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**Article**

## Productivity Growth in the United States and Germany: Is Germany Falling Further behind?

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## Productivity Growth in the United States and Germany: Is Germany Falling Further Behind?

Georg Erber and Ulrich Fritsche

The long-term development in productivity in an economy is the main indicator in an assessment of the outlook for economic development. In theory, countries that lag behind the leading countries in productivity should gradually succeed in closing that gap.

Since the mid-1990s the Federal Republic of Germany has not been able to continue the process of catching up with the trend in productivity in the United States that was typical until then. In past decades the development in Germany compared with the United States was dominated by the process of introducing best-practice technologies, for example modern information and communications technologies, but that has evidently faltered now. That is still the conclusion to be drawn after the introduction of the new methods of calculating the national accounts, which were expected to reduce the methodological differences in the assessment of productivity between Germany and the United States. However, the gap in productivity growth between the two economies may be expected to shrink again in the medium term, partly because the structural reforms on the labour market and the investment in modern information and communications technologies made in the past should have a positive effect.

Productivity growth matters in the long run. As only the wealth created can be distributed the speed at which the efficiency of an economy is increasing will mark the limit for this distribution. So without a clear rise in efficiency the population in a country cannot expect their material prosperity to continue to rise. Owing to this fundamental interrelation determining the medium to long-term growth rate in productivity, and here especially the productivity of labour, is of crucial importance.

Since the mid-1990s the typical process of catching up with the development in productivity in the United States has been interrupted in Germany. Until now economists have always assumed that a country with a lower level of productivity will be able to catch up owing to cost advantages in the acquisition of more efficient production technologies. By introducing best-practice technologies<sup>1</sup> – into their businesses and society countries that lag behind the leading productivity countries should succeed in gradually closing that gap.

That process was characteristic of the development in Germany compared with the United States in past decades, but it has evidently faltered now. The productivity gap is growing again. At the same time other OECD and newly industrialised countries are catching up with Germany. So Germany is under pressure from two sides.

The productivity gap that has been opening since the mid-1990s is putting Germany at a disadvantage in the international competition for inward investment, as on liberalized capital markets capital flows to where it can be used most productively, that is, at the highest rate of return. With the opening of markets in the newly industrialised countries, the political change in eastern Europe since the early 1990s and the resultant growing integration in the world economy Germany now has to maintain its position as a location for production in face of more intensive competition worldwide.<sup>2</sup> High labour productivity is an essential location factor. If there are insufficient incentives to invest capital in highly productive jobs in Germany unemployment will rise rapidly while wages stagnate, as the low level of investment in the domestic economy makes progress in productivity relatively modest. Hence a low level of productivity can easily lead to a low level of growth with rising unemployment.

The separation of short-term fluctuations in productivity from the medium to long-term trend in Germany compared with the United States has already been analyzed in an earlier study.<sup>3</sup> However, at that time it was not possible to use the revised data of the national accounts for Germany as these were only published by the Federal Statistical Office in April this year.<sup>4</sup> The introduction of chain indexes<sup>5</sup> and hedonic methods<sup>6</sup> in calculating the domestic product involved considerable methodological changes, and the implications of these

for the determination of the short and medium-term productivity trends in Germany and the United States will be examined in this paper.

## Divergent productivity trends in the United States and Germany since the mid-1990s

In past decades Germany has always shown clearly higher growth in productivity on average than the United States. Nevertheless, certain trends are reflected in both time series. Figure 1 shows the growth rates in productivity per hour for both economies. After relatively high rates in the 1960s the rise in productivity fell noticeably in both economies in the 1970s, but it accelerated again in the 1980s. However, since the mid-1990s the trends have moved further and further apart. While the rise in productivity accelerated again in the United States it flattened in Germany.

To establish whether this is due solely to cyclical phenomena or to a change in the productivity development trend a further examination of the trend growth rates was made using a semi-structural approach.<sup>7</sup> This is based on the fact that procyclical productivity growth ahead of the cycle is one of the stylized facts of economic cycle research (on the methods see box).<sup>8</sup> This fact was used to identify the trend component. For the calculation the average productivity growth was estimated, firstly as a deterministic model with structural breaks (step function) and secondly as a stochastic trend model (state space model).

The results of the deterministic model for Germany show that the average productivity growth is not constant. The Hansen test shows that there is at least one structural break in the average growth rate and in its variance, which is often also described as volatility. The results of the procedure used by Bai and Perron – with a given minimum gap of three years between the break

<sup>1</sup> Cf. B. van Ark, J. Melka, N. Mulder, M. Timmer and G. Ypma: 'ICT Investment and Growth Accounts for the European Union', 1980-2000, Report for the European Commission, Brussels 2002.

<sup>2</sup> Cf. e.g. G. Erber and A. Sayed-Ahmed: 'Offshore Outsourcing: A Global Shift in the Present IT Industry', in: *Intereconomics*, vol. 50, Issue 2, 2005, pp. 100-112.

<sup>3</sup> G. Erber and U. Fritsche: 'Estimating and Forecasting Aggregate Productivity Growth Trends in the US and Germany'. *DIW Discussion Paper*, no. 471, Berlin 2005 ([www.diw.de/deutsche/produkte/publikationen/diskussionspapiere/docs/papers/dp471.pdf](http://www.diw.de/deutsche/produkte/publikationen/diskussionspapiere/docs/papers/dp471.pdf)).

<sup>4</sup> Cf. Statistisches Bundesamt: 'Revision der Volkswirtschaftlichen Gesamtrechnungen (VGR)', 2005 ([www.destatis.de/basis/d/vgr/vgrevision1.pdf](http://www.destatis.de/basis/d/vgr/vgrevision1.pdf)).

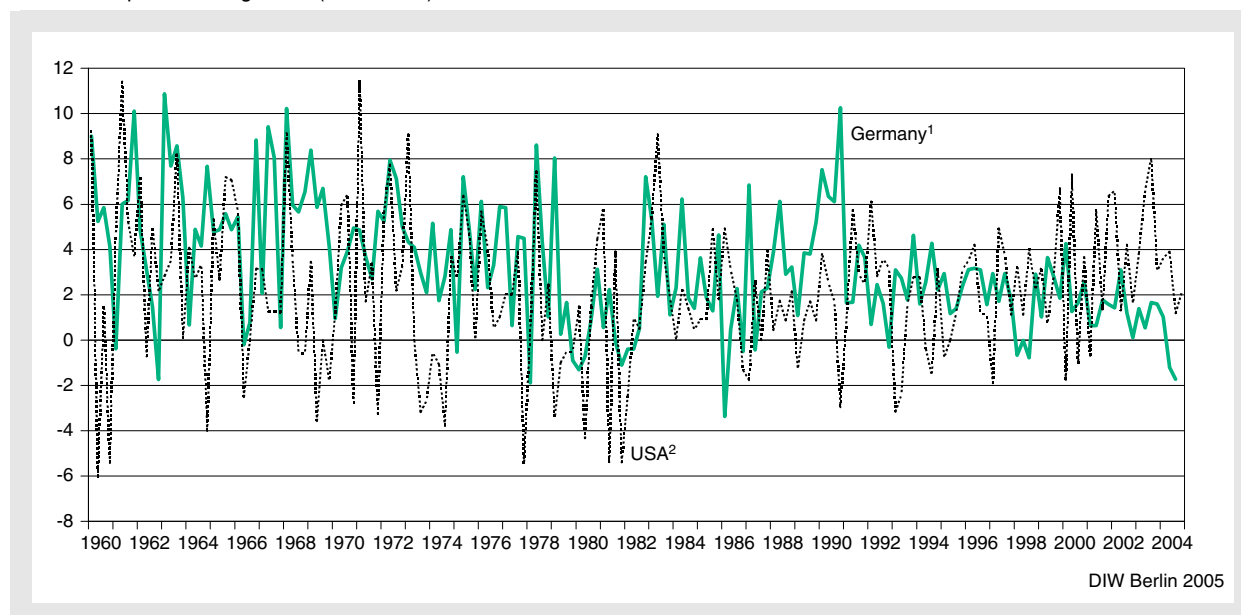
<sup>5</sup> Cf. P.M. von der Lippe: 'Chain Indices: A Study in Price Index Theory', in: Statistisches Bundesamt (ed.): *Spectrum of Federal Statistics*, vol. 16, Wiesbaden 2001.

<sup>6</sup> Cf. J. Triplett: 'Handbook on Hedonic Indexes and Quality Adjustments in Price Indexes: Special Application to Information Technology Products', in: *STI-Working Paper*, no. 9, OECD, Paris 2004.

<sup>7</sup> Cf. R.J. Gordon: 'Exploding Productivity Growth: Context, Causes and Implications', in: *Brookings Papers on Economic Activity*, vol. 34, no. 2, 2003, pp. 1-73.

<sup>8</sup> This phenomenon has been known for a long time as Verdoorn's or Kaldor's Law. Cf. J. McCombie, M. Pugho and B. Soro: 'Productivity Growth and Economic Performance. Essays on Verdoorn's Law', London 2002; J. Cornwall: 'Diffusion, Convergence and Kaldor's Law in the US and the Employment Crisis in Germany', in: H. Hagemann (ed.): 'Growth Theory and Growth Policy', London 2003, pp. 175-186. An explanation can be found in the literature on real economic cycles, cf. F.B. Kydland and E.C. Prescott: 'Time to Build and Aggregate Fluctuations', in: *Econometrics*, vol. 50, 1982, pp. 1345-1370. The theory of 'labour hoarding' combined with slow price adjustments may also explain the phenomenon, cf. J. Rotemberg and L. Summers: 'Inflexible Prices and Procyclical Productivity', in: *Quarterly Journal of Economics*, vol. 105, 1990, pp. 851-871.

Figure 1  
**Productivity Growth in Germany and the United States**  
 Quarter-on-quarter change in % (annualized)



1 Hourly productivity in the whole economy. — 2 Hourly productivity in the non-farm business sector.  
 Sources: Federal Statistical Office; Bureau of Labor Statistics; DIW Berlin calculations.

points – show that a model with altogether five breaks (4th quarter 1966, 4th quarter 1969, 2nd quarter 1979, 4th quarter 1982, 4th quarter 1996) fits best. The results are shown in figure 2, together with the state space model – here the smoothed component of the time-variable coefficient with the 95% confidence interval.

The calculations using both methods show that the average growth rate with the cyclical influences excluded has clearly decelerated and remains persistently below the 2% mark.

The results of the deterministic model for the United States show that constancy in the average productivity growth need not be rejected. The Hansen test shows that there is no permanent structural break in the average growth rate, but there is at least one in the variance. Using the procedure according to Bai and Perron – again with a given minimum gap of three years between the break points – it is clear that a model with two breaks (1st quarter of 1973 and 1st quarter of 1997) fits best.<sup>9</sup> The results are shown in figure 3, again together with the state space model.

The model results show that the productivity trend in the United States has been fluctuating within a mar-

gin of 2% to 4% a year since the mid-1990s – as it was in the 1960s, but that the variance of these fluctuations has clearly decreased. This is probably due to the frequently discussed reduction in the volatility of the real growth rates.<sup>10</sup>

Despite the uncertainties the procedures used to estimate the trends do indicate a clear decelerating of the development in productivity growth in Germany in the 1990s, while in the United States the trend appears to have settled on a relatively high level historically since the mid-1990s.

### Productivity growth in Germany after the revision of the national accounts

In the past it was argued that part of the differential between the United States and Germany in the rise in productivity could be explained by the different extent to which improvements in quality (hedonics) or other differences in calculating statistics were taken into account. After the most recently published revision of the national accounts for Germany the methodological

<sup>9</sup> On the structural break around 1997 cf. B.E. Hansen: 'The New Econometrics of Structural Change: Dating Changes in U.S. Labor Productivity', in: *Journal of Economic Perspectives*, vol. 15, no. 4, 2001, pp. 117-128.

<sup>10</sup> Cf. U. Fritsche and V. Kuzin: 'Declining Output Volatility in Germany: Impulses, Propagation, and the Role of Monetary Policy', in: *Applied Economics* (to appear shortly).

### Measuring the productivity trend growth

For this study long time series on hourly productivity were needed. Ideally the data should be for the business sector, and this is available for the United States - 'non-farm business sector' figures. For Germany hourly productivity in the economy as a whole was used – calculated by DIW Berlin. They are available back to 1960.

The model for both the structural break tests and the state space model is based on Gordon's approach.<sup>1</sup> This makes it possible that the growth rate is separated into a trend component (using either a deterministic or a stochastic model) and a cyclical component. The cyclical component is determined by regressing the growth rate of hourly productivity to future values of changes in the output gap and filtered out. In order to be able to calculate the regression up to the present the gross domestic product was forecasted using an ARIMA (4, 1, 0) process and the production gap was calculated using a Hodrick-Prescott filter ( $\lambda = 1600$ ).

The structural break tests were carried out in two stages. First the cyclical influence was filtered out and later the correspondingly adjusted increase in productivity was regressed to a constant. The Hansen test is based on the null hypothesis that there is not a single permanent structural break in the time series.<sup>2</sup> Rejection of the null hypothesis indicates at least one permanent structural break.

<sup>1</sup> Cf. R. Gordon, loc. cit.

<sup>2</sup> Cf. B.E. Hansen: 'Testing for Parameter Instability in Linear Models', in: *Journal of Policy Modelling*, vol. 14, 1992, pp. 517-533.

The Bai and Perron procedure simultaneously tests for the presence of several structural breaks and – with a given minimum distance on the gap between the breaks – calculates the best fitting break points (the least squares method).<sup>3</sup> The 'optimal' model of those that are available is chosen with the minimum information criteria (here the Schwarz information criterion).

As an alternative to the structural break tests another approach was used that implies steady and smooth fitting. A state space model with a time-variable coefficient for the trend growth rate was estimated.<sup>4</sup> The model consists of two equations, the observation equation, which is the 'observable' part of the model, and a state equation. The observation equation corresponds to Gordon's model mentioned above, in which productivity growth is divided into a trend component and a cyclical component. The trend component is modelled here through the state equation as a non-stationary stochastic process, unlike the step function that results from the structural break tests. That give a high degree of flexibility with regard to adjust the note to the data. The two equations are estimated simultaneously, together with the variance of each of the processes.

<sup>3</sup> Cf. J. Bai and P. Perron: 'Computation and Analysis of Multiple Structural Change Models', in: *Journal of Applied Econometrics*, vol. 18, no. 1, 2003, pp. 1-22.

<sup>4</sup> Cf. J.D. Hamilton: 'Time Series Analysis', Princeton 1994.

differences have clearly lessened.<sup>11</sup> But is that also having an effect on the measurement of growth rates and their variability?<sup>12</sup>

For this purpose the change in productivity from the previous year was calculated for the 'producing sector' (without construction), 'construction', 'trade, hotels and catering and transport', 'finance, leasing and corporate services providers' and for the economy as a whole; the figures were tested statistically for equality of averages and distribution. The results are shown in the table.

We see that the equality of the averages on a generally significant statistical level is accepted. The results are different for the sub aggregates. For construction and finance, leasing and corporate services providers (CSPs for short) there is no equality.

<sup>11</sup> Cf. A. Braakmann, N. Hartmann, N. R ath and W. Str ohm: 'Revision der Volkswirtschaftlichen Gesamtrechnungen 2005 f ur den Zeitraum 1991 bis 2004', in: *Wirtschaft und Statistik*, no. 5, 2005, pp. 425-462.

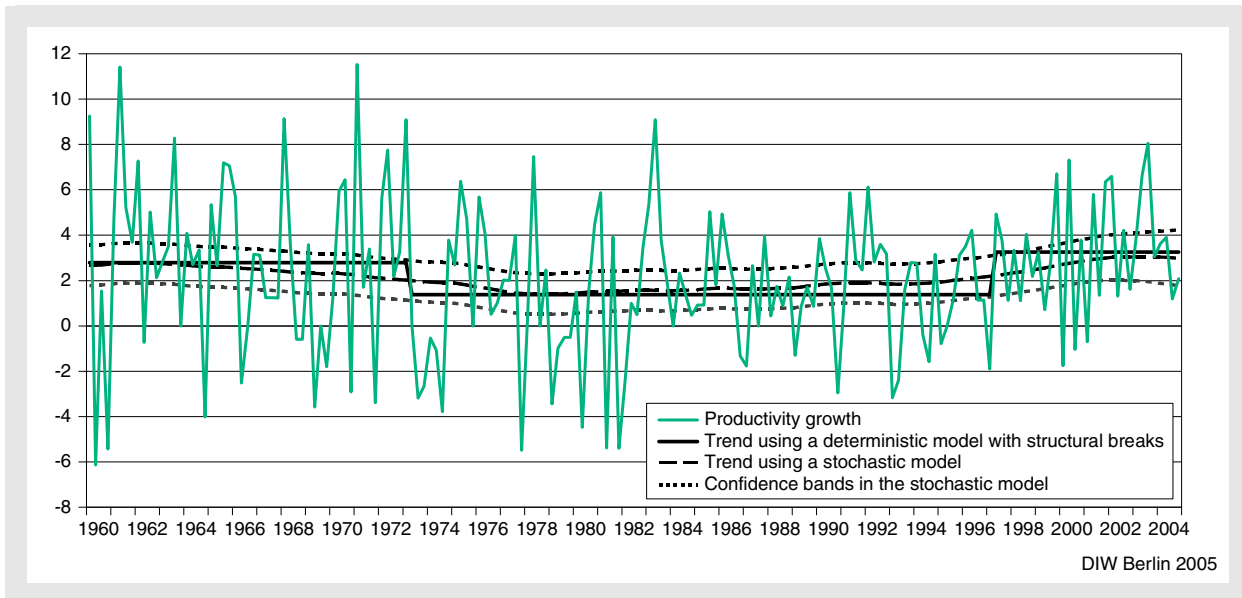
<sup>12</sup> As US data according to the 'old' method (i.e. the method used in Germany until recently) is not available the comparison can only be made for Germany.

Figure 4 shows that the estimate of the development in productivity in the 1990s appears to have been affected by the revision of the national accounts in these sectors particularly.

The clear differences in construction and CSPs are not, however, directly related to the problem of changing to the hedonic method and chain indexes. A different calculation of the value created using the FISIM method<sup>13</sup> plays a more important part here. Formerly this was roughly estimated with assumptions of a profit bonus on the incomes of employees. The current earnings situation of companies operating in Germany is now taken into account and consequently the level has risen from the previously published data, as banking services that were not previously relevant for value creation are now included in the statistics.

<sup>13</sup> FISIM, Financial Intermediation Services Indirectly Measured, is the model calculation of the indirect earnings from their lending and deposit business which the banks achieve in addition to their direct turnover, e.g. fees for handling accounts and for safe deposits. Cf. Statistisches Bundesamt: [www.destatis.de/basis/d/vgr/vgrfaq\\_16.pdf](http://www.destatis.de/basis/d/vgr/vgrfaq_16.pdf).

Figure 2  
**Productivity Growth and Trend Calculations for the USA using Different Models**  
 Quarter-on-quarter change in % (annualized)

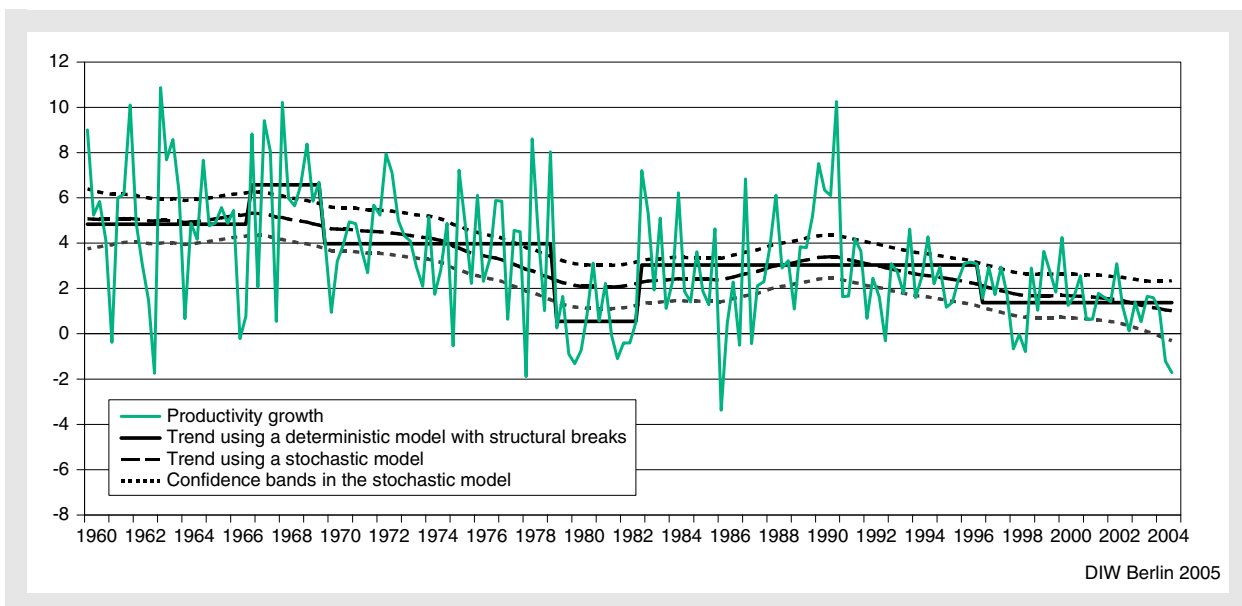


Sources: Bureau of Labor Statistics; DIW Berlin calculations.

At the same time the entire pattern of the rise in productivity over the period from the start of the 1990s to the current study has clearly changed. While the pattern for construction has essentially only been modified since

the mid-1990s by a shift in the level caused by the revision, it is evident that for CSPs the fall was much more marked than before, especially from the mid-1990s to the end of the speculative bubble in the IT sector; after

Figure 3  
**Productivity Growth and Trend Calculations for Germany using Different Models**  
 Quarter-on-quarter change in % (annualized)



Sources: Federal Statistical Office; DIW Berlin calculations.



Table  
Tests for Equality of Averages and Variance<sup>1</sup>

	Equality of averages test		Equality of variance test	
	ANOVA-F test	Likelihood of errors	F test	Likelihood of errors
Total	0.98	0.33	1.26	0.41
Producing sector (without construction)	0.77	0.38	1.01	0.98
Construction	1.39	0.24	1.67	0.07
Trade, hotels and catering, transport	2.12	0.15	1.36	0.27
Finance, leasing, corporate services providers	0.02	0.90	1.68	0.07

<sup>1</sup> The likelihood of errors in rejecting the null hypothesis is given.  
Source: DIW Berlin calculations

that productivity could be stabilized on a lower level. According to the data before the revision of the national accounts, on the other hand, the flattening of the productivity trend also continued in the first half of the current decade.

All in all it can be stated that the estimate of the growth in productivity has hardly changed for several economic sectors after the revision of the national accounts. It remains an open question whether increasing use of hedonic price adjustment beyond the IT goods sector, which is more advanced in the United States, would cause major corrections here.

## Conclusion

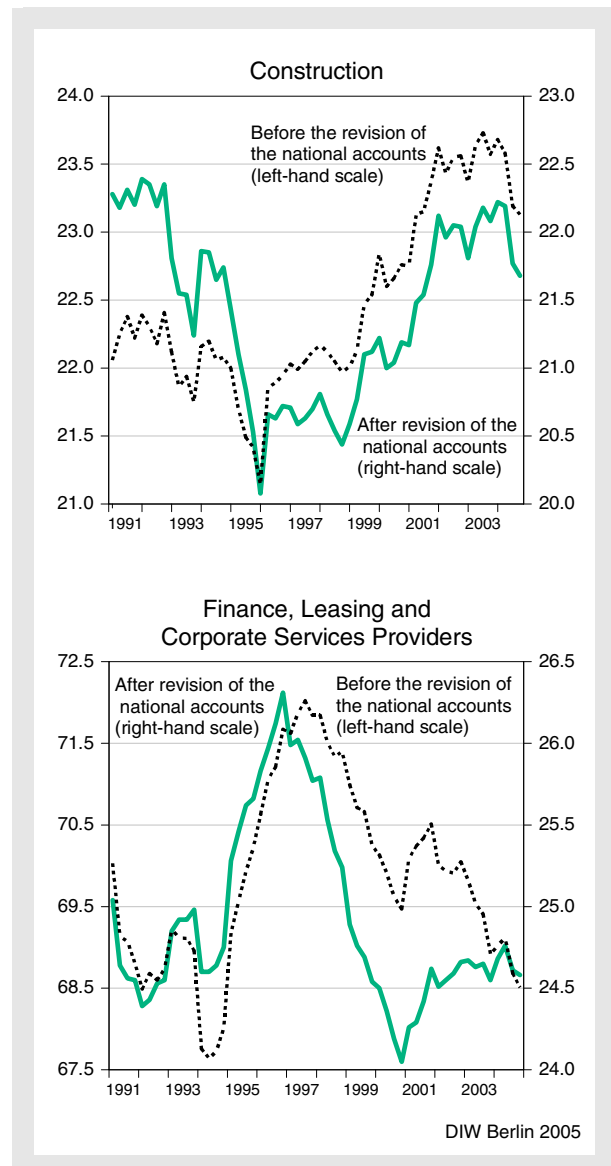
The calculations on productivity trends presented here show that the divergence that has persisted since the mid-1990s between the United States and Germany still exists.

A relative weakness in innovation in Germany in the 1990s may have contributed to this. However, current analyses of Germany's technological efficiency<sup>14</sup> and the German Government's Research Report show that there has been a certain change in the trend in recent years. So if one assumes a delay of several years before the positive effects of an increase in innovation are also reflected on the market in increasing productivity in the economy there could certainly be a change in the trend in the course of this decade.

Similarly, the structural reforms on the labour market and the investment in modern information and com-

<sup>14</sup> Cf. BMBF: 'Zur technologischen Leistungsfähigkeit Deutschlands 2005', Berlin 2005.

Figure 4  
Hourly Productivity<sup>1</sup> in Selected Sectors  
In euros



<sup>1</sup> Gross value creation (chained volumes, reference year 2000), or gross value creation in 1995 prices per hour worked.  
Sources: Federal Statistical Office; DIW Berlin calculations.

munications technologies made in the past require complementary changes in companies' organization; this includes restructuring of the value creation chains in the course of globalisation.

All these structural adjustments can actually cause labour productivity to fall temporarily, until the new production technologies and product innovations dominate the production figures. As long as structural factors continue to weigh on a considerable part of the overall result they will conceal the success of the

restructuring process in the German economy that is becoming evident in the long term.

The hypothesis put forward during the discussion over the persistent divergence of the productivity trends in the United States and Germany, namely that the differences observed are mainly due to the use of different statistical methods to calculate the domestic product and for price adjustment in the two countries, has not so far been confirmed now that the calculation methods used in Germany have come closer to those common in the United States.

The argument that these differences are only a statistical artefact and that they distort reality is not supported by the latest results from the national accounts. Hence, the revision of the national accounts has not changed the view of the productivity gap between the United States and Germany. The gap is currently widening further.