Abstract for "Measuring Technological Change in Global Production"

Marcel Timmer (University of Groningen, Netherlands)

Is technological change accelerating in today's world? As yet, we are lacking a proper answer to this question. The increasing fragmentation of production is setting new problems for the measurement of technological change. The standard way of measuring this is by deriving Total Factor Productivity (TFP) growth rates using growth accounting techniques. Based on the neoclassical Solow growth model, TFP growth can be interpreted as the change in the level of technology. There are two important preconditions for this interpretation. First, all inputs in production should be taken into account. Second, prices and quantities of all output and inputs should be properly measured (Jorgenson and Griliches, 1967, Diewert, 2000). However, this is becoming increasingly harder because of the fragmentation of production both within and across countries, such as the outsourcing of (business) services by manufacturing firms and more recently the fragmentation of production processes across borders.

It is well known that price measurement for intermediate services is difficult, and that import price trends are not well captured by existing price surveys (see e.g. Houseman et al. 2011 for the case of US). In addition, transfer pricing in multinational enterprises and the use of intangible capital input appears to be highly elusive for statistical measurement (e.g. Diewert et al, 2005; Lipsey 2010). This is on top of the well-known problems of measuring quality-adjusted prices of high-tech inputs (see e.g. Triplett, 1989 for an early statement). The underlying problem is the same in all cases: when production is fragmented in many intermediate steps, more price observations are needed to measure TFP while they are increasingly harder to measure. As a result, we have currently no proper understanding of the rate of technological progress in the world.

In this paper we propose a measure of global technological change that is much less sensitive to these measurement problems. In a first stage, it identifies all factor inputs that are directly and indirectly needed in the production of a final good. This is based on the notion of vertically integrated production where all stages of production are considered together (Pasinetti, 1973; Wolff, 1994). Based on an input-output model of the world economy, we will derive the total amounts of labour and capital in any country-industry needed for the production of the good. By construction all factor inputs in the production process are accounted for such that they measure technological change properly. Combined with the factor cost shares in production, new measures of TFP in vertical production can be derived. By considering all production stages simultaneously, there is no need to estimate productivity in each stage. Moreover, separate price and quantity indices for intermediate inputs are not needed and these new measures will thus suffer much less from the measurement problems outlined above.

We outline the new methodology and illustrate it by deriving measures of TFP in the production of final manufacturing goods in 40 countries and 14 industries over the period 1995 to 2009, using the recently released World Input Output Database (WIOD, Timmer et al. 2012).

References

- Diewert, W.E. (2000), The Challenge of Total Factor Productivity Measurement, CSLS.

- Diewert, W. E., W. F. Alterman and L. Eden (2005), "Transfer Prices and Import and Export Price Indexes: Theory and Practice", Discussion Paper No. 05-08, Department of Economics, University of British Columbia, Vancouver.
- Houseman, Susan, Christopher Kurz, Paul Lengermann, and Benjamin Mandel. (2011). 'Offshoring Bias in U.S. Manufacturing.' Journal of Economic Perspectives, 25(2): 111-32.
- Jorgenson, D. W. and Z. Griliches (1967), "The Explanation of Productivity Change" Review of Economic Studies 34(3), pp. 249-83.
- Lipsey, Robert E. (2010). 'Measuring The Location of Production in a World of Intangible Productive Assets, FDI and Intrafirm Trade.' Review of Income and Wealth 56(s1): S99-S110.
- Pasinetti, L. (1973), 'The Notion of Vertical Integration in Economic Analysis', in: Metroeconomica, vol.25, pp. 1–29.
- Timmer et al. (2012), The World Input-Output Database (WIOD): Contents, Sources and Methods, WIOD Background document available at www.wiod.org.
- Triplett, Jack E. (1989), "Price and Technological Change in a Capital Good: A Survey of Research on Computers", in: Dale W. Jorgenson and Ralph Landau (eds.), Technology and Capital Formation, Cambridge, MA: MIT Press, pp. 127-213.
- Wolff, Edward N., (1994). 'Productivity measurement within an input-output framework', Regional Science and Urban Economics, Elsevier, vol. 24(1), pages 75-92, February.