

Response to Review Article by Bert Balk on *Measurement of Productivity and Efficiency: Theory and Practice*

Robin C. Sickles

Rice University

Valentin Zelenyuk

*University of Queensland*¹

We would like to thank the Editors of the *International Productivity Monitor* (IPM), and Andrew Sharpe in particular, for commissioning a review article of our book, *Measurement of Productivity and Efficiency: Theory and Practice* (Sickles and Zelenyuk, 2019), which appeared in the Spring 2021 issue of the IPM. It is a great honour for us and we are very appreciative for this opportunity to reach out to the wide audience of the IPM. We also would like to wholeheartedly thank Professor Bert Balk for undertaking this challenging task.

The reading of Professor's Balk review article (Balk, 2021) was for us quite reminiscent of the challenges we had while writing the book itself. Indeed, in the process we recognized early on that to write a good chapter for a book takes about half a year or so, and writing two such chapters roughly doubles the time (under constant

returns to scale), not to mention the extra time to interconnect them. As combinatorial math tells us, the complexity of the interconnections among the chapters increases dramatically with the number of chapters. And, to be frank, our initial goal of combining the 17 chapters spanning several major fields (with many sub-fields) in the area of productivity and efficiency analysis was not achieved at the level of perfection we had hoped. In such a dynamic field one is always trying to catch up to a fast moving target of advances in theory and statistical methods.

Our focus on completeness and coverage of such a broad topic as productivity and efficiency was the reason the book grew to over 800 pages, which was about double what the publisher agreed to initially. Editorial oversight required us to cut or condense some of the topics and we apologize

¹ Robin Sickles is Reginald Henry Hargrove Chair of Economics Emeritus, Department of Economics, Rice University, Valentin Zelenyuk is ARC Future Fellow and Professor, School of Economics and Centre for Efficiency and Productivity Analysis, University of Queensland, Emails: rsickles@rice.edu and v.zelenyuk@uq.edu.au.

to the readers, including Professor Balk, if something they wanted to see is not there.

This also led to a reduction in citations in the author index counts for several leaders in the field of productivity and efficiency, such as Knox Lovell and Shawna Grosskopf, among others. Due to the publisher's policy, for citations where only one author is mentioned and the other authors are hidden under "*et al.*", it is only the first author who is included in the author index for such citations. Alphabetizing co-authored works in economics, the common tradition, does have its costs. In fact, we tried to convince the publisher that it would be fairer to mention all co-authors in the author index but they did not modify their editorial policy.

Professor Balk (2021:139) opines that:

"For the first part, especially Chapters 1-7, I am not so certain that there has been much progress. A global comparison with Balk (1998) reveals that theoretical differences are almost negligible."

With all respect to the book of Balk (1998), which we find as a very useful source for ourselves, we also find a substantial amount of material we cover in Chapter 1 through 7 to be very different (and the difference is far from negligible) from material in Balk (1998). Because these seven chapters contain a bit more than 40 per cent of our book, we feel obliged to clarify and thank the IPM Editors for giving us the right and the opportunity to respond to Professor Balk's review.

It is important to clarify that the topics covered in Chapters 1-7 (as well as others) are not unique either to our book or to

Balk (1998), simply because they are the foundational material that is expected to be covered in any graduate level textbook for this field. Indeed, without such material it would be hard or even infeasible to follow much of the rest of the book. We also note that the similarity of this material in both books is likely due to both in part following the classic book of Färe and Primont (1995), who in turn followed Shephard (1953, 1970), as we all did, acknowledging it at many places. Even given this, *we have a lot of new material in those seven chapters*. Moreover, the classic material is cast in different perspectives and with different emphases than in the other books. To make our explanations brief, we will focus on just a few examples.

In regard to Chapter 1, its distinctive feature is in the much deeper coverage of the axioms of production theory and how these reflect in properties of distance functions, while the distinctive feature of Chapter 2 is to cover duality for production theory in much greater detail than Balk (1998). For Chapter 3, one of the important distinctions from Balk (1998) is that it covers many types of efficiency measures that were not even mentioned in Balk (1998), e.g., hyperbolic - type measures, additive and multiplicative Russell-type measures, slack-based efficiency measures, etc. We also discussed their advantages, caveats and practical issues. Chapter 3 also presents a comprehensive discussion of axioms for the efficiency measures — material based on the stream of literature in *the Journal of Economic Theory*, started by Färe and Lovell (1978) and followed up by Zieschang (1984), Bol (1986), Russell (1990), Dmitruk and Ko-

shevoy (1991), among others, which we think is far from negligible. Another important distinction of Chapter 3 is the coverage of the most general profit efficiency framework developed most recently, by Färe *et al.* (2019), which unifies the previous developments by including other efficiency measures as special cases of this general measurement framework.

Chapter 4 and Chapter 7 — on index numbers are perhaps the closest to material covered in Balk (1998), which is natural because Professor Balk is undoubtedly one of the best experts on those topics in the world. Yet, even here, besides presenting the material in somewhat different perspectives, we have included new and important material that was discovered after 1998. We invite the readers to explore this new material.

The material we covered in Chapter 5 — on Aggregation is completely different from Balk (1998) and, to our knowledge, provides novel and the most comprehensive coverage of that topic. Here it is worth noting that Professor Balk is correct that we have omitted the topic of reallocation of resources in the context of aggregation. We do mention it in passing, in Sections 5.6 and 5.7. Chapter 5 is already quite long and extending it to cover ‘reallocation’ would require yet another chapter. Such a chapter in fact appeared a few months after our book, as Mayer and Zelenyuk(2019).

Finally, the material covered in Chapter 6 — on Functional Forms—also has a very different level of detail and coverage than what has appeared in earlier books, whether Balk (1998) or Färe and Primont (1995) or any other of which we are aware.

In summary, based on our accounting,

on the order of 50 per cent of the material in our Chapters 1-7 is new to Balk (1998). One could, of course, still claim that this new material we synthesize there (which is based on the leading journals that publish in this field, such as *Journal of Economic Theory*, *Journal of Econometrics*, *Operations Research*, etc.) is “almost negligible”. In our opinion, it is very important, although we leave it to the reader to evaluate how well we have discussed these previous works and their theoretical and empirical contributions.

We would like to use the rest of this response to point out some new and interesting publications that came out recently, as well as some that are in the pipeline. Two of these are the recent handbooks edited by Ray, Chambers and Kumbhakar (2020) and ten Raa and Greene (2019). Both have a great collection of many chapters from many giants of the field. To some extent these books overlap in coverage with each other and other works (including our book), which is natural. Yet often they cast those same topics (among others) at different angles or different degree of detail and so, we think, both deserve special attention on their own. We also hope these books will be reviewed in *the International Productivity Monitor* soon.

Two books we are eagerly looking forward to see are by Kumbhakar and Parmeter (under contract with Cambridge University Press) that focuses on Stochastic Frontier Analysis and by Simar and Wilson that focuses on statistical aspects of DEA. We also hope these two books will be reviewed by the IPM, along with other reviews, and this will help the readers navigate in the expanding and enriching liter-

ature in the field of productivity and efficiency analysis.

Again, we thank Professor Bert Balk for dedicating his efforts for reviewing our book and to the editors of IPM to publish it and for the opportunity to respond.

Last, yet not least, we believe that for any book, there is still always room for improvements—at least because the knowledge discoveries go on and thus material can become dated. Hence, we enthusiastically encourage productivity scholars to continue developing new and refining old theoretical and empirical approaches to the measurement of productivity and efficiency. Indeed, as the famous wisdom says (usually attributed to business consulting guru Peter Drucker):

“If you can’t measure it, you can’t improve it.”

Given the challenges facing the world economy, improvements in living conditions in the world by way of shared productivity growth can only be realized when its measurement has been adequately assessed. Ultimately, that is the purpose of our book.

References

- Balk, B. M. (1998) *Industrial Price, Quantity, and Productivity Indices: The Micro-Economic Theory and an Application* (Boston, MA: Kluwer Academic Publishers.)
- Balk, B. M. (2021) "Productivity Measurement with Data Envelopment Analysis and Stochastic Frontier Analysis: A Review Article on Measurement of Productivity and Efficiency: Theory and Practice," *International Productivity Monitor*, Vol. 40, Spring, pp.134–39.
- Bol, G. (1986) "On Technical Efficiency Measures: A Remark," *Journal of Economic Theory*, Vol. 38, No. 2, pp. 380–86.
- Dmitruk, A. V. and G. A. Koshevoy (1991) "On the Existence of a Technical Efficiency Criterion," *Journal of Economic Theory*, Vol. 55, No. 1, pp. 121–44.
- Färe, R., X. He, S. K. Li and V. Zelenyuk (2019) "A Unifying Framework for Farrell Profit Efficiency Measurement," *Operations Research*, Vol. 67, No. 1, pp. 183–97.
- Färe, R. and C. K. Lovell (1978) "Measuring the Technical Efficiency of Production," *Journal of Economic Theory*, Vol. 67, No. 19, pp. 150–62.
- Färe, R. and D. Primont (1995) *Multi-Output Production and Duality: Theory and Applications* (New York, NY: Kluwer Academic Publishers.)
- Mayer, A. and V. Zelenyuk (2019) "Aggregation of Individual Efficiency Measures and Productivity Indices," in ten Raa, T. and W. H. Greene, editors, *The Palgrave Handbook of Economic Performance Analysis*, Springer International Publishing, pp. 527–57.
- Ray, S. C., R. Chambers and S. Kumbhakar (2020) *Handbook of Production Economics* (Singapore: Springer Singapore.)
- Russell, R. R. (1990) "Continuity of Measures of Technical Efficiency," *Journal of Economic Theory*, Vol. 51, No. 2, pp. 255–67.
- Sickles, R. C. and V. Zelenyuk (2019) *Measurement of Productivity and Efficiency: Theory and Practice* (Cambridge: Cambridge University Press.)
- Shephard, R. W. (1953) *Cost and Production Functions* (Princeton, NJ: Princeton University Press.)
- Shephard, R. W. (1970) *Theory of Cost and Production Functions, Princeton Studies in Mathematical Economics* (Princeton, NJ: Princeton University Press.)
- Ten Raa, T. and W. H. Greene, (2019) *The Palgrave Handbook of Economic Performance Analysis*, Springer International Publishing.
- Zieschang, K. D. (1984) "An Extended Farrell Technical Efficiency Measure," *Journal of Economic Theory*, Vol. 33, No. 2, pp. 387–96.