



Book Review: The Aggregate Production Function and the Measurement of Technical Change: 'Not Even Wrong'

Felipe, J. & McCombie, J.S.L. (2013). *The Aggregate Production Function and the Measurement of Technical Change: 'Not Even Wrong'*. Cheltenham, UK and Massachusetts, USA: Edward Elgar Publishing. 400 pages. ISBN: 978-1-84064-255-1.

Although commonly used in economic research, the concept of the aggregate production function is extremely problematic. First, it lacks sound theoretical foundations, and second, its use in applied work faces the insurmountable problem that the output and input data used are linked through an accounting identity. This book discusses these flaws using examples from well-known applications in the literature.

The aggregate production function is one of the main tools that undergraduate students encounter in their first macroeconomics classes. Graduate courses go on with it as part of the toolkit used to explain growth, productivity and employment, among others, and treat it without questioning its foundations. However, there is a large literature that, for decades, has questioned the microeconomic foundations of aggregate production functions, in the sense that the conditions to aggregate microeconomic production functions into an aggregate production function are so stringent that one cannot believe that they are satisfied by actual economies. Nevertheless, these arguments have been ignored, and generations of economists have been trained believing that this concept is sound and, consequently, used it in both theoretical and empirical applications.

Felipe and McCombie's book provides a thorough and well-structured analysis of the problems that surround the use of aggregate production functions, especially in empirical analyses. They prove that the comparison of predictions based on aggregate production functions and actual observations is insufficient to decide whether this concept works. This is because the data on output, labour, and capital used to estimate aggregate production functions are linked through the accounting identity that relates value added to the sum of the wage bill plus profits. Through a simple algebraic transformation, the identity

can be rewritten in a form that resembles a typical production function. Given this logical flaw, and paraphrasing the physicist Wolfgang Pauli, Felipe and McCombie argue that the aggregate production function is 'not even wrong'.

The book is highly recommended to researchers in macroeconomics and in all related fields that use aggregate production functions (e.g., growth, labour, productivity). It contains 12 chapters. The first three cover the general arguments why the concept suffers from various problems, including a discussion of the Cambridge debates and the aggregation problems. These chapters are highly relevant for intermediate and advanced macroeconomics courses. The following nine chapters discuss special topics, all of them problematic applications of aggregate production functions in different areas, for instance, total factor productivity, growth accounting, labour demand, or the analysis of market power.

The book opens with an introduction and summary of the topics covered in the various chapters. Chapter 1 deals with the problems of aggregation and revisits the Cambridge capital controversies, Samuelson's surrogate production function, and the problem of capital reversing. The authors show that conditions for a consistent aggregation of heterogeneous capital goods, of different types of labor, and of different outputs, are so stringent that they cannot be expected to be met in the real world.

Chapter 2 is devoted to the heart of their critique, that is, the accounting identity (which holds at any level of aggregation) and the erroneous use of constant-price value data for capital (J) instead of physical quantities (K). By definition, value added (V) is equal to the total wage bill (wL) plus capital incomes (rJ), such that $V_t \equiv w_t L_t + r_t J_t$. Partial differentiation of this expression implies that the observed factor share of labour ($a_t \equiv \frac{w_t L_t}{V_t}$) must equal the elasticity of labour $\frac{\partial V_t}{\partial L_t} \frac{L_t}{V_t} \equiv \frac{w_t L_t}{V_t} \equiv a_t$ derived from any production function estimation. Furthermore, total differentiation of the accounting identity and expressing it in growth rates (indicated by a hat) yields: $\hat{V}_t \equiv a_t \hat{w}_t + (1 - a_t) \hat{r}_t + a_t \hat{L}_t + (1 - a_t) \hat{J}_t$. Now if in this economy factor shares are constant, integration of the last equation results in $V_t \equiv A_t L_t^a J_t^{1-a}$, with $A_t = w_t^a r_t^{1-a}$. This is, of course, the accounting identity, not a 'Cobb-Douglas production function". As a matter of logic, therefore, the estimation of the last expression with actual data will simply pick up the accounting identity. Very importantly,

the argument is generalized (i.e., it is not just for the Cobb-Douglas function) such that any other functional form resembling, for example, a CES or a translog, can be derived by a suitable transformation of the identity.

Chapter 3 reviews various simulation studies and explains why the estimation of aggregate production functions necessarily implies plausible results. It is shown to be due to the underlying accounting identity, and not to the estimation of an underlying technology. The remaining chapters of the book discuss special issues in greater detail and explore the problems encountered by the use of aggregate production functions in macroeconomic models. Chapter 4 gives an account of the original article of Cobb and Douglas (1928) and shows, using the original data set, that all that this famous exercise did was to pick up the identity. Chapter 5 continues with an appraisal of Solow's (1957) paper on the measurement of technical change and the growth accounting approach. Again, Felipe and McCombie show that Solow's results are entirely driven by the accounting identity underlying Solow's data. Chapter 6 focuses on total factor productivity as measurement of technical progress. Total productivity growth is, through the national accounts, identical to the weighted average of the growth rates of the wage and profit rates, what neoclassical economics refers to as the dual measure of technical progress. Chapter 7 reconsiders the Mankiw-Romer-Weil model (1992) and its relation to the critique. The authors also derive the equation that Mankiw-Romer-Weil estimated by transforming the accounting identity.

Chapter 8 discusses the use of aggregate production functions in the neoclassical dual-sector growth model, and chapter 9 investigates the externality effects of capital in endogenous growth models. Felipe and McCombie show that when constant-price values are used instead of physical quantities, factor elasticities must be close to their corresponding income shares and thus sum up to one. Empirical tests, therefore, should fail to show increasing returns to scale. They explain that, at times, economists find increasing returns because the function they estimate is a bad approximation to the data (the identity). Chapter 10 shows that Hall's (1986) approach to test the existence of market power (which he finds) is also flawed due to the underlying accounting identity that relates the data. Chapter 11 reveals that labour demand functions derived from production functions are mere statistical artefacts. Finally, chapter 12 reviews why the critique of the aggregate production function

has been ignored for so long. Joan Robinson (1975, p. 32) questioned “*How is it possible to have a controversy over a purely logical point*”, a view that is shared by Felipe and McCombie. They also respond to several points put forward in favour of the aggregate production function and sum up their arguments.

Overall, the book makes an extremely valuable contribution to the understanding of the aggregate production function and its erroneous applications in macroeconomics. It comprises 400 well-structured pages: having read the primary chapters 1 to 3, readers will easily navigate through the remaining of the book. Not every researcher might be interested in all of the particular questions dealt with in these further chapters, but the short introduction and conclusions in each chapter provide an informative overview of these issues discussed. The basic ideas are thus easily grasped without dealing with technicalities. I recommend the book to all researchers working with production functions, and in particular to instructors, both at the graduate and undergraduate levels. It is time to raise the awareness about the fundamental problems of this concept and properly educate future economists.

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