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Homogeneity Restrictions on the Translog Cost Model: A Note

ASGHAR ZARDKOOHI, NANDA RANGAN, and JAMES KOLARI*

BENSTON, HANWECK, AND HUMPHREY (BHH) [1] first applied the translog cost model to empirical analyses of depository institutions' cost characteristics. Subsequent studies by Benston, Berger, Hanweck, and Humphrey (BBHH) [2], Murray and White [7], Gilligan and Smirlock [4], and Gilligan, Smirlock, and Marshall (GSM) [5] have employed this type of flexible form cost function. As a regularity condition, the translog cost model should be linearly homogenous in all input prices. That is, given the following translog cost function:

$$\ln C = \alpha_0 + \sum_i^n \alpha_i \ln Y_i + \sum_j^m \beta_j \ln P_j + \frac{1}{2} \sum_i^n \sum_k^n \sigma_{ik} \ln Y_i \ln Y_k \\ + \frac{1}{2} \sum_j^m \sum_h^m \gamma_{jh} \ln P_j \ln P_h + \sum_i^n \sum_j^m \delta_{ij} \ln Y_i \ln P_j, \quad (1)$$

where C = total operating costs, Y_i = quantity of i th output, and P_j = unit price of j th factor input, homogeneity requires that:

$$\sum_j^m \beta_j = 1, \quad (1a)$$

$$\sum_j^m \delta_{ij} = 0, \quad (1b)$$

and

$$\sum_j^m \gamma_{jh} = 0, \quad (1c)$$

where $\gamma_{jh} = \gamma_{hj}$ by symmetry.

Unfortunately, the studies cited above by Murray and White and GSM report results that do not meet all of these restrictions. For example, in Murray and White there are three outputs and four input prices, which implies the following set of restrictions:

$$\delta_{11} + \delta_{12} + \delta_{13} + \delta_{14} = 0, \quad (2a)$$

$$\delta_{21} + \delta_{22} + \delta_{23} + \delta_{24} = 0, \quad (2b)$$

and

$$\delta_{31} + \delta_{32} + \delta_{33} + \delta_{34} = 0. \quad (2c)$$

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However, in Table II [7, p. 896], neither the simultaneous system nor the OLS equation results satisfy these restrictions. For the cross products of factor prices, they should have

$$\gamma_{11} + \gamma_{12} + \gamma_{13} + \gamma_{14} = 0, \quad (3a)$$

$$\gamma_{21} + \gamma_{22} + \gamma_{23} + \gamma_{24} = 0, \quad (3b)$$

$$\gamma_{31} + \gamma_{32} + \gamma_{33} + \gamma_{34} = 0, \quad (3c)$$

and

$$\gamma_{41} + \gamma_{42} + \gamma_{43} + \gamma_{44} = 0, \quad (3d)$$

where $\gamma_{12} = \gamma_{21}$, $\gamma_{13} = \gamma_{31}$, $\gamma_{14} = \gamma_{41}$, $\gamma_{23} = \gamma_{32}$, $\gamma_{24} = \gamma_{42}$, and $\gamma_{34} = \gamma_{43}$, but this is not the case.

In checking other studies for this problem, we found that GSM state the restrictions relating to the cross products of two outputs and two input prices as $\rho_{11} + \rho_{12} + \rho_{21} + \rho_{22} = 0$, where ρ_{ij} is the coefficient for the i th input price and the j th output quantity. However, this restriction should be $\rho_{11} + \rho_{21} = 0$ and $\rho_{12} + \rho_{22} = 0$. Table 1 [5, p. 401] of their paper confirms this misspecification.

We should note also that Denny and Pinto [3, p. 254] appear to have misstated the same restrictions as GSM (or there is a typographical error). They state that, given k outputs and i input prices, $\sum_k \delta_{ik} = 0$, which should be written instead as $\sum_i \delta_{ik} = 0$. It is not known whether or not this misspecification affected the results of empirical analyses presented later in their paper (since, in addition to linear homogeneity in factor prices, their model is linearly homogenous in outputs).

BHH [1, p. 437] observed that the restrictions for symmetry and input price homogeneity were not significant in their paper and noted that scale estimates were therefore unaffected. In a recent paper by Kolari and Zardkoohi [6], the restrictions were found to be significant, and runs in which the restrictions were misspecified (e.g., the GSM restrictions were used) revealed different scale estimates (and associated levels of significance). Hence, the correct specification of homogeneity restrictions on the translog cost model can influence the empirical results (but not necessarily). It is not known, therefore, to what extent the results reported by Murray and White and GSM were affected by this problem. Until further empirical evidence is published on the subject of scale and scope economies for depository institutions, caution should be exercised in drawing public policy (or other) inferences from the aforementioned studies.

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