Technical Change in Northern Ireland Manufacturing 1950-1968: A Comment*

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RECENTLY in this *Review*, McCullough (1974) has presented a useful and interesting analysis of technical change in Northern Ireland Manufacturing during the period 1950-1968. A major part of his analysis consisted of estimation of the Cobb-Douglas production function, adjusted to permit measurement of both disembodied and embodied technical change. However, as noted by McCullough, a well-known shortcoming of such an analysis is the assumptions of unitary elasticity of substitution between capital and labour, and only neutral technical change taking place. The object of this comment is to briefly report some problems encountered in attempting to relax these two assumptions.

An analysis based upon the CES or VES production functions allows for the possibility of non-unitary elasticity of substitution and, in addition, permits estimation of both the neutral and non-neutral components of technical change (for example, see Brown and de Cani (1963) and Revankar (1971b) respectively). Thus, in an attempt to extend McCullough's analysis, an estimate of the VES production function was made. The particular version of the VES function utilised was that derived by Revankar (1971a) which postulates a linear relation between the elasticity of substitution (δ) and the capital-labour ratio. Moreover, the VES function estimated was adjusted to allow for different vintages of capital as well as permitting the occurrence of both neutral and non-neutral technical change. In particular, "effective" capital was constructed by depreciating existing capital using an obsolescence as well as a deterioration factor. (This construction

of effective capital meets Jorgenson's (1966) point that the rate of embodied technical change is a rate of change in an index of the error in valuing capital goods when computing total factor productivity. The implication is that all technical change now appears to be disembodied. See also Carlson (1971). Furthermore, an estimate of the capital-price variable was used as an instrumental variable, in the estimation of the familiar expansion path side relation, in an attempt to avoid the bias which results from generating the capital price variable residually (i.e., the quasi-rent definition makes the price of capital an endogenous variable, and also biases δ towards zero as a result of the transitory fluctuations in profits.)

The estimation of the above VES production function generated, however, inconclusive results—in particular, negative elasticities of substitution were obtained. These negative values may be the result of the depressing effect of aggregation bias (for example, see Koutsoyiannis (1973))—with low elasticities such bias may generate negative values. Empirical estimates, by Lovell (1973), indicate that such downward bias of δ may be considerable. Another possible explanation of the negative values is that the data may contain parts of two different technological epochs. Thus, while the VES function estimated permits non-neutral technical change to take place, the data may contain two technological epochs which possess significantly different non-neutral technical change. In other words both Usherian and Schumpeterian technical change may be present in the data. However, VES estimation within such epochs did not affect the negative δ result (for method of epochal analysis see Glass (1973)).

A further theoretical explanation of the negative estimate of δ has been recently provided by Atkinson (1975). This explanation relies upon the presence of supply constraints on the part of capital-goods producers and the necessarily time-consuming processes of drawing up, placing, and filling orders for the delivery of capital equipment—the net result being an inability to adjust quickly. Hence, for a given level of output, the adjustment of factor proportions will be less than otherwise, biasing the estimate of δ downward from its *ex ante* value. Higher levels of output can be generated through the more intensive use of the existing capital equipment by hiring additional labour per unit of capital. In the latter instance, a negative estimate for δ is quite possible. However, whilst this is a valid argument, it apparently does not fully explain the VES results for Northern Ireland Manufacturing, since estimation of an aggregate CES production function provides a positive (though very small) estimate of δ. (In the CES esitmation it was assumed that all technical change is strictly factor-augmenting, but not necessarily neutral, and that this growth in the productivity of capital and labour inputs is exponentially smooth. This assumption is necessary to identify δ—see Nerlove (1967).) The different estimates of δ for the VES and CES functions indicate the sensitivity of such estimates to differences in the specification of the estimating equations.

The CES results, moreover, indicate that the Cobb-Douglas assumptions of unitary δ and neutral technical change are not empirically valid—the results obtained give a value of δ that is less than one, and also show that capital-using

technical change is present. However, whilst these results urge caution in interpreting the Cobb-Douglas estimates, the above comments, concerning the VES estimates, indicate that application of a more sophisticated production function is not satisfactory either. The problems may be due simply to measurement errors in the data, or more fundamentally to the appropriateness of the production function framework within which the parameters are estimated at the aggregate level.

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REFERENCES

ATKINSON, LLOYD C., 1975. "Empirical Estimates of the Elasticity of Factor Substitution: Some Economic Considerations", *Southern Economic Journal*, Vol. 41, No. 3, January.

BROWN, M. and J. S. DE CANI, 1963. "A Measure of Technological Employment", *Review of Economics and Statistics*, Vol. 45, November.

CARLSON, J. A., 1971. "Technical Change and the Pied Piper", *Applied Economics*, Vol. 3.

GLASS, J. C., 1973. "Factor Substitution and Demand for Labour in the Northern Ireland Engineering Industry", *Statistical and Social Inquiry Society of Ireland*, Vol. XXII, Part IV, 1971–72.

JORGENSON, D. W., 1966. "The Embodiment Hypothesis", *Journal of Political Economy*, February.

KOUTSOYIANNIS, A., 1973. *Theory of Econometrics*, ch. 12, 1.2. London: Macmillan.

LOVELL, C. A. KNOX, 1973. "A Note on Aggregation Bias and Loss", *Journal of Econometrics*, Vol. 1.

MCCULLOUGH, A., 1974. "Technical Change in Northern Ireland Manufacturing 1950–68", *Economic and Social Review*, Vol. 5, No. 2, January.

NERLOVE, M., 1967. "Recent empirical studies of the CES and related production functions" in: M. BROWN (ed.), *The Theory and Empirical Analysis of Production*, New York: Columbia University Press for the National Bureau of Economic Research.

REVANKAR, N. S., 1971a. "A Class of Variable Elasticity of Substitution Production Functions", *Econometrica*, Vol. 39, No. 1, January.

REVANKAR, N. S., 1971b. "Capital-Labour Substitution. Technological Change and Economic Growth: The U.S. Experience, 1929–53", *Metroeconomica*, Vol. 22, August.

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