Productivity of ICT and Non-ICT Capital - The Role of Rates of Return and Capital Prices

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Growth accounting studies attribute the growth acceleration in the US in the mid-1990ies to the revolution in the field of information and communication technologies (ICT). Both the ICT producing sector and ICT investment in other sectors were larger in the US than in Europe. After 2000, the US continued to grow faster than many European countries, but the sources of growth shifted to a broader range of sectors. ICT-intensive service industries such as business services and trade experienced fast productivity growth.

Growth accounting decomposes growth in labor productivity into capital deepening and a residual measure of total factor productivity growth. The contribution of capital deepening depends crucially on the way one measures capital and its productivity. In this paper, we focus on two elements that enter into the measurement of ICT and non-ICT capital: the rate of return to capital and the price deflation of ICT assets. Both enter the user cost of capital, which is assumed to reflect its marginal productivity. The user cost of individual assets is employed when aggregating them to ICT and non-ICT capital. The user cost of total ICT and non-ICT capital in turn enter the output elasticities that are used in growth accounting. Moreover, the ICT price deflator is used to convert monetary into real measures of ICT investment. In the standard growth accounting approach, the return to capital is computed as a residual, subtracting labor income from value added. ICT price deflators used nowadays, as those used in the EU KLEMS database, are based on hedonic methods or similar approaches that take into account the rapid quality change of IT hardware (and to a lesser extent of software and telecommunications equipment). The higher the measured quality change, the higher the increase in real ICT capital services and their contribution to growth.

The shortcomings of available measures both under theoretical and practical aspects are well-known and computations of capital services and contributions to growth under alternative assumptions have been undertaken in different previous studies. But there has been little systematic investigation whether the conclusions from cross-country growth accounting change in an economically meaningful way when introducing alternative measures of returns to capital and ICT prices. Moreover we explicitly focus on how different measurements influence contributions to growth from ICT and non-ICT capital.

In contrast to some previous research, we are not primarily concerned with proposing better measurement in this paper. We introduce a minimalistic measurement and then compare the growth accounting results to those obtained with the EU KLEMS data. We do not argue that one or the other measurement is better for all purposes. We rather consider that this exercise will improve the understanding of what drives differences in the contributions of capital deepening and TFP across countries and time. The sensitivity analysis may be useful in detecting these influences, independently of whether the underlying reasons are measurement error or real

differences in productivity and quality. Our aim is to disentangle the effect of the overall levels of the rate of return and of decline in ICT prices from the effect of differences in these measures across countries, sectors and time. While it is plausible to consider that the overall level reflects economic and technological conditions, we presume that the differences are more prone to measurement error. Introducing a constant rate of return to capital and a constant decline in ICT investment prices, we conduct growth accounting and consider the change in aggregate and sectoral contributions to growth. In addition, we split up the ICT contributions to labor productivity growth into a quantity and a quality component.

We compare results obtained with EU KLEMS data to the following specifications:
1. A constant real rate of return to capital of 4% plus national CPI inflation.
2. A constant decline in real IT (19%), CT (3%) and software (4%) prices plus national value added inflation.
3. A constant decline in real ICT capital input prices (7%) plus national value added inflation.
4. Jointly with assumptions 2 and 3: we apply the average decline in the value added deflator for output of the ICT producing industry (more exactly for the somewhat broader NACE industries 30-33) in the US (9%) to other countries, subtracting the difference between overall US and national value added inflation.
5. In order to disentangle changes in ICT quantity and quality, we assume that the overall inflation for Non-ICT capital can be used as a proxy for inflation in purchase prices for ICT capital (as opposed to quality-adjusted ICT prices). We than compute increase in ICT quality as the difference between growth in ICT capital services in EU KLEMS and growth in ICT capital stock based on purchase prices.

Our main results are that both the constant rate of return and the constant ICT price decline would somewhat downplay the role investment played relative to growth in total factor productivity (TFP) in fast growing countries, in particular the US and the UK, during 1995-2000. The effects occur notably in business services and are generally smaller in the other periods. Moreover, we show that more than half of the ICT contribution to growth results from growth in quality rather than quantity.

Varying the rate of return to capital shows that the contribution of ICT to growth is less sensitive to the rate of return than the contribution of non-ICT capital and total factor productivity. The reason is that the decline in ICT prices has a more important effect on user cost of ICT. Sensitivity analysis with different rates of return (real 3%and 6%) shows that the impact often small relative to total labor productivity growth, at least at the aggregate level. One may sceptically ask whether this means one could do growth accounting with a quite arbitrary rate of return without incurring a large error in the results. The low sensitivity of results can be traced back to the assumption of constant returns to scale. An extension of this paper may consider non-constant returns to scale.