Knowledge Society and the New Productivity Paradigm:
A Critical Review of Productivity Theory and the Impacts of ICT

Ilkka Tuomi
Visiting Scientist
JRC / IPTS

IPTS WORKING PAPER
19.1.2004

Executive summary

Information and communication technologies (ICTs) have become increasingly important drivers of economic growth during the last two decades. They were a major source of productivity growth during the 1990s in many developed countries. The diffusion of ICTs has been argued to permanently change the rate of sustainable economic growth, and ICTs have frequently been described as core technologies of the emerging knowledge-based economy.

This paper assesses existing research on the productivity impacts of ICT. Instead of being an exhaustive literature review, it tries to clarify and evaluate concepts and assumptions that underlie current economic knowledge on the impacts of ICT. The study is critical in the sense that it finds that research on ICT productivity often relies on problematic assumptions and models that probably do not well capture essential characteristics of ICTs. Specific emphasis is therefore given to research challenges that promise to be important in understanding the growth and productivity impacts of ICTs. Some of the discussed research challenges have potentially profound implications for current conceptualizations of productivity. The paper therefore also puts forward some tentative ideas for a new paradigm of productivity measurement in the knowledge society, and proposes new approaches for connecting productivity measurement, ICTs, and socio-economic development.

Empirical studies on the economic impacts of ICTs rely heavily on price indexes that convert nominal prices and production into "real output." A closer look on the sources of quality adjustments in computing prices reveals that such adjustments are conceptually ambiguous, as they make the value of money dependent on technical progress. This, in effect, translates the economic output into "real output" using technical characteristics that by default impute the assumed economic growth. This points to a circular logic in the treatment of output value, growth, and productivity. Without quality adjustments, semiconductor and computer industries have expanded relatively slowly during the last decades, as rapidly dropping nominal prices have to a large extent cancelled the growth in volume. Although in quality adjusted "real terms" ICT production and services grew in the 1990s in the EU, without quality adjustments their share of nominal GDP contracted. Much of the measured productivity growth depends on the very rapid technical improvements in semiconductors, which price indexes and national accounts translate into growth of real outputs and investments. Theoretically consistent quality adjustments, however, lead to prices that are not additive across product categories or time, indicating that the conventionally adopted approaches are conceptually inadequate. It is therefore not clear how much economic growth there has been during the last decade, and to what extent the growth can be associated with ICTs.

Most influential studies on ICT productivity and growth rely on neoclassical assumptions that include constant returns to the scale of production, perfect allocation of resources and investments, and competitive markets where suppliers cannot influence prices. Empirically, these assumptions cannot easily be justified and they appear to be particularly misleading in the ICT-related and knowledge-intensive sectors of economy. The neoclassical productivity framework also implicitly requires that innovation is not an important factor in growth, and that non-market factors such

as policy or geographical location do not influence the market. Many studies aggregate economies on national level, which is highly problematic in global ICT-related industries, and the networked nature of many ICT-using industries can only inadequately be captured by the conventional macroeconomic productivity frameworks.

Economists have extensively discussed alternative explanations of the apparently limited impact of ICTs on growth and productivity during the last two decades. This discussion has made visible important measurement problems, and it has also highlighted potentially important conceptual challenges in the conventional ways of measuring growth and productivity in the knowledge society. The present paper argues that these challenges are particularly visible in ICT-intensive industries, but that they also require new approaches for understanding productivity and growth. The famous "Solow paradox" can be interpreted as an indication of a need for a new productivity paradigm.

A policy-relevant conceptualization of productivity seems to require reconsideration of the links between growth and development. At the organisational level, ICTs are composite goods that consist of hardware, software, skills, systems integration, operational support, and infrastructure. Beneficial deployment of ICTs requires incremental innovation and reconfiguration of existing investments and resources. This makes it difficult to isolate the impact of specific investments in ways that typical growth accounting frameworks would require. ICTs themselves facilitate rapid recombination of existing investments, accelerating creative destruction within organisations and the overall economy, and making structural, contextual, and institutional factors increasingly important for growth. Conventional approaches in business accounting and national accounts treat some of the associated costs as consumption and some as investments, and they often remain blind to the historical and social investments that are needed for the productive use of ICTs. Research on knowledge management has highlighted the systemic nature and the interdependent elements that make ICT investments productive. As accurate measurement of investments in "ICT products" is critical for productivity studies, it is important that we conceptualize these products in an appropriate way. A multidimensional and holistic conceptualization of ICTs allows the policymakers to address the different complementary elements that are needed to make ICTs productive.

Although current economic approaches are only partially able to grasp the significance of ICTs, these technologies are transforming the foundations of economy and society. The potential impact of ICTs for social and economic development can be analyzed using Amartya Sen's capability-based model of economic development. The capability-based model allows us to ask what types of technical change and economic growth can reasonably be called development. In particular, in this framework we can ask how ICTs can provide functionality that augments and enhances capabilities that are fundamental for economic development. The capability-based model also allows us to connect key political concepts such as freedoms, rights, equality, and democracy to the more traditional considerations of economic growth.