Measurement and statistical issues related to the "new economy" with IT equipment and software in Germany and the United States as a case in point

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Preliminary

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Executive Summary:

Unlike the United States, most other industrial countries, including Germany, did not experience any noticeable increase in productivity growth (nor, for that matter, did they witness any significant increase in macroeconomic growth potential) during the second half of the nineties. Even if one concedes that the United States has a decided advantage in technology, a closer look reveals that the gap in growth is to some degree attributable to differences in the measurement of real investment in hardware and the calculation of investment in software. We are less concerned with evaluating the different methodological approaches. Instead, we seek to take the resulting distortions in international comparisons of growth, explain them and approximate them, using as examples classes of goods that are exceedingly important in the new economy.

According to the estimates used in this article, the growth differential between Germany and the United States over the second half of the nineties is likely to have been just over 0.4 percentage point p.a. smaller if more harmonised methods had been used to deflate IT goods and to calculate software investment.

This outcome is largely consistent with comparable estimates for France and the United Kingdom, where the “technology and growth gap” vis-à-vis the United States seems to likewise be statistically overstated. These methodologically related “growth effects” are significant, to be sure, yet they account for only a small part of the growth differential between Germany, France and the United Kingdom, on the one hand, and the United States, on the other.

Measurement and statistical issues related to the New Economy with IT equipment and software in Germany and the United States as a case in point

An important feature of the “new economy” in the United States has been the major surge in macroeconomic productivity since the mid-nineties, which has also contributed to correspondingly stronger, tension-free economic growth. By contrast, most of the other industrialised countries did not witness a similar “productivity miracle” in the past few years.[1] This discrepancy is largely attributed to the relatively sizeable share of the manufacture of information and communication technology (ICT) goods and their greater use in the various sectors of the US economy.

I. The pattern of real expenditure on IT equipment given different methods of deflation

The figures from the national accounts seem to put Germany far behind the United States in the manufacture and the use of new technologies, particularly information processing. If we use as an example expenditure on IT equipment (excluding purchased and self-produced software) as an indicator of the use of new technologies, for which both countries have official and relatively comparable information, from 1992 to 2000 real expenditure on IT hardware and equipment in the United States rose by an amount of around 37 %

[1] See also: Gust, C. and J. Marquez, Productivity Developments Abroad, Federal Reserve Bulletin, October 2000, pp. 665 – 681.

per year. By contrast, it only went up by 9 ½ % in Germany, according to official statistics.[2]

The discrepancy between the two countries in developments in real IT investment, however, is overstated due to different methods of measuring the prices of these goods.[3] In the United States, for quite some time now the “hedonic” approach has been used to calculate price indices for IT goods (and for other selected goods), particularly in order to take quality changes in account, which is indispensable for reliable price measurement.[4] By contrast, Germany uses more conventional methods of evaluating quality changes. They often amount to estimating the monetary value of the quality change on a case-by-case basis according to rules laid down by the Federal Statistical Office.[5] There is ample reason to believe that conventional approaches reach their limits once extremely large quality changes occur which are reflected either not at all or only in part in corresponding price increases or decreases. In the area of IT goods, a hallmark of which has for a long time been rapid and comprehensive technological progress, they probably tend to lead to quality change, and thus the real price reduction, being understated. The hedonic price measurement approach, which is based on econometric methods, rests on the basic assumption that different

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2 Information for 2000 is estimated since no such official data for Germany are available yet.

3 See also: OECD Economic Outlook, Nr. 67, June 2000, p. 182.

4 The West European countries that also use hedonic price indices to deflate the prices of IT products are France, Sweden and Denmark. See: Scarpetta, S. et al., Economic Growth in the OECD Area: Recent Trends at the Aggregate and Sectoral Level, OECD Economics Department Working Papers, No. 248, June 2000, p. 92.

5 For more details see: Szenzenstein, J., *Die Behandlung von Qualitätsänderungen im Preisindex für die Lebenshaltung*, in: Deutsche Bundesbank (ed.), *Zur Diskussion über den Verbraucherindex als Inflationsindikator*, Frankfurt, 1999, p. 41 ff. (available only in German).

varieties of a heterogeneous good can be represented as different combinations of individual and distinctly defined product characteristics. In competitive markets, price differences at a given time can be explained by deviations in the characteristics of the different "models" of a good. Thus, hedonic price equations for computers usually contain elements such as the clock rate, RAM and hard disk memory as "explanatory variables". However, hedonics are fraught with methodological problems of their own, which are not to be taken lightly. Alan Greenspan has pointed this out as follows: "..., hedonics are by no means a panacea. ... Neither hedonic nor matched-model techniques are sufficient to deal with the introduction of wholly new products that differ fundamentally in their characteristics from their predecessors."[6] This paper, however, focuses less on evaluating quality-adjustment methods but instead more on problems of international growth comparisons resulting from the use of different methods of calculation.

To approximate the effects of the differences in deflation of IT goods between the United States and Germany, we begin by calculating the implicit deflators of IT equipment.[7] This shows us that, according to US statistics, from 1991 and 2000 prices for computers and peripherals went down by four-fifths, after adjustment for quality variations, whereas in Germany the decline was "only" one-third, according to national price statistics (figure 1).

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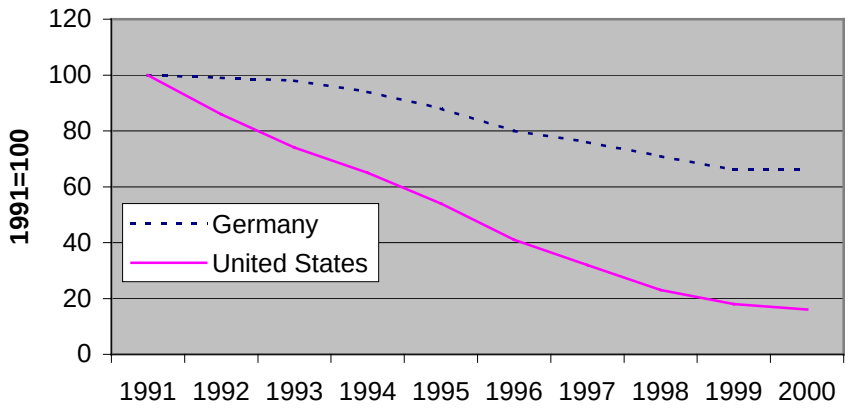
6 Greenspan, A., "The challenge of measuring and modeling a dynamic economy", Speech delivered at the Washington Economic Policy Conference of the National Association for Business Economics, Washington, D.C. on March 27, 2001.

7 See: Deutsche Bundesbank, Problems of international comparisons of growth caused by dissimilar methods of deflation – with IT equipment in Germany and the United States as a case in point, Monthly Report, August 2000, p. 8.

Figure 1: Development of IT goods prices in Germany and the United States



In a second step, nominal expenditure on IT equipment in Germany is adjusted with the corresponding US price deflator. This approach, which is theoretically founded on the "law of one price" for tradable goods, implies that the deviations in price trends between the United States and Germany are solely attributable to the aforementioned methodological differences.[8] In 2000, IT investment in Germany, after adjustment with the US price deflator, was estimated to be 140 % higher than real investment according to official statistics. In the years since 1991, real expenditure on IT equipment in Germany, based on US prices, rose by an annual average of 28 %, compared with 9 ½ % according to the conventional approach.

[8] Of minor importance is an objection which can be made to our approach. Against the simple replacement of the price indices for IT goods, it may be argued that we are dealing with the development of DM prices, on the one hand, and that of US dollar prices, on the other. Therefore, before substituting the German price indices, the US price indices would have to be adjusted for the exchange rate fluctuations between the DM and the US dollar. However, the differences between the results obtained in this manner remain within bounds and, from a methodological perspective, do not lead to different variations.

II. Quantifying the "growth effect" of different methods of deflation

Adjusting real expenditure on IT equipment in Germany in these dimensions would amount to increased growth in investment in machinery and equipment, in mathematical terms. However, we would be too quick to conclude that the macro economy has grown that much faster. When estimating what we will call the "growth effect", the IT goods contained in other demand components, particularly in private consumption, imports and exports, also need to be taken into account; in this equation, imports have a negative impact. Furthermore, it must be borne in mind that the US method of deflation, within the framework of the national accounts, deviates from that used in Germany not just regarding the quality aspect of price measurement (using the hedonic approach). In addition, since 1995 the US Bureau of Economic Analysis has been using a different indexing concept to calculate real GDP from that of the German Federal Statistical Office.[9] In fact, the US method tends to generate lower macroeconomic growth rates in the years following the base year than the conventional method. This causes the difference between the rates of change to increase as the gap between the reporting year and the base year grows.

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[9] The US method has been based on a chain Fisher volume index since 1995. The growth rate of real GDP is calculated in several stages. In a first step, a rate of change is calculated from GDP levels for two adjacent years, having previously been deflated with period-to-period prices. In a second step, this claculation is repeated based on the GDP levels evaluated with the prices of the period under report. That is followed by averaging the two rates of change, which gives us real GDP growth. The Federal Statistical Office's approach, however, is founded on a fixed-weight Laspeyres volume index, i.e. the calculation is based on GDP series which was previously valued using prices of a fixed base year (currently 1995). For more information see Scheuer, M./ H.-A. Leifer, *Zur Umstellung der Berechnung des realen Bruttoinlandsprodukts in den USA auf einen Kettenindex*, WiSt (Wirtschaftswissenschaftliches Studium), Vol. 25., 1996, pp. 473 – 478.

According to Bundesbank estimates, real GDP growth in Germany would, on average, have been almost 0.2 percentage point higher from 1996 to 1999 if the hedonic method of price measurement had been used on IT goods and the US deflation method had been applied.[10] However, since simplifying assumptions had to be made owing to difficulty in obtaining data, this result should be taken with the proverbial grain of salt.

The “growth effect” estimated for Germany lies well above the result yielded by comparable calculations for France using US deflators (increase of 0.04 percentage point as an average of the years from 1995 to 1998).[11] However, this is not all that surprising since for many years now French statistics for IT goods have already been using hedonics to measure prices as well as a chained-index method — like the United States.

Since the main issue here is the comparability of German and US GDP growth rates, it is similarly permissible to calculate US national accounts aggregates using the method normally used in Germany. According to a Credit Suisse First Boston study,[12] this cuts the contribution of the US IT sector to growth in half, to ½ percentage point as an average of the years from 1994 to 1998. During that

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[10] As regards the individual calculations, it must be noted that the US import and export deflators were not transferred to Germany because the patterns did not seem very plausible even when the situation in the US was viewed in isolation. Instead, a uniform deflator, the US price index for IT goods, was applied to all aggregates.

[11] See: Lequiller, F., The new economy and the measurement of GDP growth, Working Paper, February 2001, p. 30.

[12] See: Callow, J., The European Digital Economy, Euro-11 Special, Credit Suisse First Boston, July 2000, p. 11.

period, annual real GDP growth would not have been 3 ¾ % but instead “only” 3 ¼ %. J. Steven Landefeld and Bruce T. Grimm of the US Bureau of Economic Analysis, however, estimate that hedonic price measurement adds “only” around one-quarter percentage point to real GDP growth.[13] Even if these calculations needed to be critically examined in detail, it still seems plausible that a negative adjustment of US growth turns out to be distinctly higher than the upward revision when applying the US method to the German national accounts. After all, the IT sector — in terms of value added — carries more weight in the United States than here in Germany. Therefore, the impact of changing the deflation method is correspondingly greater.

III. On the development of software investment in Germany and the United States

The problems concerning the international comparability of national accounts data affect not only IT equipment but also numerous other categories of goods and sectors of the national accounts.[14] The distortions are particularly strong in cases of components which are growing relatively dynamically. In IT, they include not only hardware but also software. Nominal software investment in Germany rose by a total of around 80 % from 1992 to 2000, or 7 % p.a. In the United States, by contrast, the same type of investment shot up 300 % during the same period, i.e. 16 ½ % p.a.

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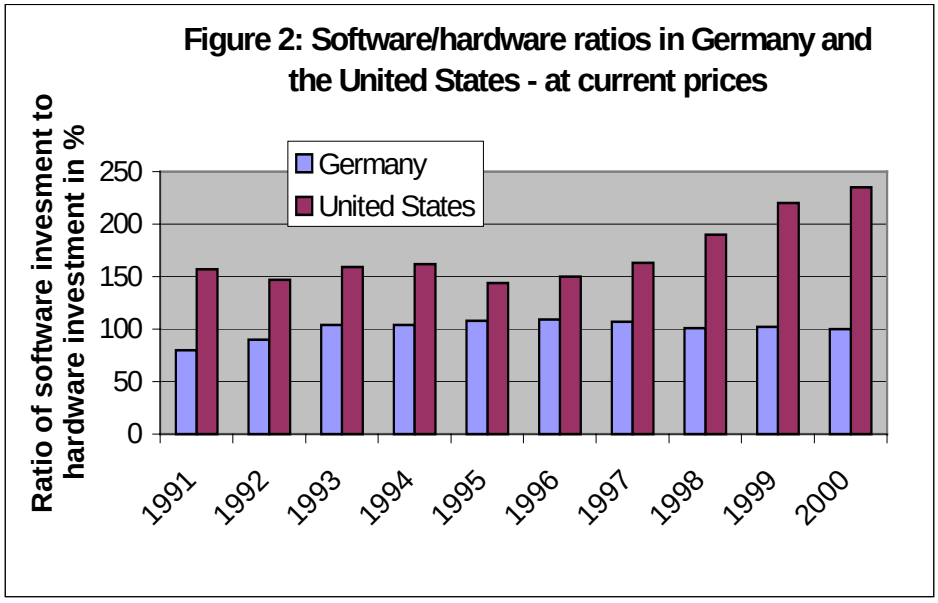
[13] Vgl. Landefeld, J. Steven and B.T. Grimm, A Note on the Impact of Hedonics and Computers on Real GDP, Survey of Current Business, December 2000, p. 20.

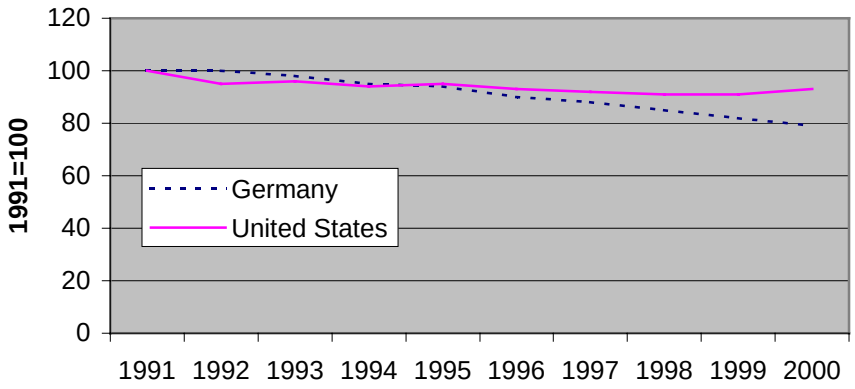
[14] In the United States, for instance, hedonics is now applied to one-fifth of GDP.

If we then compare investment in software to corporate spending on hardware, we see that in the United States $ 144 was spent on software in 1995 for every $ 100 spent on IT procurement, compared with a ratio of 108 to 100 in Germany. By 2000, the ratio in the US had risen to 235 to 100, whereas here in Germany software and hardware spending was relatively balanced (figure 2). There is hardly any analytical justification for these discrepancies given the technological complementarity between hardware and software.



Since the ratios of software to hardware are based on nominal prices, the differences in deflation (which are otherwise relatively insignificant for software investment) do not matter. Seen in that light, software prices in Germany fell by 2 ½ % as an average of the period from 1992 to 2000, compared with a ¾ % decline in the United States. What is particularly striking is that the fall in the price of purchased software in the United States was (at 3 % p.a.) only slightly greater than in Germany (see figure 3).

Figure 3: Price movements for software investment in Germany and the United States



Differences in the method of statistical recording are not enough to explain the vast differences in the results of the software/hardware ratios, even if such methods could be reconstructed using the published methodological descriptions in the first place. In the field of purchased software, the user-side measurement approach which the Federal Statistical Office has been using thus far (ifo sample in selected sectors of the economy) is, in principle, considered to be just as "safe" as the commodity-flow method used in the United States. As for own-account software, the approaches used by the United States and Germany are similar in that both models are based on persons employed in groups of software-related occupations.[15] However, this does not mean that these two methods are also "steered" in similar fashion in practice; this will be dealt with in greater detail in the following.

[15] For more information see: Federal Statistical Office, *Revision der Volkswirtschaftlichen Gesamtrechnungen 1991 bis 1998*, *Wirtschaft und Statistik*, 1999, p. 466 ff.; and Bureau of Economic Analysis, Updated Summary NIPA Methodologies, Survey of Current Business, October 2000, p. 26.

The distortions in the comparison of methods for software investment between the United States and Germany tend to indicate weaknesses in US calculations. This is particularly evident in the very strong expansion since 1997, which, compared with developments in nominal spending on hardware, does not seem plausible even if one gives the United States the benefit of a technology lead of several years. Many signs seem to indicate that spending on software and software development in the United States is more often posted on the assets side of the balance sheet as investment, thus inflating growth, whereas such spending is seen in Germany and some other EU member states as input.

Conversely, the considerably steadier software/hardware ratio in Germany is much more consistent with the existing technical complementarity between software and hardware, which changes over a longer period of time and then only in smaller steps, if at all. In addition, there are indications that the level of software investment in Germany is probably not systematically underestimated. Measured as a percentage of GDP/GNP, in fact, it is distinctly above the EU average. In turn, there is an exceptionally large spread within the EU-15.[16] The corresponding share in GDP in the United States, by contrast, is more than double that in Europe. That means the divergences revealed do not constitute a “bilateral phenomenon” between Germany and the United States.

[16] According to official statistics, the weight of software investment is especially low in the United Kingdom. This conclusion is also reached by the Bank of England, which calculated a software/hardware ratio of 40:100 for the United Kingdom. For more details, see Wadhwani, Sushil (Member of the MPC of the Bank of England), Monetary Challenges in a New Economy, Speech delivered on October 12, 2000, p. 18.

Generally speaking, there seem to be divergent notions as to when spending on software development is to be posted as investment or as intermediate consumption. A notable example is the difference in the way in which software reconfiguration to avoid Y2K-related computer problems was treated internationally. In some countries Y2K-related expenditure, if capable of being recorded in the first place, was listed on the assets side as investment. It was argued that the reconfigured programs could be used for longer than one year. In other countries, they were treated as spending on maintenance and thus listed on the balance sheet as intermediate consumption. The justification was that the Y2K-related reconfiguration did not extend the normal life-span and the effectiveness of the software but only ensured its operability. The majority of statistical offices found a solution somewhere in the middle.

V. On the relevance of different software/hardware ratios to growth

On the whole, many signs indicate that the United States national accounts compilers have been relatively “generous” in calculating software investment, particularly in the past few years. To make a rough estimate of the extent to which this has influenced bilateral growth comparisons, US software/hardware ratios, in an approach analogous to that for IT goods, have been applied to German IT equipment. The initial effect was to cause software investment to grow faster.

In real terms, software investment growth increased by just under three percentage points from 1992 to 2000, to just over 12 % p.a.

However, this method of calculation blinds us to the fact that the gap between the two countries in terms of the development of software investment has widened, especially in the second half of the nineties. If we apply US ratios, software investment growth "rises" by 14 percentage points p.a. from the years 1996 to 2000 to 27 %. That means that by "US standards", growth in this segment of investment would have been nearly three percentage points higher per annum. In terms of GDP, this yields an increase in growth of around one-quarter percentage point as an average of 1996 to 2000, with this average being even a bit higher in the period from 1998 to 2000.

VI. The overall "growth effect"

If both components — the influence of the different types of deflation and the diverging software/hardware ratios — are taken together, the result for the second half of the nineties is a "growth effect" totalling just over 0.4 percentage point annually. The growth differential between the United States and Germany could be smaller by that amount if the methods of deflation and of calculating software investment in the two countries were more closely attuned to one another than is currently the case.

This finding is consistent with the estimate for the United Kingdom made by Nicholas Oulton of the Bank of England, which puts the UK "growth bias" towards the United States from 1994 to 1998 at an average of 0.38 percentage point.[17] In France, the "distortion" compared with the United States, at a total of 0.3 percentage point,

[17] See: Wadhwani, S. (Member of the MPC of the Bank of England), Monetary Challenges in a New Economy, Speech delivered on October 12, 2000, p. 21.

was somewhat lower.[18] However, that is not surprising because the "correction factor" deriving from the different method of deflation used in France is distinctly lower — for the reasons mentioned above.

The total estimated "growth effect" of just over 0.4 percentage point is not insignificant, yet it only partly "explains" the divergence in growth between the United States and Germany, which averaged 2 ½ percentage points from 1996 to 2000. This is also true of the divergence in growth between the UK and France, on the one hand, and the United States, on the other — despite the fact that in the second half of the nineties, these growth rates, at 1½ and 2 percentage points, respectively, were much less divergent.

[18] See: Lequiller, F., The new economy and the measurement of GDP growth, Working Paper, February 2001, p. 35.

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