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Economic aspects of shift and night work in industrialised market economies [1]

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Previous papers in the *International Labour Review* have examined economic aspects of shift work predominantly from the point of view of developing countries [2] and partly from the perspective of centrally planned economies.[3] In the former case the development of shift work can be regarded as one means of generating employment opportunities in a situation of capital scarcity and labour abundance, whilst in the latter case it has been seen as an indispensable part of economic planning, a stimulus to labour productivity as well as a means of economising on scarce capital.

In the industrialised market economies, on the other hand, growing concern with the quality of working life has called into question the further development of shift work, particularly at inconvenient hours or at night. It is natural that, as economic development causes real incomes to rise, employees should not only choose to substitute leisure for income but also more pleasant for less pleasant working conditions, amongst which will be included inconvenient hours of work. Further, there has, in some countries, been growing concern at the social and physiological consequences of shift (particularly night work) operation. Thus in France, as a result of a government decision, there is to be no further extension of shift work except where it is absolutely necessary on account of technological factors.[4] More generally Carpentier and Cazamian [5] have recommended that night work should be banned wherever it has been instituted solely on cost considerations and suggest that efforts should be made to minimise harmful effects on the worker in cases of continuously operating industries and permanent public utility services.

In many countries, moreover, equality of opportunity legislation concerned with the sexual division of labour has led to a reconsideration of the application of the ILO's Night Work (Women) Convention (Revised), 1948 (No. 89), which forbids the employment of women at night in any public or private undertaking other than solely family concerns.[6] There is as yet, however, no consensus on the question whether the protective measures relating

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to women should be repealed, new protective measures relating equally to both sexes introduced or protection limited to married women or women with family responsibilities. In part the resolution of this dilemma may be influenced by the fact that rising levels of unemployment in many industrialised market economies have made it more difficult to contemplate major reductions in shift work, because of the unemployment-creating implications of such a policy. These developments do, however, point to a need to examine carefully both the current extent of and trends in shift work and the economic implications of relevant policy initiatives.

The extent of shift work

Unlike the situation with regard to such economic indicators as earnings, employment, hours of work and many other variables, few countries publish regular statistical series on the extent of shift working and this means that it is difficult to make comparative studies of its extent across countries.[7] This problem is exacerbated by the fact that shift work itself comprises a wide variety of alternative working arrangements and ideally it is necessary to establish not only the amount of shift work as a whole but also the number of workers affected by various types of system, whether two or three shift, continuous or discontinuous or involving night work on a regular or intermittent basis and so on.[8] As it is, reliance must be placed on various surveys carried out at different points in time and involving different groups of employees in order to make any sort of judgement on the matter.

It has been suggested that the number of shift workers varies from 15 to 30 per cent of the active population according to country and that on average half of all shift workers are employed on three-shift systems, with the implication that all must work at night intermittently (or some of them permanently). Further, where data are available it is estimated as a rough approximation that the growth in the number of workers engaged on shift work between 1950 and 1974 was of the order of 100 per cent.[9]

As far as can be established shift work has been growing in the large majority of industrialised market economies, though there are some interesting differences in its extent and growth between and within these countries. Thus in the Federal Republic of Germany the percentage of shift workers in the total working population grew from 12 to 27.1 per cent between 1960 and 1976; in French manufacturing the proportion of shift workers among manual workers increased from 17.8 per cent in 1959 to 31.3 in 1974; in the United Kingdom the percentage of male manual workers (all industries and services) in receipt of shift work premium payments rose from 19.3 in 1968 to 23.2 in 1976, whilst the corresponding figures for women were 7.3 and 11.2, and in Sweden the percentage of shift workers among all workers in the metal industries rose from 13 in 1957/58 to 21 in 1972. In Norway, by contrast, the percentage of men in manufacturing and mining engaged on shift work rose only moderately from 20.4 in 1950 to 24.4 in 1971 and that of women

from 12.2 to 13.0, whilst in the Netherlands the percentage of industrial shift workers rose only from 10.2 in 1963 to 10.3 in 1972 and in Japan the percentage of shift workers actually fell between 1970 and 1975 from 12.7 to 12.4. It is estimated that there were nearly 3 million night-shift workers in the Federal Republic of Germany in 1972, 2 million in France in 1974, between 1.5 and 1.8 million in the United Kingdom in 1976, possibly 150,000 in Sweden in 1973, 70,000 in the Netherlands in 1972 and 12,000 in Norway in 1971. There are correspondingly significant differences between countries in the percentage of shift workers employed at night.[10]

Within particular economies the degree of shift work will be influenced by the size and stage of development of the industrial sector, though there are important instances of shift work in the service sector (e.g. transport and health services), where the deficiency in statistical data is most marked. In this respect we should recognise that shift work has three conceptually distinct causes—cost, technology and demand—and economic analyses based on the enterprise's production function tend to obscure this fact. Partly stemming from these factors a far greater percentage of manual than non-manual employees are subject to such arrangements, though there may be some tendency for the extent of shift working in the latter group to increase. Clearly, in the absence of regular statistical series on the above aspects of shift work, it is not possible to estimate, amongst other things, the likely net costs to the economies of such countries resulting from a change in shift work patterns.

Factors determining the profitability of shift work

It is necessary in the first instance to distinguish between two situations facing the firm. In the long run, as part of its investment decision, the firm has to select an appropriate size of plant to meet the estimated demand for the product in the light of the fact that the larger the number of shifts it utilises the smaller the size of plant required. In the short run the size of plant is given, but it may still be possible to vary output by changing the number of shifts in operation. Marris,[11] for instance, notes that businessmen often explain their failure to utilise shift work by the fact that the market for the product is limited. But this does not explain the failure to build smaller plants and operate them on the basis of multiple shifts. Here, one survey [12] failed to find a single case where a firm had gone on to double shifts with the intention of producing the same output with a smaller plant, suggesting that, apart from problems of indivisibilities, changes in shift patterns come most easily to expanding firms. It is possible that there is a lack of perfect foresight in such cases or that economies of scale rule out the smaller plant. Many economic analyses have concentrated on the *ex ante* problem of selecting the appropriate size of plant and are therefore long-run theories. But as Bosworth and Dawkins [13] note, it is unlikely that new shift systems are only introduced at the investment stage (or *ex ante*). Further, we should bear in mind that the construction of new factories represents a very small proportion

of total investment, the majority being concerned with the adaptation of existing plant, and we perhaps require a short-run theory to analyse situations in which firms decide to operate multiple shifts when already committed to a fixed capital stock (or *ex post*). It may also be necessary to consider the problem in a dynamic context. Where demand is growing over time, firms may construct plants which appear too large in the context of current demand, thereby leaving current excess capacity and ruling out shift work for the present, but which in the long run will minimise their costs of production.

The size of market, the number of firms and average firm size may be important determinants of the extent of shift working. By themselves small markets do not appear to be sufficient to discourage intensive capital utilisation, but allied to other factors such as increasing returns to scale they may be important. Secondly, the number of firms competing in the market is relevant. Thus, where there is monopoly in the product market, any additional output can only be sold at a lower price and the reduced costs from shift work operation may be offset by the decline in average revenue. Whilst this does not explain the failure to construct a smaller plant for a *given* level of output, viewed in a dynamic context it may be highly relevant. Likewise, in monopolistic competition there may be too many firms to achieve production at least cost and such " excess capacity " may discourage shift work. Thirdly, small firms in particular may face problems of " lumpiness ". For instance, the introduction of a night shift may require additional management personnel for reasons of supervision at unusual hours rather than workload criteria. This tends to make variations in utilisation more difficult for small than for large firms. Analyses in a number of countries have in fact pointed to a highly significant, positive relationship between the extent of shift work and the size of undertaking.[14] To these three aspects of the product market should be added the variability of market demand, for shift work provides a degree of flexibility enabling firms to adjust output to the level of current demand. However, under some circumstances overtime working may be a more appropriate method of adjustment as far as both firms and employees are concerned.

Holding constant the above factors, it has been suggested that the major determinants of the profitability of shift work are the capital intensity of the productive process, variations in input prices over time (including size of shift work wage premiums), the relative prices of capital and labour, the elasticity of substitution (that is, the extent to which a change in factor prices induces a change in factor intensity), the degree of obsolescence and relative productivity on different shifts.[15] Recognising that each of these will interact with the others, it is necessary to examine them in turn.

Capital intensity

It is important to recognise that the capital/labour and capital/output ratios will themselves in part be determined by relative factor prices, the shift work wage premium and the elasticity of substitution,[16] and that the

effect of shift work is to reduce capital intensity. None the less, it remains true that the greater the quantity of capital relative to labour, the greater the incentive to use the capital stock more intensively. We may distinguish between fixed costs (including the cost of capital employed, i.e. the rate of interest and depreciation) and variable costs (including labour, raw materials and fuel costs). Whilst average variable costs rise in some proportion to output, average fixed costs steadily decline as output increases. The greater the ratio of capital to labour (or fixed to variable cost), the greater the reduction in cost per unit as output expands. Conversely, for a given output, the greater the incentive to economise on capital, the greater its share in total cost. Thus, the higher the capital share, the more profitable shift work will be. Few empirical analyses of these relations appear to have been undertaken, but one analysis of the engineering industry in Sweden found, for instance, that total manufacturing costs fell by 6 per cent on the introduction of a second shift.[17]

Variations in input prices over time

The gain from reductions in the cost of capital may be offset by the costs of introducing shift work, including the need to pay higher wages. As Winston[18] has noted, the prices of some factor services vary rhythmically over time. These include not only the price of labour, but also costs relating to electricity, heating, lighting and agricultural products where these are inputs to the productive process. Such cost rhythms mean that it will be optimal to build a larger plant than if such costs were constant over time in order to produce a larger proportion of output at periods of low input costs. This variation in input prices will, therefore, reduce the tendency to operate shifts and also explain in part the tendency of plants to operate at less than 100 per cent of capacity. It will be optimal to leave capacity unused to a greater degree the greater the amplitude of the cost rhythm and the more important the factor concerned in total costs. In relation to the former aspect a high elasticity of substitution will tend to reduce the effect. For instance, a given plant could be operated with fewer men at nights and weekends, when wage rates are higher. Similarly, relative to the latter aspect a high elasticity of substitution and high capital intensity will dampen the effect of a penal night-shift wage premium.

It has been suggested that particular problems arise in relation to the management and supervision of shift work, because of the fact that the same capital equipment is shared by a number of individuals who only meet at the time of changeover of shifts and that some workers are isolated from the company to the extent that their hours do not coincide with those of senior management or other employees.[19] The UK National Board for Prices and Incomes,[20] for instance, found that the additional unit labour costs incurred through the introduction of a third shift were commonly of the order of a third, although this figure varied considerably according to circumstances.

Finally, it is worth pointing out here that any attempt by governments to control the extent of shift work by regulation of the shift work premium is likely to have mixed results. If, for instance, a government legislated to increase the night-shift premium this would increase the costs of night work and reduce the demand for it by employers. But it would also have the effect of increasing the supply of workers prepared to work at nights. Assuming that supply and demand for night work were previously in equilibrium, the result would be an excess supply of potential night-shift workers. This would provide an incentive for both employers and employees to undercut the statutory rate by one means or another. It would be more effective to impose a tax on employers who operated a night shift, thereby reducing their demand for night work, so that a new equilibrium point was reached with a lower level of shift work. For instance it might be possible to replace existing depreciation allowances by ones providing for a lower rate of depreciation on the second and third shifts. This, however, would tend to reduce the size of the shift work premium.

Relative factor prices and the elasticity of substitution

One is inclined to suggest that the higher the price of capital (the rate of interest) relative to the price of labour (the wage rate) the more profitable shift work will be, *ceteris paribus*. However, the effect of changes in relative factor prices on the optimal level of utilisation is dependent upon the value of the elasticity of substitution (σ). When $\sigma<1$ an increase in the price of capital relative to labour will have the effect of increasing the capital/labour cost ratio. Therefore it will pay to economise on the capital stock by using it more intensively and the optimal level of utilisation will be higher. If $\sigma = 1$ a higher (lower) price of capital relative to labour will leave the capital/labour cost ratio unaltered, so that relative factor prices have no effect on the optimal utilisation of labour. When $\sigma>1$ the influence of relative factor prices on the optimal level of utilisation becomes perverse—that is, lower wages (or a higher rate of interest) induce a lower level of capital utilisation. This follows from the fact that substitution out of capital into labour is sufficiently great to lower the capital/labour cost ratio, thereby making it optimal to economise on labour, which now has a larger share of total costs. This makes it crucial to obtain estimates of the value of σ, on which there is little information. However, Winston and McCoy [21] suggest, on the basis of various empirical studies, that the value is likely to be between zero and one, thereby minimising the possibility of the perverse case occurring in practice.

Depreciation and obsolescence

Over time machinery will have to be replaced because of wear and tear or obsolescence. Where technological change occurs, the loss of value due to the latter, which is a function of age, must be added to wear and tear and

this will make shift work more profitable, since the cost of obsolescence will be unaffected by use. It is, however, possible that wear and tear itself may not vary proportionately with annual operating time. Indeed, Marris [22] suggests that in some cases the reverse may be true where constant starting and stopping or disuse are more harmful to machinery than continual operation. It has been estimated that obsolescence may account for two-thirds of total depreciation of capital and wear and tear for only one-third,[23] but in practice rates of obsolescence are difficult to measure.

Productivity and shift work

Any tendency for productivity to fall on the night shift or other shifts will, of course, make shift work less profitable. Medical evidence of the disturbance to biological rhythms would suggest the likelihood of such adverse effects,[24] but the evidence in practice is rather mixed. Where differences have been found in the industrialised market economies they have tended to be slight. In the United Kingdom the National Board for Prices and Incomes [25] conducted an establishment survey which included a question on this issue. Where comparative measurements had been made, 3 per cent reported that productivity was much less on the night shift, 26 per cent slightly less, 58 per cent the same and 13 per cent more.

Further work is called for on comparative levels of productivity on different shifts in various countries, taking into account factors such as absenteeism and turnover as well as output and acknowledging the fact that shift workers are a self-selected group. The studies undertaken by Fishwick and Harling [26] in the United Kingdom motor industry are an example of how this should be done. They take account of the fact that in some cases the pace and quality of work are machine controlled, so that there are no variations in average performance between shifts of different length, on different days of the week, or by day and at night. In some cases workers may choose to adopt output norms which obscure any diurnal variations in capacity. Further, certain organisational and environmental factors, such as the number of workers on the shift, the type of work and number of distractions, are favourable to night work. However, there are also some theoretical problems to be taken into consideration. The analysis of Alexander and Spraos [27] suggests that often management will deliberately restrict output on the night shift if this will maximise profits. If this restriction is brought about by using only the more productive machinery at night, output per man will tend to increase relative to day-time output, but it is conceivable that it could be lower in cases where the capital/labour ratio is fixed. It is not clear that these factors have generally been taken into account in analysing labour productivity on different shifts.

To summarise this section, therefore, shift work will be more profitable the greater the capital/labour ratio, the lower the variation in input prices over time (particularly, the lower the shift work wage premium), the higher the

elasticity of substitution, the greater the importance of obsolescence relative to wear and tear in depreciation and the smaller the difference in labour productivity between day and night shifts. But together these factors imply that it may often be profitable to run plants at less than 100 per cent of capacity utilisation.

The employment effects of shift work

It is generally held that increased utilisation via shift work will have a favourable effect on employment, for under conditions of labour surplus production can be expanded with the same (or a less than proportionate increase in) capital stock. Thus, in any economy (such as the United Kingdom's) which faces low levels of investment together with a sharp increase in the number of school-leavers, shift working appears to offer one possibility of providing the necessary complement of capital for additions to the labour force. In general, economic models suggest that the effect on employment will be greater, the more pronounced the economies of scale, and the smaller the shift differential and the capital/output ratio. It should be borne in mind, however, that such models are essentially long-run. It is generally assumed that the level of output is determined before the construction of a plant and does not refer to the addition of shift work to an existing plant. Where a firm chooses to produce a larger volume of output under shift work than under single-shift operation, total employment will usually increase depending on demand conditions (the greater the elasticity of demand the greater the employment effect) and on economies of scale. No attempt appears to have been made, however, to estimate for industrialised market economies the employment effects of multiple shift work in practice. In this respect it is necessary to take repercussion or indirect effects into account. For instance, where capital is saved we need to establish what happens to the displaced capital. Let us suppose that the government has the choice of encouraging the construction of a new plant or of extending shift work in existing plants. If the latter is chosen we must deduct the employment that would have been generated in constructing the new plant from the employment generated by the extension of shift work so as to assess the net employment effect. Whilst employment on the construction of new plant may be unimportant in countries with a high propensity to import capital, there could well be a significant, if short-run, effect in countries with major investment goods sectors.

Recently, reduced hours of work have been proposed as an alternative or complement [28] to increased shift work as a means of stimulating employment. However, reduced hours will in general only achieve this if accompanied by a proportionate reduction in earnings. Otherwise, the increased cost to the employer will have a depressing effect on employment. Assuming that there is no change in hourly rates of pay, we should note that the hours reduction may itself have a secondary employment effect by stimulating more shift work on account of the consequent decline in capital utilisation. Further,

an increase in shift work may itself tend to lead to a reduction in average hours worked. These inter-relations make it difficult to assess the merits of shift work relative to reduced hours (with constant hourly earnings) as employment-creating devices.

The supply of shift working labour

The individual employee must trade off the higher earnings that shift work provides against the inconvenience of a different pattern of leisure from the rest of the community. Where shift work is relatively widespread, as in continuous process industries, where a number of shift working industries are concentrated in a particular locality or shift work is general to an occupation, shift working may be accepted as a traditional way of life. In other cases its introduction may raise problems of recruitment. In general it appears that younger workers attach more importance to their social life and prefer day work; but as men, in particular, become older and family responsibilities grow they become increasingly attracted to the higher wages paid for shift work. There is also evidence that a process of " natural selection " takes place, whereby the population of shift workers tends to be made up of those who prefer or can best adapt to this type of work, whilst the remainder leave for other jobs.[29]

As far as the future supply of shift working labour is concerned, obviously the attitude of the trade unions is important. Whilst in some countries unions have expressed considerable concern over the growth of shift work, in others they appear to have accepted it as an inevitable feature of economic development. Indeed, if night work is as unacceptable as some have suggested, it is pertinent to ask why the present arrangements for night work have persisted in areas where unions are strong and over periods when alternative job opportunities have been plentiful.

If shift work is to continue to expand it may be necessary, however, for employers to rearrange shift patterns so that they more adequately meet the needs of shift workers or potential shift workers; but much more research is needed on the effect which different hourly working patterns have on individual workers. There are a wide number of possibilities here including flexibility of change-over times, a compressed work week and different methods of rotation. In the United Kingdom, for instance, there appears to be a strong preference for four night shifts, particularly in the motor industry. Where five night shifts are operated it is generally found that absenteeism is high on the Friday shift, as this cuts into the weekend. Consideration needs to be given to whether four nights out of seven is as psychologically disturbing as five out of seven.

The economics of night work

It has been suggested that the economic aspects of night work are comparable or even identical to those of shift work in general.[30] As indicated

above, the principle is the same whether it is a question of changing from one shift to two, or from two shifts to three. The main reason for singling out night work for particular attention is the fact that it implies the highest level of utilisation, and includes the case of technological necessity, whilst allegedly imposing the greatest costs on the parties subject to such arrangements.

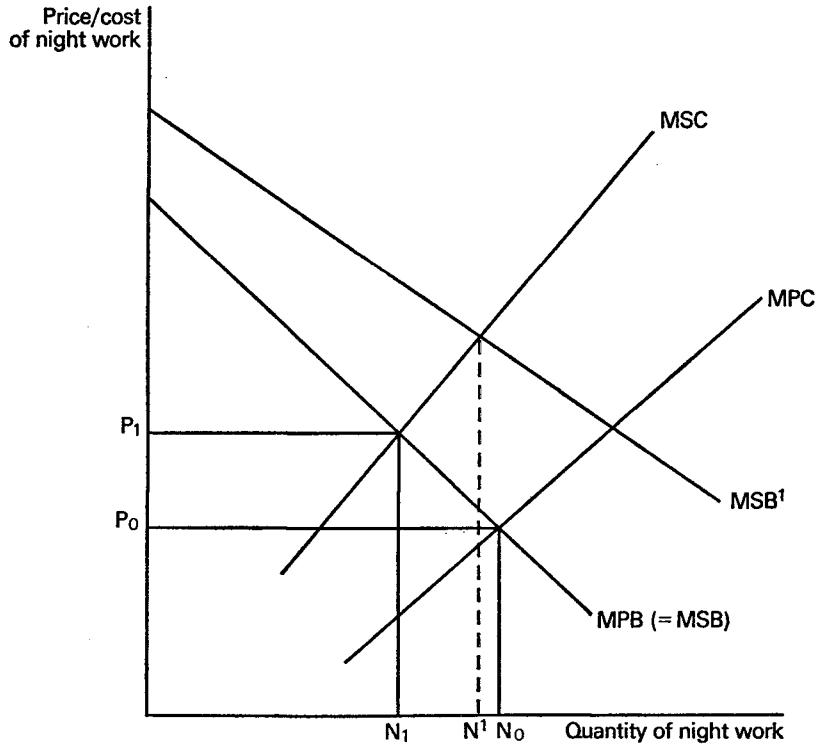
If night work is essential for cost or technological reasons we would expect it to be found throughout a particular industry and presumably this would also apply at the international level. This points to the importance of obtaining detailed statistics of night shift operation by industry on an international basis. Unfortunately, no detailed figures on the number of workers subject to such arrangements are currently available. If we assume that night shift operation is found uniformly within particular industries, any ban on it would probably need to be imposed at an international level; otherwise such industries might not survive in countries where such a ban was made effective. A further problem is that a partial ban on night work may in fact make it more difficult to improve social conditions for workers still required to work at night. The reduced demand for services at abnormal hours would lead to a contraction in the quantity available. It would, for instance, be more costly to provide special transport for such workers. Therefore, policies to reduce the extent of night work and policies to improve the conditions of night workers may well be competitive rather than complementary.

Such action presupposes, however, that society has decided that night work is unacceptable and, before such a judgement can be made rationally, far more information is needed than is currently available. We are not in a position to put a price on the social costs entailed by night work, partly because what evidence there is tends to be conflicting.[31] Nor are we able to put a value on the economic benefits to be obtained from it, partly because we do not know how far it might be possible to offset utilisation at night by greater utilisation during the day. To the extent that costs were raised by the abandonment of night work, prices would rise in the industries affected and there would be some unemployment. Further, it is possible that the optimal strategy would not be to eliminate night work, but merely adjust the amount of it. It is clear, however, that this question can only be dealt with adequately in terms of conventional cost/benefit analysis, which is discussed below.

The cost/benefit approach to shift and night work

Cost/benefit analysis rests on the supposition that certain activities give rise to externalities, which are not taken into account by the parties in their decision-making processes. Decisions will be based on marginal private costs and benefits in order to maximise individual welfare, whilst the social objective would be to maximise social welfare by equating marginal social costs and benefits. As far as night work is concerned, social costs would include adverse

Costs and benefits of night work



effects on health and the welfare of the family where these were not taken into account by the individual shift worker himself or herself, or the medical costs of screening workers where these were not borne by the enterprise. There is also the problem of moral hazard—individuals choosing to ignore any adverse effects on health—or the fact that workers may lack knowledge of any such long-term adverse effects. The social benefits of shift (and night) work include a higher level of employment in the economy, a more rapid growth rate, a spreading of peak loads in relation to electricity consumption, transport and leisure facilities,[32] and the benefit to consumers of having services available for more hours of each day.

Where marginal social costs are greater than marginal private costs there is a case for government intervention to reduce the level of a particular activity. Let us suppose that marginal private benefits (MPB) and costs (MPC) of night work are as in the diagram, so that N_0 level of night shift operation is optimal for employers and the cost curve includes an adequate shift premium to attract the necessary number of employees to night work. Assuming that marginal social costs (MSC) are greater than marginal private costs (MPC) and that there are no positive externalities as far as night work is

concerned, it would be optimal for society to reduce night work from N_0 to N_1. Only in the extreme cases where the MSC curve intersected the vertical axis above the intersection point of the MSB curve with that axis, would it be optimal to eliminate night work entirely. We must also allow, however, for the possibility that marginal social benefits (MSB) exceed marginal private benefits (MPB) through employment, peak load effects and so on.

It can be seen, therefore, that the case for a reduction in night shift operation rests on the assertion that the MSB curve intersects the MSC curve to the left of the intersection point between MPB and MPC (e.g. as N^1 in the diagram). Therefore it is imperative that more empirical evidence on the above aspects of shift work is obtained in order that we may be in a position to compute values for social costs and benefits as an aid to the policy-maker.

Conclusions

Concern with questions of the quality of working life has increased in those economies, in particular, where real incomes are relatively high, and it is not unexpected that work at inconvenient times should be an important element in this concern. Only in France, however, have major initiatives been taken to reduce night work and week-end work, whilst recognising that technological necessity may on occasion require work at such times. Indeed, rising levels of unemployment in the high-income countries imply that a major reduction in shift working at the present time is unlikely to have priority as a policy objective. However, these countries may have to devote more resources to making shift work (particularly night work) more acceptable to employees rather than reduce the number subject to such arrangements. As noted earlier, any reduction in night shift operation would in fact increase the costs of improving the conditions of work and leisure of employees who still remained on night work. It should also be noted that as hours of work are reduced the problems of shift workers are likely to diminish considerably. Indeed, more consideration might be given to the possibility of reducing hours as an alternative to paying wage premiums. Again, there is some evidence to suggest that at least some groups of night-shift workers have a preference for four nights rather than five for the same length of working week or even three shifts of 12 hours each where working conditions permit. Consideration might also be given to introducing appropriate flexible working hours arrangements involving mutually agreed transactions between different members of the labour force. If, in the long run, shortages of employees willing to work at night begin to appear or night work is limited by legal regulation, then the only means of maintaining capacity utilisation at high levels would be to introduce even more capital-intensive methods—i.e. fully automated plants. It is not known, however, how feasible such a reorganisation of methods of work would be with the relative price of capital and labour fixed at about its existing level.

A prerequisite for effective policy decisions in most countries, however, is the provision of more adequate statistics than are currently available. It is, indeed, disturbing that it is not even possible, amongst other things, to obtain in most industrialised market economies the exact number of workers subject to night shift arrangements. There is also a need for detailed case studies of shift work operation to ascertain more precisely than is often the case the financial implications of alternative shift arrangements. In addition, it would be useful to establish the uniformity or otherwise of shift working practices within particular product markets at both national and international levels. Only with the assistance of such data would it be possible to conduct meaningful cost/benefit analyses of shift work (including night work) as a basis for political decisions on the control of such activities.

Notes

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[2] R. Betancourt and C. Clague: " Multiple shifts and the employment problem in developing countries ", in *International Labour Review*, Sep.-Oct. 1976.

[3] M. Kabaj: " Shift-work and employment expansion ", ibid., Jan. 1965; and idem: " Shift work and employment expansion: towards an optimum pattern ", ibid., Sep. 1968.

[4] See *Social and Labour Bulletin* (Geneva, ILO), No. 2, June 1977, p. 143.

[5] J. Carpentier and P. Cazamian: *Night work* (Geneva, ILO, 1977).

[6] In this case " night " refers to a period of at least 11 consecutive hours, including an interval of at least seven consecutive hours falling between 10 p.m. and 7 a.m., though the competent authority may prescribe different intervals in particular industries.

[7] See, for example, M. Maurice: *Shift work : economic advantages and social costs* (Geneva, ILO, 1975).

[8] This is perhaps *the* major problem as far as the economist is concerned since it is hardly possible to explain the variance of shift work across countries, industries, enterprises or occupations and to predict changes in its extent over time.

[9] " Social problems of shift work ", in ILO: *Management of working time in industrialised countries*, Main documents of an ILO symposium on arrangement of working time and social problems connected with shift work in industrialised countries, Geneva, 3-11 May 1977 (Geneva, 1978), p. 20.

[10] I am grateful to K. H. Horn of the ILO for the provision of these figures.

[11] R. Marris: *The economics of capital utilisation: a report on multiple-shift work* (Cambridge, University Press, 1964); and idem: *Multiple shiftwork: a problem for decision by management and labour*, National Economic Development Office, Monograph 1 (London, HM Stationery Office, 1970).

[12] F. R. Eels: " The economics of shiftworking ", in *Journal of Industrial Economics* (Oxford), Nov. 1956.

[13] D. L. Bosworth and P. J. Dawkins: *Economic theories of shiftworking: a critical review*, Occasional Research Paper No. 20, Department of Economics, University of Loughborough, 1977.

[14] See, for instance, Maurice, op. cit.; and National Board for Prices and Incomes: *Hours of work, overtime and shiftworking*, Report No. 161 (London, HM Stationery Office, Cmnd. 4554, 1970).

[15] That these factors are equally relevant in developing economies is demonstrated in Betancourt and Clague, op. cit., which provides a summary of the long-run " shift work decision ".

[16] See G. C. Winston and T. O. McCoy: " Investment and the optimal idleness of capital ", in *Review of Economic Studies* (Edinburgh), July 1974.

[17] Bo F. Lindörn: *Economic aspects of night work*, unpublished manuscript (Geneva, ILO, 1974).

[18] G. C. Winston: " The theory of capital utilization and idleness ", in *Journal of Economic Literature* (Nashville (Tennessee)), Dec. 1974.

[19] W. H. Taylor: " Managerial and social implications of shift work ", in ILO: *Management of working time in industrialised countries*, op. cit., p. 63.

[20] Op. cit.

[21] Op. cit.

[22] Marris: *The economics of capital utilisation . . .*, op. cit.

[23] Marris: *Multiple shiftwork . . .*, op. cit.

[24] In fact biological rhythms may be able to adjust to permanent night work, though the problem of adjusting at weekends remains. Greater problems may occur in the adjustment between working on different shifts within the same system.

[25] Op. cit.

[26] F. Fishwick and C. J. Harling: *Shiftworking in the motor industry* (London, National Economic Development Office, 1974).

[27] K. J. W. Alexander and J. Spraos: " Shift working: an application of the theory of the firm ", in *Quarterly Journal of Economics* (Cambridge (Massachusetts)), Nov. 1956.

[28] See, for instance, J. Hughes: " Shiftwork and the shorter working week: two ways to make jobs ", in *Personnel Management* (London), May 1977, who recommends both an increase in shift work and shorter hours. He estimates that an increase of no more than 10 per cent in the number working on shifts in the United Kingdom would raise employment by over 100,000, but the basis upon which these estimates are made is not provided.

[29] See National Board for Prices and Incomes, op. cit.

[30] Carpentier and Cazamian, op. cit.; and Lindörn, op. cit.

[31] Not only is the relation between working shifts and ill health far from obvious, but often suggestions that there is a positive relation are not qualified by reference to the type of shift, the period over which workers are subject to such arrangements or the age and personality of the worker.

[32] If the night shift were eliminated, the fall in output would lead to a decline in the over-all demand for electricity, but if capacity were increased during normal working hours this would cause peak demand to intensify.