

CAPITAL UTILISATION IN ECONOMIC DEVELOPMENT: A COMMENT¹

ONE of the more perplexing “stylised facts” of less developed economies is the generally low rate of capital utilisation. Since this subject has received surprisingly little attention, Professor G. C. Winston’s recent article (1971), providing empirical evidence that was “consistently compatible with an essentially economic analysis of capacity utilisation” (*ibid.*, p. 51), was a welcome addition to the literature. It is the purpose of this note to investigate further the connection between neo-classical economic theory and the empirical specification used by Winston. In our opinion, the cross-sectional data available to Winston cannot be employed to test hypotheses deriving from Marris’ provocative work (1964) on the determinants of utilisation rates in England. However, the data are consistent with the implications of organisation theory.

I. NEO-CLASSICAL APPROACH

Following Marris, Winston suggests that entrepreneurs can choose among a number of techniques that vary in the amounts of labour that co-operate with machines. In addition, a premium has to be paid to persuade labour to work the less preferable shifts. The entrepreneur will choose a technique and the number of shifts to be operated so as to minimise the unit costs of production.

To develop the “theory” the technological environment has to be depicted. Although the paper begins with a discussion of the impact of utilisation on growth that assumes a constant capital-output ratio, the hypothesis to be tested is developed in the context of a production function that has the usual neo-classical properties. Firms can “increase labour productivity by giving labour more capital to work with” (Winston, 1971, p. 39). It is implicit that there are static expectations and that actual sales are at the level expected when investment is undertaken since the explanation of excess capacity is not to be sought in “uncertainties of demand estimation” (*ibid.*, p. 38).²

¹ Financial assistance from the International Development Research Centre is gratefully acknowledged. However the views expressed herein are a result of independent research and do not necessarily represent the views of the Centre.

² That the technology cannot generally be compressed in this neo-classical way is one of the positive analytical contributions to capital theory that has emerged from the Cambridge-Cambridge debate (Harcourt, 1972). “Perfectly sensible economic decisions” (Winston, 1971, p. 38) by entrepreneurs, minimising their unit costs while constrained by a plausible technology, may result in less capital-intensive techniques being adopted when wages are higher relative to the rate of return on capital, in a comparison of equilibrium states. Many unexceptional technologies cannot be suppressed into a neo-classical production function exhibiting diminishing returns to capital. The inconsistency of data with a hypothesis based on “perfectly sensible economic decisions” made

An extremely neo-classical specification would assume that capital is instantaneously malleable. If this were the case, the number of workers that would operate the capital equipment would vary from shift to shift. Assume instead that capital is malleable in the *ex ante* sense but not *ex post*, *i.e.*, that once a technique is chosen, a determinate amount of labour is required to operate the equipment. Capital equipment can only be rented for the day at a rental price of r and the entrepreneur has a choice of operating with one or two shifts. A unit of labour costs w for the first shift; an equivalent unit of labour costs mw for the second shift where m is greater than 1 and reflects institutional restrictions and the unpopularity of the shift. The costs per unit of operating with one shift will be compared to the costs per unit of operating with two shifts and the cost-minimising entrepreneur will choose the appropriate pattern of production. Because of the *ex ante* substitution different amounts of capital per man will be rented if it is decided to operate with two shifts rather than one.

In Winston's paper it is assumed that a general rise in real wages, *ceteris paribus*, will result in a reduction in the utilisation rate and capital deepening. It is assumed that the elasticity of utilisation is negative and the elasticity of mechanisation¹ is positive for a neo-classical technology and the response of entrepreneurs to rising wages depends on the relative size of the two elasticities.

Clearly, positive instead of negative elasticities of utilisation are possible for neo-classical production functions. In Table I the results of an example of this are summarised. The technology is represented by the CES production function $X = [\frac{1}{2}K^{\frac{1}{2}} + \frac{1}{2}L^{\frac{1}{2}}]^2$ where X is the flow of output per shift. It is assumed that the shift premium is such that a worker is paid twice as much for providing his services on the second shift. The cost to produce one unit of output *per day* is calculated² for three different wage configurations: (0.5, 1) (1, 2) and (1.5, 3) where the ordered pairs reflect wages for the first and second shift. The rental for a unit of capital for one day is 3.

In Table I the first two columns summarise the calculation of unit costs for one shift and two shift operations when wages are 0.5 and 1 in the two shifts. The middle pair of columns and the last pair of columns repeat the

in a neo-classically depicted technical environment may just indicate that the paradigm for technology is inadequate and need not reflect on the rationality of decision-makers. However the issue stressed in our subsequent discussion is that *assuming the neo-classical production paradigm* one would not necessarily expect the outcomes that Winston anticipated.

¹ The elasticity of utilisation is defined as the % change in utilisation rate divided by the % change in average hourly wage and the elasticity of mechanisation as the % change in output per man hour divided by the % change in capital per employee.

² The unit cost for one shift operation was calculated by minimising

$$wL + rK - [(\frac{1}{2}K^{\frac{1}{2}} + \frac{1}{2}L^{\frac{1}{2}})^2 - 1]$$

The unit cost for two shift operation was calculated by minimising

$$wL + mwL + rK - [2(\frac{1}{2}K^{\frac{1}{2}} + \frac{1}{2}L^{\frac{1}{2}})^2 - 1]$$

calculations as wages rise to 1 and 1.5 in the first shift and to 2 and 3 in the second shift.

Since equilibrium states are being compared, the own wage rises with the general increase in money wages. However as wages rise in the first shift from 0.5 to 1.5 and in the second from 1 to 3, it will become cheaper per unit to operate two shifts instead of one. In Winston's terms, there is a positive elasticity of utilisation. Generally rising wages may as this example shows be accompanied by *increased* utilisation as well as capital deepening. The direction of response of utilisation rates to rising wages will of course depend on the specific nature of the neo-classical technology as specified in the production function.¹

TABLE I

Comparison of Unit Costs of One Shift and Two Shift Operations as Wages Rise

	Wage Regime (0.5, 1).		Wage Regime (1, 2).		Wage Regime (1.5, 3).	
	One shift operation.	Two shift operation.	One shift operation.	Two shift operation.	One shift operation.	Two shift operation.
Wage for shift one	0.5	0.5	1.0	1.0	1.5	1.5
Wage for shift two	1.0	1.0	2.0	2.0	3.0	3.0
Daily rental price per unit of capital	3	3	3	3	3	3
Shift one: labour hired per unit of capital	36	4	9	1	4	0.44
Shift two: labour hired per unit of capital	nil	4	nil	1	nil	0.44
Total costs per unit of capital	21	9	12	6	9	5
Daily output per unit of capital	12.25	4.5	4	2	2.25	1.39
Total costs per unit of output	1.71	2.0	3.0	3.0	4.0	3.6

In Winston's article (1971) a positive elasticity of mechanisation and the assumption of a negative elasticity of utilisation imply that the correlation between changes in capital-output ratios and utilisation rates in response to rising wages will not be positive. If data *on a time series basis* had been available, Winston presumably would have anticipated a negative sign for the coefficient of the capital-output ratio in a regression explaining the utilisation rate *for an industry*. As the above example illustrates, neo-classical production theory can just as well involve a positive sign for this coefficient. However in the actual cross-sectional regression run by Winston, he expects a positive sign for this coefficient for reasons that are discussed below.

Even if the neo-classical technology were such that the elasticity of

¹ Professor Winston has sent us an article, co-authored with Thomas O. McCloy which is scheduled to be published in the *Review of Economic Studies*. In that article an elegant general analysis is presented that agrees with our conclusion but the implications of those conclusions for the earlier empirical work by Winston are not drawn. (See also G. C. Winston, *Capital Utilisation, Investment and Employment* (mimeographed).)

utilisation was negative the meaning of Winston's cross-sectional regression is not clear. Winston derives a hypothesis about the sign of the capital-output coefficient in a regression explaining the utilisation rate in the following way. The economy in the year of the regression is assumed to have adjusted to a previous wage increase. Some industries will have adjusted by stressing capital-deepening relative to reducing utilisation rates. Other industries would have emphasised adjusting by reducing the number of shifts. To measure capital-deepening as a means of increasing labour productivity the capital-output ratio per shift would be appropriate. Winston, however, uses the "ratios of real value of assets to value added for West Pakistan *unadjusted for capacity use*" (1971, p. 55). The capital-output ratio then responds to changes in capacity use; such changes would not be positively correlated with changes in output per man-shift.¹

Suppose, for the moment, that the capital-output measure used by Winston is an appropriate measure of capital deepening. Would the rational reactions of entrepreneurs in a restricted neo-classical production environment to a previous wage increase result in a positive correlation between the utilisation rate and the capital-income ratio?

Suppose we have three industries in the economy. Before the wage increase, they all have adopted the same utilisation rate and the same capital intensity. Each industry responds differently to the wage increase. Industry 1 only increases its capital intensity while industry 3 only decreases its utilisation rate. The second industry does a bit of both. (The observations in the year after the change are marked as X_i 's in Fig. 1 (a).) A positive correlation would be observed between the utilisation rate and the capital-income ratio in this situation, but this is not the only possible configuration.

In Fig. 1 (b) all industries start with the same utilisation rate but different capital intensities. The *reaction* to the wage increase is the same as depicted in 1 (a) but the observations in the year after the change are now negatively correlated. Restrictions on the original situation and on the responses to the change in wages are necessary if Winston's predicted correlation is to be realised in a world of rational men.

To conclude this section,² the hypothesis concerning the relation of the

¹ Marris, using 1951 United Kingdom data, does not confound the two effects: "a typical shift-working operative may have behind his elbow two to three times as much fixed capital as a non-shift worker. On the other hand, capital which is operated on a shift system is used by two or three times as many workers daily as other capital." *Op. cit.*, p. 136.

² An additional minor issue can also be raised. Winston claims that he is working in the "as if" methodological tradition. The Pakistan economy is assumed to have reacted as if the wage rate had risen. The "as if" approach is usually applied to the objective function being maximised. Entrepreneurs react "as if" they were maximising wealth; consumers react "as if" they were maximising utility. One justification used by advocates of the "as if" approach is that motivations cannot be measured. (Coddington, although not an advocate, concisely summarises this view [1972, pp. 7 and 8].) It hardly seems to be an assumption applicable to changes in the objective constraints facing decision makers. The wage in Pakistan either decreased or increased. Surely one must determine what past experience was and not assume that past economic variables acted in a particular way.

utilisation rate to capital intensity cannot be derived even when one assumes that the technology can be depicted in the neo-classical manner. Even if the neo-classical technology were restricted to have the properties that Winston required, the *cross-sectional* regression results cannot be related to the hypothesis without further restrictions.

II. ORGANISATION THEORY APPROACH

Can an economic theory of capital utilisation which predicts that the productivity of labour will be lower and the capital-output ratio higher in industries with an above average level of capacity utilisation be developed?

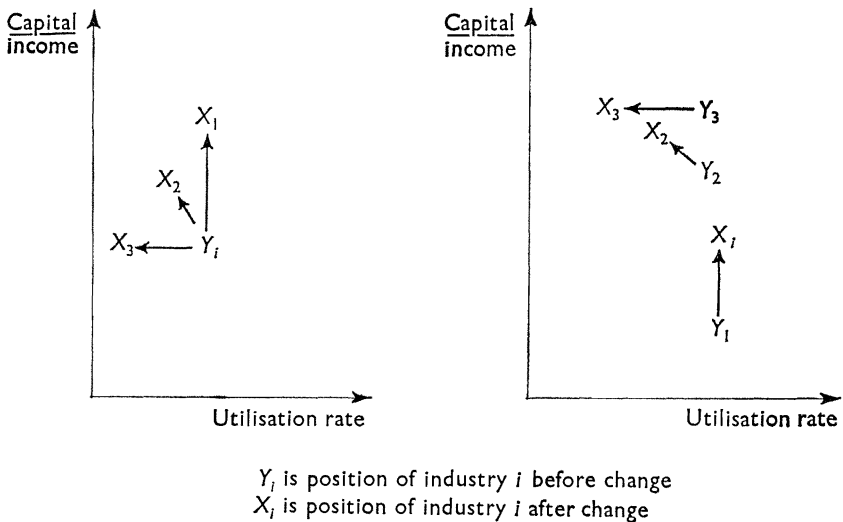


FIG. 1.

At the same time, will the theory be consistent with the findings of both Marris (1964, p. 136) and Winston (1971, p. 44) that there is a positive correlation between the size of the firm and capacity utilisation? We believe that organisation theory can be employed in this context and meet both criteria.

Following Alchian and Demsetz (1972),¹ a manager can be regarded as a monitor who earns his income by "metering input productivity and metering rewards" (*ibid.*, p. 778). In most cases a worker is paid an hourly wage so that this pecuniary income does not depend upon his effort or productivity on the job. The wage earner thus has an incentive to shirk, to increase his consumption of non-pecuniary income which, if undetected, is not at the expense of pecuniary income. The function of the monitor is to check the input performance of employees so that shirking does not go undetected. In

¹ See also Williamson (1970), McManus (1971) and the references cited therein.

short, given a fixed amount of equipment per worker, the productivity of labour depends upon management.

But if workers have an incentive to shirk, so do the managers. "Who will monitor the monitor?" (*ibid.*, p. 782). In the classical firm of economic theory, the monitor has an incentive not to shirk because the profits of the enterprise are his income. The owner/manager/monitor of a firm has a claim to any residual product not paid to the owners of other factor inputs. He "earns his residual through the reduction in shirking that he brings about" (*ibid.*, p. 782). As Williamson (1970) and other students of organisation theory have pointed out, problems of managerial shirking or "slack" are apt to arise when the pecuniary income of management is independent of the level of profits and when competitive pressures do not discipline managers. When conditions internal and external to the firm are favourable, we can expect to find managers (hence workers) exercising discretionary behaviour at the expense of input productivity and profits.

Consider now the organisational consequences of adding a second shift of operators in an existing plant. A second shift of supervisory personnel must also be added, and two changes in the organisation of the firm are possible. First, one or more of the shift supervisors may share in the residual product of the firm. In this case all managers will have some incentive to shirk, for their individual pecuniary income is less perfectly correlated with individual behaviour: one manager can increase his non-pecuniary income and the cost will be borne in part by others. Secondly, the shift supervisors may be salaried employees, in which case there is no pecuniary constraint on (undetected) shirking in the second shift. In either case, the productivity of factor inputs will fall as a result of control loss. Organisation theory thus implies a *negative* relationship between labour productivity and capital utilisation. This prediction is consistent with the Pakistan data.

The above conclusion must, however, be qualified to the extent that productive activities lend themselves easily to a piece-rate method of payment for labour services.¹ In such circumstances the firm represents not the "suppression of the price mechanism" (Coase, 1937) but rather the substitution of a "private" for a "public" market. If the "private" or intra-firm market is effective, the existence of shift-work should have no effect on labour productivity. Piece-rate systems are most effective when the productivity of one worker does not depend on that of another.² No correlation is thus expected between capital utilisation and labour productivity in an

¹ Marris reports that "in practice, with permanent night-shifts, supervision is often reduced to a minimum, with the result that, contrary to what might be expected, output per man-hour is often increased" (1964, p. 92). But his example is based on an interview with a piece-rate worker.

² In their survey article Opsahl and Dunnette (1966, p. 98) state that "the chief disadvantage with group incentives is the likelihood of a low correlation between a worker's own performance and his pay in larger groups." They also state that there is evidence "that individual output decreases as the size of the work group increases and this is apparently due to workers perceiving a decreased probability that their efforts will yield increased outcomes."

industry such as garment-making, where the wage payment can easily be made a function of productivity. Furthermore, since control loss is more serious when there is more than one shift of workers, piece-rate systems should be more common in plants working more than one shift than in those working only one shift.

Capital intensity is another factor that affects the cost (control loss) of employing more than one shift of workers. Labour productivity is more variable, hence more dependent upon the performance of a monitor, in operator-paced than in machine-paced activities (Hirschman, 1958, p. 145, n. 15). Poor management is thus less apt to result in low productivity when machine-paced techniques are used. Since machine-paced techniques are generally more capital intensive than operator-paced techniques, one can expect a positive relationship between utilisation and the capital-output ratio.

Firms employing capital-intensive techniques of production are apt to be larger than firms employing labour-intensive techniques, so for this reason alone we can expect a positive correlation between firm size and capacity utilisation. The size of the firm does, however, have an independent influence on utilisation, irrespective of the production techniques employed. Small firms are most often controlled by a single proprietor who is the sole monitor of input productivity and normally works only one shift.

The larger the number of persons who are residual claimants in an enterprise, the less serious is the problem of control loss resulting from a second or third shift. When there is only one residual claimant, who cannot be physically present at a plant 16 or 24 hours a day, it is rational to be reluctant to delegate authority. Unless the proprietor has some way of monitoring the performance of a shift manager, he has every reason to expect that the operation of a second shift will not be profitable. As ownership becomes more dispersed, either shift managers may share in the residual product or—when there is separation of ownership and control—control loss may be no greater on a night than on a day shift. In summary, the more dispersed the ownership of the firm, meaning usually the larger the firm, the higher is the level of capacity utilisation.²

One potentially significant explanatory variable that has been neglected in Winston's study is the presence of foreign ownership and control.³

¹ The capital-output ratio referred to here is the reciprocal of the average product of capital per unit of time.

² Marris' discussion of the indivisibilities of management and capital equipment (1964, pp. 80-3, 92-4) complements our focus on the number of persons who share in the residual product of the enterprise.

³ Professor Winston has informed us that he did include a variable defined as the proportion of management that was foreign or Pakistani and was surprised that it was statistically insignificant. The relevant variable, however, would be foreign *control* rather than management, for some international firms are known to recruit locally a large proportion of their managers (Vernon, 1971, p. 149). Moreover, we believe that a cross section study of *firms within an industry* would be a preferable test structure. Data for such a study in Central America are being assembled by Mr. Willmore. Preliminary indications are that the data are consistent with the hypothesis.

Foreign corporations can be expected to utilise capital more intensively than comparable domestic firms in a developing economy for two reasons. First, the foreign firm may employ superior techniques of management, with the result that co-ordination and monitoring of input productivity can be achieved at a lower cost. Secondly, the subsidiary enjoys preferred access to new technology through the parent company, and will thus be the first to adopt new and profitable innovations. Innovations are positively associated with utilisation because intensive capital utilisation will be profitable for an innovating minority provided that other firms imitate and adapt only after a significant time lag.

III. SUMMARY OF CONCLUSIONS

In summary, organisation theory suggests that both the size of the firm and the capital intensity of production have a positive effect on the level of capacity utilisation. Utilisation in turn may have a negative effect on the productivity of factor inputs.

Both the paper by Winston and the study directed by Marris represent pioneering attempts to measure the effect of structural variables on an important aspect of industrial performance. However, we believe that the capital-output ratio as used by Winston is an inappropriate explanatory variable for the reasons outlined in section I. The systematically low levels of capital utilisation in particular industries may reflect the problems of organising and controlling shift operations. The theory of organisation would suggest alternative theoretical reasons for the explanatory power of some of the variables included in Winston's regressions and would suggest some additional variables for future specifications.

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CAPITAL UTILISATION IN ECONOMIC DEVELOPMENT: A REPLY

PROFESSORS WILLMORE and ACHESON have written a very useful paper. I am replying to it not so much to argue with their two points, both of which have much validity, as to suggest that a somewhat different tone and emphasis might better serve the future investigation of capital utilisation. Both Willmore-Acheson (W-A) and I now have the advantage that there has been a good deal of development of both theory and relevant fact since the 1971 article on which they comment (see References). This is important to both of their main points: (1) that the empirical cross section data from Pakistan which I used in that earlier paper do not prove that economic forces influence capital utilisation and (2) that an organisation theory of the firm, based on the recent Alchian-Demsetz (1972) analysis of shirking, could also provide the basis for an explanation.

In taking issue with my use of the empirical evidence from Pakistan, W-A appear to be saying something a good deal more damning than they in fact are saying about the claims of that paper. They are guilty of a stylistic quirk that somewhat overstates their case. It is apparent in their first paragraph. They say (1) that my study described the empirical evidence as "*consistently compatible with*" an economic interpretation of utilisation but (2) that the data "cannot be employed to test [those] hypotheses" while (3) the data (in contrast?) "are *consistent with*" organisation theory. They are quite right. The data are "consistent with" (or "consistently compatible with" in my phrase) *both* the economic interpretation used in the original article *and* the organisation theory they propose. And they are right that the data cannot "test" the hypotheses—either of them. But since no *test* was claimed in the original article, it is hard to see that this is a very telling criticism. At best, W-A offer an alternative theory to explain the puzzling fact that levels of utilisation appeared terribly low in a capital scarce country—an alternative that is also consistent with the data.

But even "alternative" is too strong a word because there is no inherent conflict between their emphasis on organisation and the "essentially economic" framework of the original article; the picture of the firm drawn