German Institute
for Economic Research
(DIW Berlin)
Koenigin-Luise-Str. 5
14195 Deutschland
customerservice@diw.de

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A Multi-Country Comparison of the Efficiency of the German Telecommunications Industry

Georg Erber

In an international comparison of the efficiency of the telecommunications (TC) industry for the period 1981 to 2002 Germany is in a middle position; France and Great Britain are better, while the Netherlands and the United States are in a less favourable position. However, supply-side efficiency is subject to strong fluctuations over time. Germany's TC industry suffered a temporary slump in efficiency compared with the other countries during deregulation, and this could only be made up again gradually from 2000.[1] For a time Germany was actually bottom of the list, but in 2001 it had moved up again to fourth place. The fluctuation can be interpreted in this way: Germany undertook the structural reforms needed to increase efficiency in the TC industry later than other countries, and the first signs of success only appeared after 1999, the year of the low.

In this analysis the stochastic possible production frontiers (SPFs) method is used for the first time in a multi-country comparison of the TC industry. The advantage of this method over others is that it is based on a well-founded theoretical concept of production.[2]

The importance of the TC sector in the economy as a whole

International comparisons in which countries are ranked according to their relative performance have always aroused public interest. They provide important indications of the strengths or weaknesses of individual countries, and those that are shown to be in a worse position than others can profit especially, as they can learn from the best practices of the countries higher up the list.[3]

The TC industry is a sector distinguished worldwide by growth far above the average compared with the economy as a whole. At the same time

[1] The advantages of deregulation for the demand side are not considered in this analysis.

[2] This avoids a weighting of the individual indicators to form an overall indicator using subjective criteria in expert opinions, which is the method often used in other studies. Moreover, mathematical statistical methods corresponding to the general methodological standards in econometrics are used to estimate the ranking parameters.

the deregulation and reregulation of TC markets is causing continuous institutional change in the framework conditions for the industry.[4]

Efficient TC services are an important input for the rest of the economy, and they are becoming increasingly important in the global competition for inward investment, influencing decisions on investment locations and consequently on gains in employment. Hence an efficiency analysis of the TC industry is of macroeconomic importance beside its significance for this sector individually.

Benchmarking in the TC Sector

Benchmarking[5] has become a standard procedure for comparing countries, regions, sectors or individual companies or institutions on every level of economic activity. However, there are big differences in the selection of the criteria, the measurement and formation of indicators, and in drawing up the ranking lists. In the information and telecommunications sector ranking lists of 'networked readiness' have been drawn up since 2001. The Networked Readiness Index (NRI)[6] is published regularly by the World Economic Forum together with INSEAD and the World Bank. Germany was most recently No. 14 of 104 countries covered by the study. The countries are ranked in a cross-sectional analysis using annual data.

The present study, by contrast, is based on an unbalanced multi-country panel data set.[7] Stochastic production possibility frontiers (SPFs, see box 1) have for some time proved to be a flexible instrument for benchmarking, and they have already been used in studies by the World Economic Forum, the World Bank[8] and the FAO[9] for ranking in a wide variety of sectors as well as to measure inefficiency.

The data base of the multi-country panel

This analysis of the TC industry compares only a clearly fewer number of countries than the number in the NRI, as the data currently available for an SPF analysis did not permit the inclusion of a larger number. However, the method can be applied to a large number of countries and any periods required; it can also be used for pure cross-sectional analyses. The data base used here was the time series of the Groning Growth and Development Centres (GGDC) for the period 1980 to 2002.[10]

On principle efficiency is an expression of the relation of output to input, so that data on both is needed for an efficiency analysis. This data set contains gross value at 1995 prices as the output indicator, while the input factors are real gross fixed assets at 1995 prices, separated into information, communication and telecommunications (ICT) capital and Non-ICT capital, the volume of labour measured by hours worked and an indicator to measure the changes in the quality of the labour force due to the composition of the human capital. This enabled data on four primary input factors to be used to estimate an SPF on the basis of gross value creation. The ICT capital stocks were deflated with a uniform hedonic price index for ICT equipment goods.[11]

The GGDC data set contains data on the United States and four EU member states, Germany, France, Great Britain and the Netherlands. For the four EU countries (here EU-4) the corresponding multi-country aggregates of value creation and input factors have been taken into account as further elements in the estimate. So at least for this group of EU member states an overall comparison with the United States is possible.[12]

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[3] The Pisa studies for the years 2000 and 2003 on the performance of national education systems are a particularly striking example of how benchmarking can stimulate policy making, first to consideration and then to action.

[4] Cf. e.g. M.E. Cave, S.K. Majumdar and I. Vogelsang (eds.): 'Handbook of Telecommunications Economics, Vol. 1, Structure, Regulation and Competition', Amsterdam 2002.

[5] Cf. TNS Infratest: 'Monitoring Informationswirtschaft, 8. Faktenbericht', Munich, April 2005.

[6] Cf. 'The Global Information Technology Report 2004-2005', Oxford 2005. The NRI could be interpreted as an attempt to convert Abramowitz's 'social capability' into an operational measurement concept for the use of ICT. Cf. M. Abramowitz: 'Catching-up, Forging Ahead and Falling Behind', in: *Journal of Economic History,* vol. 46, 1986, pp. 385-406.

[7] A panel is 'unbalanced' when the same number of observations is not available for all the units observed.

[8] Cf. R. Jayasuriya and Q. Wodon: 'Efficiency in Reaching the Millennium Development Goals', *World Bank Working Paper,* no. 9, Washington D.C., 2003.

[9] FAO: Food and Agriculture Organization of the United Nations.

[10] Cf. *www.ggdc.net/*.

[11] This reveals some methodological differences from the data on these variables published so far by the statistical offices of these countries. However, the methodological changes traced in the GGDC, especially on hedonic price adjustment, are currently the model for the revision of the official national accounts based on the European System of National Accounts (ESNA); cf. *www.destatis.de/download/d/stat_ges/haussh/040.pdf*. In Germany this revision has already been made. Cf. A. Braekmann, N. Hartmann, N. Räth and W. Strohm: 'Revision der Volkswirtschaftlichen Gesamtrechnungen 2005 für den Zeitraum 1991 bis 2004'; in: *Wirtschaft und Statistik,* no. 5, 2005, pp. 425-462.

[12] However, data on 2002 is not available for France and Great Britain, so the multi-country data panel contains correspondingly fewer observations for these countries and for the EU-4.

Box 1

Measuring inefficiency with deterministic or stochastic production possibility frontiers

The basic principle in an econometric estimate of SPFs starts from the production possibilities set common in neo-classical economic theory as the possible range of solutions to choose a production process. So production possibilities consist of a bundle of results that can be produced with factors like capital, K, and labour, L.

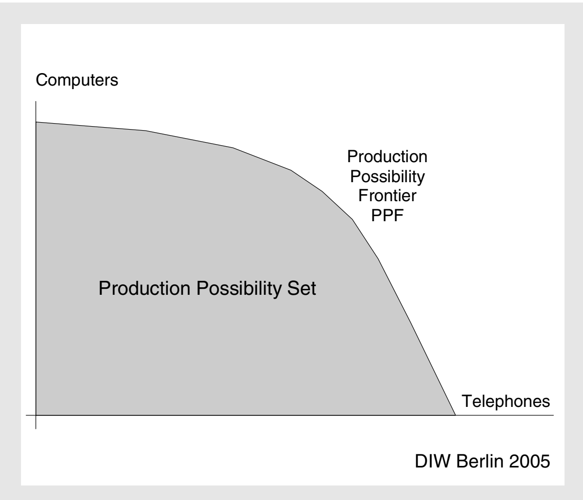
In contrast to the neo-classical production function long in use in empirical economic research, the concept of production possibility sets also includes the inefficient use of factors in achieving an output. While in the model of a production function it is always assumed that all the factors are always used efficiently, this restrictive assumption is dropped when a possible production set is used as a base. Hence the neo-classical production function only provides a location for an output that is potentially efficient but is not necessarily achieved owing to the inefficient use of factors. The gap between the output that is achieved and what could be achieved with an efficient use of factors thus provides a standard to measure the economic inefficiency of a specific production process (cf. figure 1).

In the literature two different concepts are discussed for measuring a production possibility frontier and the relative inefficiency curve (cf. figure 2):

– With deterministic production possibility frontiers it is assumed that there will always be a production unit like a country or a company producing in best practice on the efficient production possibility frontier. Inefficiency is therefore always measured relative to this unit.
– With a stochastic production possibility frontier on the other hand it is assumed that even a best practice production unit does not necessarily succeed in achieving the optimal use of factors. On principle it always has the potential to improve further. Exogenous shocks play a central part in the development of inefficient factor allocation.[1]

Figure 1

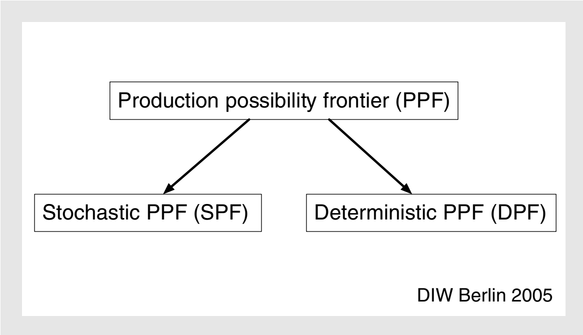
Example of a Production Possibility Set and Frontier[1]



1 The area below and on the curve is the quantity of the bundle of goods that can be produced by using the total available capital assets (K) and the available volume of labour (L). The further a point lies away from the origin the higher is the output achieved – here computers and telephones. All the points on the edge of the quantity are the maximum achievable output volumes.
All the points inside the boundary are inefficient productions, that do not fully exploit the available K and L. All the points outside are impossible production volumes, as an insufficient amount of inputs are available for them.
Cf. http://www.netmba.com/econ/micro/production/possibility/ or http://en.wikipedia.org/wiki/Production_possibility_frontier.
Source: DIW Berlin.

Figure 2

Types of Production Possibility Frontiers



Source: DIW Berlin.

So beside these fundamental differences between the two concepts what are their advantages and disadvantages that would enable a decision to be taken for one or the other?

The deterministic production possibility frontier does offer a simpler econometric procedure for estimating than the stochastic, but it has a serious disadvantage conceptually if the robustness of the estimate of inefficiency is taken as the criterion. In estimating the deterministic PPF the model parameters are estimated using the usual Ordinary Least Square Method (OLS), and then shifting the frontier upward so that it runs up through the value with the biggest random deviation. This parallel shift ensures that at least one observation unit lies on the DPF. However, in practice it quickly becomes apparent that the measurement of the inefficiency of the other observation units derived from the method is volatile, as this extreme value can be subject to strong fluctuations from case to case.[2]

Hence for some time now the stochastic model approach has been preferred to the deterministic one. Particularly since the problems of the econometric estimation of the model parameters have been solved, and as appropriate software packages are now available, this model approach can be used in empirical research, without great additional efforts by applied researchers, just like the deterministic production possibility frontier.

[1] Critics of this approach see a weakness in that unlike non-parametric methods, e.g. data envelopment analysis (DEA), it needs an explicit assumption regarding the parametric probability distribution function.

[2] If in random sample surveys, e.g. of individual companies, the best practice company is not included in the random samples this can greatly distort the inefficiency measurement downwards.

Box 2

J Curve adoption of innovations that increases efficiency and phase delays in adoption

Innovations in the telecommunications sector – technological innovations like the Internet, or institutional innovations like the deregulation of the TC markets – and the growing innovation competition they create – were carried out in different form from country to country and at different times during the 1990s. In the literature on innovation processes in the economy it has been pointed out[1] that the introduction of such innovations frequently gives rise to temporary or transitory efficiency losses. The reorganization that is initially necessary is a major cause of these. Efficiency gains are thus only evident after some time. These considerations on the development in efficiency after the introduction of an innovation that will ultimately increase efficiency lead to a development that in this study is called a J curve (cf. figure 3).[2]

If this consideration of the development in efficiency on adoption of an innovation is taken together with the asynchronous start of the adoption in different countries the result is shifts in the phase of adoption of an innovation. Figure 3 shows this using two countries as examples (A and B).

A particular feature of the dynamics of the adoption process is evident if these are compared, not relative to the efficiency level of the production possibility frontier but in the form of bilateral relative inefficiency ratios.

First, while the efficiency level of Country B remains unchanged, Country A shows a fully equivalent course in both its relative and absolute efficiency developments. But if Country B also starts adopting the innovation, after n periods (the corresponding delays) the results of the two measures diverge clearly. In particular it becomes clear that Country A shows a particularly strongly marked transitory rise in its relative efficiency compared with Country B, of around 2.7 times that of Country B (figure 3, below), although in relation to the absolute efficiency level only a rise of altogether around 44 percentage points (figure 3, above) is achieved.

[1] Cf. e.g. F.A. David, loc. cit. (footnote 19 to the text).

[2] In other contexts, like the development in the trade balance when exchange rates are changed, the transitory effect of a temporary deterioration in the trade balance with devaluation of the national currency against others has been discussed in detail and shown in empirical research.

This effect in overstating the actual dynamic of the increase in a country's efficiency if only bilateral comparisons are made should warn us to be careful in interpreting such results. Without an absolute reference system, which is also needed for multilateral comparisons like multi-country ranking, misinterpretations can easily be made if only the relative level or its changes as used as indicators. The relative dynamic in adopting the innovation then appears to be very much more dramatic than would be the case in a more suitable observation, taking the phase shifts into account and using an appropriate reference system like the PPF.

Productivity miracles like that proclaimed for the New Economy in the United States during the 1990s could thus later prove to be straws in the wind, when other countries go through the 'vale of tears', that is, the phase of the transitory slump in their efficiency.[3] At present, however, the available data is not sufficient to venture upon a definite judgement on this.[4] But doubts have increasingly been expressed recently that the productivity miracle that has lasted since the mid-1990s in the United States will not prove permanent.[5]

[3] Cf. Georg Erber and Ulrich Fritsche: 'Productivity Growth in the United States and Germany: Is Germany falling further behind?' In: Weekly Report, DIW Berlin, no. 20/2005.

[4] The growth rate in total factor productivity (TFP) on the basis of a neo-classical production function, the growth rate in technical progress and the rate of change in inefficiency in the model of the production possibility frontiers are closely related in that the first is the sum of the last two. Cf. T.T. Raa and P. Mohnen: 'Neoclassical Growth Accounting and Frontier Analysis: A Synthesis', in: Journal of Productivity Analysis, vol. 18, 2002, pp. 111-128.

[5] Cf. Bureau of Labor Statistics (BLS): 'Productivity and Costs', Washington D.C., 9 August 2005. In the latest figures on the development of productivity in the United States published by the BLS considerable revisions have been made to the growth in labour productivity, not only for the current year but also for the years 2002 to 2004. For 2002 the average annual growth rate in labour productivity in the private sector has been revised downward from 4.3% to 4.0%. For 2003 the same growth rate has been revised down from 4.4% to 3.9% and it was lowered again for 2004, from 3.9% to 3.4%. For the second quarter of 2005 the growth rate in labour productivity is only 2.1% over the same quarter of the previous year. So a rapid fall in the development in productivity that was not previously known appears to becoming evident in the United States.

SPF model specifications to measure inefficiency

Various model specifications were used to estimate the SPFs (table 1). A logarithmic linear Cobb-Douglas production technology (model 1) was used, as it is the simplest model. In the next step Harrod-neutral technical progress was included in the model equation (model 3). This was supplemented with estimates of the translog function as the more flexible production function (models 2 and 4).[13]

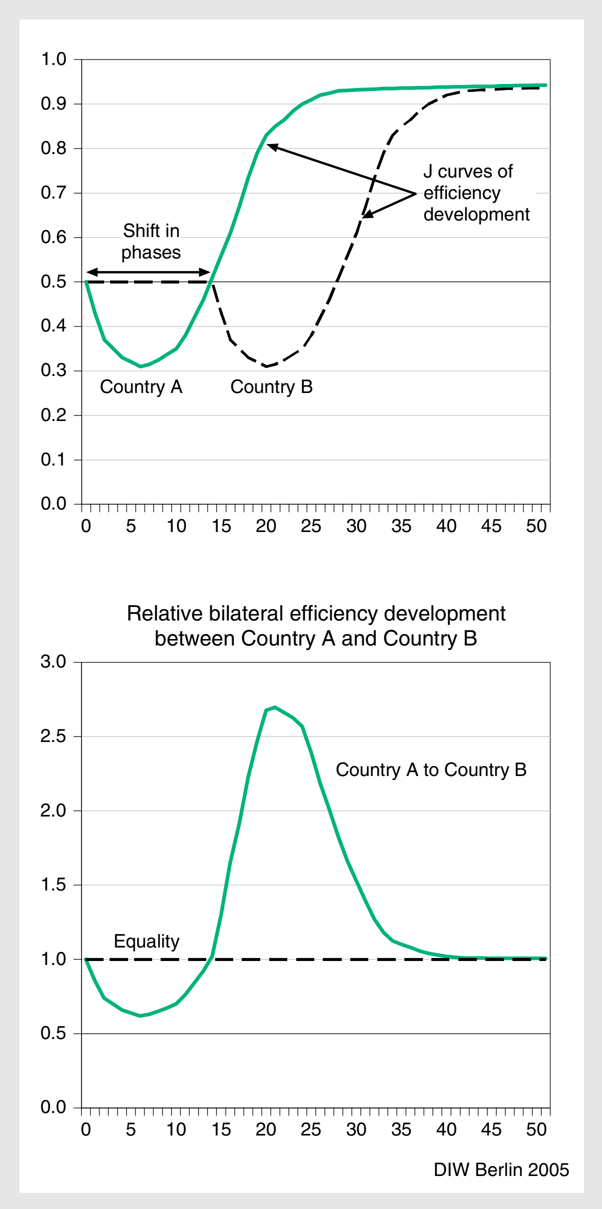
For the estimates a simultaneous maximum likelihood estimate of all the model parameters, including the variances and other parameters of the two distribution functions, was carried out. A software package especially developed for this purpose, Frontiers 4.1, was used.[14]

The results of model 3 are used here, as owing to the large number of parameters in model 4, namely 21 (plus

[13] Cf. L.R. Christensen, D.W. Jorgenson and L.J. Lau: 'Transcendental Logarithmic Production Frontiers', in: *The Review of Economics and Statistics,* vol. IV, no. 1, 1973, pp. 28-45.

[14] Cf. T. Coelli: 'A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation', Centre for Efficiency and Productivity Analysis, University of New England, Armidale, Australia 1996.

Figure 3
J Curve Adoption in Efficiency with Phase Delays



Source: DIW Berlin calculations.

2 to 4)[15] and the altogether relatively low number of observations (N=129), the estimates for this model were unsatisfactory. Model 4 was inclined to over-fitting to

[15] The number of parameters for the distribution of the random variables of the truncated normal distribution varies according to the assumptions on the basic random process. If a semi-normal distribution is assumed the parameter area is reduced by one. Similarly, if auto-correlation of the first order is taken into account in this distribution the parameter area can be increased or reduced by one.

Table 1
Model Specifications of SPFs Studied

	Cobb-Douglas function	Translog function
Without technical progress	Model 1	Model 2
With technical progress	Model 3	Model 4

Source: DIW Berlin.

the data while at the same time the number of statistically insignificant model parameters increased. The decision not to include technical progress in the production function in models 1 and 2 also proved an unacceptable simplification of the model.[16]

The Results

The results of the estimates of the average inefficiency parameters are shown and compared in figure 4. Of the five countries considered France (0.988) has achieved the greatest average technical efficiency in the use of its production factors, ahead of Great Britain (0.861), Germany (0.849), the Netherlands (0.745) and the United States (0.735). So the range of inefficiency from the country with the best practice to the country with the worst is around 16 percentage points. That fits the general estimate that Europe has enjoyed a comparative advantage in the telecommunications industry in recent decades.[17]

With the help of a modified model approach by Battese and Coelli the variation in inefficiency over time can be determined.[18] The time flows of the development in inefficiency of the five countries and of the multi-country aggregate EU-4 estimated using model 3 are shown in figure 5 and table 2.

It is evident that the United States particularly, and the Netherlands, initially registered a steady rise in the inefficiency of their telecommunications industries. In

[16] Detailed results for these model estimates and the other model parameters for the other three models are given in a different publication. Cf. G. Erber: 'Benchmarking ICT-Efficiency Usage in the Telecommunications Industry in the US and Major European Countries, A Stochastic Possibility Frontiers Approach', Berlin, August 2005 (in preparation).

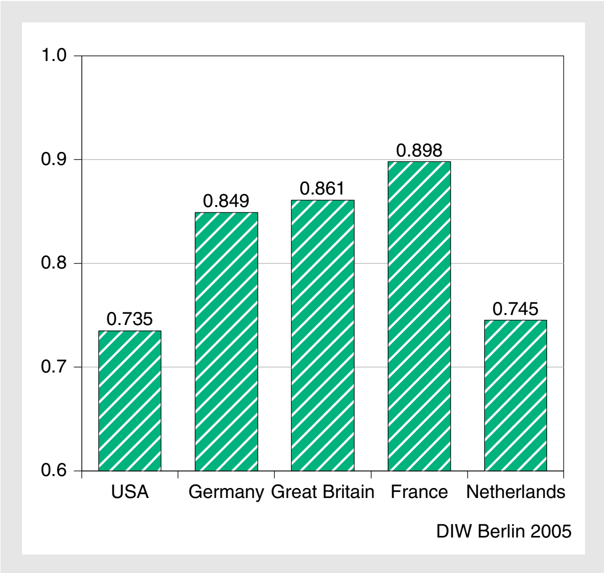
[17] Cf. EU: 'European Electronic Communications Regulation and Markets 2004', Communication from the Commission, SEC (2004) 1535, Brussels, 2 December 2004.

[18] Cf. C.E. Battese and T.J. Coelli: 'A Model for Technical Inefficiency Effects in a Stochastic Frontiers Production Function for Panel Data', in: *Empirical Economics,* vol. 20, 1995, pp. 325-332.

Figure 4

Average Inefficiency[1] in the Telecommunications Industry in the United States and Selected EU Countries

Technological efficiency effects[2] 1981 to 2002



1 If the value is one there is perfect efficiency. Values below one show the relative gap to the SPF. On the basis of an estimate of the Cobb-Douglas production function with Harrod-neutral technical progress. — 2 Cf. G.B. Battese and T.J. Coelli (see footnote 18 to the text) and G. Erber (see footnote 16 to the text).
Sources: Groning Growth and Development Centres; DIW Berlin calculations.

the United States the efficiency level fell from 0.910 in 1981 to 0.682 in 1993. Then came a clear increase again to 0.874 by 2001. In 2002 when the New Economy bubble burst there was another rise in inefficiency. In both cases two factors may have been the chief cause. Firstly, fiercer competition led to a fall in measured value creation as prices were lowered, and secondly excess capacities developed in the TC network infrastructure.

While the United States fell to its low in inefficiency in 1993 the rise in inefficiency in the Netherlands continued until 1996 (0.669). Only after that date did a rapid and clear recovery set in, taking efficiency up to the level typical of the other European countries.

Great Britain has passed through two inefficiency cycles in the last two decades. After a low in 1986 at 0.832 1991 brought recovery to 0.908. After that the efficiency level dropped again, to a new low at 0.790 in 1994. Great Britain recovered quickly in the following years, and in 2001 it was in second place among all the countries considered with 0.960.

Germany and France show a clearly parallel development. In the 15 years from 1981 to 1995 the two countries first shared top place. Then a moderate downward movement started in France in 1993, which lasted until 1997, while Germany only reached its low in 1999. After that date the efficiency level in both countries recovered. In 2001 the European countries were close together on a high efficiency level, while the United States was able to reduce the gap to the European countries as a whole, but was still clearly around 9 percentage points behind. The gap has probably grown again slightly since the New Economy bubble burst.

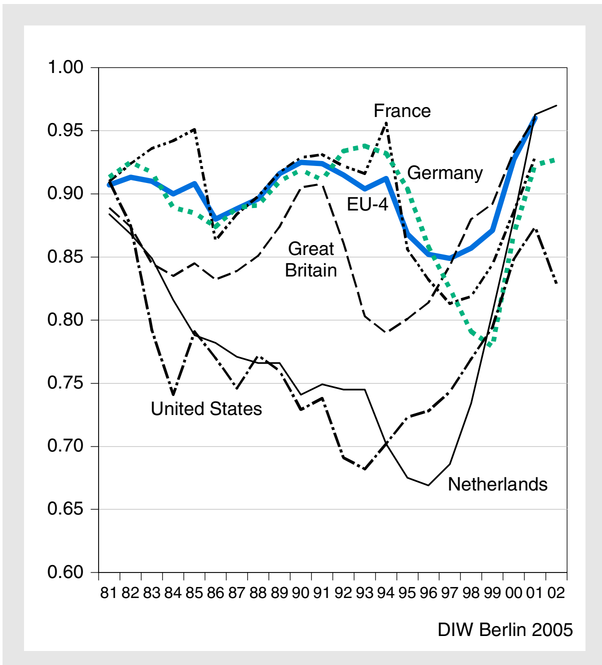
If 2001 is taken as the reference year the Netherlands is ahead of Great Britain, France and Germany. The United States again brings up the rear. However, the development in the increase and decrease in inefficiency in the telecommunications industry in the individual countries was clearly asynchronous. The different times at which new TC technologies and the Internet were introduced may be the main reason here, as may increases in efficiency due to innovative changes in the regulatory framework for the TC markets. Moreover, markets take time to adjust to the new framework conditions, and their adjustment proceeds at differing speeds.[19]

However, if only the relative inefficiency gaps are considered a different picture emerges (see box 2, table 3

Figure 5

Inefficiency[1] Development in the Telecommunications Industry in the United States and Selected EU Countries

Technological efficiency effects[2] 1981 to 2002



1 If the value is one there is perfect efficiency. Values below one show the relative gap to the SPF. On the basis of an estimate of the Cobb-Douglas production function with Harrod-neutral technical progress. — 2 Cf. G.B. Battese and T.J. Coelli (see footnote 18 to the text) and G. Erber (see footnote 16 to the text).
Sources: Groning Growth and Development Centres; DIW Berlin calculations.

Table 2

Inefficiency[1] in the Telecommunications Industry in the United States and Selected EU Countries

Technological efficiency effects 1981 to 2002

	USA	Germany	Great Britain	France	Netherlands	EU-4
1981	0.910	0.913	0.889	0.910	0.884	0.907
1982	0.875	0.925	0.874	0.924	0.868	0.913
1983	0.792	0.917	0.845	0.936	0.849	0.910
1984	0.741	0.889	0.835	0.942	0.816	0.900
1985	0.791	0.885	0.845	0.951	0.788	0.908
1986	0.770	0.874	0.832	0.863	0.782	0.880
1987	0.746	0.889	0.839	0.884	0.771	0.888
1988	0.772	0.891	0.851	0.898	0.766	0.896
1989	0.760	0.910	0.874	0.917	0.766	0.916
1990	0.729	0.919	0.905	0.929	0.741	0.925
1991	0.738	0.911	0.908	0.931	0.749	0.924
1992	0.691	0.934	0.861	0.922	0.745	0.915
1993	0.682	0.938	0.803	0.916	0.745	0.904
1994	0.702	0.932	0.790	0.956	0.702	0.912
1995	0.723	0.904	0.801	0.856	0.675	0.868
1996	0.728	0.858	0.814	0.832	0.669	0.852
1997	0.743	0.825	0.843	0.813	0.686	0.849
1998	0.769	0.791	0.880	0.819	0.734	0.857
1999	0.794	0.779	0.892	0.844	0.806	0.871
2000	0.848	0.868	0.933	0.886	0.880	0.927
2001	0.874	0.923	0.960	0.929	0.963	0.960
2002	0.829	0.927	.	.	0.970	.
∅ Rank 1981 to 2002	5	3	2	1	4	
Rank 2001	5	4	2	3	1	
Minima	1984, 1993	1986, 1999	1986, 1994	1986, 1997	1996	1997
Maxima	1985, 2001	1983, 1993, 2002	1991, 2001	1985, 1994, 2001	1981, 2002	1985, 1991, 2001

1 If the value is one there is perfect efficiency. Values below one show the relative gap to the SPF. On the basis of an estimate of the Cobb-Douglas production function with Harrod-neutral technical progress.
Sources: Groning Growth and Development Centres; DIW Berlin calculations.

and figure 6). The bilateral country comparisons often undertaken in other studies do not therefore show the changes in a form suitable for the SPF as the absolute reference system. They show the time flows relative to a country, but not in relation to the system as a whole – as shown in the SPFs. So these bilateral comparisons are not enough to answer the question of what potential is available to increase efficiency. They are only suitable for a comparison of the relative competitiveness of two countries, like a snapshot of the current state.

Conclusion

The results presented here of measuring the technical inefficiency of the telecommunications industry using stochastic production possibility frontiers show that in the past two decades Germany was at first able to maintain a good position vis-à-vis the other four countries. Since the mid-1990s the United States has been able to reduce its gap to the European countries but not close it altogether.

[19] Cf. F.A. David: 'The Dynamo and Computers: A Historical Perspective in a Not-Too Distant Mirror', in: Technology and Productivity: Challenges for Economic Policy, OECD, Paris 1991, pp. 315-337; ibid: 'Understanding Digital Technology's Evolution and the Path of Measured Productivity Growth: Present and Future in the Mirror of the Past', in: E. Brynjolfsson and B. Kahin (eds.): 'Understanding the Digital Economy', Cambridge MA 2000, pp. 49-95.

Table 3
The Relative Inefficiency[1] of Germany's Telecommunications Industry compared with the United States and Selected EU Countries
Technological efficiency effects 1981 to 2002

	Compared with (the) ...				
	United States	Great Britain	France	Netherlands	EU-4
1981	100.4	102.7	100.4	103.3	103.3
1982	105.7	105.8	100.1	106.6	104.6
1983	115.7	108.4	97.9	108.0	103.7
1984	120.0	106.6	94.4	108.9	100.6
1985	111.9	104.8	93.1	112.3	100.2
1986	113.4	105.0	101.3	111.8	98.9
1987	119.1	105.9	100.5	115.3	100.6
1988	115.3	104.7	99.2	116.3	100.8
1989	119.8	104.2	99.3	118.8	103.0
1990	126.0	101.5	98.9	123.9	104.0
1991	123.4	100.3	97.8	121.6	103.1
1992	135.3	108.6	101.3	125.5	105.7
1993	137.6	116.8	102.3	125.9	106.1
1994	132.8	118.0	97.4	132.8	105.4
1995	125.1	112.9	105.7	134.0	102.3
1996	117.8	105.4	103.2	128.3	97.1
1997	111.2	98.0	101.5	120.3	93.4
1998	102.8	89.9	96.6	107.8	89.5
1999	98.2	87.3	92.3	96.7	88.2
2000	102.3	93.0	97.9	98.6	98.2
2001	105.6	96.1	99.3	95.8	104.4
2002	111.9	.	.	95.6	104.9

1 Relation between inefficiency in Germany and that of the other countries in percent based on an estimate of the Cobb-Douglas production function with Harrod-neutral technical progress.
Sources: Groning Growth and Development Centres; DIW Berlin calculations.

So the above-average growth in productivity in the US telecommunications industry since the mid-1990s could be chiefly the expression of the reduction of previous inefficiencies compared with the European countries. At the same time, as the low came early in the United States compared with some European countries, the opening of the relative productivity gap would have been particularly high, but only temporarily so, owing to the catching-up process (see table 2 and figure 5). As the adjustment started in one EU country after another after a timelag as well, the gap to the individual countries is noticeably smaller, at the latest from 1999 (see table 3 and figure 6).[20]

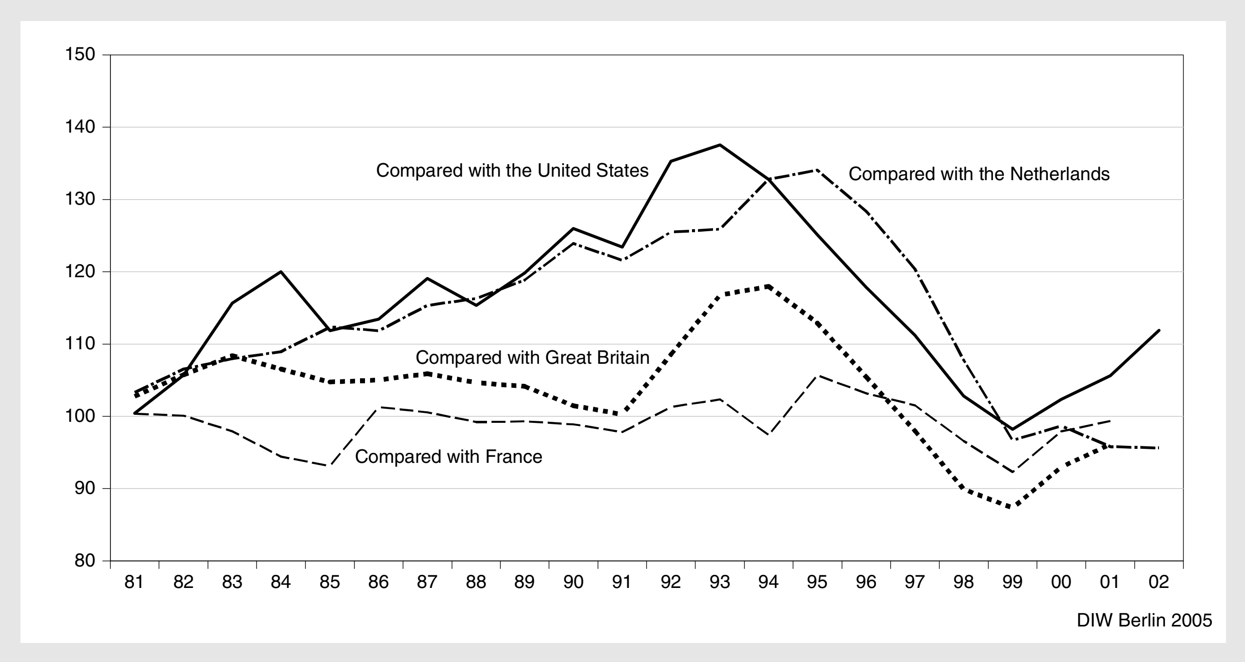
The United States, France, the Netherlands and Great Britain were able to change to increasing efficiency in their telecommunications industries much earlier than Germany. However, the Netherlands and the United States particularly had to start the catching-up process from a clearly lower level. The high tempo of the catching-up process in these two countries cannot therefore be seen as the expression of a sustained rise in long-

[20] These details are not recognizable in the studies of average productivity growth rates over several years in the individual countries in the usual growth accounting studies; this is due to the formation of these averages. However, more up to date figures on the current development would help to enable more exact statements to be made.

Figure 6

The Development in Relative Inefficiency Gaps[1] in the Telecommunications Industry in Germany Compared with the United States and Selected EU Countries

Technological efficiency effects[2] 1981 to 2002



1 If the value is 100 there is perfectly equal efficiency/inefficiency. Values below 100 show Germany's relative efficiency shortfall against the other country. Values above 100 show Germany's efficiency lead. On the basis of a Cobb-Douglas production function with Harrod-neutral technical progress. — 2 Cf. G.E. Battese and T.J. Coelli (see footnote 18 to the text) and G. Erber (see footnote 16 to the text).
Sources: Groning Growth and Development Centres; DIW Berlin calculations.

term productivity development. Germany and France were able to sustain a higher efficiency level than other countries for a long time, until the mid-1990s, and as their loss in efficiency was subsequently only slight, they have not since then had any great potential for reducing inefficiencies.

All the countries suffered a slump in efficiency in the second half of the 1990s through the introduction and use of new TC technologies like the Internet and broadband, and through extensive restructuring and deregulation of the TC markets. Only gradually could they derive benefit from this subsequently in the form of a gradual rise in efficiency. Germany was later than the other countries in undertaking the necessary structural adjustments. However, all four EU countries were relatively close together by 2001.

The creation of a single market for telecommunications by the European Commission and the governments of the member states may have made a considerable contribution to this convergence.[21] However, considerable efforts will still be needed to defend the advantage enjoyed so far over the United States, or indeed to increase this. The rapid spread of new TC technologies has so far brought the EU countries comparative competitive advantages for a few years at least, but several years may be needed to restructure the TC industry, make efficient use of the new technologies and adjust to a new regulatory environment to promote competition in innovation. In the case of Germany this initially clearly increased the relative losses in efficiency compared with other countries, as the process started here later than in these countries.

So there is also a J curve in the adoption of new TC technologies in regard to the development in efficiency. In the short term supply-side efficiency falls, and it only gradually readjusts to the new technological level. However, asynchronous adjustment processes between the more advanced and less advanced countries tend relatively to overstate the dynamic in the individual countries in bilateral comparisons, as failure to take the shifts in phases between the countries into account causes the relative efficiency gaps to widen and then close again especially rapidly. The relative productivity leap in individual countries that are advanced in internalizing the efficiency gains does not, however, mean

[21] Cf. EU: 'European Electronic Communications Regulation and Markets 2004', loc. cit.

that they have a permanent advantage in efficiency which they can always defend.

In an overall assessment of the institutional framework conditions for the TC industry the gains in prosperity and the demand side must also be taken into account. This must be left for later studies.

With the convergence of speech and data communication through VoiP[22] and the creation of an integrated platform of mobile phones and wireless access to fixed lines like WiFi and WiMax the TC industry is again facing a wave of innovations that may be expected to produce a similar cycle of efficient use for the rest of this decade. This time Germany should not oversleep the development, as it did last time by delaying adjustment.

[22] Voice over Internet Protocol (Internet-based telephones).

Supplement: Economic Indicators
Weekly Report No. 26/2005
(data as of 16 September 2005)

Germany – Selected Seasonally Adjusted Economic Indicators[1]

		Unemployment		Vacancies		Orders in manufacturing (volume)[2]													
						Manufacturing						Intermediate goods industry		Capital goods industry		Durable consumer goods industry		Non-durable consumer goods industry (incl. semi-durable goods industry)	
						Total		Domestic		Abroad									
		in 000s				2000 = 100													
		month	quarter	month	quarter	month	quarter	month	quarter	month	quarter	month	quarter	month	quarter	month	quarter	month	quarter
2003	J	4 316		391		98.2		93.3		104.2		97.6		99.4		89.0		98.5	
	F	4 363	4 332	379	385	98.4	97.1	94.8	92.9	103.0	102.3	96.9	96.5	100.4	98.4	88.0	87.6	100.0	97.6
	M	4 388		371		94.7		90.7		99.7		95.0		95.3		85.7		94.4	
	A	4 405		365		96.9		92.7		102.1		96.2		98.5		86.8		96.6	
	M	4 399	4 397	352	358	93.1	95.8	91.7	92.4	94.8	99.9	93.6	95.3	93.2	97.0	83.8	84.6	95.6	96.7
	J	4 384		345		97.3		92.9		102.7		96.0		99.5		83.1		97.8	
	J	4 392		346		97.3		92.9		102.7		97.5		98.0		88.2		96.5	
	A	4 401	4 395	341	343	97.3	97.7	92.2	93.1	103.6	103.5	97.1	97.7	98.4	98.9	85.6	87.3	97.7	96.8
	S	4 404		338		98.7		94.2		104.2		98.6		100.2		88.1		96.0	
	O	4 406		333		99.7		94.8		105.9		100.2		100.5		89.2		98.5	
	N	4 400	4 400	330	331	100.2	100.1	95.7	94.7	105.9	106.7	100.9	100.9	101.6	100.8	87.4	88.3	95.8	97.5
	D	4 381		324		100.2		93.7		108.4		101.8		100.3		88.4		98.3	
2004	J	4 296		313		99.7		94.9		105.7		100.6		100.8		87.7		95.1	
	F	4 272	4 299	301	306	100.7	101.0	95.3	95.8	107.5	107.5	102.4	102.2	101.5	102.2	87.6	87.9	94.4	95.4
	M	4 280		286		102.6		97.3		109.2		103.5		104.2		88.3		96.6	
	A	4 316		275		103.6		97.2		111.7		104.7		105.0		87.7		98.8	
	M	4 334	4 324	279	279	106.8	104.2	98.5	97.2	117.2	113.0	106.8	105.1	109.3	105.8	90.4	88.7	99.8	98.4
	J	4 365		279		102.1		95.7		110.2		103.9		102.9		88.2		96.6	
	J	4 402		276		102.9		96.1		111.4		102.7		105.1		87.2		98.3	
	A	4 440	4 418	274	276	103.3	103.1	97.0	96.1	111.2	111.8	104.3	103.4	104.9	105.2	87.5	86.6	97.2	97.8
	S	4 456		276		103.1		95.2		113.0		103.1		105.7		85.1		97.8	
	O	4 475		280		102.8		95.6		111.8		101.9		106.1		83.8		97.0	
	N	4 494	4 491	283	282	102.1	103.6	94.6	96.2	111.6	112.8	101.7	101.5	104.4	107.8	85.5	84.5	100.2	98.6
	D	4 551		291		105.8		98.4		115.1		100.8		113.0		84.1		98.6	
2005	J	4 727		305		105.0		96.2		115.9		103.6		108.0		85.6		103.1	
	F	4 824	4 755	326	318	103.7	104.7	94.4	95.5	115.3	116.1	101.2	102.4	107.4	108.3	85.9	85.9	103.6	103.7
	M	4 876		355		105.3		95.9		117.1		102.3		109.6		86.2		104.3	
	A	4 831		382		103.5		95.5		113.5		101.1		107.1		87.7		101.8	
	M	4 842	4 843	397	387	103.3	105.1	95.0	96.6	113.8	115.8	102.1	102.7	106.2	109.0	84.4	87.1	103.0	103.3
	J	4 836		409		108.5		99.2		120.0		105.0		113.6		89.2		105.0	
	J	4 831		426		109.0		98.4		122.1		106.3		113.5		87.3		106.5	
	A	4 850		450															
	S																		
	O																		
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1 Seasonally adjusted by the Berlin Method (BV4). With this method, the addition of new data can change previous seasonal adjustment patterns even if the original, unadjusted, figures remained unchanged. Quarterly figures are calculated from seasonally adjusted monthly figures. — 2 Also adjusted for working days.
Sources: Federal Labour Office; Federal Statistical Office; DIW Berlin calculations.

Germany – Selected Seasonally Adjusted Economic Indicators[1] (continued)

		Employment in mining and manufacturing		Manufacturing output[2]										Retail trade turnover		Foreign trade (Special trade)[2]			
				Manufacturing		Capital goods industry		Durable consumer goods industry		Non-durable consumer goods industry (incl. semi-durable goods industry)		Construction industries				Exports		Imports	
		in 000s		2000 = 100										2003 = 100		Euro billion			
		month	quarter	month	quarter	month	quarter	month	quarter	month	quarter	month	quarter	month	quarter	month	quarter	month	quarter
2003	J	6 190		99.6		102.4		88.1		97.5		85.6		100.6		55.5		45.7	
	F	6 181	6 177	100.1	99.3	104.1	102.3	89.1	87.7	97.5	97.0	81.1	83.8	100.4	99.8	55.5	165.1	44.8	135.6
	M	6 172		98.0		100.4		85.8		96.1		84.8		98.5		54.0		45.1	
	A	6 161		99.8		101.7		87.6		98.9		86.8		100.3		54.3		44.5	
	M	6 152	6 157	97.7	98.5	100.2	100.2	85.6	85.6	95.8	97.6	84.9	85.7	102.0	100.3	54.1	163.3	44.1	133.3
	J	6 141		97.9		98.7		83.8		97.9		85.5		98.7		54.9		44.6	
	J	6 130		99.6		102.1		88.6		97.8		86.5		99.7		55.7		44.0	
	A	6 116	6 123	98.2	98.8	99.8	100.8	85.5	87.0	97.4	97.2	83.6	84.8	99.1	99.8	55.7	168.2	44.2	132.1
	S	6 106		98.5		100.6		86.8		96.4		84.4		100.7		56.8		43.9	
	O	6 094		100.3		102.3		88.1		97.8		84.4		101.1		55.7		44.3	
	N	6 087	6 091	101.2	101.1	104.7	104.0	88.2	88.4	97.1	97.7	83.8	84.3	98.8	100.2	56.9	171.0	45.6	135.4
	D	6 078		101.8		105.1		89.0		98.2		84.7		100.7		58.3		45.5	
2004	J	6 048		100.6		103.0		88.0		97.4		81.2		100.5		58.1		45.2	
	F	6 041	6 049	101.2	101.3	103.1	103.8	87.5	88.3	97.2	97.2	86.0	83.7	100.3	100.8	58.5	176.0	46.2	137.0
	M	6 035		102.1		105.3		89.4		97.0		83.8		101.7		59.4		45.6	
	A	6 032		102.5		105.4		88.6		97.8		80.7		100.9		61.4		47.0	
	M	6 023	6 027	105.3	103.7	109.1	107.3	92.2	90.0	99.6	98.3	82.6	81.2	97.9	100.3	62.5	183.9	48.2	142.0
	J	6 019		103.3		107.3		89.1		97.5		80.5		101.9		60.1		46.8	
	J	6 011		102.8		105.9		87.9		97.8		78.9		101.5		60.9		48.7	
	A	6 010	6 011	104.0	103.7	107.8	107.3	88.5	87.8	98.2	98.3	80.7	79.5	100.7	101.0	60.6	181.7	48.2	146.1
	S	6 007		104.2		108.1		87.1		98.8		78.8		100.7		60.3		49.1	
	O	6 001		103.5		107.9		85.8		98.0		77.7		99.4		62.6		49.4	
	N	5 992	5 996	102.4	102.5	104.4	105.3	85.4	85.5	98.7	98.1	77.4	77.5	102.5	101.2	61.9	185.0	48.9	146.5
	D	5 985		101.7		103.7		85.3		97.7		77.3		101.8		60.5		48.2	
2005	J	5 970		105.2		107.9		88.1		100.5		80.0		100.8		63.1		49.7	
	F	5 959	5 965	104.3	104.9	107.2	108.0	88.4	88.1	100.8	101.0	72.3	73.8	101.5	101.3	62.5	189.1	48.7	148.0
	M	5 949		105.2		108.9		87.7		101.6		69.1		101.6		63.5		49.7	
	A	5 941		105.3		109.8		88.8		99.7		74.9		100.9		62.0		49.8	
	M	5 936	5 938	103.4	105.2	105.8	109.1	84.0	88.2	100.2	100.1	72.6	74.3	102.3	102.1	62.6	189.1	50.9	150.8
	J	5 925		106.9		111.6		91.7		100.4		75.4		103.1		64.4		50.1	
	J			106.6		110.3		86.2		102.1		73.7		99.4		64.4		51.0	
	A																		
	S																		
	O																		
	N																		
	D																		

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