Impact of automation on productivity in a multisectoral economic system

Topic: Input-Output Theory and Methodology - III
Author: Wolfgang Koller
Co-Authors: Mikulas Luptacik

Impact of automation on productivity in a multisectoral economic system
Koller., W. â€“ Luptacik, M.

Technological progress and innovation, nowadays strongly associated with Industry 4.0 (internet of things) and digitalization, are main drivers of economic growth. Consequently they are in the focus of wide and intensive public debates as well as increasing scientific theoretical and empirical research. An important subarea of the ongoing technological transformation is automation Fundamental implications can be expected for the labour market. Crucial for the consideration of the impact of automation for the labour market is the relationship between automation and productivity change.

How does the adoption of industrial robots (as the most advanced area of automation) contribute to the productivity growth compared to the contributions of the other production factors?

We developed a multi-sectoral model in the spirit of Ten Raa and Mohnen (2002) and based on Luptacik and Mahlberg (2016) in order to measure productivity growth of an economy without recourse to data on factor input shares or prices. The economy is represented by the Leontief input-output model which is extended by constraints on primary inputs. The primary inputs considered are production capital of three different categories, one of them being industrial robots, and labour of three different groups of educational levels. The primary input coefficients, capacity constraints and capacity uses for all primary inputs are determined in a capacity use model that is carried out beforehand as a step of data preparation. The novelty of our approach vis-Ã -vis prior work thus consists mainly in these two aspects: i) integrating a capacity use model into an input-output model and ii) extending the primary inputs with a focus to be able to carve out the role of industrial robots.

Following Chambers et al. (1996, 1998) and Luptacik and Mahlberg (2016) for the intertemporal analysis, we use the non-oriented proportional Luenberger indicator of productivity change. It is known (FÃ¤re et al., 2008) that in the special case of single output, constant returns to scale and Hicks neutrality, the Luenberger productivity indicator is equivalent to the Solow specification of technical change. It offers the possibility to decompose productivity change into catchâ€“up or efficiency change (movement of an economy towards the frontier) and frontier shift or technical change (movement of the frontier). In the next step, as the main contribution and core of the paper, productivity growth is decomposed to estimate the contribution of each individual primary input or production factor (robots, physical capital, and labour according to the different skills) as well as of each individual commodity to the efficiency as well as to the technical change. The sum of change in efficiency and change in technology yields productivity change. In this way the impact of automation on productivity taking into account the complex interrelationships between different sectors of an economy can be estimated. Furthermore, the potential for the improvement of the performance and consequently for the competitiveness of an economy can be identified.

For illustration purposes, Austrian deflated input-output tables for the period 2011-2019 have been extended by robots, capital stocks and employment by educational levels (ISCED) and used for implementing the model. The robot stocks have been compiled from data provided by the International Federation of Robotics (IFR). The results provide interesting and useful insights into the contributions of the primary inputs and the contribution of the final demand structure to the economic growth.

Cited Literature:
Chambers, R. G., Y. Chung and R. FÃ¤re (1996) Benefit and distance functions. Journal of Economic Theory, 70, 407-419.
Chambers, R. G., Chung and R. FÃ¤re (1998) Profit, directional distance functions, and Nerlovian efficiency. Journal of Optimization Theory and Applications, 98, 351-364.
FÃ¤re, R., S. Grosskopf and D. Margaritis (2008) Efficiency and productivity: Malmquist and More. In: H. O. Fried, C. A. AK. Lovell and S. Schmidt (eds.) The measurement of of productive efficiency and productivity growth. Oxford, Oxford University Press, 522-621.
Luptacik, M. and B. Mahlberg (2016) Productivity change in a multisectoral economic system. Economic Systems Research, 28, 344-361.
Ten Raa, T. and P. Mohnen (2002) Neoclassical growth accounting and frontier analysis: A synthesis. Journal of Productivity Analysis, 18, 111-128.