth of users, number of page views). In effect, many companies have valued more than hundred times their expected sales. The valuation of the stock market drifted more and more away from what was justified by even the most optimistic assumptions regarding future growth.

Eventually, it was unavoidable that the high stock market valuations could not hold any longer and the speculative bubble had to burst. In the downturn, the selection between acceptable and less acceptable business models finds its expression in the magnitude of valuation adjustments. The companies with a sustainable "business model" will survive and have a good chance to recover. The others will be eliminated from the market in the long run. The analysis of the long-term development of the NADSAQ index therefore leads to another conclusion: Contrary to some very euphoric expectations regarding the economic effects of e-commerce, the index will only continue on its upward trend, a tendency which could already be observed for three decades.

2.2.3 E-commerce Market

2.2.3.1 Definition of e-commerce

The rapid worldwide expansion of telecommunications networks and, based on the use of these networks, the Internet has broadened the potential of the exchange of information and goods significantly. Nearly the whole economic and social system will be affected by this development. In Germany the Internet is becoming firmly established as a mass medium in a similar way as it is in the U.S. This affects, on the one hand, the areas of communication (e-mail, chats, ICQ etc.), information (news, databases, advertisement, etc.), as well as entertainment (music, videos, PC-games, on-line casinos, etc.), and, on the other hand, the so-called "electronic commerce". This e-commerce represents one of the most important applications based on ICT.

Generally, e-commerce is understood as the exchange of goods and services via electronic networks, mainly via Internet. Alongside with on-line trade in goods, the provision of services via Internet such as on-line banking, on-line booking or on-line auctions falls into this category. For statistical purposes e-commerce comprises all trade activities conducted via the Internet regardless of whether the billing takes place on-line or not, and of how the respective product is delivered. This exceeds widely the mere electronic invitation of an on-line deal and the pure initiation of a transaction. These activities lead to the formation of more or less closed user groups, to a rising business volume, and to the formulation of standards for contracts and appropriate business conduct.

In principle one can distinguish between three types of transactions:

- Business to Business (B2B): business relations between enterprises;

- Business to Consumer (B2C): business relations between enterprises and consumers;

- E-government: performance of government services via electronic networks.

By B2B, interactions among enterprises via so-called virtual "market places" can be made on-line. Until now, B2B-trade has been of greater importance, especially in branches with standardized products like electronics, automobiles, energy, as well for the chemical industry, and some service sectors (financial services, trade etc.). An expansion into other branches is absolutely conceivable in the near future. Besides the on-line sales of goods sent to the consumers (books, CDs, DVDs, hardware, software, automobiles, equipment, clothing, food etc.), B2C also deals with a range of services (travel bookings, on-line banking, on-line stock brokerage, on-line auctions etc.). This B2C-trade focuses on retail trading as well as on the areas of finance, communications, and information. E-government has the aim to improve the information and data exchange within the public administration. Furthermore, citizens should be enabled to carry out certain administrative acts via Internet.

In general, it is quite difficult to assess whether the introduction of e-commerce has led to additional economic activity. While, for instance, a car or a book might be ordered and paid on-line, its preceding inspection might well have proceeded in the traditional fashion. Thus, any expansion of the overall volume of trade can only stem from productivity and real income effects, as well as from product innovations. Such changes go far beyond substitution effects. Many of these new products concern digitized goods. For instance, book extracts can be sold directly via Internet. This would have the advantage that the consumer can access the desired text at any time (that means 24 hours per day). Most importantly, the customer can scan the product without having to buy the whole book. Similar considerations pertain to the on-line distribution of music, videos or software, in particular, if eventually a sufficient coverage with the broadband technique is provided.

2.2.3.2 Effects

Overall, e-commerce will exert a wide range of effects. Among the effects which are most likely are the following:

- opening-up of new markets: this does not only include the substitution of traditional trade, but also the development of new products and product combinations;
- optimization of the cost structure: this effect will be achieved by cutting the transaction, distribution and marketing costs as well as by rationalization;
- increasing productivity: this effect will emerge from the faster and more efficient exchange of data and goods; in connection with cost cutting measures we can expect decreasing input and consumer prices as well as increases in real income;
- intensification of competition; and
- improvement of market transparency.

Besides the impacts of these factors, there are some empirically important effects of e-commerce on other macroeconomic aggregates:

- changes across regions and sectors in the course of time;
- impacts in areas such as outsourcing, vertical integration, and cooperation networks;
- changes in the capital stock;
- changes in the demand for labor;
- impacts on procurement and supply chain practices;
- changes in the existence and role of intermediaries; and
- changes in complementary investments (e.g., human capital).

Through B2B-trade via virtual "market places", the transaction costs can be lowered. Furthermore, B2B-trade leads to an increase in the intensity of competition and, with that, to more efficient markets because, e.g., a greater number of input suppliers will offer their products on-line. Therefore, positive network externalities are generated by B2B: The more enterprises offer their goods and services via the Internet, the better will be market transparency and the greater will be consumer welfare. Consequently, the long-term overall economic importance of B2B-trade is lying in the rationalization of business transactions and an efficient coordination of the procurement activities within the business sector. This gives enterprises a competitive advantage connected with corresponding gains in efficiency. Moreover, it is possible that enterprises are getting access to new markets.

Because of the lower-cost distribution of B2C-trade, some of the classical distribution channels are replaced, but also new products and sales strategies are developed. B2C leads to considerable cuts in the distribution costs, for example, in the on-line distribution of software, plane tickets or insurance policies, and in on-line banking. From a macroeconomic perspective, a considerable overall cost-cutting potential has been identified (OECD 1999). On the one hand, the reduction in the transaction, distribution and marketing costs could lead to an increase in competition and market transparency. On the other hand, it is conceivable that the range of offered goods and services could expand considerably.

E-government might lead to an acceleration of the internal and external communication as well as the exchange of information and data between government agencies and their citizens. Ultimately, this should contribute to an increase in the efficiency of public administration, and to an improvement in the supply of administrative services.

2.2.3.3 Evaluation of Selected Market Studies

Now and in the future, prices of PCs and Internet access are continuously declining, contents in the Internet are qualitatively and quantitatively expanding, and the meaning of e-commerce is worldwide increasing. Most forecasts conclude that these processes will lead to substantially enhanced growth rates. Above all, observers expect that Europe will be able to narrow the presently existing gap between Europe and North America regarding Internet use (EITO 2000). Unfortunately, the German Federal Statistical Office does not provide any administrative data on e-commerce in Germany. However, as indicated above, some private data sources do exist. The EU is conducting a pilot study on e-commerce in which 100,000 firms in 13 countries take part (Eurostat 2001b). However, the results are not yet available. In any case, e-commerce represents only one aspect of the change in business processes that occur in accordance with the "new economy". More generally, there is a need for a systematic accounting of different dimensions of the electrification and networking of business processes within and outside of the firm. This accounting should ideally be integrated into the System of National Accounts.

Various studies have provided different assessments of the worldwide e-commerce sales level. ActivMedia Research assumed that the sales worldwide are about 300 bn $ in the year 2001, whereas Goldman Sachs estimates the e-commerce sales at 1.2 tn $ (NFO Infratest 2001a: 219). These differences arise because it is often disputable whether an activity should count as e-commerce or not. Nevertheless, the different studies give at least roughly an impression about the quantitative importance of electronic trade.

Table 17

Projection of e-commerce Sales until 2010
2001 bis 2010

	2001	2005	2010
	e-commerce sales, bn $		
Germany	19	140	700
USA	390	1,200	3,500
World	550	2,000	7,000
	Share in the worldwide e-commerce sales, %		
Germany	3.5	7.0	10.0
USA	71	60	50
World	100	100	100
	e-commerce sales in % of the gross output value		
Germany	0.6	3.5	14.5
USA	2.2	6.0	14.1
World	1.0	3.0	8.1
	e-commerce sales per resident, $		
Germany	230	1,700	8,650
USA	1,350	4,050	11,350
World	90	315	1,050

Source: Dehio, Graskamp 2002. RWI ESSEN

Below, a study of eMarketer will be discussed in more detail (an overview over the results is given by NFO Infratest 2001a). According to this study, the worldwide e-commerce sales amounted to about 550 bn $ in the year 2001. With a share of 70 percent, the U.S. has got by far the highest share in the worldwide e-commerce sales, even if this share – compared to the year 2000 – has already been decreasing. Asia and Europe score sales shares of 14 percent and 12.5 percent, respectively. In all regions of the world the sales shares in this market are dominated by B2B-trade. The share of B2B-trade of the whole e-commerce market in 2001 has even increased compared to the previous year, from just under 80 percent to approximately 82 percent. Accordingly, in the year 2001 about 450 bn $ of e-commerce is allotted to B2B- and 100 bn $ to B2C-trade.

Hence, in 2001 Germany is at the leading edge in Europe in the e-commerce market with sales of about 19 bn $. The German share of the worldwide e-commerce sales amounted to 3.5 percent. Nevertheless, in relation to the gross output per resident as well as the e-commerce sales per resident, Germany lags considerably behind. The U.S. may score e-commerce sales of about 390 bn $ in the year 2001 (Table 17). Whereas in 2001, Germany's share of e-commerce sales in relation to total gross output amounted to a little bit more than ½ percent (230 $ per resident), the share of the U.S. had already been at over 2 percent (1,350 $ per resident). In the year 2001 the share of the worldwide e-commerce sales in relation to the world gross output amounted to approximately 1 percent (90 $ per resident).

According to eMarketer's estimates, the worldwide e-commerce sales will increase to just under 3.2 tn $ by the year 2004. Thus, in the next three years sales will increase by 480 percent overall and by 80 percent on annual average, respectively. Probably not more than 60 percent of the sales will be produced in the U.S., whereas in Europe more than 20 percent of sales will be produced by then. So, the gap between the U.S. and Europe would get considerably closer, but the gap cannot be closed completely by then. Not only in the short run but also in the long run the e-commerce growth will be dominated by B2B-trade. The share of B2B in relation to the whole e-commerce market may rise to about 90 percent in the medium term.

For the year 2004, for example, Forrester Research and the Gartner Group predict even far higher worldwide e-commerce sales of about 7 tn $. This result is mainly due to their relatively encompassing definition of the e-commerce market. The very large differences in the magnitudes of the sales estimates of the different studies suggest that all available forecasts for the trend of e-commerce sales are subject to some reservations. However, the various studies differ only slightly referring to the projected growth rates (see the following section).

2.2.3.4 Prospects

Below, the potential medium-term growth of the e-commerce market is estimated for different countries and various projection years. The projection for the year 2001 (Table 17) is based on the estimate of e-commerce sales by eMarketer. Compared with other studies, this definition of e-commerce is relatively restrictive (e.g., Goldman Sachs assume that the total sales volume for the year 2001 is more than twice as high). In the context of the projection, however, we expect a lower annual growth rate for the following years than that assumed by various studies available. The reason for this moderate assessment is that the worldwide penetration of broadband technology is expected to be lower than predicted by earlier expectations. Moreover, with respect to investments in the B2B area, not only has the problem of providing the e-market places with the necessary complex and functioning software been underestimated – a variety of problems have arisen in this area with respect to functionality and guarantee of sufficient applicability – but also the problem of making these compatible with the conventional software concepts of the participating enterprises. In addition, different technical, institutional and cultural inhibiting factors that delay the use of the Internet for e-commerce purposes may well be more important than was assumed in some very optimistic forecasts. In this respect, Internet security aspects are particularly important.

For the year 2005, the worldwide e-commerce sales are expected to reach 2 tn $, which means for the period of 2001 to 2005 an average annual growth rate of little less than 40 percent. eMarketer and Forrester Research predict that the growth of e-commerce sales between the years 2001 and 2004 will probably be twice as high as the growth rate mentioned before, while Ovum and ActivMedia Research forecast a growth rate of between 59 percent and 84 percent on average. IDC Research and Goldman Sachs are standing in the middle with their prediction of somewhat less than 70 percent (the growth rates are based on sales figures estimated by different studies, cited by NFO Infratest 2001a: pp. 218).

Furthermore, it is assumed that worldwide e-commerce sales will increase to 7 tn $ by the year 2010, which would mean an average annual growth rate of 28 percent in the second half of the current decade. The assumption of 7 tn $ in e-commerce sales in the year 2010 means that a sufficient coverage of broadband cable network must be available so that the throughput velocity in data transfer can be significantly increased. Moreover, it is assumed that the Internet will have attained high security standards so that one of the greatest factors inhibiting its use for e-commerce can be eliminated.

Additionally, it is assumed that Germany's share of worldwide e-commerce sales will increase to 7 percent by the year 2005, and to 10 percent by the year 2010, while the share of the U.S. will decrease to 60 percent by 2005 and 50 percent by 2010. Consequently, e-commerce sales in Germany will amount to 140 bn $ in 2005, and 700 bn $ in 2010, while in the U.S. there will be 1.2 and 3.5 tn $, respectively. Accordingly, e-commerce sales in Germany would grow by about seven times by the middle of the decade, while in the U.S. it would rise – despite a much higher starting level – by more then 200 percent at any rate. By the year 2010, according to this projection, the German e-commerce sales would increase again by five times, while in the U.S. it would increase by nearly three times.

The continuously declining share of the U.S. can be traced to the catch-up effect in Europe. The increase of Germany's share of worldwide e-commerce sales is advancing even more dynamically than Europe as a whole.[4] The following points are decisive in explaining the disproportionate increase in Germany:

> Germany already has a highly modern network infrastructure and is a leader in fixed networks. For example, nearly one quarter of all ISDN connections in the world take place in Germany (BITKOM 2000: 7). Some 23 of every 100 German households had an ISDN connection in the year 2000, while only 10 out of 100 West European and 5 out of 100 U.S. households

[4] For example, eMarketer assumes that even in the year 2004 the German share in worldwide e-commerce sales is about 9 percent.

had one (BITKOM 2001 cited by NFO Infratest 2001a: 77). With respect to cable connections, Germany was with 55 out of 100 households just behind the U.S. with 65 out of 100 households, and considerably above the West European average of 29 out of 100 households (BITKOM 2001 cited in NFO Infratest 2001a: 89). With respect to the expansion of the broadband cable network, Germany still lags behind. Meanwhile, it has become apparent that the availability of dial-up connections over xDSL, direct lines and interactive digital TV will progress more rapidly from now on. Currently, some 15 mill. households worldwide have network access based on broadband technology (Multimedia Research Group 2001 cited in NFO Infratest 2001a: 69).

A reliable indicator for the availability of cable and DSL connections in a country with modern e-commerce infrastructure is the number of the so-called SSL-servers (server with secure socket layer). These servers are used for the transmission of encrypted information and are therefore especially suitable for e-commerce. The U.S. currently has 24 SSL servers per 100,000 residents (NFO Infratest 2001a: 114), more as – that means per capita – five times as many SSL servers as in Germany. This ratio corresponds almost exactly to the relation between the per-capita sales in e-commerce in Germany and the U.S. Nevertheless, Germany has been catching up in comparison to previous years. This process seems to be continuing.

Currently, there are just under 2,200 B2B platforms worldwide, more than half of those in the U.S., about 800 of these virtual market places in Europe, and almost 300 of those in Germany (Berlecon Research 2001 cited in NFO Infratest 2001b: 31).The fact that some 13 percent of all and 36 percent of the European B2B market places are in Germany is an indication that German enterprises should be well prepared for the dynamic sales growth predicted for the B2B industry.

For 2005, it is expected that the number of mobile Internet users in Europe, around 170 million, will be about 80 percent more than in the U.S and Canada (Ovum 2000 cited in NFO Infratest 2001a: 157). The growth rate will be very high, above all in Germany so that Germany is predicted to be in a very strong market position in the area of mobile-commerce (m-commerce) in the next few years.

If one relates e-commerce sales to gross production value, the share of e-commerce sales by the year 2005 according to this projection would – assuming an increase in the nominal gross production value by an average 4 percent annually – increase to 3.5 percent (1,700 $ per resident) and in the U.S. by 6 percent (4,050 $ per resident). In 2010, accordingly, the shares in Germany and in the U.S. would be almost equal, at 15 percent. With respect to the share of e-commerce sales in production, Germany could close the gap with the U.S. by the end of the current decade. In per-capita calculations, however, Germany with

8,650 $ would still lag considerably behind the U.S. in 2010 with its 11,350 $. If it is assumed that about nine-tenths of e-commerce sales concern the B2B-area, then it follows that about 30 percent of purchases of goods and services via the Internet will be conducted in Germany and the U.S. in 2010.

The share of worldwide e-commerce sales in world gross production value, according to the projection – with 3 percent in the year 2005 – will amount to 8 percent in the year 2010. If one relates the e-commerce sales to the number of residents – with the assumption of 1.1 percent average annual growth in the world population – it becomes clear that the per-capita sales in the next ten years will increase more than tenfold. With just a little more than 1,000 $ nominally by per resident in the year 2010, that is equivalent to about 850 $, taking today's purchasing power into account. By world standards, however, e-commerce sales will only have relatively limited importance by the end of the current decade. On the other hand, in the industrialized countries, e-commerce will reach considerable proportions, even with respect to production as well as per-capita sales. Moreover, these projections for the year 2010 are based on comparatively conservative assumptions and the following conclusions can be drawn:

(1) It can be assumed that the growth rate of e-commerce sales will be higher in Germany than in the U.S. in the next few years, due to a catch-up process resulting from the less advanced development of the German e-commerce market.

(2) Despite the high growth rates projected for the coming years, the importance of e-commerce may continue to be relatively low. Accordingly, in the U.S. the share of e-commerce sales in total gross output value would only amount to about 6 percent despite the comparably high level in 2001 – with a share of over 70 percent in the worldwide e-commerce sales.

(3) Although the gap between Germany and the U.S. in gross output value will become smaller, e-commerce sales in the U.S. are likely to continue to be greater than in Germany over the medium term.

(4) Presumably, e-commerce sales will only become an important factor in the world economy in 2010. Having amounted to just about 1 percent of world gross production value in 2001, this share is expected to be about 8 percent of world gross output value in 2010. Therefore, e-commerce will already play an important role by world standards towards the end of the current decade, even though considerable growth potential may still have to be released.

(5) Because of the highly heterogeneous structure of this market as well as the large capital-spending required for the set-up of the necessary infrastructure, the predicted e-commerce sales and high annual growth rates pro-

vide only a limited indication for the actual macroeconomic significance with respect to productivity, cost structure, and real income.

The majority of studies on e-commerce are considerably limited to estimates of sales volume and sales trend. It is surely undisputed that e-commerce sales will grow disproportionately quickly in the next few years. There is doubt, however, about whether sales are a good indicator of e-commerce market trends, since the amount of sales does not permit any conclusions on the real national economic implications.

2.2.3.5 Overall Economic Effects

The basis of economic action in the future will no longer be the classical value-added chain (input supplier – intermediary – producer – distributor – dealer – final consumer), but a value-added creation network (Urchs 2000: 72). With this network, there will no longer be linear, but multidimensional relationships between the participating actors. If, for example, a network of 50 companies already exists, a 51st will want to use the entire network and communicate or interact with other users. Other companies already in the network also benefit from this. The additional utility of such a network does not necessarily correspond to the increase in the number of users (which in this case increases by 2 percent), but actual use may rise disproportionately. The resulting external network effects cannot be easily verified empirically. It is even not immediately clear whether they are positive at all.

Many aspects of individual or social welfare which may be enhanced by e-commerce are difficult to qualify. These aspects comprise ease of information access, time savings in the ordering of goods, increased entertainment and communication possibilities, or positive ecological consequences caused by savings in the packaging of digitized products, etc. Consequently, they will not be reflected in the national accounts. Accordingly, the gross domestic product as an indicator of social welfare will provide an underestimation of the positive effects of the Internet and e-commerce, respectively. An increase in the volume of e-commerce first of all promises to deliver lower input prices and positive productivity effects. As a result of increasing competition, a tendency towards declining inflation and interest rates is expected, as well as higher overall growth and an improvement in the supply of goods. Specifically, many observers expect the enhanced provision of new kinds of goods, such as digital books, the downloading of individual music titles or diverse information and communication services.

If the order of magnitude predicted for the trend in e-commerce sales is realistic, market participants will be convinced that investing in this field is economically sensible. In those branches of industry in which e-commerce has eventually exceeded the critical threshold, the question of competition arises: A company that does not use e-commerce may lose market shares. In this respect, it will no longer just be a question of the direct profitability of e-commerce investment, but a question of survival in the marketplace. Enterprises face therefore, the alternative of making the vision of e-commerce as a part of their business, or going out of business. For enterprises that have met the prerequisite for e-commerce, it will be necessary to attain large shares of the market in order to achieve scale effects. With rising quantities, average costs can be reduced, which leads to increased competitiveness due to the scope of price reductions or increases in profit.

Below, another attempt will be made to assess quantitatively the order of magnitude of the overall economic growth effects of B2B over a longer period. For this, with the help of input-output-analysis, the effects of B2B trade on the growth rate of gross domestic product will be calculated (Brookes, Wahai 2001). The analysis is based on the assumption that B2B trade will be one-third of the output by the end of the current decade. Furthermore, a calculation will be made of the extent to which cost reductions result and are reflected in the corresponding reduction of input prices. The U.S., Germany, Japan, France and Great Britain are included in this analysis.

For the period of 2000 to 2010, an additional nominal GDP average annual growth of 0.25 percentage points per year was calculated in comparison to a base solution (without B2B) for all countries included in this analysis (Brookes, Wahai 2001). For Germany, the result was an additional growth of 0.4 percentage points per year; for the U.S. less than a quarter of a percentage point, and for Japan, France and Great Britain 0.3 percentage points per year. Despite this growth impetus, with respect to the entire period of time, there was no increase in the inflation rate, while in some countries the inflation rate even decreased slightly.

The results are consistent with our projection (see above) that Germany has a comparably greater potential for further development of e-commerce, even if e-commerce has only a relatively small effect on the level of overall economic activity. By the way, also of some interest is the long-term calculated growth potential through B2B, which is 5 percent on average for the countries included in the analysis. In Germany it is 5.7 percent, and 4.4 percent for the U.S. (2000 to 2010). Overall, these results suggest that long-term GDP would be higher by 5 percent as a result of B2B than it would be without B2B. Accordingly, e-commerce does not lead to a long-lasting increase in growth rates, but only to a level effect. The long-term growth path is not permanently affected.

Nevertheless, the magnitude of the growth effect determined by this empirical analysis should not be overstated, since the market trends of B2B and the effects from it are not yet sufficiently appraisable in any exact way. However, positive overall economic effects can still be expected which – with respect to the influence on GDP growth – are predicted to be smaller than commonly assumed and are only of a temporary nature in particular. Because the magnitude of these growth effects is quite uncertain, no general statement about the future growth effects of e-commerce is possible at this time.

2.2.3.6 Policy Interventions in Germany

Small- and medium-sized enterprises in Germany use e-commerce relatively reluctantly. Many of them never use the Internet for the intermediate trade between enterprises (B2B) or as a channel of distribution (B2C). Obviously, there are still considerable impediments, such as:

- security problems (e.g., with on-line payment),
- implementation costs,
- integration of e-business applications into existing IT-systems, and
- shortfalls in know-how at both the management and the specialist level.

It may still take some time, therefore, until e-market places alter the economy significantly. In the following areas, suitable conditions should be created to facilitate the acceleration of development:

- creation of more legal security in worldwide trade via the Internet,
- introduction of international industry standards for online transactions,
- integration of IT-systems over the entire value-added creation chain,
- creation of intelligent logistics systems.

It is the primary task of the individual economic actors to create conditions in the areas that facilitate rapid market penetration of e-commerce (see Rothgang, Scheuer 2001; Schmidt 2001a, b). The government must act mainly with respect to the creation of more legal security to facilitate the dynamic growth predicted for e-commerce sales.

Currently, the European eCommerce-Guidelines represent the legal framework for cross-border electronic trade. These EU-Guidelines were converted into national law in Germany at the end of the year 2001 through the "Legislation Governing the Legal Framework Conditions for Electronic Business". In addition, modifications were also made in the German Civil Code, with regard to obligations for companies to provide information as well as stipulations for electronic ordering. For this purpose, the individual sub-section "Special Forms of Distribution" (§§ 312ff. German Civil Code), was created. One of the essential regulations of the European eCommerce-Guidelines is the "country of origin"-principle. According to this, the activities of an enterprise on the Internet are subject to the legal provisions of the country in which it has its headquarters and its branch establishment. This provision is not without problems regarding Internet enterprises, because valid legal regulations in the destination country could possibly be dodged, since it is relatively easy for an Internet enterprise to move their servers to a country which offers relatively favorable legal framework conditions for the respective business purpose.

However, with respect to the payment of value added tax (VAT) it is not the country of origin-principle, but rather the country of destination-principle which is effective in the EU. According to this, the taxes must be paid in the country in which the customer is residing. At present, third countries, such as the U.S., do not have to pay any value added tax within the scope of B2C. However, the EU also intends to charge value added tax for such products of B2C-Online trade offered by suppliers from non-EU countries in order to reduce present competitive disadvantages for EU countries. In this regard, the absence of tax harmonization within the EU is problematic, with the consequence that the tax rates in the individual EU countries are different.

The collection and payment of taxes with different rates demands the existence of national tax borders. The abolition of border-controls in the EU would thus really have required tax harmonization within the single market. This has, however, not yet been accomplished with regard to value added tax. Thus far, the result of this effort has been a considerable administrative expenditure, since the tax authorities have to approach the importers directly in contrast to previously when the goods were taxed as they crossed the borders. However, this possibility cannot be applied for on-line goods trade. In this case there are normally no importers at all since the goods are purchased directly from the foreign enterprise. In addition, it is possible for the final consumer to disguise his country of origin, so that he or she will possibly only have to pay the taxes of a low-tax country. As such, the new EU regulation could be dodged with the result that the desired competition-promoting effects may not be able to develop to their full extent.

In order to keep the bureaucratic expenditure as low as possible, provisions in the EU are intended to obligate third countries in the future to choose a freely determinable EU country as a so-called country of registration to which they will have to pay the value added tax for all B2C transactions within the EU on the basis of the respective tax rates of the country of destination. The country of registration will then subsequently transfer the value added tax to which the respective member country is entitled. The problems in connection with the collection of a value added tax for B2C products will, however, probably not be satisfactorily solved before a means for more efficient supervision of online trade has been found, and tax harmonization has been accomplished. This is to be striven for within the EU in any case; such harmonization is, however, also desirable with the U.S., the country – as demonstrated – which has at present (and probably also in future) by far the greatest significance with regard to e-commerce.

3. Concluding Remarks

With respect to ICT use, the "new economy" in the present is mostly associated with

- immediate productivity increases as a result of ICT input in production of goods and services, and
- development of e-commerce as new market-place for goods and services.

However, by looking at structural aspects on the industry and microeconomic level more deeply, the underlying processes become more obvious. There is no simple linear relationship between ICT use and productivity. Complementary investments and changing business processes are in most cases the crucial prerequisite for productivity increases. Before this background, e-commerce represents an indicator for one aspect of a whole range of changing firm-internal and external business processes in the value-added chain. The future task of economic analysis at the microeconomic and industry level will be to uncover the connection between these changes and business performance at the micro, industry, and macro level.

Even though the exact mechanisms that establish the connection between ICT production and productivity growth are still unclear, the importance of ICT infrastructure for international competitiveness is unquestioned: The liberalisation of the information- and telecommunications service industry in Germany has provided the precondition necessary for a future reduction in the cost of telecommunication services and, therefore, an increase in the use of ICT. Presently, Germany is lagging behind countries like the U.S. that have deregulated their communications sector earlier with respect to usage of telephone services, Internet and e-commerce. Great efforts with respect to price, quality and efficiency of the supplied services as well as increased R&D expenditures will be necessary in order to catch up to nations like the U.S., but also other European nations like Sweden and the United Kingdom.

In order for e-commerce sales to develop dynamically in the coming years, broadband Internet access should be provided as far as possible. Guaranteeing this will require considerably more investment in network infrastructure. Negative developments in world technology stock markets have created doubts about the profitability of these investments, but the recent downswing in the stock markets has not totally altered the long-term trends of infrastructure investments. Growth has just become somewhat slower at the most.

The intensified use of e-commerce has partly led to mere substitution of standard business procedures, but also to the creation of new products or product combinations. This concerns B2B (online purchases of input goods and services between companies) as well as B2C (online distribution from companies to the final consumer). From e-commerce one expects to develop new distribution and procurement channels, a reduction in transaction, distribution and marketing costs and therefore lower input and consumer prices. Consequently, it will likely lead to an increase in productivity, competitiveness, market transparency and, finally, an increase in real income.

Depending on the particular estimate, worldwide e-commerce sales in 2001 amounted to just about 1 or 2 percent of world gross output value. However, the growth rate of e-commerce sales will be very high in the coming years. Germany's share in worldwide e-commerce sales will increase considerably, as Germany already has a highly modern network infrastructure, is a leader with respect to B2B-platforms, and has large growth reserves in the field of mobile communications. By the year 2010 Germany – according to own projections – will further close the gap with the U.S. In B2B area, some 30 percent of inputs will be conducted via the Internet in these countries by then. The share of worldwide e-commerce sales in the world production will be 8 percent in 2010, according to the results of this projection.

The trend in e-commerce sales still does not say anything about the accompanying productivity, cost, and income effects. One indicator of the estimation of the overall economic effects of e-commerce is the influence on gross domestic product growth, although it is uncertain whether all utility aspects connected with e-commerce or the Internet are, in fact, reflected here. Some econometric studies that assume declining input prices and increasing productivity also assume that a change in the level will occur caused by e-commerce over the long run with respect to GDP (which may well be above 5 percent). However, there will not be a lasting increase in the growth rate, i.e. the long-term growth path will not be affected permanently.

In the future, all enterprises – as far as possible – should be in a position to use the Internet for intermediate trade (B2B) or as a distribution marketing channel (B2C). This requires, among other things, the successful integration of e-business applications into existing IT-systems, more legal security in worldwide trade via the Internet, and the implementation of internationally accepted industry standards for online transactions. Additionally, the further rapid expansion of e-commerce activities does not depend solely on greater ICT investments, but also on the success of efforts to make e-business more attractive and, above all, more secure.

Chapter 5

Macroeconomic Consequences of ICT

This chapter draws on calculations of the contribution of ICT (use and production) to the recent increase of GDP and productivity growth in the U.S., a performance that is often associated with the "new economy". During the last years Germany experienced a slight productivity growth as well. Here, we analyse whether Germany also experienced a "new economy"-effect. Furthermore, we investigate how robust our conclusions are, when different computer price indices are employed and we analyse the importance of cyclical factors. In our analysis, standard growth accounting calculations are employed, similar to the method used by Oliner/Sichel (2000). Our choice of data intends to ensure comparability between Germany and the U.S.

1. Methodological Approach

Our analysis uses a standard growth-accounting framework. This approach was applied by Oliner/Sichel (2000) to calculate the growth contribution of ICT investment for the U.S., and has been enhanced by Gordon (1999a, 2000a) to take the effect of the business cycle on productivity into account. Gordon's analysis is based on the observation that productivity behaves procyclically (Gordon 1999a: 4–5, 2000a: 54, 1993) because employment does not adjust immediately and completely to output. We do not intend to improve upon these approaches methodologically. The aim of this study is to overcome data inconsistency problems in order to gain comparable measures of the ICT effects for both countries. Of central interest to this study is the question of whether and to what extent the "new economy"-effect that was observed in the U.S. could also be seen in the statistical evidence for Germany.

In the statistical data, different effects of ICT can be identified. Firstly, the ICT producing sectors have themselves gone through a period of rapid productivity increase in the production of hardware (Chapter 4). Depending on the size of this effect and the relative importance of the computer sector for the non-farm business sector in the U.S. and Germany, multifactor productivity growth increases can be calculated for the whole economy. Apart from the computer-producing sector, the rest of the economy has seen an increased accumulation of investment in computers and related ICT products. This effect shows up capital deepening for the whole economy. While the growing capital stock per employee raises labor productivity, this development exerts no effect on multifactor productivity. However, in so far as spillover effects of the use of ICT to the whole economy exist, and to the extent that they translate to more efficient business processes, an increase of total factor productivity should be observed as well.

In our approach we assume a neoclassical linear-homogeneous macroeconomic production function. Firms adjust their capital stock immediately to the optimal long-run level so that higher net returns of investing in ICT capital are diminished. Having these assumptions in mind, the following decomposition of output growth can be derived:

$$(1) \qquad \frac{\dot{Y}}{Y} = \alpha_c \frac{\dot{K}_c}{K_c} + \alpha_{sw} \frac{\dot{K}_{sw}}{K_{sw}} + \alpha_{CE} \frac{\dot{K}_{CE}}{K_{CE}} + \alpha_0 \frac{\dot{K}_0}{K_0} + \alpha_L \left(\frac{\dot{L}}{L} + \frac{\dot{Q}}{Q} \right) + \frac{\dot{MFP}}{MFP}.$$

While Y represents the potential long-run output of the non-farm business sector, K_C denotes computer capital stock, K_{SW} software, K_{CE} communications equipment and K_O non-ICT capital stock. The increase in the labor utilization L can be adjusted by a quality component Q. The share of output growth not attributable to these input factors is captured by the multifactor productivity term MFP. Under the maintained conditions, output elasticities α are identified with factor income shares.

The calculation of the income shares of capital is based on the theory of optimal capital accumulation (Hall, Jorgenson 1967; Kopits 1982; RWI 1988). Firms are assumed to adjust their capital stock according to their user cost of capital. This user cost has to take into account the required rate of return to finance the capital input, the rate of depreciation of the capital stock, the price change of capital goods and tax deduction possibilities. For each component of the capital stock, the user cost of capital for a given year is calculated by

$$(2) \qquad UC_t = P_t^* \left(r + \delta - \pi_t \right) T$$

where P_t^* is the price of the capital good, r represents the average real rate of return (e. g. current yield of fixed-interest securities), δ the depreciation rate, π_t the rate of price change for the capital good, and T denotes the tax deduction possibilities and investment credits, whereby T ranges from 0 to 1. While r represents the opportunity cost of capital, δ and π_t show the loss of value of the capital stock within a period. The income share is given by

(3) $$\alpha_t = UC_t \frac{K_t}{P_t Y_t},$$

where K_t denotes the capital stock and $P_t Y_t$ the nominal output. We proceeded in several steps:

- In section 2, data problems are discussed. The scope of our analysis is mainly determined by the quality and comparability of the different data sources for the U.S. and Germany. While data sets for ICT investment can be obtained from official statistics, existing data for the development of the human capital stock are insufficient and therefore not suitable to analyse the growth effect of human capital accumulation.

- In sections 3.1 and 3.2, we quantify the growth contributions of the computer capital stock, the software capital stock, the other capital stock and labor, measured by working hours. Unfortunately, working hours for the non-farm business sector excluding government employment are not available for Germany since 1990. Thus, private working hours have to be estimated from the official data set. In order to adjust for different definitions of computer and software capital stocks and to include the communication equipment, one might choose private data sources. Yet, in order to avoid data quality problems, we only used data from official sources in our final calculations.

- The standard growth accounting method only measures the direct growth effect of capital deepening associated with the use of ICT capital. One important question that is discussed in section 3.3 regards the increase in multifactor productivity attributable to enhanced business processes that can be traced back to the use of computers. For its measurement, the correction for cyclical effects is of crucial importance, though. Past experience of productivity increase as a response to output growth above the long-run trend is used to estimate the cyclical effects for the U.S. and Germany, respectively. Because of different institutional frameworks both in product and labor markets, the adjustment of productivity in the course of the business cycle could be quite different in both countries.

- Another question that arises with the use of U.S. price deflators concerns the consequences for our international comparisons of employing the new chain index price deflators published by the U.S. Department of Commerce since 1996 (section 4.2) (Whelan 2000a; Lequiller 2001b; Wadhwani 2000). By contrast, Germany uses – like most of the other European countries – a Laspeyres quantity index. The U.S. index generates lower growth rates for the price index than does the Laspeyres index in the years following the basis period (Deutsche Bundesbank 2001: 42). We try to quantity the magnitude of the corresponding differences.

- One factor that accounts for a noticeable part of the measured differences in economic performance is the difference in the measurement of the prices for computer hardware and software. This effect will be discussed in section 4.3. The U.S. uses hedonic price deflators in order to reflect the increased quality of computer hardware and software. For the computer capital stock, the value of the income share crucially depends on δ and π. The hedonic pricing method used in the U.S. leads to a gross return to capital for computers $(r+\delta-\pi)$ of about 60 percent, given depreciation rate of about 30 percent and a calculated price decline of about 30 percent per year for the last few years. The imputed value would be much smaller if German price deflators for computers would be used. Thus, the question arises, what part of the observed differences should be attributed to these measurement issues.
- Differences between Germany and the U.S. exist with regard to the statistical acquisition of software-capital spending. While in Germany software-capital spending is partially entered in German national accounting as intermediate goods, the U.S. states comparable expenditures as capital formation. In section 4.4. it will be analysed how these different registration methods affect the comparison between Germany and the U.S. regarding software-hardware relations.
- In order to assess the results of our analysis in the light of or the long-term development of total factor productivity growth and capital accumulation, we calculate total factor productivity and the capital deepening effect for both countries (section 5). Therefore, we account for changes in the quantity of labor and capital inputs over time and their effect on input costs for firms. Changes in the quality of production inputs are not identified in this step. They are included into the growth residual. We compare long-term trends of productivity and capital deepening for both countries in order to assess the changes that occurred in the U.S. during the last years.

2. Data Availability

2.1 Data on ICT Investment and Other Economic Indicators

Macrodata in the U.S. and Germany are not perfectly comparable. The calculations of growth effects are based on official data from the Statistisches Bundesamt for Germany, from the Bureau of Economic Analysis and the Bureau of Labor Statistics for the U.S. and partly from the OECD. Detailed information was needed for the separation of high-tech capital from the rest of the capital stock.

The calculations of long-term trends in productivity performance and capital deepening for the U.S. and Germany in section 5 are based on data from the OECD (2000d). We use data with the basis year 1996 for the U.S. and 1995 for

Germany. While the U.S. data are based on a chain price index, the data for Germany are deflated by a Laspeyres index that was calculated by the Statistisches Bundesamt.

The first comparison of the effect of ICT on GDP growth for a bigger number of industrialized countries (Daveri 2001) relied on data on ICT spending from a private source for Germany and other countries in order to overcome the lack of official data (WITSA 2000). These data on "Information Technology" for the time period 1992–99 were collected by a private consultant, the International Data Corporation. The ICT data were collected in interviews with local computer vendors. Together with the data, only the size and structure of the sample are published, so that the quality of the data is difficult to evaluate. In order to account for the shortcomings of the private information sources (Daveri 2001: 6–7), the calculations used in this study rely totally on data published by the statistical office.

In the official statistics of the Statistisches Bundesamt, investment in computer hardware is covered in the section „Büromaschinen, Datenverarbeitungsgeräte und -einrichtungen" (WZ 93, DL 30), which includes data processing machines, micro computers, peripheral machines like printers and terminals, but also traditional office equipment like manual and electrical typewriters, cash registers, and electrical pencil sharpeners. Production and consulting by producers are included, but not maintenance and repair. Telecommunications investment is split up between different sections and therefore cannot be identified separately. In order to gain an indicator for the use of communications capital, the section "Rundfunk-, Fernseh- und Nachrichtentechnik" (DL 32) was used. This section includes the production of elements of communications infrastructure, and radio and TV sets.

Since the last revision of the national accounts, investments in software (bought and internally produced) and large databases are included as immaterial investments. Data are available on a yearly basis back to 1991. The section regarding immaterial investment also includes license fees and exploration of resources. However, software investment is by far the most important component. In 1995, immaterial investment added up to 28.3 bn DM from which computer software accounted for 22.5 bn DM, license fees for 5.6 bn DM, and exploration for 0.2 bn DM.

When comparing software data for different countries, there are some problems with the identification and evaluation of software investments. While pre-packaged software is sold together with hardware components and therefore normally included into hardware investment data, the situation is different for bought and self-produced software. The investment in self-produced software has to be calculated indirectly from data on job characteristics of employees – in Germany from the Microcensus. Up to now, there are no international rules regarding how this should be done. Typically, estimates of the value of software are more conservative in Germany than in the U.S.

2.2 Labor Quality

To provide a methodologically convincing study of the differences in productivity performance between the U.S. and Germany we would have liked to incorporate an index of labor quality into our calculations, similar to the BLS measure (BLS 2001). However, primarily because of the substantial differences in the educational systems of both countries, we do not follow this route. In the U.S., training on the job plays an important role in the professional qualification of the work-force, whereas the German system is characterized by two- to three-year apprenticeship program at the beginning of the working life.

The international data on educational attainment based on the ISCED-Classification do not pay sufficient attention to these differences. Comparisons between the two countries which are based on measures such as the share of the employees with tertiary education lead to implausible differences between Germany and the U.S. (Löbbe et al. 2002).

3. Growth Accounting Analysis

3.1 Calculation Procedure

This analysis follows the previous studies for different countries (Oliner, Sichel 2000; Daveri 2001; Colecchia, Schreyer 2001). First we calculate the income shares for labor and different elements of the capital stock (equation 3) comprising the user cost of capital (equation 2) and the nominal capital output ratio. The user cost of capital consists of the market rate of return on capital (r), the rate of depreciation (δ) and the capital gain or loss which is connected with the purchase of the new capital good π. The rate of return on capital was calculated similar to the method used by Daveri (2001) and Oliner/Sichel (2000).

The depreciation rates were taken close to the BEA values (Fraumeni 1997). For hardware, software and communications equipment, depreciation rates of 32 percent, 44 percent, and 15 percent were imputed, while for the other capital stock rates of 10 percent were taken. According to the study of Daveri, the harmonization of price indices was achieved by applying the U.S. price deflator for computers to the investment data for Germany. Thus, the results of the growth accounting do not necessarily reflect the actual behavior because no hedonic price deflator exists for Germany. They have to be interpreted "as if" the U.S. deflator would also reflect the price change in Germany. However, because of the international comparability of computer characteristics that are the most important factor for determining the hedonic price indices, any resulting errors should not be too big. For the other capital items, the official national deflators were applied to national data for Germany and the U.S.

For the calculation of the ICT and non-ICT capital stocks, seven different capital assets were distinguished. ICT capital comprises IT hardware, software, and telecommunication capital. For non-ICT capital we counted non-residential buildings, other construction, transport equipment and other non-ICT-assets based on the statistical aggregates in the U.S. We refer to productive capital stocks, i.e. the value that the use of a capital good has in production, as opposed to the wealth capital stock based on its market value (Harper 1982). By using the perpetual inventory method, the value of use for each investment vintage in the subsequent years was calculated. For these calculations, the lifetime duration of service for the different investment goods has to be assumed a priori as well as retirement and age-efficiency schedule. Because there is no empirical evidence of the actual productive value in use, this procedure is somewhat arbitrary and has to rely on plausible assumptions. In order to ensure comparability, the calculations in this study tried to reproduce those calculations used in other studies.

The assumed average service lifes were 7 years for IT hardware, 4 years for software and 15 years for communications equipment, figures which were also utilized by Daveri. For non-ICT investment, 15 years were assumed for transport equipment and other equipment, 60 years for non-residential buildings and 20 years for other structures as in Colecchia/Schreyer (2001). For the age-efficiency schedule, a hyperbolic function was used with the formula $(t–T)(t–0.9T)$. For the retirement function, a cumulative normal distribution was used which was assumed to be truncated in the beginning of the service lifes (for the first years of the service lifes, no retirement was assumed, while after two times the average service life the cohort was retired fully). The resulting growth rates for the ICT and non-ICT capital stock for Germany and the United States are shown in Table 18.

For the U.S., a noticeable increase in the ICT capital stock can be observed. This growth was accelerating both for computer hardware and for communications equipment in the second half of the nineties. This acceleration partly reflects the sharp price decline associated with shortening production cycles and fierce competition mainly in the semiconductor industry. For Germany, the data tell a somewhat different story. The computer hardware capital stock also shows an acceleration in the second half of the nineties, even though the increase was less pronounced than in the U.S. In the explanation of this trend, one has to bear in mind that the U.S. price deflator was used to deflate the nominal investment date for Germany. For communications equipment and software, the growth rate of the capital stock decreased in the second half of

Table 18

ICT and Non-ICT Capital Stock in Germany and the United States
1990 to 2000; annual average growth rate in %

	Computer hardware	Communications equipment	Software	Other capital
United States				
1990 to 1995	16.0	3.3	14.7	2.6
1995 to 2000	39.5	9.2	16.2	4.0
1990 to 2000	27.2	6.3	15.4	3.3
Germany				
1990 to 1995	14.4	23.5	12.5	3.1
1995 to 2000	31.4	6.2	8.4	1.9
1990 to 2000	22.6	14.5	10.4	2.5

Authors' own calculations. RWI ESSEN

the nineties. This pattern reflects, among other aspects, backlog demand shortly after German re-unification.

3.2 Results

The results of the calculations for GDP growth are summarized in Table 19. In the U.S., GDP growth in the nineties was obviously strongly driven by ICT capital accumulation. On the average, ICT accumulation accounted for 0.68 percentage points of the 3.65 percent increase in GDP during the nineties while non-ICT capital accumulation accounted for 0.51 percentage points. The labor force increase accounted for a 0.99 percentage point increase in production. Multifactor productivity increased by 1.47 percent. However, this indicator includes several different factors. There is a cyclical effect that is difficult to quantify. In addition to the increase in efficiency of production itself, human capital accumulation is included in the estimate of multifactor productivity.

Notably, the data on the U.S. growth performance in the nineties show an increase at the end of the nineties. While the growth effect of the labor force increased from 0.76 to 1.21, the contribution of the ICT capital rose from 0.42 percentage points at the beginning to 0.92 in the second half of the nineties. Most of this increase can be accounted for by the expansion of the hardware capital stock. Also the contribution of multifactor productivity rose from 1.09 to 1.88 percentage points.

During the nineties, economic growth in Germany was clearly smaller than in the U.S. The available data show that the contribution of ICT capital to GDP growth (2.33 percent) was 0.44 percentage points, whereas the other capital stock accounted for 0.93 percentage points. While capital deepening during the nineties was more intensive in Germany than in the U.S., ICT played a

Table 19

Decomposition of GDP Growth into its Components
1980 to 2000; annual average growth rate in %

	1980/90	1990/00	1990/95	1995/00
		United States		
1 GDP growth	3.25	3.65	2.65	4.64
2 Contribution of labor	1.40	0.99	0.76	1.21
3 Contribution of capital deepening (4 + 8)	1.08	1.19	0.80	1.55
4 Contribution of ICT capital (5 to 7)	–	0.68	0.42	0.92
5 Hardware	–	0.33	0.17	0.48
6 Software	–	0.27	0.21	0.32
7 Communications	–	0.08	0.04	0.12
8 Other capital	–	0.51	0.38	0.63
9 Multifactor Productivity (1 – (2 + 3))	0.87	1.47	1.09	1.88
		Germany		
1 GDP growth	2.43	2.33	2.15	2.52
2 Contribution of labor	0.26	0.03	–0.44	0.41
3 Contribution of capital deepening (4 + 8)	0.99	1.37	1.54	1.21
4 Contribution of ICT capital (5 to 7)	–	0.44	0.44	0.45
5 Hardware	–	0.23	0.16	0.30
6 Software	–	0.10	0.11	0.09
7 Communications	–	0.11	0.17	0.06
8 Other capital	–	0.93	1.10	0.76
9 Multifactor Productivity (1 – (2 + 3))	1.18	0.93	1.05	0.90

Authors' own calculations based on data from BEA, BLS and Statistisches Bundesamt. RWI ESSEN

much smaller role. A more pronounced, more labor-intensive but less capital intensive upswing in the United States could already be observed in the eighties. Total factor productivity was only of moderate importance for German economic growth during the nineties, as well as in earlier times.

Considerable differences characterize the growth performance in Germany during the first and the second half of the nineties. The first half of the nineties was dominated by an increase in the "other capital stock" which dominated especially in the years 1992 and 1993 with growth effects of the non-ICT capital stock of above 2 percentage points in these two years. This investment boom was mainly associated with German re-unification. In the second half of the nineties, the growth effect of the hardware capital stock doubled from 0.16 to 0.30 percentage points which is well below the U.S. rate. While the growth effect of the communications capital stock was above the value for the U.S., the minor impact of the German ICT investment is mainly due to lower investment in IT hardware and software.

Table 20 shows the results of our study in context of other calculations. On the whole, these studies estimate similar effects of ICT capital accumulation on

Table 20

Growth Effect of ICT Capital in Selected Studies
1991 to 2000; annual average growth rate in %

Study	Period	Hardware	Communication equipment	Software	ICT capital
		United States			
Oliner/Sichel 2000	1991/1995	0.25	0.07	0.25	0.57
	1996/1999	0.63	0.15	0.32	1.10
Daveri 2001	1991/1999	0.50	0.08	0.36	0.94
Colecchia/Schreyer	1990/1995	0.20	0.08	0.14	0.42
2001	1995/2000	0.47	0.15	0.25	0.87
RWI	1990/1995	0.17	0.04	0.21	0.42
	1995/2000	0.48	0.12	0.32	0.92
	1991/1999	0.30	0.06	0.25	0.61
	1996/1999	0.48	0.10	0.30	0.88
		Germany			
Daveri 2001	1991/1999	0.24	0.13	0.12	0.49
Colecchia/Schreyer	1990/1995	0.24		0.06	0.30
2001	1995/2000	0.30		0.07	0.37
RWI	1990/1995	0.16	0.17	0.11	0.44
	1995/2000	0.30	0.06	0.09	0.45
	1991/1999	0.19	0.10	0.10	0.39

Sources see text. RWI ESSEN

growth. While Daveri's calculations for the period 1991/99 (using the WITSA data base) for Germany are a bit higher than our results, those of Colecchia/Schreyer show little higher growth effects for the U.S. and lower effects for Germany than our study. One probable reason for this could be attributed to differences in the calculation of the ICT capital stocks and different assumptions on ICT investment growth in the 80s. The overall result is that the growth effect of ICT was much smaller in Germany than in the U.S.

3.3 Cyclical Effects and Multifactor Productivity Growth

While the remarkable accumulation of ICT capital is documented by multiple studies, some debate remains about the existence and scale of long-term increases of technical progress in the U.S. in the second half of the nineties – as measured by total (multi-) factor productivity. In our calculations, total factor productivity in the U.S. rose by nearly 0.8 percentage points in the second half of the nineties. According to the estimates of Oliner/Sichel (2000) one can assume that 37 percent of this increase is attributable to total factor productivity growth in the computer and computer-related semiconductor manufacturing industry. This fraction of the total factor productivity increase is mainly caused by the rising performance of personal computers. What fraction of the remaining 63 percent can be attributed to cyclical factors and to structural technical change remains unclear.

Gordon (1993, 1999a) estimates the cyclical factor to account for all the remaining growth in total factor productivity. He argues, specifically, that typically in a business cycle upswing output growth precedes working hour growth. This leads to a temporary increase in productivity which is corrected downward as the cycle matures. This result was challenged by the U.S. Council of Economic Advisers. The CEA calculated that only a very small fraction of the productivity increase in the second half of the nineties had to be attributed to cyclical effects (CEA 2001). This view was also confirmed for the U.S. by the German *Sachverständigenrat* (SVR 2001: 57).

For our comparison of the effects of the "new economy" in Germany and the U.S. the identification of the cyclical effects of the productivity increase poses a substantial problem. Most important, for the nineties a transfer of the methods used for identifying the cyclical effect in the U.S. to data for Germany is not possible. Not only do business cycles look quite different in Germany and the U.S., also German re-unification represents a major structural change. Irrespective of these technical problems, the relative growth contribution of the computer and semiconductor sector is much lower in Germany than in the U.S. (Chapter 3). Thus, the resulting direct productivity effects – which cannot be calculated exactly for Germany because of a lack of data on the sectoral level – are supposed to be much smaller.

4. Influence of Deflating Methods on Measured Growth

Against the background of the significantly rising importance of the ICT sector in the last years, the possible influence of different deflating methods on the measurement of the real macroeconomic growth is of increasing interest.

4.1 Initial Situation

For international comparisons the methods employed in the price statistics play an important role. There are differences between the countries especially in the type of price indices employed and the way changes in quality are taken into account. International organizations like the United Nations, the OECD or Eurostat exert a great effort to harmonize their methodological and conceptual approaches. But frequently, we have to rely on non-harmonized national statistics especially in international comparisons.

The methodological debate has led – primarily in the U.S. – to changes in the instruments for deflating time series. New approaches of calculation of price indices especially for the use of hedonic techniques had already been discussed at the German Federal Bureau of Statistics in the nineties and the use of these techniques was tested in the context of a study (see Gnoss, Minding 1990). That the inflation rate may have been overestimated in the past was the principal result of a group of experts appointed by the "Finance Committee" of the U.S.-Senate (Boskin et al. 1996; see also Gordon 1999d). This "Boskin Report" established that the inflation rates stated in the U.S. were overestimated and with it, the real figures underestimated. The results of the study led to some methodological modifications. In Germany, studies were also carried out to this subject (see, e.g., Hoffmann 1998). Details of these modifications and their consequences will be discussed in detail later on. In what way methodological modifications are also meaningful for German national accounting (VGR) and which consequences they will probably have, is also examined in the course of the following analyses. Primarily, there are methodical differences between Germany and the U.S. in the following areas:

- calculation of price indices: indices based on a basis year versus chain-indices,
- taking account of quality effects: conventional price-adjustment-methods versus hedonic techniques.

For deflating of time series in the context of the German national accounting the German Federal Bureau of Statistics uses an index that expresses real GDP in constant prices of a fixed basis year, whereby an update of the basis year takes place only every five years. For the elimination of quality effects, some traditional methods are used. The Bureau of Economic Analysis (BEA), however, applies a chain-index that takes the structural changes more quickly into account than a regular updating of the basis year could do. Furthermore, BEA uses hedonic price indices in some areas for the adjustment of quality.

Apart from the U.S., chain-indices and hedonic price indices are still being used at the present in Canada, Australia and France for example; chain-indices alone are used in Great Britain, the Netherlands and Norway. Only hedonic price indices are used in Japan, Denmark and Sweden; whereas the methods applied in Germany are being used in – among others – Italy, Finland, Ireland and Spain (Gust,Marquez 2000: 676). Differences between Germany and the U.S. exist moreover with regard to the statistical acquisition of software-capital spending: While in Germany software capital spending is partially entered in the national accounting as intermediate goods, the U.S. states comparable expenditures as capital formation.

Before analyzing trends in total factor productivity, in the following sections the methodical differences are analyzed in more detail. Only on this basis an accurate judgement of productivity growth in Germany and the U.S. is possible.

4.2 Deflating of GDP

4.2.1 Methodology of the German National Accounting

The German national accounting shows nominal GDP and real GDP in constant prices of a basis period. Nominal GDP is transferred formally into a real value by the division with a Paasche-price-index. The index places the current expenses of any year *t* under review into relation to the hypothetical expenses arising from the prices (*p*) of the basis period 0 (Nierhaus 2001: 41):

Paasche-price-index: $\sum_i Q(i,t) \cdot p(i,t) / \sum_i Q(i,t) \cdot p(i,0)$

The deflated time series results that in year *t*, valued at constant prices of the basis period 0, are:

$$BIP_{real} = \sum_i Q(i,t) \cdot p(i,0)$$

Since the German national accounting does not calculate a Paasche-price-index, product categories are deflated by Laspeyres-price indices at a disaggregated level:

Laspeyres-price-index $\sum_i Q(i,0) \cdot p(i,t) / \sum_i Q(i,0) \cdot p(i,0).$

The corresponding sub-aggregates are finally added up and represent then a relatively good approximation for that real GDP figure which would have been deflated by a "real" Paasche-index (Nierhaus 2001: 42). The division of real GDP of year *t* by real GDP of the basis period 0 yields a Laspeyres-quantity-index that shows the relative change of real GDP:

Laspeyres-quantity-index: $\sum_i Q(i,t) \cdot p(i,0) / \sum_i Q(i,0) \cdot p(i,0).$

This Laspeyres-quantity-index can be interpreted as a mean value of weighted quantity, weighted with constant expenditure-shares in the basis year ("fixed-weighted index"; Nierhaus 2001: 42). The advantage of this "fixed-weighted index" applied in Germany is in particular – beside the simplicity and the easy interpretation – its additive consistency. The individual components of final demand – real private consumption, real public consumption, real gross-capital formation, real net exports – can be calculated individually and afterwards added up to the real GDP without any residual amount. However, the results of this method depend on the selection of the basis year.

The influence of the selection of the basis year on the level of the calculated growth rate is the more important, the more structural changes occur in quantities and prices. These problems gained importance for the first time in the beginning of the seventies in the context of increasing energy prices, and gained even more relevance in the last years due to rapidly declining prices of ICT goods.

The essential effect resulting from fixing a basis year is the so-called substitution bias (Landefeld, Parker 1997). This bias arises from the fact that the demand for goods and services, whose prices rise at below-average rates or even fall, typically increases. If the price-basis of deflating time series changes to a more current basis year, these goods and services get a smaller weight because of their lower prices. Consequently, part of the amount which was reported as growth before will be eliminated from the calculations by this correction.

Reflecting this substitution bias, the more product prices deviate downwards in relation to the average price development, the more pronounced is the overestimation of the growth rate that has been stated before the change to the new basis year. The same effect occurs, if the import prices rise over-proportionately. This effect was observed for oil prices in the seventies. In order to eliminate the substitution bias at least from time to time, in Germany the basis year is updated – as mentioned before – about every five years on average.

To illustrate the issue we present a simple model calculation in the following (for similar calculations see also Nierhaus 2001: 49). For the sake of simplicity, in Table 21 the calculation of the GDP is reduced to one consumer product (product 1) and one investment good (product 2) in a closed economy. The quantities of product 1 and 2 are defined as Q_1 and Q_2 and the prices as p_1 and p_2. The sum of the turnovers of these two goods yields nominal GDP for each year. While in our hypothetical example the consumer good is characterised by moderate increases in quantities and prices, the capital good is chosen to represent the ICT sector. This sector is characterised by declining prices with disproportionate increases in output.

Different indices are calculated now and indexed as 100 for each basis year, whereby in the upper part of the table the basis year 1995 and, in the lower part 1999 was chosen. The index of turnover relates to the development of the nominal turnover. The Paasche-price-index can be calculated by inserting the corresponding output and prices into the formula described above. One gets the real GDP by division of the nominal GDP through the GDP-deflator (Paasche-price-index). By division of the real GDP for a particular year under review through the GDP of the basis year, one gets the Laspeyres-quantity-index. According to the definition, multiplication of the Paasche-price-index and the Laspeyres-quantity-index results again in the index of the nominal turnover. These partial indices represent the decomposition of the total index subdivided into a price and a quantity component.

Table 21

Deflating of the GDP by Several Basis Years – an Illustration

	Product 1		Product 2		Nominal GDP		GDP-deflator		Real GDP	
	quantity Q_1	price p_1	quantity Q_2	price p_2	in current prices	Index of turnover	Paasche-price-index	Laspeyres-quantity-index	in prices of 1995	growth rate
	apiece	DM	apiece	DM		basis year = 100			DM	%
					basis year 1995					
1995	100	8.0	50	4.1	1,005	100.0	100.0	100.0	1,005	
1996	102	8.1	53	3.6	1,017	101.2	98.4	102.8	1,033	2.8
1997	104	8.2	57	3.3	1,041	103.6	97.7	106.0	1,066	3.1
1998	106	8.3	60	3.0	1,060	105.5	96.9	108.9	1,094	2.7
1999	108	8.4	63	2.6	1,071	106.6	95.4	111.7	1,122	2.6
2000	110	8.5	66	2.3	1,087	108.1	94.5	114.5	1,155	2.5
					basis year 1999					
1995	100	8.0	50	4.1	1,005	93.6	103.6	90.6	970	
1996	102	8.1	53	3.6	1,017	95.0	102.3	92.9	995	2.5
1997	104	8.2	57	3.3	1,041	97.2	101.9	95.4	1,022	2.7
1998	106	8.3	60	3.0	1,060	99.0	101.3	97.7	1,046	2.4
1999	108	8.4	63	2.6	1,071	100.0	100.0	100.0	1,071	2.4
2000	110	8.5	66	2.3	1,087	101.5	99.2	102.3	1,096	2.3

Authors' own calculations based on Nierhaus 2001. RWI ESSEN

Regarding the calculated growth rates of real GDP corresponding to different basis years, in the example the derived growth rate would decrease by 0.2 to 0.4 percentage points in individual years, if the basis year changed from 1995 to 1999. This effect is the result of the already discussed substitution bias that becomes more important, the more pronounced the structural changes in prices and quantities are in the years which follow the basis year. In this example, the capital goods prices are relatively low after the re-basing, but their quantity increased disproportionately.

4.2.2 Using of Fisher-Chain Indices by the BEA

The BEA has rearranged the calculation of real GDP in the U.S. on a chain-index in the year 1996 (Scheuer, Leifer 1996). By using the chained Fisher-quantity-indices, real GDP is actually the result of an averaging of the expansion rate based on prices of the corresponding previous year, on the one hand, and the rate which results from the calculation of the GDP valued at prices of the year under review, on the other hand (Deutsche Bundesbank 2001: 42). The substitution effects are taken into consideration because the actual price and quantity structures are also reflected in this procedure.

Therefore, a chained Fisher-quantity-index is used by the BEA to eliminate the substitution bias promptly. This index is a so-called „chain-type annual-weighted" index that corresponds in the end to the geometrical average of a Laspeyres- and a Paasche-quantity-index of the year under review *t* in comparison to the previous period *t*–1 (Nierhaus 2001: 43).

$$\text{Fisher-quantity-index } (t, t-1) = ((\text{Laspeyres-quantity-index } (t, t-1) \text{ x}$$
$$\text{Paasche-quantity-index } (t, t-1))^{0,5}.$$

Finally, a chain index arises from the linkage or multiplication of the individual Fisher-quantity-indices. Since the Fisher-chain-index is calculated every year, it is guaranteed that changes in the price and quantity structures are taken into consideration promptly and that the substitution bias is eliminated.

$$\text{Fisher-chain-index } (t,0) = \text{Fisher-quantity-index } (t-1,0) \text{ x}$$
$$\text{Fisher-quantitiy-index } (t, t-1)$$

$$BIP_{real}(t) = \sum_i Q(i,0) \cdot p(i,0) \cdot \text{Fisher-chain-index } (t,0) \ / \ 100.$$

The Fisher-quantity-index can alternatively be determined by deflating of nominal GDP with a Fisher-price-index. The Fisher-price-index, which is the geometric average of a Laspeyres- and Paasche-price-index, is also called "economic price index" (Nierhaus 2001: 43). The microeconomic theory of consumption defines – as it is well known – the term "cost of living" as those expenses which are necessary for reaching a certain level of utility. Therefore, a price index that measures the costs of living appropriately, should give expression to the minimal costs connected with different price structures in order to guarantee a certain level of utility. With that, the Laspeyres-price-index represents the upper limit, the Paasche-price-index represents the lower limit of an economic price index which is orientated to utility maximization. Therefore, the Fisher-price-index can be interpreted as an approximation of the individual preferences of private households:

$$\text{Fisher-price-index } (t,t-1) = ((\text{Laspeyres-price-index}(t,t-1) \text{ x}$$
$$\text{Paasche-price-index}(t,t-1))^{0,5}.$$

The data referring to the individual components of GDP subdivided into income and product cannot be interpreted in constant prices any more, because the real changes recorded by the indices described above are not only caused by changes in quantities, but also in the price structure. Therefore, the components are not additively consistent any longer. Nevertheless, the use of Fisher-chain-indices is recommended by the SNA as well as the ESVG 1995. The German Federal Bureau of Statistics ought to adopt the Fisher-chain-indices for deflating the GDP by the year 2005 at the latest.

4.3 Quality Effects

Quality effects play an important role especially for goods characterized by surges of innovations, such as in case of some ICT products (e.g., personal computers). In Germany more traditional price adjustment methods are used, whereas in the U.S. hedonic prices indices for elimination of quality effects came into operation in some areas.

4.3.1 Elimination of Quality Effects in German National Accounting

There is always a change in quality if a new product provides a higher or lower utility value than the old one (Szensenstein 1999: 45). Increases in quality refer not only to technical characteristics of a product, but they can also exist when additional services are offered (e.g. transportation). A product feature influences the utility value of a product if for different characteristics there is also a different willingness to pay an appropriate price. However, if the consumer pays a higher price as an equivalent for the increase in utility value caused by an improvement in quality in at least one product feature that is not a "real" price increase. If that factor is not taken into account when deflating GDP, an underestimation of the real development would be the consequence.

Changes in quality are very pronounced for certain products . Their prices are often characterized by an underproportional rise or even an absolute decline. The German Federal Bureau of Statistics eliminates a part of these quality changes from the prices. Nevertheless, according to model calculations only one half of the actual quality progress is captured by this procedure (Hoffmann 1999: 13). This is caused by the fact that changes in quality are not completely taken into consideration, e.g., if new and qualitatively improved goods with unchanged prices come onto the market or if the price difference is large, but the change in quality is relatively small.

In German price statistics traditional quality adjustment methods are used (see Szensenstein 1999: pp. 48). With that, methods come into operation which make a direct estimation of the monetary value of the change in quality possible, such as additional equipment, an improved performance or service sold together with a product. However, there is no doubt that the implicit quality features of new products can be captured only insufficiently by these methods. The Federal Bureau of Statistics reached this conclusion at the beginning of the nineties in the course of a study that dealt with the possibilities of the adjustment of quality effects by using hedonic methods (Gnoss, Minding 1990).

A separation of quality and pure price effects is necessary when using hedonic techniques. With the help of regression analytical methods, an expectation value for the utility of a product can be modelled by decomposition of the components (Harhoff 1999: 74). In this context it is assumed that individual goods can be decomposed in elementary as well as qualitatively relevant product characteristics and that the price of the combination of these characteristics can be fixed. Then one gets an estimation of the individual quality characteristics by using regression methods so that the monetary value of a change in quality can be determined (Szensenstein 1999: p. 57).

In spite of some reservations about the application of hedonic price indices, such as a supposed subjectivity in the selection of the functional form, the problem of intercorrelation or the personnel and financial demands on resources that are inevitably connected with the implementation of such techniques, the Federal Bureau of Statistics has already decided to use hedonic price indices. Only the exact point of time for the implementation remains open, because the German Federal Bureau of Statistics is currently waiting for the results of various studies.

4.3.2 Use of Hedonic Techniques by the BEA

As already mentioned, hedonic price estimations for the separation of quality and price effects are based on regression analytical methods (for an overview see Harhoff 1995; Moulton 2001). Therefore, different versions of a product can be presented as different combinations of individual product features. Hedonic regression equations for personal computers contain as explanatory variables, for example, the clock rate along with the capacity of the RAM and the hard disk (see Deutsche Bundesbank 2001: 8). Typically, stronger decreases in prices are estimated by the U.S. by the quality adjustment. For example, the prices of computers and peripheral devices in the U.S. fell between 1991 and 1999 by approximately four-fifths of the level of 1991. In Germany prices decreased by less than 30 percent in the same period.

It is to be assumed that these results are mainly due to methodological differences; other reasons may hardly be of such great importance that they could explain a considerable part of the difference. If German spending in electronic data processing capital (EDP capital) had been price-adjusted with the U.S. deflator, in 1998, the real spending would have amounted to 64 bn DM which was more than 100 percent above the value recorded by the official statistics; in the year 1999 even by 170 percent (Deutsche Bundesbank 2001: 8). According to that, since 1991 the EDP equipment would not only have risen by 6 percent per year, but by more than 27 percent.

The bias, which has occurred in comparison to the U.S. in the last few years is caused by the fact that the German Federal Statistical Office uses no hedonic methods up to date. However, judged by the impact on the macroeconomic growth rate, this bias may be smaller than commonly assumed. In Germany the ICT sector has still not gained such an importance as in the U.S. So, for example, between 1992 and 1999 real capital spending in EDP equipment in the U.S. manufacturing sector increased by about 40 percent per year, but in Germany by only 6 percent.

The following aspect should also be considered: Hedonic measuring methods are – like in Germany as well – being tested in several countries at present and these methods have already been implemented in other countries besides the U.S. It is to be expected that other countries will follow this example. A renunciation of this methodology in Germany would lead to the fact that in the wake of the expected development in the ICT sector international growth comparisons would become increasingly less meaningful.

However, the use of hedonic techniques in the price-statistics calculation is connected with some problems according to the experiences in the U.S. So considerable efforts were made with respect to data acquisition and data organisation. This means an additional burden not only for the statistical offices, but also for the companies which have to provide the necessary data in the appropriate format. Owing to the highly demanding methodology connected with the hedonic measuring methods, one has to provide the corresponding resources. Consequently, such a methodological switch-over would hardly be possible in Germany, if staffing and technical equipment of the statistical offices remained unchanged.

Moreover regression methods applied in connection with hedonic price indices do not measure directly the utility of changed product characteristics. In this respect it is doubtful whether the “real” utility of an increased clock rate or an increased capacity of a hard disk can actually be reflected appropriately by the use of regression functions. Nevertheless, this is not a point against the use of these methods, but – on the contrary – for the further development of such methods; e.g., trying to measure the possible utility value of a new feature. By the way, concerning the increasing diffusion of using this set of instruments, it would be desirable if an international harmonization could be reached with regard to the goods that ought to be included and – as far as possible – the functional form that will be used.

4.4 Software-Hardware Relations

Hedonic price-measurements in the U.S. involve not only computer-hardware but also computer-software, although to a lesser extent. In comparison to Germany there are large differences even with regard to nominal capital spending:

The nominal software-capital in Germany, which amounted to approximately three quarters of the intangible assets, increased by 70 percent between 1992 and 1999, i.e. 7 percent per year. Nevertheless, in the U.S. this spending increased by 215 percent in the same period. Thus, the growth rate in the U.S. was twice as large in Germany (Deutsche Bundesbank 2001: 44). In the year 1999, for example, the software-capital spending in Germany corresponded to the level of the hardware-capital spending, but in the U.S. the software-capital spending was more than twice as large. This difference is presumably based on the fact that in the U.S. spending on software and software-development is to a greater extent stated as capital spending than in Germany. Obviously, in German national accounting this spending is registered – at least partly – as intermediate goods. Within the framework of the revision in autumn 2001, BEA took these problems into account and carried out appropriate modifications bringing software-hardware relations in line with German figures.

4.5 Macroeconomic Impacts of Methodological Adjustments in Germany

In the last few years, decreases in hardware prices have not been accounted for sufficiently by traditional methods of quality adjustment. This may have led to an underestimation of the macroeconomic growth rate. But simultaneously, the so-called substitution bias became smaller. After the change to a new basis year in the German national accounting, revisions of real growth rates will turn out to be smaller. Admittedly, a certain systematic underestimation of the actual real growth rate will be left in the end, but the scale of underestimation will be smaller than it is commonly supposed owing to the offsetting effects discussed above.

In the U.S. the substitution bias is eliminated by use of the chained Fisher-indices. In this respect, there are no distortions of the stated real growth rates owing to changes in the price and quantity structures. Therefore, the more pronounced "substitution bias" in the U.S. resulting from the stronger decline in various ICT products, has a direct impact on the direction of a slight slowdown in the stated real macroeconomic growth. BEA estimates that the contribution of the hedonic price-measurement to estimated growth in the U.S. is one quarter percentage point (Landefeld, Grimm 2000: 20). Since the German ICT sector is less important than that in the U.S., the implementation of hedonic techniques is likely to have a smaller effect here.

We derived some own estimates of the effects of hedonic price-adjustment methods on the level of the real macroeconomic growth rate. For this purpose, we maintained the assumption that the German development of hardware prices prevailed in the U.S. as well as in Germany, and repeated our growth accounting exercise. It was not until 1996 that the indices were implemented. A significantly great difference found for the second half of the nineties can therefore be traced back to the use of hedonic techniques.

According to the calculations by using the hedonic techniques in the U.S., the macroeconomic growth rate increased by 0.2 or 0.3 percentage points on average per year in this period of time, whereas this rate in Germany would have turned out to be higher by just 0.1 to 0.2 percentage points, if in Germany hedonic price indices had been used as well. Nevertheless, if the software-hardware relation of the U.S. is applied to Germany, since 1996 the macroeconomic growth rate would have turned out to be higher by approximately 0.25 percentage points per year (Deutsche Bundesbank 2001: 45). In the context of the revision of the productivity data in the U.S. carried out recently, the disproportion of the software-hardware relation compared to Germany and other European countries was adjusted by the BEA. When the revised data are taken as a basis, one of the important methodological differences, namely the different measurement of software capital spending, does no more exist, and thus does not affect estimated growth rate any longer.

All in all, macroeconomic growth in Germany in the second half of the nineties would have turned out to be not more than 0.1 up to 0.2percentage points higher on average, if the U.S. methodology, chained Fisher-quantity indices and hedonic price indices, had been applied to German official statistics. Similar results are derived by the Federal Bank of Germany (Deutsche Bundesbank). Its results show that the growth of GDP from 1996 to 1999 would have increased also by only 0.2 percentage points per year on average, if the hedonic price indices had been applied to EDP-products and for purpose of deflating time series a chained quantity-index that is comparable to the U.S. Fisher-index had been used (Deutsche Bundesbank 2001: 42). Thus, these empirical studies show that only a relatively small part of the growth difference can be explained by the statistical acquisition and deflating methods. However, this situation could change in the future, if the ICT sector in Germany gained in importance. Moreover, it is conceivable that in future hedonic price indices can be applied to other product categories as well. Therefore, in Germany an adjustment to the methodology of chained indices and hedonic techniques may prove to be necessary. It would also be desirable, if a wide-ranging harmonization of the official data reporting could be achieved in order to generate an internationally comparable data base.

5. Trends of Total Factor Productivity and Capital Deepening

Bearing in mind that the different deflating methods applied in Germany and the U.S. has only been of little importance for the measurement of overall economic growth, we can assume that the results of the following analysis are sufficiently comparable. In our calculation of total factor productivity we use a simple framework. We calculate productivity for two factors of production (capital and labor) with no correction for changes in quality and composition (RWI 1988: 180–182). We use the OECD Outlook data for the business sector from 1960 to 2000, with estimates for 2000 and 2001. Employment is given per employee (in full-time equivalents), not on an hourly basis. We estimate total factor productivity with varying factor shares by assuming a substitution of labor with capital (capital deepening). The underlying assumption is that the factors of production are compensated with their marginal products on a macroeconomic scale. Labor and capital productivity $\left(LP_t \text{ and } CP_t\right)$ are

(4) $$LP_t = \frac{Y_t}{LV_t}.$$

(5) $$CP_t = \frac{Y_t}{K_t}$$

with the capital stock K_t and the labor volume LV_t. Labor and capital cost $\left(LC_t \text{ and } CC_t\right)$ are computed by

(6) $$LC_t = W_t LV_t$$

(7) $$CC_t = R_t K_t,$$

whereas the labor income is W_t and the unit capital cost R_t are assumed to be equal and constant in Germany and the U.S. However, its value depends on different factors like tax treatment of investment that will be addressed in refined calculations. The weights of the two factors of production (φ_t for labor and γ_t for capital) are

(8) $$\varphi_t = \frac{W_t LV_t}{W_t LV_t + R_t CS_t}$$

(9) $$\gamma_t = \frac{R_t CS_t}{W_t LV_t + R_t CS_t}.$$

Total factor productivity is denoted as

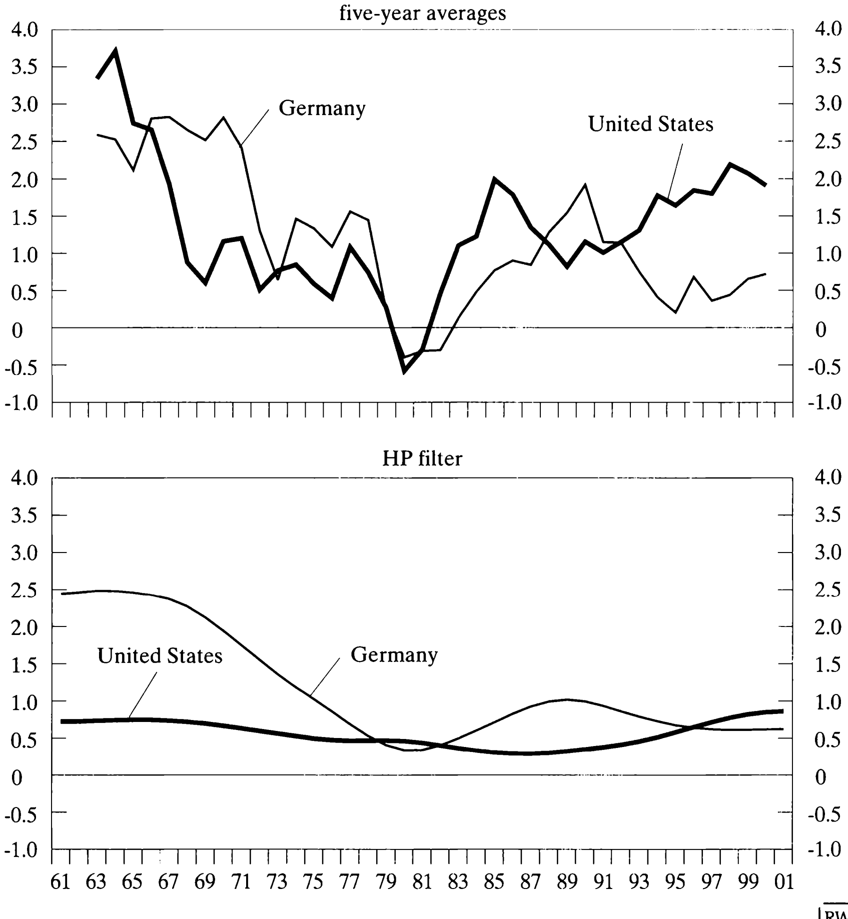
(10) $$TFP = \varphi_t \cdot LP_t + \gamma \cdot CP_t.$$

From this measure, we calculated annual growth rates. In order to account for short-run fluctuations in productivity growth, five-year averages are shown in Figure 22. Capital deepening denotes the share or labor productivity that is not attributable to total factor productivity but, instead, to an increase in the capital stock per employee. The capital deepening component (SC) is given by the difference between labor productivity and total factor productivity,

Figure 22

Trend Component of Total Factor Productivity in Germany and the United States

1961 to 2001; growth rates in %



Authors' own calculations based on OECD 2000d.

whereas total factor productivity is the residual that results from changes in labor productivity, if the capital deepening effect is taken into account. Capital deepening (growth rates) is calculated from equation

$$\frac{\dot{SC}}{SC}=\varphi_t+\gamma_t\cdot\frac{\frac{\dot{CS}}{CS}}{\frac{\dot{LV}}{LV}}. \tag{11}$$

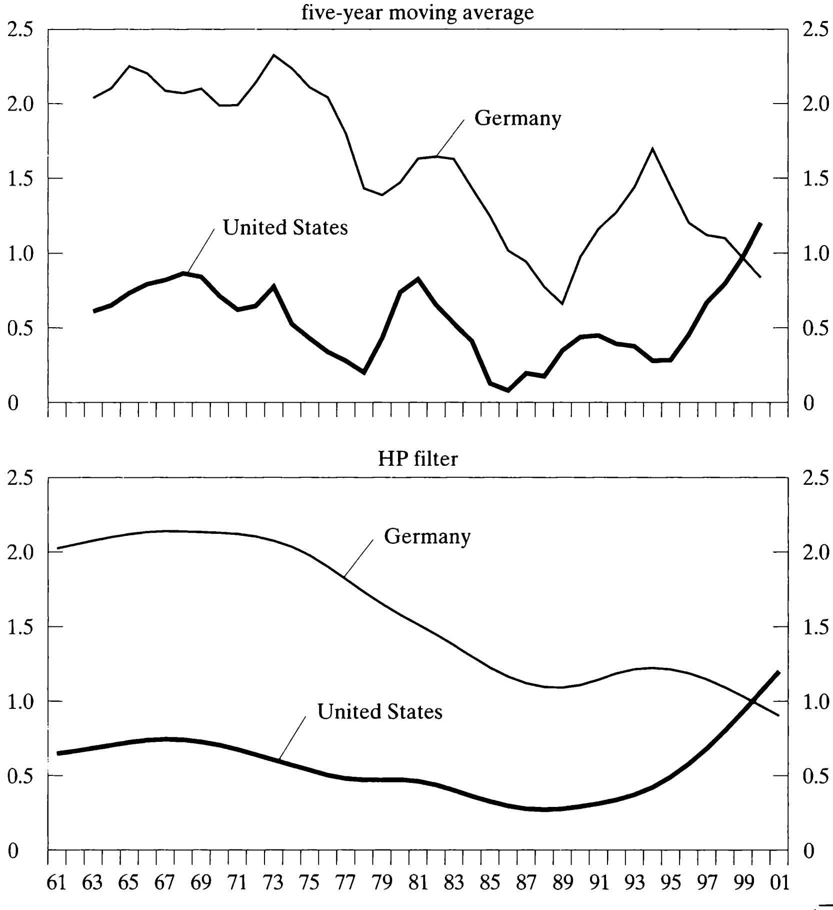
Figure 22 shows total factor productivity growth of Germany and the U.S. since the sixties. The development was influenced both by structural and cyclical factors. The sixties were characterized by high productivity growth rates in both countries which were seen to decrease during the seventies. That happened some years earlier in the U.S. than in Germany. Both the oil crises and the resulting recessions have contributed to this development. Very high growth rates were observed during the long-run upswing of the eighties, in Germany prolonged through the re-unification boom. From then on, total factor productivity increased strongly in the U.S. while a reduction can be noticed for Germany with only a small increase since 1995. The annual estimates in the U.S. for the years 2000 and 2001 based on the OECD forecasts show a reduction of total factor productivity growth in the U.S. to about the same range as in Germany. This cannot be seen in the graph because of the permanent effect of the higher productivity growth rates of the end of the nineties. Though, in the aggregated HP trend estimates a new economy trend reversal may be observed for the U.S., but not for Germany in the last years.

Figure 23 shows the five-year averages for the capital deepening effect. Again, both cyclical and structural factors account for the time patterns. Traditionally, Germany has been characterized by a much faster growth of capital intensity than the U.S. Different factors, e.g., high wages for low qualification jobs have contributed to this trend. However, these long-term trends seem to have reversed during the last years. Capital deepening has sharply increased in the U.S. during the nineties. This effect is mainly attributed to the increased use of ICT capital (Gordon 2000a: 56; Oliner, Sichel 2000: Table 2). We get the same results from the HP filtered time trends for Germany and the U.S.

In comparison to the development of labor productivity (see Chapter 1), it is obvious that the strong growth of labor productivity in the sixties – and partly the seventies – in Germany in comparison to the U.S. was mainly a result of the strong capital-deepening effect while the strong trend growth in labor productivity in the U.S. compared to Germany that happened during the last few years is both a result from increased total factor productivity and a substantial increase in capital accumulation.

To sum up our findings regarding the long-term development of total factor productivity and capital deepening, the available data show that the structural changes that were observed in the U.S. since the middle of the nineties could not be found in the data for Germany. Both total factor productivity and the capital deepening trend growth accelerated considerably in the U.S. in comparison to Germany.

Figure 23
Capital Deepening in Germany and the United States
1961 to 2001; growth rates in %



Authors' own calculations based on OECD 2000d.

6. Concluding Remarks

The roots of the growth accounting calculations carried out in this chapter go back to the seminal paper by Solow (1957) who used a macroeconomic production function in order to analyse the long-term causes of production growth. Solow found that a big fraction of production growth cannot be explained by factor accumulation, but by the technical progress hidden in the residual component of total factor productivity. Solow's findings were carried on by Jorgensen/Griliches (1967). They took up the idea of vintage models of capital-bound technical progress (Arrow 1962) and observed that the unexplained factor for technical progress can be reduced strongly by allowing for changes in the quality of labor and capital inputs. Like Solow's capital stock, both of these factors can be traced back to accumulation of a factor (human capital or R&D in the case of better investment goods) for which consumption has to be postponed.

Besides controlling for random changes in productivity, total factor productivity in this definition only captures increasing efficiency in the organization of production processes that cannot be directly traced back to factor accumulation. By applying this kind of empirical analysis, the papers by Jorgensen/Stiroh (1999, 2000a), Oliner/Sichel (2000) and Gordon (1999a) tried to quantify the effects of the sharply increased ICT investment on GDP growth in the U.S. both by total factor productivity and ICT capital accumulation. This kind of analysis was used in order to quantify the effects for Germany, based on certain crucial assumptions that deserve some further considerations:

First of all, the scale of the effects depends heavily on the measurement of the quality and price change incorporated in IT hardware capital. On both aspects, the hedonic price index for the U.S. was applied for the data on the U.S. and Germany in the calculations. Especially the question whether the hedonic price deflators measure the quality of IT hardware correctly is open to debate. The hedonic measurement uses characteristics of the goods involved like speed of the CPU and capacity of the hard disk as productivity component. However if there is decreasing utility in use of these factors, the hedonic deflators should overestimate real productivity effects. The effect would be that productivity increases that are caused by other factors are attributed to IT hardware.

The model used to quantify the effects of the ICT capital stock is based on the assumptions of rational, profit maximizing firms and a linear homogenous production function. Especially with respect to the IT software and hardware investments of the last years, the question arises – and was also discussed in this chapter – how much of this accumulation in the U.S. was based on a cyclical component with a short-term overinvestment that could not be sustained. Meanwhile, the discussion has come to the stage that the existence of a noticeable cyclical component is recognized. However, with respect to the increased capital accumulation this expansion has shifted the U.S. economy to a higher growth path that could be sustained in the future.

Another crucial assumption of the growth accounting framework concerns the separability of the measured quality improvements. Many publications on innovation processes stress the network character of new processes. This aspect has become even more important with the use of the Internet. Hardware and software components are networked with human knowledge in the framework of firm organization structures for production and service activities that are monitored through certain governance structures determined by shareholders under special legal conditions. In this context, it is unclear how the effects of different elements of these networks can be separated from each other. Additionally, the adaption of the different elements of production processes often takes much time so that a substantial time-span may lie between the investment in ICT and the resulting increase in productivity (David 2000; see also chapter 4).

In a nutshell, our growth accounting exercises took certain observable high-tech components – which are increasing strongly in supply out of these networks – and attributed GDP growth to them. Besides the network problem described above it is difficult to find the right definition of investment in the official statistics. For the calculation of the communications capital stock which is certainly very important in connection with the Internet, an aggregate was used that includes certain elements of telecommunications infrastructure. However, a noticeable part of the telecommunications infrastructure is not captured by these elements but hidden in investment in non-residential structures.

Chapter 6

Summary and Conclusions

1. Issues and Objectives of the Study

Already since the beginning of the year 2001, and even more so since the terror attacks in the United States in early September, economic growth has been declining in most parts of the world. The decline ends, at least temporarily, a long lasting phase of accelerated growth. This protracted growth had contributed to a rapidly rising real income and the creation of a great number of attractive jobs in the U.S. and some other countries for several years. The associated combination of accelerated growth and monetary stability was often addressed as the emergence of a "new economy". This new era was supposed to lead the U.S. to yet another "golden age" of growth and full employment, making the stagflation of the seventies and the productivity slowdown of the eighties a forgotten historical episode. Many observers assumed that the driving forces of this "new economy" – primarily the development and the increasing diffusion of new technologies, especially ICT – would lead to an ever accelerating factor productivity and the creation of new jobs, to low inflation and increasing "sustainable" real income.

However, the existence of a "new economy" in the U.S. is not an undisputed fact. In the U.S. literature there is an intensive discussion about the role of cyclical components and capital deepening on the one hand, and the contribution of technical progress (or total factor productivity) and falling ICT prices on the other hand. Lower restrictions regarding trade in goods and capital, an investment-friendly environment and a willingness to foster intensive competition, the associated adaptations of corporate structures, a skilful macroeconomic policy (a good mix between fiscal consolidation and countervailing monetary policy) and singular events (so-called peace bonus, drop in raw materials prices) are also important for the existence of the "new economy". Last but not least there was a debate about the appropriate calculation and statistical determination of labor and total factor productivity, qualifying the large growth figures to some extent.

From the European, and especially the German perspective, further factors that could have contributed to economic growth and employment should be pointed out. Extension and more intense implementation of the European Community, re-unification of Germany, reforms such as the deregulation of several sectors, privatization of public enterprises, reforms in public procurement and the creation of new instruments for business finance. These changes also have contributed to the accelerated change in sectoral structures, numerous mergers and acquisitions and the creation of new enterprises. All this resulted in a higher degree of competition and a greater share of small and medium-sized enterprises. Nevertheless, during the nineties economic growth in most European countries was modest – and proved not sufficient in reducing the high unemployment rate. Under these conditions, the debate about the "new economy" in the U.S. was observed more and more carefully in most European countries.

At first glance, the attractiveness of the term "new economy" concept has decreased markedly since the bursting of the speculative bubble on the stock markets. But one should bear in mind that the connection between both phenomena is weak: While at the micro-economic valuation of individual companies is at issue, at the macro-economic level it is the development of total factor productivity which is of interest. For this reason the study has tried to give a detailed analysis of the "new economy", especially to the following questions:

- Does the recent acceleration in the growth of U.S. productivity really imply a fundamental change in the long-lasting trend of a protracted productivity slowdown? Which differences exist between the U.S. and Germany, with respect to long-term economic growth and employment, factor productivity and inflation?

- How can these differences be explained? What is the importance of technological, cyclical and statistical factors?

- Is ICT really a basic technology in the sense that it fundamentally alters the production process in the overall economy?

- Do the general and sector-specific economic advantages arising from ICT correspond to those experienced during earlier technological revolutions?

- Are there spillover effects from the ICT-sector into the remaining sectors of the economy?

- What is the structural framework and which are the supporting macroeconomic policies that will foster the further development of the "new economy"?

2. Economic Development in Germany and the U.S.

For analysing the differences between the U.S. and Germany with respect to long run economic growth and employment, factor productivity and inflation, one has to focus on changes in the growth path of the economic aggregates. The cyclical fluctuations are of minor interest in this context. A well-known method to identify the trend path of economic aggregates is smoothing the corresponding time series with the Hodrick-Prescott filter (HP filter). If one assumes that a trend in a time series only changes, if there are structural changes in the economy and in the technology, the HP filter is an appropriate instrument to find out whether the U.S. time series since 1991 have been driven by other structural forces than in former times. For Germany one has to bear in mind the structural break in the data because of the re-unification. To overcome this break, the two parts of the series are linked. Summarizing our results suggest the following conclusions:

- Since 1991 there is a diverging development in the trend growth of GDP between the U.S. and Germany; the average trend growth rate in the U.S. has accelerated from 2.8 percent in 1990 to 3.8 percent in 2000, whereas the German trend growth rate has started on nearly the same level in 1991, but has slowed down to 1.8 percent.

- The U.S. trend growth rate of employment (between 1.5 and 2 percent) has always been higher than in Germany (below 0.5 percent). At the same time, the working-age population in the U.S. was growing more slowly, leading to a decline in the NAIRU and in the unemployment rate.

- The trend growth rate of labor productivity has always been higher in Germany than in the U.S. Since 1995 for the first time the velocity of U.S. productivity growth has – now with 2.5 percent – surpassed the corresponding German rate with 1.3 percent.

- In Germany labor productivity by sector is growing with different constant rates – the highest in manufacturing, the lowest in the service sector. By contrast, in the U.S. the growth rates are rising with a different acceleration rate in each sector. The manufacturing sector is contributing strongly to this accelerated growth of labor productivity. In the service sector in the first half of the nineties there had been a very slight reduction of labor productivity. Yet, since 1995 the reduction has slowed and in the end of the nineties there is a small growth of labor productivity in Germany. So in the U.S., the effects of an acceleration of productivity growth do not only show up in the ICT sector, but also in the manufacturing sector.

- Although German inflation was higher than in the U.S. for the period of 1992 to 1995, and was considerably lower in 1996 to 2000, there is a long-term tendency of a decrease in the CPI growth rates in both countries.

Clear differences in economic development between Germany and the U.S. emerge in the nineties. Explaining this divergence is difficult, not least because of German re-unification. Attributing it only to ICT is certainly inappropriate. After all, the application and diffusion of ICT is not a special feature of the nineties, it already started 30 years ago. What is new in the nineties, is the Internet, but its effects have not yet been reflected by the data.

3. ICT and Earlier Technical Revolutions

One of the main issues of the study refers to the question whether the general and particular economic advantages of the new technologies correspond to those of earlier technological revolutions. Economic growth is not a continuous, but rather a stepwise phenomenon. The corresponding structural change itself is induced by innovations. The concept of innovation comprises the transformation of scientific knowledge into new products and production processes, but also new organisational forms of firms, institutions, and labor. Life-cycle theory explains the sequence starting from innovation, and leads over its diffusion, to the maturity of the product and its descent. The rise and fall of new products or processes are reflected by the rise and decline of industries and sectors.

Inspired by this insight, some observers have suggested the existence of long swings in economic development. They argue, in particular, that the economic development of the past 200 years can be divided into five large cycles, the so-called Kondratieff cycles. Each of them is viewed as being caused by different fundamental technologies. Those fundamental innovations induce changes in the methods of production in the overall economy which are accompanied by changes in the structure of value added. These changes are in turn supported by the tendency to substitute new, more information intensive products for traditional products. The fundamental innovations are often followed by incremental or derivative innovations which induce a “bandwagon effect”. If these incremental innovations are complementary innovations, they can cause a sustainable upward shift of the growth path of an economy until their benefits are exhausted.

The five Kondratieff cycles implicated by this literature are:

– The first cycle ranges from the end of the 18th century to the middle of the 19th century and is based on the use of the stationary steam engine (industrial revolution).

– The second cycle spans from the middle to the end of the 19th century and is based on the mobile steam engine (of steel processing, formation of the railway system, manufacturing of machinery).

- The third cycle started at the beginning of the 20th century and ended in the Second World War (characterized by widespread application of electricity, electric motor, radio and telephone, and by mass production as a new production process).
- The fourth cycle started after the Second World War and was mainly based on improvements of existing technologies (petrochemicals, plastic materials and textiles, based on mineraloil). Finally, the first computer and the microchip were developed. The fourth cycle was ended by the oil crisis in the early seventies.
- Since the end of the fourth cycle there has been a fundamental structural change in the economy, mainly driven by an increasingly international division of labor, the globalisation process, and the increasing importance of information as both a production factor and a technology.

Comparing all of the fundamental technological innovations and driving forces of economic growth during the past 200 years, one can find the tendency toward an increasing service intensity and a qualitative change in communication structures, connected with the dispersion and application of the innovations in the economy. However, the productivity effects within the service sector are more difficult to evaluate than in the manufacturing sector because the input and the output in the first mentionened are more difficult to define than in the latter.

Furthermore, accelerated growth in connection with fundamental innovation, its diffusion, and the emerging structural change can take place more easily, if there is an innovation-friendly economic and social framework. For this reason the U.S. might have had the better preconditions for the diffusion and adoption of ICT, while in Germany, especially during the nineties, the challenges of re-unification had to be mastered. Besides this special effects during the nineties some further structural changes dominated, e.g. deregulation. So in the nineties, the diffusion of ICT in the U.S. took place in highly competitive and quickly changing markets. This structural framework was less volatile and easier to predict than in Germany.

Analyzing trend growth of GDP and productivity, which cover the important fundamental innovations of the past, one can see that the velocity of GDP growth since the nineties in the U.S. has not been higher than in some time intervals of the past, for example after 1930 and in the fifties. Intervals of long-term economic growth have always been followed by intervals of lower growth rates, so until now the pattern of the recent development is not unusual. However, the recent upswing in the U.S. looks similar to upswings in the past, which were induced by fundamental innovations. However, until now, ICT has seemingly not caused greater, but rather smaller effects on the economy than earlier technological revolutions.

In Germany the recent trend growth rates of GDP are far away from those which can be connected with an upswing because of a fundamental technological innovation. Nevertheless, at the end of the observed time series there is a turning point which has changed the direction of the trend growth upwards.

Concerning labor productivity since the end of the twenties, the trend growth rate in the U.S. has, for the first time, surpassed the corresponding German rate. The U.S. trend growth rate of labor productivity is characterized by a downward tendency since the beginning of the forties. Yet, in the eighties there was a turning point with increasing rates from this time on. In Germany, the deceleration of the growth of labor productivity started in 1960 and is still continuing. However, the deceleration of productivity growth since 1960 is not unusual because it could not be expected that the extraordinarily high productivity growth caused by the restructuring process after World War II would last forever.

The usual time lag between the date of the technological innovation and the widespread application of this innovation, which induces a structural change of the existing economic situation, typically takes about half a century. The invention of the computer took place more than fifty years ago, and the widely spread application already began in the seventies and eighties. Thus, on the one hand a large part of the productivity effects already occurred in the past. On the other hand, a lot of effects will only arise in the future, because many problems concerning information technology still have to be solved; for example the efficient transformation of information into useful knowledge.

The Internet can be interpreted as an incremental innovation which has followed the technical innovation of computers. The economic effects of the Internet, however, have not yet shown up until now.

4. ICT Sector

Following a widespread assumption, in the highly industrialized economies of the western hemisphere the ICT sector has grown much faster than other industries and substantially contributed to the overall employment – at least since the middle of the nineties. By contrary, the empirical evidence shows clear differences among the countries. According to recent OECD publications, the ICT sector is of substantial importance for overall economic value added and employment primarily in the U.S. and the United Kingdom and in some smaller countries like Finland and Sweden, but only of limited importance in Germany, Italy, France, and Japan. With the exceptions of Finland, Japan and Sweden, all selected countries are net importers of ICT products.

RWI has made some efforts to implement the ICT definition of the OECD on the basis of official datasets. Time series for different product groups and service categories in Germany and the U.S. were calculated. However, a comparison with the U.S. is only possible on the basis of nominal value added and people employed. Due to different methods of inflation measurement it is not possible to compare real GDP. The analysis period focuses on the years 1995 to 2000; a cyclical adjustment was not possible.

The results emphasize the concurrent findings of the OECD and EITO that Germany, with a 6.6 percent share of the ICT sector on the value added of all private companies (excluding agriculture, forestry and dwellings) is far behind the U.S. (11.0 percent), both in manufacturing goods (hardware 1.8 percent, compared with 2.8 percent) and services (software 4.8 percent, compared to 8.3 percent). Yet, the nominal value added of hardware producers in Germany rose much more briskly than that of software providers. Contrary to this, the U.S. trend was more strongly driven by service companies. All in all, the ICT sector, with 5.6 percent per year, grew significantly faster than the average for all companies. The situation was similar to the U.S. However, because of the lower share, the direct contribution of the ICT sector to overall economic growth in Germany is estimated at just 0.2 percentage points per year. By contrast, in the U.S., the direct impact is estimated at just 0.5 percentage point.

In Germany, changes in employment of the ICT sector turned out to be decidedly disappointing. Even in the field of hardware there were job cuts. Mainly two reasons are responsible for this: On the one hand, until the recent past, industrial production in the field of office and data processing machines is characterized by "classical" typewriting and calculating machines, copiers, cash registers, and postage meters. This sector had to cut jobs to a great extent and to close down manufacturing plants. The capacity and employment cuts could not be compensated by the producers of mainframe computers and desktop computers or peripheral devices. Additionally, the leading suppliers carried out outsourcing of parts of their production to legally and economically independent enterprises of the service sector.

On the other hand, the framework conditions and organizational structures changed decisively in telecommunications. As a consequence of liberalization and far-reaching privatization, the need to rationalize has increased considerably. Although numerous suppliers entered the market and established companies expanded their product scope, the number of employed people declined markedly. Many activities in fields like premium rate services, broadband cable services, information and innovation management or asset management were outsourced to companies in other sectors.

According to this data, in the year 2000 in Germany only 1.1 mill. people or 3.4 percent of private business sector employment worked in the field of ICT (in comparison: the ICT sector of the U.S. employed 5.7 mill. people, 5.1 percent of all employed workers). In Germany, like in the U.S., the ICT sector contributed directly only a little (by at most 0.1 percentage point) to the overall economic employment growth.

All in all, the results confirm that the ICT sector was a dynamic factor of the economy in the U.S. as well as in Germany, at least in the nineties. The production was obviously connected with rapid technological and organizational progress. This has contributed considerably and directly to the acceleration – at least to stabilization – of overall economic output and productivity growth. But our results also suggest that the ICT sector was driven by a long-lasting cyclical upswing especially in the U.S., and by the corresponding investments. These investments occurred last, but not least in ICT hardware and software and in an unidentified factor with little relation to the "new economy" and computer use. These insights lead to the conclusion that the substantial growth differences between the U.S. and the German economy cannot be attributed to the different shares of ICT production alone.

Unfortunately, further conclusions about the reasons underlying the fluctuations characterizing the ICT sector are impossible, due to restricted data availability. It would be welcome if there were, for example, data about the input structure by kind of goods as well as by domestic or foreign suppliers in order to be able to estimate the cross-border impacts of the ICT sector. For instance, while the German ICT concentrates more heavily on the West European region, U.S. producers are obviously connected to a greater extent with suppliers from abroad; e.g., from Ireland or the Asian-Pacific region. These connections may have contributed to the fact that the U.S. ICT producers are more successful than their German competitors and to the fact that the Asia emerging economies could surmount the Asian crisis in 1997/98 very quickly.

Considerable information would also be needed on capital inputs. A carefully conducted accounting exercise could contribute to the explanation of the observed high productivity in the ICT sector. This accounting would also uncover prematurely to what extent excess capacities have been built up. Only after the bursting of the speculative bubble on the "new market" these excess capacities were detected to be unprofitable investments and, consequently, were written off.

5. Sectoral Use of ICT

In respect to ICT use, the "new economy" in the present is mostly associated with immediate productivity increases as a result of ICT input in production of goods and services, and the development of e-commerce as a new market-place for goods and services.

However, by looking at structural aspects on the industry and microeconomic level more deeply, the underlying processes become more obvious. There is no simple linear relationship between ICT use and productivity. Complementary investments and changing business processes are in most cases the crucial prerequisite for productivity increases to appear. On this background, e-commerce represents an indicator for one aspect of a whole range of changing firm-internal and external business processes in the value-added chain. The future task of economic analysis at the microeconomic and industry level will be to uncover the connections between these changes and business performance at the micro, industry, and macro level.

Even though the exact mechanisms that establish the connections between ICT production and productivity growth are still unclear, the importance of ICT infrastructure for international competitiveness is unquestioned: The liberalization of the information- and telecommunications service industry in Germany has provided the precondition necessary for a future reduction in the cost of telecommunications services and, therefore, an increase in the use of ICT. Presently, Germany is lagging behind countries like the U.S. that have deregulated their communications sector earlier in respect to usage of telephone services, Internet and e-commerce. Great efforts with respect to price, quality and efficiency of the supplied services as well as increased R&D expenditures will be necessary in order to catch up to the U.S., but also to other European nations like Sweden and the United Kingdom. In order for e-commerce sales to develop dynamically in the coming years, broadband Internet access should be provided. This requires considerably more investment in network infrastructure.

The usual business with e-commerce has partly been replaced, but new products or product combinations have also been offered. This concerns B2B (online purchases of input goods and services between companies) as well as B2C e-commerce (online distribution from companies to the final consumer). From e-commerce one expects to develop new distribution and procurement channels, a reduction in transaction, distribution and marketing costs and therefore lower input and consumer prices, along with an increase in productivity, competitiveness, market transparency and, finally, an increase in real income.

Depending on the particular estimate, worldwide e-commerce sales in 2001 amounted to just about 1 or 2 percent of world gross output value. However, the growth rate of e-commerce sales will be very high in the coming years. Germany's share in worldwide e-commerce sales will increase considerably, as Germany already has a highly modern network infrastructure, is a leader with respect to B2B platforms, and has large growth reserves in the field of mobile communications. By the year 2010 Germany – according to own projections – will further close the gap with the U.S. In B2B area, some 30 percent of inputs will be conducted via the Internet in these countries by then. The share of worldwide e-commerce sales in the world production will be 8 percent in 2010, according to the results of this projection.

The trend in e-commerce sales still does not say anything about the accompanying productivity, cost, and income effects. One indicator of the estimation of the overall economic effects of e-commerce is the influence on GDP growth, although it is uncertain whether all utility aspects connected with e-commerce or the Internet are, in fact, reflected here. Some econometric studies that assume declining input prices and increasing productivity also assume that a change of these levels will occur as a result of e-commerce over the long run with respect to GDP. However, there will not be a lasting increase in the growth rate, that means that the long-term growth path will not be permanently affected.

In the future, all enterprises should be in a position to use the Internet for intermediate trade (B2B) or as a distribution marketing channel (B2C). This requires, among other things, the successful integration of e-business applications in existing IT-systems, more legal security in worldwide trade via the Internet, and the implementation of internationally accepted industry standards for on-line transactions. Additionally, the further rapid expansion of e-commerce activities does not depend solely on greater ICT investments, but also on the success of efforts to make e-business more attractive and, above all, more secure.

6. Macroeconomic Consequences of ICT

By looking at the results of the growth accounting analysis, one has to bear in mind that the possibilities of a comparison of macroeconomic developments in the U.S. and Germany is restricted by the availability of appropriate data. With the statistical data for each country by itself, many more possibilities to analyze the effect of ICT on growth performance do exist. The calculations of growth effects are based on official data from the Statistisches Bundesamt for Germany, from the Bureau of Economic Analysis and the Bureau of Labor Statistics for the U.S. and partly from the OECD. Detailed information was needed for the separation of high-tech capital from the rest of the capital stock. However, special care is required in order to ensure comparability in the methods used in aggregation of the data to come to valid results.

The growth rates for the productive ICT and non-ICT capital stock for both Germany and the U.S. were computed separately by using the perpetual inventory method. For the U.S., a noticeable increase in the ICT capital stock can be observed from these calculations. This growth was accelerating both for computer hardware and for communications equipment in the second half of the nineties. The acceleration of the hardware capital stock growth partly reflects the sharper price decline which, again, has to do with shortening production cycles and sharp competition in the semiconductor industry and other suppliers of the producers of PCs. For Germany, the data tell a somewhat different story. The computer hardware capital stock also shows an acceleration in the second half of the nineties, even though the increase was less pronounced than in the U.S. In the explanation, one has to bear in mind that the U.S. price deflator was used to deflate the nominal investment data for Germany. For communications equipment and software, the growth rate of the capital stock decreased in the second half of the nineties. This observation has to do with backlog demand shortly after German re-unification and certainly also with the characteristics of the business cycle in the nineties.

The analysis of growth effects is based on the calculated capital stocks. It uses a standard growth accounting framework that has been applied to calculate the growth contribution of ICT investment for the U.S. In the U.S., GDP growth in the nineties was strongly driven by ICT capital accumulation. On the average, the ICT accumulation accounted for 0.68 percentage points of the 3.65 percentage points increase in GDP while non-ICT capital accumulation accounted for 0.51 percentage points. The labor force increase accounted for a 0.99 percentage points increase in production, multifactor productivity for 1.47 percentage points. However, this indicator includes several different factors. There is a cyclical effect that is difficult to quantify. In addition to the increase in efficiency of production itself, human capital accumulation is included in the estimate of multifactor productivity.

Notably, the data on the U.S. growth performance show an increase in the growth performance at the end of the nineties. While the growth effect of the labor force increased from 0.76 to 1.21 percentage points, the contribution of the ICT capital rose from 0.42 percentage points at the beginning to 0.92 in the second half of the nineties. Most of this increase can be accounted for by the expansion of the hardware capital stock. Also multifactor productivity rose from 1.09 to 1.88 percentage points.

During the nineties, economic growth in Germany was clearly smaller than in the U.S. The contribution of ICT capital to GDP growth (2.33 percentage points) was 0.44 percentage point, whereas the other capital stock accounted for 0.93 percentage point. While capital deepening during the nineties was more intensive in Germany than in the U.S., ICT technologies played a much smaller role. A more pronounced, more labor-intensive but less capital intensive upswing in the U.S. could already be observed in the eighties. Multifactor productivity was only of moderate importance for German economic growth during the nineties, as well as in earlier times.

Considerable differences characterize the growth performance in Germany during the first and the second half of the nineties. The first half of the nineties was dominated by an increase in the "other capital stock" which dominated especially in the years 1992 and 1993. This investment boom was mainly associated with German re-unification. In the second half of the nineties, the growth effect of the hardware capital stock doubled from 0.16 to 0.30 percentage points which is well below the U.S. rate. While the growth effect of the communications capital stock was above the value for the U.S., the minor impact of the German ICT investment is mainly due to lower investment in IT hardware and software.

For our comparison of the effects of the "new economy" in Germany and the U.S. the identification of the cyclical effects of the productivity increase poses a substantial problem. Most important, for the nineties a transfer of the methods used for identifying the cyclical effect in the U.S. to data for Germany is not possible. Not only do business cycles look quite different, also German re-unification represents a major structural change. Irrespective of these technical problems, the relative growth contribution of the computer and semiconductor sector is much lower in Germany than in the U.S. Thus, the resulting direct productivity effects are much smaller.

Also of importance for international comparisons are the methods employed in the price statistics. There are differences between the countries especially in the type of price indices employed and the way of changes in quality are taken into account. According to the so-called "Boskin Report", an overestimation is determined of the reported rates of inflation in the year 1996, because of different methodical changes were introduced in the U.S. (chained Fisher-indices and hedonic price-indices). Therefore, the question arises how these methods – which are also to be introduced in Germany in the near future – have an effect on the measurement of real growth rates. All in all, macroeconomic growth in Germany in the second half of the nineties would have turned out to be not more than 0.1 to 0.2 of percentage points on average, if the U.S. methodology, chained Fisher-quantity indices and hedonic price indices, had been applied to the German data. Thus, only a relatively small part of the growth difference observed in the last years between Germany and the U.S. can be explained by the deflating methods.

7. Fields of Activity and Economic-Political Implications

As the study shows, the provision and application of ICT have contributed to the development of new and international competitive goods and services, to the introduction of more efficient types of business and company organization and to more intensive utilization of the benefits of the sectoral and international labor division. The accompanying high level of corporate investment in the realignment of production and distribution concepts has stimulated demand and created numerous new and attractive jobs – not just in the field of

ICT. Higher real income, but also greater options and conveniences with respect to the supply of goods and services have been made available to consumers. It is true that losses of employment have occurred in other fields (the "old economy"), but this is mainly the expression of the sectoral, regional and institutional structural change which usually accompanies and supports long-term growth.

Above all, the development and spreading of the basic innovation that was derived from the digitilization of information some thirty years ago and which subsequently led to the development of modern ICT and the manifold applications based on this are regarded as the driving force of the "new economy". The overall economic significance of ICT must be – even after the bursting of the speculative bubble at the technology stock exchanges – rated as just as great as before, since under economic considerations, the point is less the assessment of particular enterprises, but rather primarily the influence of technical progress on long-term production and employment potential. Additionally, however, some other factors have also influenced the utilization of technical progress and the development of the total factor productivity in the nineties. Worthy of mention are, among others, economic components, falling prices for raw materials as well as hardware and software, capital deepening within the scope of a more investment-friendly environment as well as the opening of national borders for the free exchange of goods, services and capital. Furthermore, factors of monetary and fiscal policy as well as the worldwide trend towards globalization have also been significant.

The aforementioned factors have also played a role in Germany, although the intensity of these factors has been different. In this case, a further specific factor was particularly important against the background of continuing European integration: German re-unification. In addition, some structural reforms which had previously already been largely accomplished in the U.S. were only belatedly initiated in Germany, such as the deregulation and the privatization of various sectors combined with appropriate changes in the legal and institutional general setting. Similar to the situation in the U.S., an intensification of competition and the augmentation of sectoral structural change were also involved in this regard. Ultimately, new instruments of enterprise funding were introduced with added force (venture capital, technology stock exchanges) which had long been quite usual in the U.S. and which were abundantly used there accompanied, among others, by an increase in business start-ups as well as mergers and acquisitions. In addition to the lower level of ICT diffusion, the fact that the European economy and, due to re-unification of the German economy in particular, were faced with considerable adjustment problems. These problems can be regarded as an explanation for the lagging economic growth in Europe in comparison with the U.S., particularly in the second half of the nineties.

While it is comparatively easy to document the direct contribution to growth of the ICT sector in retrospect, the effects related to its utilization are less conclusive, as the most recent data available do not yet correspondingly reflect these effects. The result is that there is substantial potential in this area with regard to the realization of cost reduction and productivity effects. The economic slowdown and the collapse of the technology stock exchanges which have recently been observed worldwide should be considered as a temporary development. The deployment and utilization of ICT will continue to be connected with rapid technological and organizational progress which should contribute to the acceleration of production growth and productivity in the future.

The study in question is primarily designed as an analysis. Its intention was to explore the theoretical and empirical background of the economic differences in development between the U.S. and Germany during the last decade. Proposals for concrete measures in individual policy areas can and should not be made here. Nevertheless, it becomes visible that there are expectations on politics in three central fields of activity to support structural change and to secure the position of Germany in international technology competition.

(1) Complementary Investments and Human Capital
Complementary investments and changed business procedures are an essential prerequisite for creation of increases in productivity. Although the exact mechanisms creating the connections between productivity growth and utilization of ICT goods remain unclarified, there is no doubt about the central significance of the ICT infrastructure for the international competitiveness of a country. Even if the future utilization of ICT cannot be conclusively determined at present, one can assume that the direct effects connected with the production of ICT goods only represent one aspect with regard to the overall economic effects of the "new economy". They are the starting point of a myriad of interactions within the entire value added chain that ultimately radiate out to the whole economic system and the society.

Human capital plays a central role in the realization of those productivity effects linked with ICT. This is necessary in order to convert the information provided by new technologies into knowledge which can then be utilized within the scope of value added processes. This is a special task for the governmental education policy. The curricula of general and vocational schools as well as universities (including universities of applied science) should be adjusted to the modified technical and economic conditions, and the sufficient endowment of these educational institutions should be guaranteed. In addition, an improvement in research collaboration via reinforced networking of universities, publicly supported research facilities and the business sector should be striven for. This, for instance, was accomplished in the U.S. and is regarded as one of the essential reasons for the attainment of the leading position of the U.S. in the field of ICT.

(2) Promotion of Innovations and Deregulations

The technological changes in the "new economy" take place in very long intervals. The interval between the time of the technological innovation and its broad application generally takes about half a century. These long-term (so-called Kondratieff-) cycles are respectively initiated by basic technological innovations. They induce changes in the production processes throughout the economy accompanied by modifications in the value added structure, and are normally the catalyst for incremental follow-up innovations which predominantly effect the application and diffusion of the new products and processes. If the innovations correspond to one another in a complementary relationship leading to synergy effects, a sustainable change of the growth path of a national economy is generated until their utilization capacity is exhausted. The acceleration of growth in the U.S. in the nineties resembles the development of previous basic innovations; in Germany, however, the trend growth rate is still far from this, although a turning point is at least becoming apparent recently.

Accordingly, it will be the task of economic and technology policy to support the process of catching-up. In doing so, the diffusion of basic innovation takes place more rapidly in an environment that is demonstrating innovation-friendly rather than in an environment that impedes its diffusion. An important role is played in this regard by the adaptation of the institutional setting through which the development of the new markets could be supported in the future. The preconditions for more intensive utilization of ICT goods and services have also been created by the liberalization on ICT services. Nevertheless, at present there is still a considerable backlog in comparison with the U.S., which had already deregulated its telecommunications sector with regard to telephone services, the Internet and e-commerce previously. Therefore, more effort is still required in Germany in order to compensate for this competitive disadvantage. To this end, the provision of a suitable physical and financial infrastructure for the foundation of enterprises in the field of technology as well as the financing of their internal and external growth should be guaranteed, e.g., by creating markets that are right for venture capital.

(3) General Setting for e-commerce

The electronically supported trade (e-commerce) represents a partial aspect of changing internal and external business processes within the framework of the entire e-business sector. With the expansion of e-commerce, new channels of distribution and procurement can be opened up and a reduction of transaction, distribution and sales expenses can be achieved connected with decreasing intermediate input and consumer prices, gains in productivity, competitiveness, an increase in market transparency and, ultimately, an increase in real income. Germany has good infrastructural preconditions for being able to play an important role in e-commerce in the future, since the network infrastructure is relatively modern and there are still large growth reserves in the field of mobile radio service, for example. Although it is questionable as to what extent the economic growth path will be considerably affected by e-commerce on a long-term basis, a positive scale effect should at least become evident on a medium-term basis with regard to the level of the GDP, provided that the expected effects of productivity occur.

The growth rates of e-commerce sales will probably be very high in the next few years. However, a particular precondition for this is the increased expansion of Internet accessibility on the basis of broadband technology. In addition, the economic, institutional and legal general setting should be structured in such a way that e-commerce can undergo dynamic development. This concerns, e.g., regulations for electronic business and electronic signatures or the law of liability for cross-border online trade. In addition, efforts should be intensified to increase the security of Internet transactions, since this medium is still – at least subjectively – regarded by many market participants as too insecure. Finally, existing competitive disadvantages for enterprises active in e-commerce (e.g., in the administrative and fiscal political field, i.e. with regard to the obligation to pay value added tax) should be removed where possible.

As far as policy intends to occupy itself with the outlined fields of activity it should nevertheless restrict such action to the establishment of the organizational and institutional framework that could contribute to a stronger diffusion of ICT and its more intensive utilization, even if this only means the removal of impediments disturbing the application of these technologies. The creation of the general setting that promotes the further expansion of ICT and its utilization could contribute to overcoming the present weakness of growth in Germany and would open perspectives for taking on a more active part in international location competition than at present. The objective of future research work of the structural changes of ICT and the applications that are based upon it in the wake of the "new economy" will be, among others, to provide further indications for the concrete arrangement of the economic policy, institutional and legal environment and to examine the related effects on overall economic development and sectoral structural change.

Bibliography

Alecke, B. and G. Untiedt (2000), Information and Communication Technologies, Globalisation and Competitiveness: A Selective Survey. *Vierteljahrshefte zur Wirtschaftsforschung* 69 (4): 544–558.

Alexandre, P. et M. Touati (2000), *Le Retour Du Plein-Emploi*. Une nouvelle révolution francaise. Paris: Editions Anne Carrière.

Allen, D.S. (1997), Where's the Productivity Growth (from the Information Technology Revolution)? *Federal Reserve Bank of St Louis Review* 1997: 15–25.

Altvater, E. und B. Mahnkopf (2000), "New Economy" – nichts Neues unter dem Mond? *WSI-Mitteilungen* 53 (12): 770–778.

anon. (1997), Jobs durch elektronischen Handel. *Handelsblatt* 1997 (6. Juni): 13.

anon. (1998), The Growth and Management of Intangible Investment. In OECD (ed.) (1998a), 113–134.

anon. (2000a), Das Internet kann die Einkaufskosten um 80 Prozent senken. *Frankfurter Allgemeine Zeitung* 2000 (20. Januar): 28.

anon. (2000b), Internet-Revolution verläuft schleppender – Ergebnisse der Studie „2014" des Münchener Kreises. *Handelsblatt* 2000 (20. Januar): 22.

anon. (2000c), Survey of the New Economy. *Economist* 2000 (23. Septempber): 5–44.

anon. (2001a), 27 Millionen Deutsche nutzen das Internet. *Frankfurter Allgemeine Zeitung* 2001 (21. August): 15.

anon. (2001b), Beschäftigungsmotor Informationstechnik gerät ins Stocken. *Frankfurter Allgemeine Zeitung* 2001 (7. Juni): 19.

anon. (2001c), Dem Online-Werbemarkt fehlt die Transparenz. *Frankfurter Allgemeine Zeitung* 2001 (23. August): 21.

anon. (2001d), Fast 25 Millionen nutzen das Internet in Deutschland. *Handelsblatt* 2001 (4. Septempber): 21.

anon. (2001e), Internet-Revolution hat gerade erst begonnen. *Frankfurter Allgemeine Zeitung* 2001 (16. Mai): 19.

anon. (2001f), Jeder fünfte Deutsche nutzt Online-Banking. *Frankfurter Allgemeine Zeitung* 2001 (22. August): 23.

anon. (2001g), Mit IT allein wächst die Wirtschaft noch nicht. *Neue Zürcher Zeitung* 2001 (17. Oktober): 23.

anon. (2001h), Nach erfolgreichen Tests folgt nun die heiße Phase der elektronischen Beschaffung im Internet. *Frankfurter Allgemeine Zeitung* 2001 (21. Juni): 23.

anon. (2001i), Online-Shopping setzt sich durch. *Handelsblatt* 2001 (26. Oktober): B01.

anon. (2001j), Special report: The new economy – What's left? *Economist* 2001 (12. Mai): 83–86.

anon. (2001k), Stationäre Anbieter gewinnen Übermacht über Online-Händler. *Frankfurter Allgemeine Zeitung* 2001 (31. Mai): 31.

Ark, B. van (2000), Measuring Productivity in the "New Economy" Towards a European Perspective. *De Economist* 148 (1): 87–105.

Ark, B. van (2001), The Renewal of the Old Economy: Europe in an Internationally Comparative Perspective. University of Groningen. STI Working Papers no. 5. Paris.

Ark, B. van, E. Monnikhof and N. Mulder (1999), Productivity in Services: An International Comparative Perspective. *Canadian Journal of Economics* 32 (2): 471–499.

Arrow, K.J. (1962), The Economic Implications of Learning by Doing. *Review of Economic Studies* 29 (3): 155–173.

Artus, P. (2000), *Les deux versions de la nouvelle économie.* Paris: Caisse des Deopots et Consignations.

Associazione Elis (ed.) (2000), *Labour in the new economy.* Meeting 2000: Labour at the Dawn of the New Century. Bank of Italy, Rome.

Atkeson, A. and P.J. Kehoe (2000), The Transition to a New Economy Following the Second Industrial Revolution. Federal Reserve Bank of Minneapolis Working Paper 606. Minneapolis, MN.

Atkinson, R.D. (2000), Myths of the New Economy: Getting the Parameters of Change Right. *Progressive Policy Institute – New Economy* 7 (1): 54–58.

Atkinson, R.D. and R.H. Court (1998), *The New Economy Index.* Understanding America's Economic Transformation. The Progressive Policy Institute's Technology, Innovation, and New Economy Project. Washington, DC.

Atrosic, B.K., J. Gates and R. Jarmin (2000), *Measuring the Electronic Economy: Current Status and Next Steps.* U.S. Census Bureau, Washington, DC.

Bach, S., M. Hubbert and W. Müller (2000), Taxation of E-Commerce: Persistent Problems and Recent Developments. *Vierteljahrshefte zur Wirtschaftsforschung* 69 (4): 657–678.

Bailey, M. and R.Z. Lawrence (2000), Do We Have a New E-Economy? NBER Working Papers 8243. Cambridge, MA.

Baily, M.N. and R.J. Gordon (1988), The Productivity Slowdown, Measurement Issues, and the Explosion of Computer Power. *Brookings Papers on Economic Activity* 19 (2): 347–420.

Baker, D. (1998), The New Economy Does Not Lurk in the Statistical Discrepancy. *Challenge* 41 (4): 5–13.

Baker, D. (ed.) (1998), *Getting Prices Right.* The Debate Over the Consumer Price Index. Armonk, NY, and London: Sharpe.

Bakos, J.Y. and E. Brynjolfsson (1999), Bundling Information Goods: Pricing, Profits and Efficiency. *Management Science* 45 (12): 1613–1630.

Bakos, Y. (2001), The Emerging Landscape for Retail E-Commerce. *Journal of Economic Perspectives* 15 (1): 69–80.

Bangemann, M. et al. (1994), *Europe and the Global Information Society.* The Bangemann Report. Recommendations to the European Council. EU, Bruxelles.

Barber, B.M. and T. Odean (2001), The Internet and the Investor. *Journal of Economic Perspectives* 15 (1): 41–54.

Barnes, M. (2000), Technology, the New Economy and the US Long Wave Upturn. *Bank Credit Analyst* 2000 (7).

Barras, R. (1986), Towards a Theory of Innovation in Services. *Research Policy* 15: 161–173.

Bassanini, A., S. Scarpetta and I. Visco (2000). Knowledge, Technology and Economic Growth: Recent Evidence from OECD Countries. Economics Department Working Papers 259. OECD, Paris.

Basu, S., J. Fernald and M. Shapiro (2000), Productivity Growth in the 1990's: Technology, Utilization, or Adjustment? *Carnegie Rochester Conference Series on Public Policy* 55: 117–165.

Bathelt, H. and E.W. Schamp (2000), Knowledge-based industry and regional growth. IWSG-Working Papers 02/2000. Frankfurt: Johann Wolfgang Goethe-Universität.

BEA – Bureau of Economic Analysis (ed.) (1998), *Fixed Reproducible Tangible Wealth in the United States.* Washington, DC: Government Printing Office.

BEA – Bureau of Economic Analysis (ed.) (2001), *National Income and Product Account Tables.* Internet: www.bea.doc.gov/bea/dn/nipaweb/TableViewFixed.asp, visited October 26, 2001.

BEA – Bureau of Economic Analysis (ed.) (2002), *BEA's Economic Accounts.* Internet: www.bea.doc.gov, visited February 4, 2002.

Beiersdörfer, K. (2000), Basistrends in der heutigen Informationstechnik. *Orientierungen zur Wirtschafts- und Gesellschaftspolitik* 86 (4): 39–40.

Berg, P. (ed.) (2000), Creating Competitive Capacity. Labour Market Institutions and Workplace Practices in Germany and the United States. Forschung aus der Hans-Böckler-Stiftung 23. HBS, Berlin.

Bergius, S. (2001), Beispielhaftes Comeback der „Old Economy". *Handelsblatt* 2001 (17. September): 34.

BITKOM – Bundesverband Informationswirtschaft, Telekommunikation und neue Medien (Hrsg.) (2000), *Wege in die Informationsgesellschaft.* Status quo und Perspektiven Deutschlands im internationalen Vergleich. Berlin und Frankfurt.

BITKOM – Bundesverband Informationswirtschaft, Telekommunikation und neue Medien (Hrsg.) (2001), *EITO Update 2001.* München.

Black, S.E. and L.M. Lynch (2000), What's Driving the New Economy: The Benefits of Workplace Innovation. NBER-Working Paper 7479. Cambridge, MA.

Black, S.E. and L.M. Lynch (2001), How to Compete: The Impact of Workplace Practices and Information Technology on Productivity. *Review of Economics and Statistics* 83 (3): 434–445.

Blinder, A.S. (1997), *The Speed Limit. Fact and Fancy in the Growth Debate.* Internet: www.prospect.org/print-friendly/print/V8/34/blinder-a.html, visited April 20, 2001.

Blinder, A.S. (2000), The Internet and the New Economy. Brookings Policy Brief 60. Washington, DC.

Blow, L. and J. Crawford (2001), The Cost of Living with the RPI: Substitution Bias in the UK Retail Prices Index. *Economic Journal* 111 (472): F357–F382.

BLS – Bureau of Labor Statistics (ed.) (1999), *Changes in the Composition of Labor for BLS Multifactor Productivity Measures.* Washington, DC.

BLS – Bureau of Labor Statistics (ed.) (2001), *Changes in the Composition of Labor for the BLS Multifactor Productivity Measures.* Internet: www.bls.gov/mfp/mprlabor.pdf, visited February 10, 2001.

Bluestone, B. and B. Harrison (1997), *Why We Can Grow Faster.* Internet: www.prospect.org/print.friendly/print/V8/34/bluestone-b.html, visited April 20, 2001.

BMBF, BMWT – Bundesministerium für Bildung und Forschung sowie Bundesministerium für Wirtschaft und Technologie (Hrsg.) (1999). Innovation und Arbeitsplätze in der Informationsgesellschaft des 21. Jahrhunderts. Internet: http://www.bmbf.de/pub/inno21d.pfd (visited: 20. April 2001).

BMF – Bundesministerium der Finanzen (Hrsg.) (2001), Reformkurs fortsetzen – Wachstumsdynamik stärken. Jahreswirtschaftsbericht der Bundesregierung zur Wirtschafts- und Finanzpolitik. Jahreswirtschaftsbericht 2001. Berlin.

BMWT – Bundesministerium für Wirtschaft und Technologie (Hrsg.) (1999), Bündnis für Arbeit, Ausbildung und Wettbewerbsfähigkeit vereinbart konkrete Maßnahmen zur Ausschöpfung des Beschäftigungspotentials in der Informationswirtschaft. BMWi-Tagesnachrichten 10905. Berlin.

BMWT – Bundesministerium für Wirtschaft und Technologie (Hrsg.) (2001), *Benchmarking Internationale Telekommunikationsmärkte.* Herbst 2001. Berlin.

Bond, S.R. and J.G. Cummins (2000), The Stock Market and Investment in the New Economy: Some Tangible Facts and Intangible Fictions. Comments by Janice Eberly and Robert J. Shiller. *Brookings Papers on Economic Activity* 2000 (1): 61–124.

Bornheim, S. und J. Weppler (2000), Neue Organisationen in der neuen Ökonomie. In E. Brauchlin (Hrsg.), 273–282.

Boskin, M., E. Dulberger, R. Gordon, Z. Griliches and D. Jorgenson (1998), Toward a More Accurate Measure of the Cost of Living. Final Report of the Advisory Commission of the Senate Finance Committee to Study the Consumer Price Index. Washington D.C. In D. Baker (ed.), 5–77.

Bosworth, B., S.M. Collins and Y. Chen (1995), Accounting for Differences in Economic Growth. Brookings Discussion Papers in International Economics 115. Washington, DC: Brookings Institution.

Bosworth, B. and J.E. Triplett (2001), What's New about the New Economy? IT, Economic Growth and Productivity. *Tokyo Club Papers* 14: 1–31.

Brauchlin, E. (Hrsg.), *Unternehmer und Unternehmensperspektiven für Klein- und Mittelunternehmen.* Festschrift für Hans Jobst Pleitner. Berlin: Duncker & Humblot.

Breshnahan, T.F. and M. Trajtenberg (1995), General Purpose Technologies: Engines of Growth. *Journal of Econometrics* 65: 83–108.

Bresnahan, T.F., E. Brynjolfsson and L.M. Hitt (1999), Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence. NBER Working Papers 7136. Cambridge, MA.

Broadbent, B., D. Walten (2000), How "new" is the UK economy? Goldman Sachs Global Economics Paper 43. New York.

Brookes, M. and Z. Wahhaj (2000), Is the Internet better than Electricity? Goldman Sachs Global Economics Papers 49. New York.

Brookes, M. and Z. Wahhaj (2001), The Economic Effects of Business to Business Internet Activity. *National Institute Economic Review* 175 (1): 95–108.

Brown, W.S. (2000), Market Failure in the New Economy. *Journal of Economic Issues* 34 (1): 219–227.

Browne, F. (2000), Discussing the Papers of Gordon and Felderer. In Österreichische Nationalbank (Hrsg.), 209–217.

Brynjolfsson, E. and B. Kahin (eds.) (2000), *Understanding the Digital Economy*. Cambridge, MA, et al.: MIT-Press.

Brynjolfsson, E. and L.M. Hitt (2000a), Beyond Computation: Information Technology, Organizational Transformation and Business Performance. *Journal of Economic Perspectives* 14 (4): 23–48.

Brynjolfsson, E. and L.M. Hitt (2000b), Computing Productivity: Firm Level Evidence. Working Paper. Internet: http://ecommerce.mit.edu/erik/cp.pdf, visited March 29, 2001.

Brynjolfsson, E. and L.M. Hitt (2000c), Paradox Lost? Firm-Level Evidence of High Returns to Information Systems Spending. *Management Science* 42 (4): 541–548.

Brynjolfsson, E. and S. Yang (1999), *The Intangible Benefits and Costs of Computer Investment*: Evidence from the Financial Market. MIT Sloan School of Management, Cambridge, MA.

Brynjolfsson, E. and S. Yang (2001), Intangible Assets and Growth Accounting: Evidence from Computer Industries. NBER Reporter. Cambridge, MA.

Brynjolfsson, E., L.M. Hitt and S. Yang (2000), *Intangible Assets: How the Interaction of Computers and Organizational Structure Affects Market Valuations.* Internet: http://ecommerce.mit.edu/erik/itqo%20final-7-00.html, visited April 2, 2001.

Bryson, P.J. (2001), Economy and "New Economy" in the United States and Germany. *Intereconomics*, 36 (7/8): 180–190.

Buch, C.M. und S.M. Golder (2000), Finanzdienstleister in der Neuen Ökonomie: Eine neue Rolle der Banken? *Weltwirtschaft* 2000 (4): 410–429.

Bullard, J. and E. Schaling (2000), New Economy – New Policy Rules? Discussion Paper of the Center for Economic Research 2000–72. Tilburg University.

CBO – Congressional Budget Office (1999), *The Budget and Economic Outlook: Fiscal Years 2002–2011*. A Report to the Senate and House Committees. Washington, DC.

CBO – Congressional Budget Office (ed.) (2001), *The Budget and Economic Outlook: Fiscal Years 2002-2011*. A Report to the Senate and House Committees on the Budget. January. Government Printing Office, Washington, DC.

CEA – Council of Economic Advisers (1999), *Annual Report of Council of Economic Advisers*. Washington, DC: Government Printing Office.

CEA – Council of Economic Advisers (2001), *Economic Report to the President*. Washington, DC: Government Printing Office.

Choi, S.-Y, D.O. Stahl and A.B. Whinston (1997). *The Economics of Electronic Commerce*. Indianapolis, IN: MacMillan Technical.

Clement, R. (2000), Braucht die New Economy eine neue Regulierung? *Wirtschaftsdienst* 80 (9): 542–548.

Cohen, S.S., J.B. DeLong and J. Zysman (1999), *An E-conomy?* Internet: http://www.j-bradford-delong.net/oped/virtual/technet/an_e-conomy.html, visited April 20, 2001.

Cohen, S.S., J.B. DeLong and J. Zysman (1999), *Speculative Microeconomics for Tomorrow's Economy*. Internet: http://www.firstmonday.org/issues/ issue5_2/delong/index.html, visited April 20, 2001.

Cohen, S.S., J.B. DeLong and J. Zysman (2000), Tools for Thought: What is New and Important about the "E-conomy"? BRIE-Working Paper 138. Internet: www.informationcity.org/resources/The_Information_society, visited April 20, 2001.

Colecchia, A. and P. Schreyer (2001), ICT Investment and Economic Growth in the 1990s: Is the United States a Unique Case? A Comparative Study of Nine OECD Countries. STI Working Papers 2001/7. OECD, Paris.

Coppel, J. (2000), E-commerce: Impacts and Policy Changes. Economics Department Working Papers 252. OECD, Paris.

Credit Suisse First Boston (ed.) (2000), The European Digital Economy. Euro-11 Special. New York.

Croes, M.M. (2000), *Data for intangibles in selected OECD countries*. OECD and Dutch Ministry of Economic Affairs, Voorburg.

Daveri, F. (2001), *Information Technology and Growth*. Draft: May 10, 2001. University of Parma and IGIER – Innocenzo Gasparini Institute for Economic Research, Parma.

David, P. (2001), Productivity Growth Prospects and the New Economy in Historical Perspective. In European Investment Bank (ed.), 41–62.

David, P.A. (1990), The Dynamo and the Computer: A Historical Perspective on the Modern Productivity Paradox. *American Economic Review – Papers and Proceedings* 80 (2): 355–361.

David, P.A. (1999), *Digital Technology and the Productivity Paradox*: After Ten Years, What has Been Learned? Paper prepared for the Conference "Understanding the Digital Economy" held at the U.S. Department of Commerce. Washington, DC. May 25–26 1999. Internet: www.informationcity.org/resources/The_Information_Society, visited Februry 25, 2001.

David, P.A. (2000), Understanding Digital Technology's Evolution and the Path for Measured Productivity Growth: Present and Future in the Mirror of the Past. In E. Brynjolfsson and B. Kahin (eds.), 49–95.

David, P.A. and G. Wright (1999), Early Twentieth Century Productivity Growth Dynamics: An Inquiry into the Economic History of Our Ignorance. Discussion Papers in Economic and Social History 33. University of Oxford, Internet: www.nuff.ox.ac.uk/Economics/History/Paper33/ 33david4.pdf, visited March 29, 2001.

Davies, G., M. Brookes and N. Williams (2000), Technology, the Internet and the New Global Economy. Global Economics Papers 39. New York, NY, et al.: Goldman Sachs.

Dehio, J. und R. Graskamp (2002), Perspektiven der Internet-Wirtschaft. RWI-Mitteilungen 53 (1–4): 41–64.

Dekle, R. (2001), A Note on Growth Accounting with Vintage Capital. *Economic Letters* 72 (2): 263–267.

DeLong J.B. (2000), *Micro and Macro Studies Agree*: Computer Investments are Driving Our Current Economic Boom: Internet: http://econ161.berkely.edu/OpEd/virtual/nef/nef1.html, visited February 21, 2001.

DeLong, J.B. (2001), *Do We Have a "New" Macroeconomy*? Internet: www. j-bradford-delong.net/Econ_Articles/Jaffe/new_makroeconomy.html, visited April 03, 2001.

Deutsche Banc Alex. Brown Inc. (ed.) (2000a), *Global Economic Analysis – New Economy Debate*. Internet: www.yardeni.com, visited February 15, 2001.

Deutsche Banc Alex. Brown Inc. (ed.) (2000b), *Global Economic Analysis – Old Fed Versus New Economy*. Internet: www.yardeni.com, visited February 15, 2001.

Deutsche Banc Alex. Brown Inc. (ed.) (2000c), *Global Economic Analysis – The Productivity Revolution*. Internet: www.yardeni.com, visited February 15, 2001.

Deutsche Banc Alex. Brown Inc. (ed.) (2001), *New competitive economy primer*. Internet: www.yardeni.com, visited February 15, 2001.

Deutsche Bank Research (ed.) (2000a), "New Economy" in den USA: Fakt oder Fiktion? Economics vom 15. Juni 2000. Frankfurt a.M.

Deutsche Bank Research (ed.) (2000b), "Produktivitätswunder" in den USA: Nur ein Computer-Phänomen? Aktuelle Themen 151. Frankfurt a.M.

Deutsche Bank Research (ed.) (2000c), Das Internet – eine neue Basistechnologie? *Economics* 2000 (9. Aug.): 1–11.

Deutsche Bank Research (ed.) (2000d), Emerging Asia: From hardware base to e-commerce space? *Economics* 2000 (9): 2–8.

Deutsche Bank Research (ed.) (2000e), Internet-Revolution und "New Economy". Mikroökonomische Aspekte der Internet Economy. *Economics* 2000: 3–10.

Deutsche Bank Research (ed.) (2000f), Mikroökonomische Aspekte der Internet Economy. *Economics* 2000 (9. Aug.).

Deutsche Bundesbank (ed.) (1999), Zur Diskussion über den Verbraucherpreisindex als Informationsindikator. Diskussionspapiere der Volkswirtschaftlichen Forschungsgruppe 3/99. Frankfurt a.M.

Deutsche Bundesbank (ed.) (2000a), Internationales und europäisches Umfeld. *Monatsberichte* 52 (1): 6–20.

Deutsche Bundesbank (ed.) (2000b), Probleme internationaler Wachstumsvergleiche auf Grund unterschiedlicher Deflationierungsmethoden – dargestellt am Beispiel der EDV-Ausrüstungen in Deutschland und den USA. *Monatsberichte* 52 (8): 8.

Deutsche Bundesbank (ed.) (2001), Exkurs: Probleme internationaler Wachstumsvergleiche – eine ergänzende Betrachtung. *Monatsberichte* 53 (5): 41–46.

Deutsche Bundesbank und Statistisches Bundesamt (eds.) (2001), *Hedonic Methods in Price Statistics.* Symposium. Wiesbaden.

Deutsches Institut für Wirtschaftsforschung (DIW) und Universität Hohenheim (eds.) (2001), *Die Produktivitätsentwicklung in den USA und der Bundesrepublik Deutschland in den neunziger Jahren im Vergleich.* Abschlussbericht. (Bearb.: G. Erber und H. Hagemann.) Berlin und Stuttgart.

Deutsch-Französisches Wirtschaftspolitisches Forum (ed.) (2000), EMU and economic growth in Europe. ZEI – Zentrum für Europäische Integrationsforschung (ZEI-Policy Paper B7-2000). Bonn.

Dhrymes, P.J. (2001), Structural Implications of Deregulation and of the New Economy. In Rheinisch-Westfälisches Institut für Wirtschaftsforschung (ed.), *Strukturpolitische Grundlagen einer beschäftigungsfördernden Makropolitik*. Theoretische Grundlagen und empirische Erfahrungen. Gutachten im Auftrag des Bundesministeriums für Wirtschaft und Technologie. Essen, pp. 179.

Dickertmann D. und V.W. Piel (2000), Amerikas "New Economy". Internet: www.uni-trier.de/~vwl-fbs/lehrefiwi/newecon.htm, visited February 03, 2001.

Diewert, E. and K.J. Fox (1999), Can measurement error explain the productivity paradox? *Canadian Journal of Economics* 32 (2): 251–280.

DiMartino, V. and L. Wirth (1990). Telework: A New Way of Working and Living. *International Labour Review* 129 (5): 529–554.

DIW – Deutsches Institut für Wirtschaftsforschung (ed.) (2000), Die Ökonomie der Informationsgesellschaft. *Vierteljahrshefte zur Wirtschaftsforschung* 69 (4): Sammelband: 485–695.

DIW – Deutsches Institut für Wirtschaftsforschung (ed.) (2001), Wandel der Logistik- und Verkehrssysteme durch E-Commerce – Informationsdefizite abbauen und Regulierungsrahmen schaffen. *DIW-Wochenbericht* 68 (34): 517–525. (G. Erber, P. Klaus, U. Voigt).

Djellal, F. (2000), The Rise of Information Technologies in "Non-Informational" Services. *Vierteljahrshefte zur Wirtschaftsforschung* 69 (4): 646–656.

Dornbusch, R. (2000), New economy: no requiem yet. *World Economic Trends* 9 (3): 16–18.

Doyle, C. and H. Morris (1999), *The net effect: rethinking the regulatory role of the nation state in the global electronic economy.* London: Fabian Society.

Dudley, L. (1999). Communications and Economic Growth. *European Economic Review* 43 (3): 595–619.

Durth, R. (2000), Transaktionskosten und "Neue Ökonomie". *WiSt – Wirtschaftswissenschaftliches Studium* 29: 637–639.

EIM – Business and Policy Research (ed.) (2001), Making Sense of the New Economy. Research Report 009/E. (Bearb.: J. Meijaard.). Zoetermeer.

EITO – European Information Technology Observatory (ed.) (2000), *Millennium Edition*. Frankfurt a.M.

EITO – European Information Technology Observatory (ed.) (2001), *Observatory 2001*. Frankfurt a.M.

Elbel, G. (1999), Die Berechnung der Wägungsschemata für die Preisindizes für die Lebenshaltung. *Wirtschaft und Statistik* 1999 (3): 171–178.

Eldridge, L.P. (1999). How Price Indexes Affect BLS Productivity Measures. *Monthly Labor Review* 122 (2): 35–46.

Elixmann, D. and K.-H. Neumann (eds.) (1990), *Communications Policy in Europe*. Berlin, New York et al.: Springer.

Eriksson J.A. and M. Ådahl (2000), Is there a "new economy" and is it coming to Europe? *Bank of Sweden Economic Review* 2000 (1): 22–67.

Essig, H., N. Hartmann et al. (1999), Revision der Volkswirtschaftlichen Gesamtrechnungen 1991–1998. Ergebnisse und Berechnungsmethoden. *Wirtschaft und Statistik* 1999 (6): 449–478.

Europäische Kommission (ed.) (1998), *Inhalt- und handelgetriebene Strategien in globalen Netzwerken*. Aufbau der Network Economy in Europa. Brüssel.

European Commission (ed.) (2000a), SINE – Statistical Indicators for the New Economy. 10/2000. Brüssel.

European Commission (ed.) (2000b), The Contribution of Information and Communication Technologies to Growth in Europe and the U.S.: A Macroeconomic Analysis. European Economy Supplement A: Economic Trends 12. Brüssel.

European Commission (ed.) (2001), *Auswirkungen der E-Economy auf die Unternehmen in Europa*: Analyse der wirtschaftlichen Aspekte und Einflüsse auf die Politik. Mitteilung der Kommission an den Rat und das Europäische Parlament KOM (2001) 711 vom 29. 11. 2001. Brüssel.

European Investment Bank (ed.) (2001), European Economic Growth: The Impact of New Technologies. *EIB-Papers* 6 (1).

Eurostat (ed.) (2001a), Handelsstatistik, Online-Einzelhandel – eine Herausforderung für den Einzelhandelssektor. *Statistik kurz gefasst* 2001 (4-43): 1–8.

Eurostat (ed.) (2001b), Statistik über die Informationsgesellschaft. *Statistik kurz gefasst* 2001 (4–34): 1–8.

Eurostat (ed.) (2001c), *Information Society Statistics* – Pocketbook. Luxemburg.

Evans, D. and R. Schmalensee (2000), *Paying with Plastic*: The Digital Revolution in Buying and Borrowing. Cambridge, MA, and London: MIT-Press.

Fabel, O. (2000), *Humankapital und "New Economy": Anforderungen an den Bildungssektor*. Arbeitskreis Dialog Wirtschaftspolitik. Impulsreferat der Friedrich-Ebert-Stiftung. FES, Berlin.

Fahrholz, B. (2001), Die "Next Economy" verändert die Welt. Deutschlands Position im internationalen Wettbewerb. *Internationale Politik* 56 (7): 1–7.

Fassbender, H. (2000), New economy, new banking: das Entstehen der modularen Bank. In O.J. Keese, G.A. Schröder und D.B. Simmert (Hrsg.), Finanzdienstleistungsmärkte: Perspektiven der öffentlich-rechtlichen Institute: 43–61. Stuttgart: Deutscher Sparkassen-Verlag.

Feenstra, R.C. and G.H. Hanson (1999), The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979–1990. *Quarterly Journal of Economics* 114: 907–940.

Felderer, B. (2000), Why do long-term economic trends in the U.S. differ from those in Europe? In Österreichische Nationalbank (Hrsg.), 189–197.

Felderer, B. (2001), Warum unterscheiden sich die langfristigen Wachstums- und Produktivitätstrends Europas und der USA? *ifo-Schnelldienst* 54 (1): 15–23.

Finkelstein, J. (ed.) (1989), Windows to a New World: The Third Industrial Revolution. Contributions in Economics and Economic History 88. New York, Westport, CT, and London: Greenwood.

Flaig, G. (2001), Gibt es einen "New Economy"-Effekt auf das amerikanische Produktionspotential? *ifo-Schnelldienst* 54 (5): 16–21.

Foley, D.C. and T.R. Michl (2001), The Production Function and Productivity. *Journal of Economic Perspectives* 15 (3): 257–258.

Fraumeni, B.M. (1997), The Measurement of Depreciation in the U.S. National Income and Product Accounts. *Survey of Current Business* 77 (7): 7–23.

Fraumeni, B.M. (2001), E-Commerce: Measurement and Measurement Issues. *American Economic Review – Papers and Proceedings* 91 (2): 318–322.

Fraumeni, B.M., M.E. Manser and T.L. Mesenbourg (2000), *Government Statistics: E-Commerce and the Electronic Economy*. Paper presented at the Federal Economic Statistics Advisory Committee (FESAC). June 15, 2000. U.S. Bureau of the Census, Washington, DC.

Freeman, C. (2001), A Hard Landing for the "New Economy"? Information Technology and the United States National System of Innovation. *Structural Change and Economic Dynamics* 12 (2): 115–139.

Freeman, R.B. (1995), Are Your Wages Set in Beijing? *Journal of Economic Perspectives* 9 (3): 15–32.

Freytag, A. (2000), Was ist wirklich neu an der New Economy? *Zeitschrift für Wirtschaftspolitik* 49 (2000): 303–312.

Fromm, G. (ed.) (1971), *Tax Incentives and Capital Spending*. Washington, DC: Brookings Institution.

Funk, L. (2000a), Bleibt die "New Economy" in Deutschland zweitklassig? *Orientierungen zur Wirtschafts- und Gesellschaftspolitik* 86 (4): 34–38.

Funk, L. (2000b), Eine New-Economy für Deutschland? *Wirtschaftsdienst* 80 (5): 271–276.

Gassmann, H.P. (1981), Is There a Fourth Economic Sector? *OECD Observer* 113 (Nov): 17–19.

Gerke, W. (2001), Der Neue Markt braucht wieder eine Chance. *Handelsblatt* 2001 (12. Sept.): 10.

Gern, K.-J. et al. (2000), Euroland: Peak of the Upswing – Little Evidence of a New Economy. Kiel Discussion Papers 10/2000. IfW, Kiel.

GfK – Gesellschaft für Konsumforschung (ed.) (2000), *eCommerce aus Verbrauchersicht: Europa vor dem Megaboom?* Jahrestagung 2000 der GfK- Nürnberg. Nürnberg.

Gillespie, A., R. Richardson and J. Cornford (2001), Regional Development and the New Economy. In European Investment Bank (ed.), 109–132.

Gnoss, R. und B. v. Minding (1990), Neue Ansätze zur Berechnung von Preisindizes. Ausgewählte Arbeitsunterlagen der Bundesstatistik 13. Statistisches Bundesamt, Wiesbaden.

Godeluck, S. (2000), *Le boom de la netéconomie*. Comment internet bouleverse les règles du jeu economique. Paris : Edition La Découverte.

Goldin, C. and L.F. Katz (1999), The Returns to Skill in the United States Across the Twentieth Century. NBER Working Papers 7126. NBER, Cambridge, MA. Internet: www.nber.org/papers/w7126, visited 20. April 2001.

Goldman Sachs (ed.) (1999), *B2B: 2B or not 2B? E-comerce/Internet*. Goldman Sachs Investment Research. New York.

Goldman Sachs (ed.) (2000a), Productivity and the Digital Revolution. *Global Economic Weekly* 2000 (23): New York.

Goldman Sachs (ed.) (2000b), The Case Against the IT Miracle. *Global Economic Weekly* 2000 (28): New York.

Goldman Sachs (ed.) (2000c), The Digital Revolution Outside the United States. *Global Economic Weekly* 2000 (27).

Gomme, P. (1998), What Labor Market Theory Tells Us About the "New Economy". *Federal Reserve Bank of Cleveland Economic Review* 34 (3): 16–23.

Goodhart, C. (2001), What Weight Should Be Given to Asset Prices in the Measurement of Inflation? *Economic Journal* 111 (472): F335–F356.

Gordon, R.J. (1989), The Postwar Evolution of Computer Prices. In D.W. Jorgenson and R. Landau (eds.), 77–125.

Gordon, R.J. (1992), Productivity in the Transportation Sector. In Z. Griliches (ed.), 371–427.

Gordon, R.J. (1993), The Jobless Recovery: Does It Signal a New Era of Productivity-led Growth? *Brookings Papers on Economic Activity* 1993 (1): 271–316.

Gordon, R.J. (1995), Is there a Trade-off between Unemployment and Productivity Growth? NBER-Working Papers 5081. NBER, Cambridge, MA.

Gordon, R.J. (1996a), Macroeconomic Policy in the Presence of Structural Maladjustment. NBER Working Papers 5739. NBER, Cambridge, MA.

Gordon, R.J. (1996b), Problems in the Measurement and Performance of Service-Sector Productivity in the United States. NBER-Working Papers 5519. NBER, Cambridge, MA.

Gordon, R.J. (1997), The Time-Varying NAIRU and its Implicates for Economic Policy. *Journal of Economic Perspectives* 11 (1): 11–32.

Gordon, R.J. (1998), "Foundations of the Goldilocks Economy: Supply Shocks and the Time-Varying NAIRU". *Brookings Papers on Economic Activity* 1998 (2): 297–346.

Gordon, R.J. (1999a), *Has the "New Economy" Rendered the Productivity Slowdown Obsolete?* Paper presented at the Meeting of Economic Advisors at the Federal Reserve Bank of Chicago. Revised Version, June 14, 1999. Northwestern University and NBER, Cambridge, MA.

Gordon, R.J. (1999b), Monetary Policy in the Age of Information Technology. IMES-Discussion Papers 99-E-12. Institute for Monetary Economic Studies, Tokyo.

Gordon, R.J. (1999c), The Aftermath of the 1992 ERM Breakup: Was there a Macroeconomic Free Lunch? NBER Working Papers 6964. NBER, Cambridge, MA. Internet: www.nber.org/papers/w6964, visited April 4, 2001.

Gordon, R.J. (1999d), The Boskin Commission Report and Its Aftermath. *Monetary and Economic Studies* 12: 41–68.

Gordon, R.J. (1999e), U.S. Economic Growth since 1870: One Big Wave? *American Economic Review – Papers and Proceedings* 89 (2): 123–128.

Gordon, R.J. (2000a), Does the "New Economy" Measure up to the Great Invention of the Past? *Journal of Economic Perspectives* 14 (4): 49–74.

Gordon, R.J. (2000b), Interpreting the One Big Wave' in US Long-Term Productivity Growth. NBER-Working Papers 7752. NBER, Cambridge, MA.

Gordon, R.J. (2000c), Neither too Hot nor too Cold: the US Economy in the 1990s. Policies towards Full Employment: 61–66. OECD Proceeding. Paris.

Gordon, R.J. (2000d), *Was the Economy of the 1990s a New One?* Presentation for CBO New Economy Briefing, Senate Budget Committee. 06/2000. Washington, D.C.

Gordon, R.J. (2001a), *Apparel Prices and the Hulten/Bruegel Paradox*. Internet: http://faculty-web.at.northwestern.edu/economics/gordon/researchhome.html, visited June 22, 2001.

Gordon, R.J. (2001b), *Five Controversial Propositions About the U.S. Economy.* Outline of Speech at European Central Bank. ECB, Frankfurt a.M.

Gordon, R.J. (2001c), Technology and Economic Performance in the American Economy. NBER-Working Papers 8771. Cambridge, MA.

Gordon, R.J. and Z. Griliches (1997), Quality Change and New Products. *American Economic Review* 87 (2): 84–88.

Graef, B. and S. Heimerl (2000), USA: Inflation auch in der "New Economy" nicht tot. *Aktuelle Themen: Deutschland, Europa, international* 2000: 5–11.

Greenlees, J.S. and C.C. Mason (1996), Overview of the 1998 Revision of the Consumer Price Index. *Monthly Labor Review* 119 (12): 3–9.

Griliches, Z. (ed.) (1992), *Output Measurement in the Service Sectors.* University of Chicago for NBER.

Griliches, Z. (1994), Productivity, R&D, and the Data Constraint. *American Economic Review* 84: 1–23.

Groarke, L. (1998), *The Ethics of the New Economy*: Restructuring and Beyond. Waterloo, Ontario: Wilfrid Laurier Univ. Press.

Grossman, G.M. and E. Helpman (1991), *Innovation and Growth in the Global Economy.* Cambridge, MA.

Gruber, H. (2001), The Diffusion of Information Technology in Europe. In: European Investment Bank (ed.), 151–163.

Gundlach, E. (2001), Interpreting Productivity Growth in the New Economy: Some Agnostic Notes. Kiel Working Papers 1020. IfW, Kiel.

Gust, C. and J. Marquez (2000), Productivity Developments Abroad. *Federal Reserve Bulletin* 2000 (10): 665–681.

Hall, R.E. (2000), E-Capital: The Link between the Stock Market and the Labour Market in the 1990s. *Brookings Papers on Economic Activity* 2000 (2): 73–118.

Hall, R.E. and D.W. Jorgenson (1967), Tax policy and investment behaviour. *American Economic Review* 57: 391–414.

Haltiwanger, J. (2000), Aggregate Growth: What Have We Learned from Microeconomic Evidence? OECD Economics Department Working Papers 267. OECD, Paris.

Haltiwanger, J. and R.S. Jarmin (2000), Measuring the Digital Economy. In E. Brynjolfsson and B. Kahin (eds.), 13–33.

Harhoff, D. (1995), Methodik und Einsatz hedonischer Preisindizes – Ein Überblick. In D. Harhoff und M. Müller (eds.), 37–60. Nomos.

Harhoff, D. (1999), Die Behandlung von Qualitätsänderungen im Preisindex für die Lebenshaltung. Diskussionspapiere der Volkswirtschaftlichen Forschungsgruppe 3. Deutsche Bundesbank, Frankfurt a.M., 65–81.

Harhoff, D. and M. Müller (eds.) (1995), *Preismessung und Technischer Fortschritt*. Baden-Baden: Nomos.

Harper, M. J. (1982), The Measurement of Productive Capital Stock, Capital Wealth, and Capital Services. BLS Working Papers 128. Bureau of Labor Statistics, Washington, DC.

Hartmann, N. (1999), Revision der Volkswirtschaftlichen Gesamtrechnungen 1999 – Anlass, Konzeptänderungen und neue Begriffe. *Wirtschaft und Statistik* 1999 (4): 257–278.

Haskel, J. and M. Queen (2000), *Productivity and the New Economy*: Who Disagrees and Why? University of London.

Hauser, H. (2001), Nothing Ventured, Nothing Gained. In European Investment Bank (ed.), 101–109.

Haynes, M. and S. Thompson (2000), The Productivity Impact of IT Development: An Empirical Evaluation of ATM Introduction. *Oxford Bulletin of Economics and Statistics* 62 (5): 607–619.

Heckerott, B (2001), Traditionelle Händler sind die Gewinner im E-Commerce. *Frankfurter Allgemeine Zeitung* 2001 (5. Juli): 22.

Heilemann, U. and H.D. von Loeffelholz (1994), Wachstum durch Transeuropäische Netze? Zum Infrastrukturprogramm des Weißbuches. In H. König (ed.), 83–100.

Heilemann, U., R. Döhrn, H.-D. von Loeffelholz and E. Schäfer-Jäckel (2000), Der Wirtschaftsaufschwung der Vereinigten Staaten in den neunziger Jahren – Rolle und Beitrag makroökonomischer Faktoren. Untersuchungen des RWI 32. RWI, Essen.

Heindl, H. and D. Pauschert (2000), Analysen zu den Grundlagen der "New Economy": Benchmarking und Internet Ökonomie. In F.H. Witt und K. Bartölke (Hrsg.), *Unternehmung und Informationsgesellschaft: Management – Organisation – Trends.* Reinhard Rock zum 60. Geburtstag. Wiesbaden: Gabler, 169–184.

Hellenbroich, A. (2000), *Mythos Informationsgesellschaft: ernüchternde Perspektiven für die "New Economy"*. Das Produktivitätsparadox im Computerzeitalter. Wissen statt Information. "Künstliche Intelligenz" und Fortschrittfeindlichkeit. EIRNA – Executive-Intelligence-Review-Nachrichtenagentur, Wiesbaden.

Herkommer, S. and J. Bischoff (2000), *Zukunftswerkstatt Amerika?* Der Bobo-Kapitalismus und die neue Ökonomie. Hamburg: VSA-Verlag.

Herman, S. (2000), Fixed Assets and Consumer Durable Goods. *Survey of Current Business* 80: 19–30.

Herzenberg, S., J. Alic and H. Wial (1999), A New Deal for a New Economy. *Challenge* 42 (2): 102–129.

HM Treasury (ed.) (2000), *Productivity in the UK*: The Evidence and the Government's Approach. Internet: www.hm-treasury-gov.uk, visited 20. April 2001.

Hoffmann, J. (1998), Probleme der Inflationsmessung in Deutschland. Diskussionspapiere der volkswirtschaftlichen Forschungsgruppe 1/98. Deutsche Bundesbank, Frankfurt a.M.

Hoffmann, J. (1999), Zur Abschätzung der statistischen Verzerrung in der deutschen Inflationsrate. Diskussionspapiere der Volkswirtschaftlichen Forschungsgruppe 3. Deutsche Bundesbank, Frankfurt a.M., 7–20.

Holdway, M. (2001), *Quality-Adjusting Computer Prices in the Producer Price Index*: An Overview. Bureau of Labor Statistics, Washington, DC.

Hulten, C.R., (1997), Quality Change in the CPI. *Federal Reserve Bank of St. Louis Review* 79 (3): 87–100.

Hulten, C.R., J.W. Robertson and F.C. Wykoff (1989), Energy. Obsolescence, and the Productivity Slowdown. In D.W. Jorgenson and R. Landau (eds.), 225–258.

Hummel, M. et al. (1999), Der Beitrag des IuK-Sektors zur Verbesserung der Innovations- und Wettbewerbsfähigkeit der inländischen Produktion und Beschäftigung. ifo-Studien zur Strukturforschung 28/I. ifo, München.

Hummel, M. und C. Saul (1997). Beschäftigungspotentiale neuer elektronischer Medien. *ifo-Schnelldienst* 50 (3): 3–18.

Hummler, K. (1999), Strukturwandel und die Gesetze der Ökonomie. Neues und weniger Neues in der "New Economy". *Schweizer Monatsheft* 79 (3): 9–13.

Hurst, C. and K. Uppenberg (2001), Wonders will Never Cease: Prospects for a New Economy in Europe. In European Investment Bank (ed.), 9–40.

Hüther, M. (2000a), Was ist wirklich neu an der "New Economy"? *Zeitschrift für Wirtschaftspolitik* 49 (3): 286–295.

Hüther, M. (2000b). Was die New Economy ausmacht. *Handelsblatt* 2000 (5. Sept.): 53.

Hüther, M. (2001), Die New Economy steht erst am Anfang. *Handelsblatt* 2001 (16. Okt.): 9.

IKB Deutsche Industriebank (ed.) (2001), Starker IT-Einsatz als Motor der US-Wirtschaft – Deutschland holt auf. *Unternehmerthemen* 2001 (2): 7–10.

IMF – International Monetary Fund (ed.) (2000), Germany: Selected Issues. IMF Staff Country Report 00/142. Washington, DC, 1–99.

IW – Institut der deutschen Wirtschaft (ed.) (2001a), Determinanten der New Economy im internationalen Vergleich. (Bearb.: J. Matthes.) *iw-trends* 28 (1): 52–77.

IW – Institut der deutschen Wirtschaft (ed.) (2001b), Produktivitätstrends der 90er Jahre. Statistische Überzeichnung dämpft New Economy Hoffnungen. (Bearb.: M. Grömling.) *iw-trends* 28 (1): 21–36.

Jensen, J.B., R.H. McGuckin and K.H. Stiroh (2001), The Impact of Vintage and Survival on Productivity: Evidence from Cohorts of U.S. Manufacturing Plants. *Review of Economics and Statistics* 83 (2): 323–332.

Jorgenson, D.W. (2001), Information Technology and the U.S. Economy. *American Economic Review* 91 (1): 1–32.

Jorgenson, D.W. and Z. Griliches (1967), The Explanation of Productivity Change. *Review of Economic Studies* 34 (3): 249–283.

Jorgenson, D.W. and R. Landau (eds.) (1989), *Technology and Capital Formation*. Cambridge, MA, and London: MIT Press.

Jorgenson, D.W. and K. Stiroh (1995), Computers and Growth. *Economic of Innovation and New Technology* 1995 (3/4): 295–316.

Jorgenson, D.W. and K. Stiroh (1999), Information Technology and Growth. *American Economic Review – Papers and Proceedings* 89 (2): 109–115.

Jorgenson, D.W. and K.J. Stiroh (2000a), Raising the Speed Limit: U.S. Economic Growth in the Information Age. Comments by Robert J. Gordon and Daniel Sichel. *Brookings Papers on Economic Activity* 2000 (1): 125–235.

Jorgenson, D.W. and K.J. Stiroh (2000b), U.S. Economic Growth at the Industry Level. *American Economic Review* 90 (2): 161–167.

Kahn, J., M.M. McConnell and G. Perez-Quiros (2001), Reduced Volatility of the U.S. Economy. Policy of Progress? Preliminary version (January 25, 2001). Federal Reserve Bank of New York Working Paper. New York.

Kalmbach, P. (2000), Eine neue Wirtschaft im neuen Jahrtausend? *Wirtschaftsdienst* 80 (4): 210–217.

Kalmbach, P. (2001), Neue Ökonomie: Ökonomisch Neues oder "Same Procedure as Every Year"? IKSF-Discussion Paper 27. Institut für Konjunktur- und Strukturforschung, Bremen.

Katz, L. (1999), *Technological Change, Computerization and the Wage Structure*. In E. Brynjolfsson and B. Kahin (eds.), 217–244.

Kay, J. (2001), What Became of the New Economy? *National Institute Economic Review* 177: 56–69.

Kelly, G.M. (2000), Employment and Concepts of Work in the Global Economy. *International Labour Review* 139 (1): 5–32.

Kendrick, J.W. (1961), *Productivity Trends in the United States*. Princeton University Press for NBER.

Kiley, M.T. (1999), *Computers and Growth with Costs of Adjustment*: Will the Future Look Like the Past? Internet: www.federalreserve.gov/pubs/feds/ 1999/index.html, visited November 1, 2000.

Kiley, M.T. (2001), Computers and Growth With Frictions: Aggregate and Disaggregate Evidence. *Carnegie-Rochester Conference Series on Public Policy* 55: 171–215.

Klein, J. (2000), *Rethinking Antitrust Policies for the New Economy*. US Department of Justice, Washington, DC.

Klemmer, P. (2000), *Globalisierung, New Economy und Überalterung – eine bildungspolitische Herausforderung*. Vortrag vor der Fördergesellschaft des RWI am 4.7.2000. Manuskript, RWI, Essen.

Klodt, H. (1995), Wettbewerb und Regulierung in der Telekommunikation. Kieler Studien 272. Tübingen: Mohr-Siebeck.

Klodt, H. (2001a), Die Neue Ökonomie: Aufbruch und Umbruch. *Weltwirtschaft* 2001 (1): 78–98.

Klodt, H. (2001b), The Essence of the New Economy. Kieler Diskussionsbeiträge 375. IfW, Kiel.

Kneller, R. and G. Young (2001), The New British Economy. *National Institute Economic Review* 177 (July): 70–83.

Kolatek, C. (1993), Informational Networks and Regional Business Potential: An Economic Analysis for Japan. WZB-Discussion Papers FS IV 93–27. WZB, Berlin.

König, H. (Hrsg.) (1994), Bringt die EU-Beschäftigungsoffensive den Aufschwung? Die deutsche Wirtschaftsforschung nimmt Stellung zum Delors-Weißbuch. ZEW-Wirtschaftsanalysen Sonderband 1. Baden-Baden; Nomos.

Kopitz, G. (1982), Factor Prices in Industrial Countries. IMF Staff Papers 29. IMF, Washington, DC.

Kotkamp, S. (2000), Informationswirtschaft: Das Neue in der New Economy. *Karlsruher Transfer* 24: 6–13.

Kouparitsas, M.A. (1999), Is there Evidence of the New Economy in the Data? Federal Reserve Bank of Chicago Working Papers Series WP 99–21. Federal Reserve Bank of Chicago, 1–15.

Krugman, P. (1997), How Fast Can the U.S. Economy Grow? *Harvard Business Review* 75 (4): 123–129.

L'Hoest, R. and W. Schönig (2000), Die Internet-Wirtschaft als Reformmotor der Wirtschafts- und Sozialpolitik. *Wirtschaftsdienst* 80 (5): 277–283.

Laaser, C.-F. and R. Soltwedel (2001), Raumstruktur und New Economy - zur Bedeutung von E-Commerce für die Arbeitsteilung im Raum. *Weltwirtschaft* 2001 (2): 173–189.

Landefeld, J.S. and B.M. Fraumeni (2001), Measuring the New Economy. *Survey of Current Business* 81 (3): 23–40.

Landefeld, St.J. and B.T. Grimm (2000), A Note on the Impact of Hedonics and Computers on Real GDP. *Survey of Current Business* 80 (12): 17–22.

Landefeld, St.J. and R.P. Parker (1997), BEA's Chain Indexes. Time Series and Measures of Long-Term Economic Growth. *Survey of Current Business* 77 (5): 58–68.

Lequiller, F. (2001a), La nouvelle économie et la mesure de la croissance du PIP. Série des documents de travail de la Direction des Etudes et Synthèses Économiques G2001/01. Malakoff Cedex. Institut National de la Statistique et des Etudes Economiques. Paris.

Lequiller, F. (2001b), *The new economy and the measurement of GDP growth*. Institut National de la Statistique et des Etudes Economiques, Paris.

Litan, R.E. and A.M. Rivlin (2000), The Economy and the Internet – What Lies Ahead? Brookings Conference Report 4. Washington, DC: Brookings Institution.

Litan, R. and A. Rivlin (2001), Projecting the Economic Impact of the Internet. *American Economic Review – Papers and Proceedings* 91 (2): 313–317.

Löbbe, K. et al. (1993), Strukturwandel in der Krise. Untersuchungen des RWI 9. RWI, Essen.

Löbbe, K., H. Schrumpf et al. (1997), Der Wirtschaftsstandort Deutschland vor dem Hintergrund regionaler Entwicklungstendenzen in Europa. Untersuchungen des RWI 22. RWI, Essen.

Löbbe, K. et al. (2002), Der Standort Deutschland im internationalen Vergleich – Zur Lage der Wettbewerbsfähigkeit. Untersuchungen des RWI 39. RWI, Essen.

Lucas, R.E. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics* 22: 3–42.

Lucking-Reiley, D. and D.F. Spulber (2001), Business-to Business Electronic Commerce. *Journal of Economic Perspectives* 15 (1): 55–68.

Lum, S.K.S. and B.C. Moyer (2000), Gross Domestic Product by Industry for 1997–99. *Survey of Current Business* 80 (12): 24–35.

Lum, S.K.S. and R.E. Yusakavage (1997), Gross Product by Industry, 1947–96. *Survey of Current Business*, 77 (11): 20–35.

Lum, S.K.S., B.C. Moyer and R.E. Yuskavage (2000), Improved Estimates of Gross Product by Industry for 1947–98. *Survey of Current Business* 80 (6): 24–54.

MacDonald, S., P. Anderson and D. Kimbel (2000), Measurement or Management? Revising the Productivity Paradox of Information Technology. *Vierteljahrshefte zur Wirtschaftsforschung* 69 (4): 601–617.

Mackenzie, G.C. and S. Thornton (1996), *Bucking the Deficit*. Economic Policy Making in America. Boulder and Oxford: Westview Press.

Malik, F. (2001), Schulden statt Flausen. Die New Economy ist in der Old Reality angekommen. *Handelsblatt* 2001 (28. Sept.): K3.

Mandel, M. (2001), *Crash.com. Warum endet der High-Tech-Boom?* München: Financial Times Prentice Hall.

Mann, C.L. (1999), *Is the U.S. Trade Deficit Sustainable?* Institute for International Economics, Washingten, DC.

Mason, G., K. Wagner, D. Finegold and B. Keltner (2000), The "IT Productivity Paradox" Revisited: International Comparisons of Information Technology, Work Organisation and Productivity in Service Industries. *Vierteljahrshefte zur Wirtschaftsforschung* 69 (4): 618–629.

Mattke, S. (1999). Der Schutz privater Daten wird vernachlässigt – E-Commerce-Anbieter nehmen die Bedenken ihrer Kunden offensichtlich nicht ernst. *Handelsblatt* 1999 (30. Jan.): 18.

McGuckin, R.H. (2000), *Productivity in the "e-age"*. The American Experience with the Knowledge-Led Economy. Remarks at Asian Productivity Conference. New Delhi, India.

McKinsey Global Institute (ed.) (2001), *US Productivity Growth 1995 to 2000*: Understanding the Contribution of Information Technology Relative to Other Factors. Washington, DC.

McKnight, L. and J.P. Bailey (eds.) (1997), *Internet Economics*. Cambridge, MA: MIT Press. Cambridge.

McMorrow, K. and W. Roeger (2001), Potential Output: Measurement Methods, "New" Economy Influences and Scenarios for 2001–2010 – A Comparison of the EU 15 and the US. Economic Papers 150. Brüssel.

Meinig, W. and H. Mallad (2001), E-Commerce im selektiven Vertriebssystem der Automobilwirtschaft. Ergebnisse empirischer Studien zu Kunden- und Händleransprüchen. *Jahrbuch der Absatz- und Verbrauchsforschung* 47 (2): 155–171.

Meyer-Krahmer, F., J. Müller and B. Preißl (eds.) (1990), *Information Technology: Impacts, Policies and Future Perspectives*. Promotion of Mutual Understanding between Europe and Japan. Berlin, New York et al.: Springer.

Michler, I. (2001), Aus der Traum vom ewigen Wachstum. *Welt* 2001 (2. Mai): 16.

Mitchell, B.R. (1980), *European historical time series, 1750–1975*. London: MacMillan.

Mokyr, J. (2001), The Rise and Fall of the Factory System: Technology, Firms, and Households Since the Industrial Revolution. *Carnegie-Rochester Conference Series on Public Policy* 55: 1–45.

Motohashi, K. (1997), ICT Diffusion and its Economic Impact in OECD Countries. *STI-Review* 20: 13–45.

Moulton, B.R. (1999), *GDP and the Digital Economy*: Keeping Up With the Changes. Bureau of Economic Analysis, Washington, DC.

Moulton, B.R. (2001), *The Expanding Role of Hedonic Methods in the Official Statistics of the United States*. Bureau of Economic Analysis. Washington, DC. Internet: www.bea.gov/bea/about/expand3.pdf, visited August 30, 2001.

Müller, E. (1999), Standortfaktor Informationstechnologie. In P. Oberender (ed.), 15–28.

Murphy, K.M. et al. (1998), Wages Skills, and Technology in the United States and Canada. NBER Working Papers 6638. Cambridge, MA. Internet: www.nber.org/papers/w6638, visited February 15, 2001.

Mussa, M. (2000), *Factors Driving Global Economic Intergration*. Federal Reserve Bank of Cansas-City Symposium: 08/2000. Kansas City, Federal Reserve Bank of Kansas City, WY.

Nakamura, L.I. (1999), Intangibles: What put the New in the New Economy? *Federal Bank of Philadelphia Business Review* 1999: 13–16.

Nakamura, L.I. (2000), Economics and the New Economy: The Invisible Hand Meets Creative Destruction. *Federal Reserve Bank of Philadelphia Business Review* 2000: 15–30.

Nefiodow, A. (1990), *Der fünfte Kondratieff.* Strategien zum Strukturwandel in Wirtschaft und Gesellschaft. Frankfurt a.M. and Wiesbaden: Frankfurter Allgemeine Zeitung et al.

Nefiodow, L.A. (1986). Von der Rechen-Maschine zur Maschinen-Intelligenz. *Technologie-Manager* 35 (2): 6–15.

NFO Infratest (ed.) (2001a), *Monitoring Informationswirtschaft.* 3. Faktenbericht 2001. Band I. München.

NFO Infratest (ed.) (2001b), *Monitoring Informationswirtschaft.* Chartbericht zum 3. Faktenbericht 2001. Band II. München.

Nierhaus, W. (2001), Wirtschaftswachstum in den Volkswirtschaftlichen Gesamtrechnungen: Ein Vergleich Deutschland – USA. *ifo Schnelldienst* 54 (3): 41–51.

Nonnast, T. (2001), Die IT-Branche ist auf dem schmerzlichen Weg in die Normalität. *Handelsblatt* 2001 (10. Okt.): 11.

Nordhaus, W.D. (1972), The Recent Productivity Slowdown. *Brookings Papers on Economic Activity* 1972 (3): 493–536.

Nordhaus, W.D. (2000), *Policy Rules in the New Economy.* Internet: www.econ.yale.edu/~nordhaus/homepage/sbc%20cbo%20060500.PDF, visited April 2, 2001.

Nordhaus, W.D. (2001a), Productivity Growth and the New Economy. NBER Working Papers 8096. NBER, Cambridge, MA.

Nordhaus, W.D. (2001b), Alternative Methods for Measuring Productivity Growth. NBER Working Papers 8095. NBER, Cambridge, MA.

Nordhaus, W.D. (2001c), New Data and Output Concepts for Understanding Productivity Trands. NBER Working Papers 8097. NBER, Cambridge, MA.

Oberender, P. (ed.) (1999), Die Dynamik der Telekommunikationsmärkte als Herausforderung an die Wettbewerbspolitik. Schriften des Vereins für Socialpolitik N.F. 266. Berlin: Duncker & Humblot.

OECD (ed.) (1998a), *Technology and the Economy.* Paris.

OECD (ed.) (1998b), *The Software Sector*: A Statistical Profile for Selected OECD Countries. Paris.

OECD (ed.) (1999), *The Economic and Social Impacts of Electronic Commerce* – Preliminary Findings and Research Agenda. Paris.

OECD (ed.) (2000a), A New Economy? The Changing Role of Innovation and Information Technology in Growth. (Bearb: A. Wyckoff and D. Pilat.) OECD Document 91377. Paris.

OECD (ed.) (2000b), *Is There a New Economy?* First Report on the OECD Growth Project. Paris.

OECD (ed.) (2000c), *Measuring the ICT Sector.* Paris.

OECD (ed.) (2000d), *OECD Economic Outlook.* Statistics on Microcomputer Diskette 68. Paris.

OECD (ed.) (2000e), *OECD Information Technology Outlook*. ICTs, E-Commerce and the Information Economy. Paris.

OECD (ed.) (2000f), The Contribution of Information and Communication Technology to Output Growth: A Study of the G7 Countries. OECD Working Papers 2/2000. Paris.

OECD (ed.) (2001a), *Business to Consumer Electronic Commerce*. An Update on the Statistics. Internet: www.oecd.org/sti/consumer-poliy, visited December 15, 2001.

OECD (ed.) (2001b), *The New Economy: Beyond the Hype*. The OECD Growth Project. Paris.

OECD (ed.) (2001c), *Innovation and Productivity in Services*. Paris.

OECD (ed.) (2001d), *OECD Forum 2001*: Sustainable Development and the New Economy. Policy Implications of the New Economy (by I. Visco, Chief Economist, OECD). Paris.

OECD (ed.) (2001e), *OECD Productivity Manual*: A Guide to the Measurement of Industry-Level and Aggregate Productivity Growth. Paris.

OECD (ed.) (2001f), *Science, Technology and Industry Scoreboard 2001* – Towards a knowledge-based economy. Internet: www1.oecd.org/publications/e-book/92-2001-04-1-2987, visited October 22, 2001.

Oesterle, H. (2000), Ein Platz in der "New Economy". In E. Brauchlin (ed.), 261–272..

Österreichische Nationalbank (ed.) (2000), *Das neue Millennium – Zeit für ein neues ökonomisches Paradigma?* 28. Volkswirtschaftliche Tagung. Wien.

Oliner, S.D. and D.E. Sichel (1994), Computers and Output Growth Revisited: How Big Is the Puzzle? *Brookings Papers on Economic Activity* 1994 (2): 273–334.

Oliner, S.D. and D.E. Sichel (2000). The Resurgence of Growth in the Late 1990s: Is Information Technology the Story? *Journal of Economic Perspectives* 14 (4): 3–22.

Pakko, M.R. (1999), The U.S. Trade Deficit and the "New Economy". *Federal Reserve Bank of St. Louis Review* 1999 (Sept./Oct.): 11–19.

Paqué, K.-H. (2001), Soziale Marktwirtschaft und globale "New Economy": Ein Widerspruch? *Aus Politik und Zeitgeschichte* B9/2001: 31–38.

Park, S.O. (2000), *Knowledge-based industry and regional growth*. Frankfurt a.M.: Department of Economic and Social Geography. Johann Wolfgang Goethe Universität, Frankfurt a.M.

Piazolo, D. (2001), The New Economy and the International Regulatory Framework. Kiel Working Paper 1030. IfW, Kiel.

Picot, A., D.K. Heger and R. Neuburger (2001), Der elektronische Handel – Potentiale für Unternehmen. *ifo-Schnelldienst* 54 (6): 19–26.

Picot, A., R. Reichwald and R.T. Wigand (1996), *Die grenzenlose Unternehmung: Information, Organisation und Management*. Lehrbuch zur Unternehmensführung im Informationszeitalter. Wiesbaden: Gabler.

Pilat, D. and F.C. Lee (2001), Productivity Growth in ICT-Producing and ICT-Using Industries: A Source of Growth Differentials in the OECD? STI Working Paper 4/2001. Paris.

Piller, F. (1998), Das Produktivitätsparadoxon der Informationstechnologie. *WiSt – Wirtschaftswissenschaftliches Studium* 27 (5): 257–262.

Porat, M.U. (1976), *The Information Economy.* Vol. 1. Institute for Communication Reasearch, Stanford, CA.

Porat, M.U. (1977), The Information Economy: Sources and Methods for Measuring the Primary Information Sector. OT Special Publication 77-12 (1). Departement of Commerce, Washington DC.

Preißl, B. (2000), The Economics of Information Technology – Editorial. *Vierteljahrshefte zur Wirtschaftsforschung* 69 (4): 487–490.

Preißl, B. and H. Haas (unter Mitarbeit von C. Rickert) (1999), E-Commerce – Erfolgsfaktoren von Online-Shopping in den USA und in Deutschland. DIW-Sonderheft 168. Berlin: Duncker & Humblot.

Presse- und Informationsamt der Bundesregierung (ed.) (1997), Info 2000 – Deutschlands Weg in die Informationsgesellschaft. Aktuelle Beiträge zur Wirtschafts- und Finanzpolitik 16. Berlin.

PricewaterhouseCoopers (ed.) (2000), *Consumers or Content? The Digital Dilemma.* The European Digital Television Report 2000. London.

Quah, D. (2001), ICT Clusters in Development: Theory and Evidence. In: European Economic Growth: The Impact of New Technologies. EIB-Papers 6 (1): 85–100.

Rentenmeister, J. and S. Klein (2001), Geschäftsmodelle in der New Economy. *WISU – Das Wirtschaftsstudium* 30 (3): 354–361.

Roach, S.S. (1991), Services Under Siege – The Restructuring Imperative. *Harvard Business Review* 1991 (Sept./Oct.): 82–91.

Roach, S.S. (1998a), *Global Restructuring: Lessons, Myths, and Challenges.* Morgan Stanley Dean Witter – International Investment Research: Special Economic Study. Tokyo u.a.

Roach, S.S. (1998b), *The Boom for Whom: Revisiting America's Technology Paradox.* Morgan Stanley Dean Witter – International Investment Research: Special Economic Study. Tokyo u.a.

Röller, L.-H. (2000), Telecommunications Infrastructure and Economic Development: A Simultaneous Approach. Centre for Economic Policy Research Working Paper 2399. Centre for Economic Policy Research, Berlin.

Romer, P. (1986), Increasing Returns and Long-Run Growth. *Journal of Political Economy* 94 (5): 1002–1037.

Romer, P.M. (1990), Endogenous Technological Change. *Journal of Political Economy* 98 (5): 71–102.

Rosegger, G.C. (1998), Technischer Wandel und Produktivität: Eine US-Perspektive. *Wirtschaftspolitische Blätter* 45 (1): 9–18.

Rothgang, M. and M. Scheuer (2001), Braucht der E-Commerce eine eigenständige E-Commerce-Politik? Überlegungen aus ordnungspolitischer Sicht. TA-Datenbank-Nachrichten 4. Institut für Technikfolgenabschätzung und Systemanalyse, Forschungszentrum Karlsruhe.

Rowthorn, R. (1999), Unemployment, wage bargaining and capital-labour substitution. *Cambridge Journal of Economics* 23: 413–425.

Rupp, J. (2001), Neue Wirtschaft – Neues Management? Überlegungen zum deutschen Management in der New Economy. *Aus Politik und Zeitgeschichte* B9/2001: 23–30.

RWI – Rheinisch-Westfälisches Institut für Wirtschaftsforschung (ed.) (1987), *Analyse der strukturellen Entwicklung der deutschen Wirtschaft* – RWI- Strukturberichterstattung 1987. Band 3: Die Auswirkungen staatlicher Marktregulierungen auf die sektorale Strukturbildung und Faktorallokation – Möglichkeiten und Auswirkungen von Deregulierungen in einzelnen Wirtschaftsbereichen. Gutachten im Auftrag des Bundesministers für Wirtschaft. Essen.

RWI – Rheinisch-Westfälisches Institut für Wirtschaftsforschung (ed.) (1988), *Analyse der strukturellen Entwicklung der deutschen Wirtschaft* – RWI- Strukturberichterstattung 1987. Band 6: Methoden und Materialien. Gutachten im Auftrag des Bundesministers für Wirtschaft. (Bearb. K. Löbbe et al.) Essen.

RWI – Rheinisch-Westfälisches Institut für Wirtschaftsforschung (ed.) (2000), *Wachstums- und Beschäftigungspotentiale der Informationsgesellschaft bis zum Jahre 2010.* Gutachten im Auftrag des Bundesministers für Wirtschaft und Technologie. (Bearb. K. Löbbe et al.) Essen.

Scarpetta, S., A. Bassani, D. Pilat and P. Schreyer (2000), Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level. OECD Economics Department Working Papers 248. OECD, Paris.

Schaden, B. et al. (1999a), Tertiarisierung und neue Informations- und Kommunikationstechnologien. ifo-Studien zur Strukturforschung 28/III. ifo, München.

Schaden, B. et al. (1999b), Globalisierung und neue Informations- und Kommunikationstechnologien. ifo-Studien zur Strukturforschung 28/II. ifo, München.

Schedl, H. (2001), Wo steht der elektronische Handel in Deutschland? *ifo-Schnelldienst* 54 (6): 27–33.

Schedl, H., H. Penzkofer and H. Schmalholz (2001), Anwendungshemmnisse beim Einsatz integrierter IuK-Technologien im Kontakt mit dem Kunden. *ifo-Schnelldienst* 54 (5): 22–29.

Scheuer, M. and H.-A. Leifer (1996), Zur Umstellung der Berechnung des realen Bruttoinlandsprodukts in den USA auf einen Kettenindex. *WiSt – Wirtschaftswissenschaftliches Studium* 25 (9): 473–478.

Schlueter-Langdon, C. (2001), Elektronische Märkte und Netze ändern Industriestrukturen. *Frankfurter Allgemeine Zeitung* 2001 (10. Januar): 23.

Schmidt, H. (2001a), Deutschland bleibt von der Entlassungswelle der Neuen Ökonomie weitgehend verschont. *Frankfurter Allgemeine Zeitung* 2001 (9. Oktober): 20.

Schmidt, H. (ed.) (2001b), *Die Potentiale der Internet-Ökonomie.* Neue Regeln bestimmen die digitale Wirtschaft. Frankfurt a.M.: Frankfurter Allgemeine Zeitung.

Schmidt, I. (2000), Computer.com & @ktien – die neuen Quellen des Wachstums? *Gewerkschaftliche Monatshefte* 51 (8/9): 486–496.

Schmidtchen, D. (1973), Politische Ökonomie staatlicher Preisinterventionen. Veröffentlichungen des Forschungsinstituts für Wirtschaftspolitik an der Universität Mainz 28. Berlin: Duncker & Humblot.

Schnorr-Bäcker, S. (2001), Neue Ökonomie und amtliche Statistik. *Wirtschaft und Statistik* 2001 (3): 165–175.

Schreyer, M. (2000), Wachstum und Beschäftigung vor dem Hintergrund des Solowschen Produktivitätsparadoxons. Schriftenreihe des Promotionsschwerpunkts Makroökonomische Diagnosen und Therapien der Arbeitslosigkeit 14/2000. Stuttgart-Hohenheim.

Schreyer, P. (2000), The Contribution of Information and Communication Technology to Output Growth: A Study of the G7 Countries. STI Working Papers 2/2000. OECD, Paris.

Schulmeister, S. (2000), Die Unterschiedliche Wachstumsdynamik in den USA und Deutschland in den Neunziger Jahren: Referat im Rahmen der Tagung "USA – Dekonstruktion eines Modells?!" WIFO Working Papers 134. Österreichisches Institut für Wirtschaftsforschung, Wien.

Schweizerische Rückversicherungs-Gesellschaft, Economic Research & Consulting (ed.) (2000), E-Business in der Versicherungswirtschaft: Zwang zur Anpassung – Chance zur Erneuerung. Sigma 5/2000. Zürich.

Selhofer, H. (2000), Skills Shortage vs. Job Creation: A Review of Empirical Evidence on the Issues of ICTs and Employment. *Vierteljahrshefte zur Wirtschaftsforschung* 69 (4): 510–526.

Seufert, W. (2000), The Development of the Information and Communications Sector in Germany. *Vierteljahrshefte zur Wirtschaftsforschung* 69 (4): 491–509.

Shapiro, C. and H. Varian (1999), *Information Rules: A Strategic Guide to the Network Economy*. Harvard: Harvard Business School Press.

Sichel, D.E. (1997a), *The Computer Revolution*: An Economic Perspective. Washington, DC: Brookings Institution.

Sichel, D.E. (1997b), The Productivity Slowdown: Is a Growing Unmeasurable Sector the Culprit? *Review of Economics and Statistics* 79: 367–371.

Siebert, H. (2000a), The New Economy – What Is Really New? Kiel Working Papers 1000. IfW, Kiel.

Siebert, H. (2000b), Noch viel zu tun für eine "New Economy" in Euroland. *Handelsblatt* 2000 (21. Februar): 2.

Siedenberg A. (2000), New Economy in Euroland: Hoffnung oder Wirklichkeit? *Deutsche Bank Research* 2000: 1–42.

Silver, M. and S. Heravi (2001), Scanner Data and the Measurement of Inflation. *Economic Journal* 111 (472): F383–F404.

Sinclair, J. and B. Cantor (1990), An Experimental Price Index for the Computer Industry. *Monthly Labor Review* 113 (10): 16–24.

Soete, L. and B. ter Wel (2001), Computers and Employment: The Truth About E-Skills. In European Investment Bank (ed.), 133-150.

Solow, R.M. (1957), Technological Change and the Aggregate Production Function. *Review of Economics and Statistics* 39 (3): 65–94.

Solow, R.M. (1987), We'd Better Watch Out. *New York Times Book Review* 12: 36.

Stahl, M. (2000), Die Finanzmärkte im Spannungsfeld der New Economy. *Wirtschaftsdienst* 80 (7): 415–422.

Stanback, T.M. jr. et al. (1981), Services: The New Economy. Conservation of Human Resources Series 20. Totowa, NJ: Littlefield Adams.

Standage, T. (1998), *The Victorian Internet*. New York: Walker Publishing.

Starr, P. (2000), Health Care Reform And The New Economy. Does the new digital economy require a different vision for health reform – its principles as well as its possibilities? *Health Affairs* 2000 (Nov./Dec.): 23–32.

Stasz, C. et al. (1997), *Education and the New Economy*. A Policy Planning Exercise. National Center for Research in Vocational Education, Berkely, CA.

Statistisches Bundesamt (ed.) (1999), Neuberechnung des Verbraucherpreisindex für Telekommunikationsdienstleistungen auf Basis 1995. (Bearb.: I. Beuerlein.) *Wirtschaft und Statistik* 1999 (4): 329–336.

Statistisches Bundesamt (ed.) (2001a), Konten und Standardtabellen 2000 – Hauptbericht. Fachserie 18: Volkswirtschaftliche Gesamtrechnungen, Reihe 1.3. Stuttgart: Metzler-Poeschel.

Statistisches Bundesamt (ed.) (2001b), Neuer Preisindex für die Internet-Nutzung. (Bearb.: I. Beuerlein.) *Wirtschaft und Statistik* 2001 (3): 176–180.

Statistisches Bundesamt (ed.) (2002), *Volkswirtschaftliche Gesamtrechnungen* – Jahresergebnisse der Inlandsproduktsberechnung. Internet: www.destatis.de, visited January 15, 2001.

Staudt, E. (2001), Wirtschaften und regieren im digitalen Zeitalter. *Frankfurter Allgemeine Zeitung* 2001 (12. Sept.): 11.

Steindel, C. and K.J. Stiroh (2001), Productivity: What Is It and Why Do We Care About It? FRBNY-Staff Report 122. Federal Reserve Bank of New York.

Stevens, C. (1996). The Knowledge-Driven Economy. *OECD Observer* 200 (June/July): 6–10.

Stierle, M.H. (2000), New Economy – Wunschtraum oder Realität? *Wirtschaftsdienst* 80 (9): 549–557.

Stierle, M.H. (2001), Neue Ökonomie: Charakteristika, Existenz und Herausforderungen für die Wirtschaftspolitik. *Aus Politik und Zeitgeschichte* B9/2001: 15–22.

Stiglitz, J.E. (2000), The Contributions of the Economics of Information to Twentieth Century Economics. *Quarterly Journal of Economics* 115 (4): 1441–1478.

Stiroh, K.J. (1999), Is There a New Economy? *Challenge* 42 (4): 82–101.

Stiroh, K.J. (2001a), ICT Productivity Revival. *Economic Trends* 1: 67–71.

Stiroh, K.J. (2001b), Information Technology and the US Productivity Revival: What Do Industry Data Say? FRBNY Staff Report 115. Federal Reserve Bank of New York.

Stiroh, K.J. (2001c), Investing in Information Technology: Policy Payoffs for U.S. Industries. *Current Issues* 7 (6): 1–6.

Stiroh, K.J. (2001d), *New and Old Economics in the "New Economy"*. Economic Policy Issues of the New Economy. Berlin u.a.: Springer.

Stiroh, K.J. (2001e), What Drives Productivity Growth? *Federal Reserve Bank of New York Economic Policy Review* 2001 (3): 37–59.

SVR – Sachverständigenrat zur Begutachtung der Gesamtwirtschaftlichen Entwicklung (2000), *Chancen auf einen höheren Wachstumspfad*. Jahresgutachten 2000/2001. Stuttgart: Metzler-Poeschel.

SVR – Sachverständigenrat zur Begutachtung der Gesamtwirtschaftlichen Entwicklung (2001), *Für Stetigkeit – gegen Aktionismus*. Jahresgutachten 2001/2002. Stuttgart: Metzler-Poeschel.

Szensenstein, J. (1999), Qualitätsänderungen im Preisindex für die Lebenshaltung. In: Deutsche Bundesbank (Hrsg.) (1999), Zur Diskussion über den VerbraucherPreisindex als Inflationsindikator. Beiträge zu einem Workshop in der Deutschen Bundesbank. Diskussionspapier 3/99. Frankfurt a.M., Deutsche Bundesbank.

Szyperski, N. (2000), Was ist wirklich neu an der New Economy? *Zeitschrift für Wirtschaftspolitik* 49 (2000): 296–302.

Taylor, T. (2001), Thinking about a "New Economy". *Public Interest* 143: 3–19.

Theuringer, T. (2000), Ist die "New Economy" mehr als ein Schlagwort? *Orientierungen zur Wirtschafts- und Gesellschaftspolitik* 86 (4): 29–33.

Theuringer, T. (2000/01), *Die "Neue Ökonomie" in Deutschland*. Rissener Jahrbuch 2000/01. Hamburg: Haus Rissen, 178–186.

Triplett, J.E. (1989), Price and Technology Change in a Capital Good: A Survey of Research on Computers with Comment of R.J. Gordon. In D.W. Jorgenson and R. Landau (eds.), 127–224.

Triplett, J.E. (1996), Depreciation in Production Analysis and in Income and Wealth Accounts: Resolution of an Old Debate. *Economic Inquiry* 34 (1): 91–115.

Triplett, J.E. (1997), Measuring Consumption: The Post-1973 Slowdown and the Research Issues. *Federal Reserve Bank of St. Louis Review* 1997 (May/June): 9–42.

Triplett, J.E. (1999a), Economic Statistics, the New Economy, and the Productivity Slowdown. *Business Economics* 34 (2): 13–17.

Triplett, J.E. (1999b), *The Solow Productivity Paradox*: What do Computers do to Productivity? Washington, DC: Brookings Institution.

Triplett, J.E. (2001), Should the Cost-of-Living Index Provide the Conceptual Framework for a Consumer Price Index? *Economic Journal* 111 (472): F311-F334.

Triplett, J.E. and B.P. Bosworth (2000), Productivity in the Service Sector. Brookings Discussion Papers in International Economics. Washington, DC: Brookings Institution.

Tyers, R. and Y. Yang (2001), Global Effects of US "New Economy" Shocks: The Role of Capital-Skill Complementarity. Working Papers in Economics 387. Australian National University, Canberra.

Tyson, L. (1999), Old Economic Logic in the New Economy. *California Management Review* 41 (4): 8–16.

U.S. Census Bureau (ed.) (1999), *Statistical Abstract of the United States* (119th edition). Washington, DC: Government Printing Office.

U.S. Census Bureau (ed.) (2000), *Statistical Abstract of the United States* – The National Data Book. Washington, DC: Government Printing Office.

U.S. Census Bureau (ed.) (2000a), *Statistical Abstract of the United States* (120th edition). Washington, DC: Government Printing Office.

U.S. Census Bureau (ed.) (2000b), *Digital Economy 2000*. Washington, DC: Government Printing Office.

U.S. Census Bureau (ed.) (2001), *Measuring Electronic Business*. Internet: www.census.gov/eos/www/ebusiness614.htm, visited November 15, 2001.

Urchs, O. (2000), Von der Kommunikation zur eCommunication: Neue Trends im Online-Marketing. In Gesellschaft für Konsumforschung (ed.), 59–73.

Vanhoudt, P. and L. Onorante (2001), Measuring Economic Growth and the New Economy. In European Investment Bank (ed.), 63–84.

Vatter, H.G. and J.F. Walker (2001), Did the 1990s Inaugurate a New Economy? *Challenge* 44 (1): 90–116.

Visco, I. (2000), The New Economy – Fact or Fiction? *OECD-Observer* 221/222: 6–10.

Vogelsang, I. (1992), Zur Privatisierung von Telefongesellschaften. Diskussionsbeiträge zur Telekommunikationsforschung 101. WIK – Wissenschaftliches Institut für Kommunikationsdienste. Bad Honnef.

Vosselman, W. (1998), *Initial Guidelines for the Collection and Comparison of Data on Intangible Investment*. OECD, Paris.

Wadhwani, S. (2000), *Monetary Challenges in a New Economy*. Speech to be delivered to the HSBC Global Investment Seminar. Bank of England, London.

Waldstein, I. (2000), Standortpolitik in der New Economy. *Conturen* 2000 (3): 51–59.

Wassermann, S. (2001), E-Commerce und Beschäftigung: Ergebnisse eines Expertenworkshops. *TA-Informationen* 2001 (4): 36–38.

Welfens, P.J.J. (2000), Globaler Internetwettbewerb. Über Europas Rückstand in der New Economy. *Wirtschaftswoche* 2000 (37): 38–41. Internet: www.genios.de/cgi-bin/webesearch, visited February 15, 2001.

Welsch, J. (1998), Der Telekommunikationssektor – "Beschäftigungslokomotive" der Informationsgesellschaft? Beschäftigungseffekte von Multimedia in einer Schlüsselbranche der Zukunft. *WSI-Mitteilungen* 51 (1): 61–71.

Welsch, J. (2001), *Wachstums- und Beschäftigungsmotor IT-Branche*. Fachkräftemangel, Green Card und Beschäftigungspotenziale. Friedrich-Ebert-Stiftung, Bonn.

Whelan, K. (2000a), *A Guide to the Use of Chain Aggregated NIPA Data*. Finance and Economics Discussion Series Papers 2000-6. Federal Reserve Board, Washington, DC. Internet: www.federalreserve.gov/ pubs/ feds/ 2000/index.html, visited June 12, 2001.

Whelan, K. (2000b), *Computers, Obsolescence, and Productivity*. Internet: www.federalreserve.gov./pubs/feds(200/index.html, visited November 1, 2000.

Wilcox, J.A. (1998), Is there a New Economy? *California Management Review* 41 (1): 74–85.

Wirtschaftspolitisches Forum (2000), Was ist wirklich neu an der "New Economy"?. Mit Beiträgen von M. Hüther, N. Szyperski und A. Freytag. *Zeitschrift für Wirtschaftspolitik* 49 (3): 285–312.

Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft und Technologie (ed.) (2001), Wettbewerbspolitik für den Cyberspace. BMWi-Dokumentation 495. Bonn.

Wissenschaftsstatistik im Stifterverband für die deutsche Wissenschaft (1999) (ed.), *Abschlussbericht zum Projekt: Erfassung und Messung von Forschungs- und Entwicklungsaktivitäten im Dienstleistungssektor.* Gutachten im Auftrag des BMBF. (Bearb.: C. Revermann und E.M. Schmidt.) Essen.

WITSA – World Information Technology and Services Alliance (ed.) (2000), *Digital Planet 2000.* The Global Information Economy. Wien.

Yang, S. and E. Brynjolfsson (2001), Intangible Assets and Growth Accounting, Evidence from Computer Investments. Working Paper. Mimeo, MIT, Cambridge, MA.

Zahn, E. (2000), Innovative Strategien für die "New Economy". In E. Zahn und S. Foschiani (Hrsg.), *Erfolgsstrategien für den Wandel.* Stuttgart: Schäffer-Poeschel, 1–20.

ZEI – Zentrum für Europäische Integrationsforschung (ed.) (2000), *EMU and Economic Growth in Europ*e. Internet: www.zei.de, visited 20. April 2001.

Zerdick, A., A. Picot, K. Schrape et al. (1999), *E-conomics. The Economy of E-Commerce and Internet.* Berlin et al.: Springer.

Ziesemer, B. (2000), Japan schafft die Grundlagen für die nächste Internetgeneration. *Handelsblatt* 2000 (17. Jan.): 2.

Zschäpitz, H. and H. Kruse (2001), Börsianer entdecken die "Next Economy". *Welt* 2001 (24. April): 19.

Zysman, J. and S. Weber (2001), Governance and Politics of the Internet Economy – Historical Transformation of Ordinary Politics With A New Vocabulary? In N.J. Smelser (ed.) (2001), *International Encyclopedia of the Social & Behavioral Sciences.* Amsterdam: Elsevier.