

## **Abstract for “Drivers of productivity: conceptual framework and results for the Netherlands”**

**Michael Polder (Statistics Netherlands)**

**Erik Veldhuizen (Statistics Netherlands)**

**George van Leeuwen en Hugo de Bondt (Statistics Netherlands)**

Economic growth, usually measured as growth in gross domestic product (GDP), is key to the material well-being of people. Despite shortcomings, economic growth is a focal point of economic policy, and accordingly, research about its determinants is vast and has a long history. GDP growth can be decomposed into growth in labour, and productivity. In the face of ageing populations and increasing (international) competition, the latter component has gained importance, and policy interest centers around it, as exemplified in Europe by the goals of the former Lisbon Agenda and the Europe 2020 strategy to support employment, productivity and social cohesion. The main goal of this study is to investigate the relative importance of different determinants of economic growth. Special attention is given to the role of Information and Communication Technology (ICT), in line with a substantial body of empirical evidence that ICT related factors are the main explanation for the gap between US and EU productivity performance. Moreover, we aim to investigate how different drivers of economic growth are interrelated. For example, there is special interest in the indirect effect of ICT on productivity via its impact on other factors, in line with its nature of General Purpose Technology (GPT). ICT does not only contribute directly to a firm’s production as a part of the firm’s capital stock, it also affects for example the innovative capacity of a firm and its flexibility to adjust to economic shocks. Moreover, there is increasing evidence on the need to complement ICT investment with for example changes in the organization, and appropriate skills.

We present a conceptual framework for analysing different determinants of productivity. The framework makes a distinction between growth accounting and econometric analysis of drivers of productivity and growth. The first approach is based on decomposing overall economic growth into the contributions of different components, where the magnitude of the growth contributions is determined by the size and volume change of a component relative to other components. In contrast, econometric analysis is about the determination of correlations and causal effects of the determinants with productivity.

Based on our reading of the literature we distinguish three broad categories of determinants of economic/productivity growth:

1. input variables in the production process (e.g., tangible/intangible capital, labour)
2. firm and industry dynamics underlying aggregate growth;
3. the business environment of a firm.

For each group we discuss the relevant determinants, the role of ICT, and the way to analyse the determinants within the general framework. Our literature review on determinants of productivity growth at different levels of aggregation, reveals that there is no unifying model in which all these determinants have been gathered. Rather, what is found to be important in one branch of the literature, may be implicitly assumed away in another branch. In this study, we identify the augmented production function as a common approach to assessing productivity effects, which can also be linked to the practice of growth accounting which is more rooted in index theory.

In the empirical part of the paper, we look at various determinants of productivity at the industry-level, contrasting the growth-accounting approach to results from production function estimations. In so doing, we go beyond the usual detail in data on factor inputs. Foremost, we use data available from the Dutch knowledge satellite account, which contains information on intangible assets according to the Corrado-Hulten-Sichel framework. In addition, using results from the ICT and Economic Growth project, commissioned and financed by the Dutch Ministry of Economic Affairs, we increase further the detail of the industry-level data on physical capital and labour inputs. In the case of capital, we distinguish between ICT and non-ICT capital, where ICT-capital is at its turn further broken down into hardware, software, and telecommunication equipment. For labour, we account for changes in the skill composition.

Preliminary results using Dutch industry-level data indicate that:

1. There are strong differences between the contribution of input factors to growth based on growth-accounting and production elasticities obtained from the estimation of (augmented) production functions. Especially the contribution of both IT and non-IT capital is higher when estimated from the production function approach, indicating that there are above-normal returns to capital investment.
2. There are possible interactions between ICT capital and knowledge capital. Moreover, there is evidence that knowledge capital has a non-linear effect on growth due to the interaction with ICT. For example, intangible capital related to intellectual property initially increases productivity, but this effect turns negative as the industry becomes more ICT intensive. By contrast, economic competencies and computerized information only have a positive effect on productivity when industry is relatively ICT intensive. We determine threshold values for the ICT intensity where the pertinent changes in sign occur.
3. Results vary quite substantially over different estimation methods. We intent to review the current state-of-the-art for production function estimation, and discuss how different methods affect our results and conclusions.