

Title: *Measurement Problems with Non-Invariant Economic Index Numbers of Outputs, Inputs, and Productivity: The Case of Italy*

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This paper is focused on measurement problems with composite index numbers of outputs, inputs, and productivity when input and output aggregation conditions are not satisfied. The discussion is aimed at devising a general framework where nonseparable outputs and inputs can be aggregated together and an invariant measure of technical change can be obtained. In economic theory, it is well-known that price and quantity aggregates of inputs and outputs exist if and only if the underlying functions are homothetically separable. Under this condition a composite quantity index can be constructed with the required property of linear homogeneity (a scalar change in all elementary quantities changes the index by the same proportion), while its “dual” composite price index is independent from reference variables. In production activities, constant returns to scale and Hicks-neutral technical progress leave the price indexes invariant with respect to the output levels and technical change. By contrast, in the general non-homothetic case, any attempt to define composite indexes of outputs, inputs and total factor productivity ends up to path-dependent magnitudes that are not robust to measurement choices. In the current state of the art of index numbers, this difficulty is assumed to be circumvented by adopting implicitly “approximating formulas”. In this paper, we show that this is not correct and an alternative method based on the use of profit functions is introduced. This does not separate a priori inputs and outputs and permits us to construct net aggregates that are always linearly homogeneous even in the non-homothetic case. This method is applied empirically to the data of the Italian industries using the newly built database of the EUKLEMS project. Homotheticity seems to be the exception rather than the rule during the period 1970-2003 and the results obtained are contrasted with those of traditional approaches that assume homothetic input-output separability. Although these alternative measures are not fully comparable, we conclude that the TFP decline recently reported in Italy is not confirmed in size and direction by our findings on technical change.