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Multiple shifts and the employment problem in developing countries

Roger BETANCOURT and Christopher CLAGUE [1]

It is a paradox that in countries where labour is abundant and capital is scarce a great deal of the capital stock is allowed to stand idle for 16 hours a day. Would it not be desirable to use the abundant labour to keep the factories going for 24 hours, thereby increasing employment and output at the same time?

This question, which is obviously of great importance for countries with serious employment problems, is now being researched by the ILO [2], the World Bank and others interested in economic development and employment.[3] The present article attempts to contribute to that research effort in two ways: first by clarifying some of the issues involved in the question posed above, and second by proposing and justifying some specific policy measures.

When factory managers are asked why they do not work multiple shifts, they frequently reply that there is insufficient demand for the product or that raw materials or working capital are in short supply. These factors may be quite important in explaining why a businessman does not add a second or third shift in a plant now working one shift, but they fail to explain why shift work is not more common when a new plant is constructed, or when a major expansion takes place. The entrepreneur could then plan to satisfy

[1] University of Maryland.

[2] J.-P. Arlès: "Emergency employment schemes", in *International Labour Review*, Jan. 1974, pp. 69-88.

[3] On the theory of multiple shifts see R. Marris: *The economics of capital utilization* (Cambridge, University Press, 1964); G. Winston and T. McCoy: "Investment and the optimal idleness of capital", in *Review of Economic Studies* (Edinburgh), July 1974, pp. 419-428; G. C. Winston: "Capital utilization and optimal shift work", in *Bangladesh Economic Review* (Dacca), Apr. 1974, pp. 515-558; R. R. Betancourt and C. K. Clague: "An economic analysis of capital utilization", in *Southern Economic Journal* (Chapel Hill (North Carolina)), July 1975, pp. 69-78; G. C. Winston: "The theory of capital utilization and idleness", in *Journal of Economic Literature* (Nashville (Tennessee)), Dec. 1974, pp. 1301-1320; and M. Maurice: *Shift work : economic advantages and social costs* (Geneva, ILO, 1975), especially Ch. 2 and pp. 107-108.

whatever market he anticipates with a multiple-shift plant instead of a single-shift one. In general it is more profitable to work shifts in a plant designed for that purpose than to add an extra shift in a plant designed for a single shift, as will be explained below. Thus it makes sense to focus our attention on the question why single-shift operation is so frequently planned when a major investment is undertaken.

It seems most useful to start out with the assumption that businessmen make appropriate calculations and attempt to maximise profits. Then if single-shift operation is widespread during periods of normal business activity, it must be because multiple shifts would not be profitable. But how can this be if the country has abundant labour and scarce capital? The answer may lie in various divergences between private and social costs. This hypothesis will be a major theme of the present paper. The first section examines the private profitability of shift work and subsequent sections explore the reasons why private profitability calculations may not lead to a socially desirable outcome. Throughout, our focus will be on the firm's long-run decision, that is, why it may plan for single-shift operation at the time a major investment is undertaken.

Our long-run approach may be contrasted with a short-run theoretical framework in which the capital stock is taken as given. In such a framework, shift work appears to offer the possibility of a large increase in employment, through appropriate governmental policies to manage aggregate demand. This policy suggestion will be compared, in a concluding section on policies, with the ones derived from our long-run theoretical framework. In the opinion of the present authors, maintaining a clear distinction between the two theoretical approaches is vital to developing an understanding of the true potential of shift work for ameliorating the employment problem.[1]

Determinants of the private profitability of shift work

This section will summarise the theory of the long-run shift work decision, as it has been presented by Marris, Winston, and Betancourt and Clague. First some crucial variables need to be defined. The first of these is the night-time wage differential *(α)*, or the percentage by which the night-time wage exceeds the day-time wage for workers of a given skill. It is important to note that even when the explicit wage differential for the night shift is zero, firms may have to pay higher average wages for all shifts if there is worker resistance to being required to work at night. Supervisors may also have to be compensated for night-time work, either explicitly or implicitly. The variable α should reflect the implicit as well as the explicit increase in costs per unit of labour as a result of the decision to work shifts. Next, θ is the share (under single-shift operation) of fixed-capital costs in combined labour and fixed-capital

[1] This distinction has also been stressed by other authors, including Marris and Winston (see references above). Nevertheless, it is frequently blurred in practical discussions.

costs; it is viewed here as a measure of the capital intensity of the production process. It is assumed that the firm can select among various techniques (with different capital/labour ratios) *before* the plant is constructed, but that after installation the crew size of each machine is fixed.[1] Single-shift operation will be referred to as system 1 and multiple-shift operation as system 2.

It is quite obvious that a high night-wage premium (α) discourages shift work by making the average wage rate higher under system 2. A high capital intensity encourages shift work; one way of seeing this is to note that shift work makes it possible for the firm to produce the same output with a much smaller capital stock, and the cost savings of doing so would be greater the greater is θ. Clearly it will not be profitable to operate very labour-intensive processes at night if the differential is substantial.

Another important variable is the elasticity of substitution (σ) between labour and fixed capital, a measure of the degree to which the optimal instantaneous capital/labour ratio varies in response to a change in factor prices. This variable plays several roles in the analysis. For present purposes, its most important role is to provide a link between changes in factor prices and changes in θ. Economic theory says that if σ is less (greater) than one, an increase in the ratio of wages to the price of capital will reduce (increase) θ.

The next important variable is the cost elasticity (ϕ), defined as the percentage by which average costs are increased (under single-shift operation) when output is cut in half. This is a measure of economies of scale at the level of output at which the firm is operating. The cost elasticity has its maximum impact on the shift work decision in the case where the firm's output is constrained to a given level, perhaps because it is in oligopolistic equilibrium or because it already occupies the whole national market. Then the decision to work two shifts involves constructing a plant only half as large, and this would raise costs by the fraction ϕ. If, on the other hand, the firm faced a smooth downward-sloping demand curve, it could increase its total output under shift work and thereby ameliorate the diseconomies of small-scale operation, but it would do this at the cost of lowering its average revenue. Only under perfect competition would the cost elasticity be irrelevant. But where small firms operate in imperfectly competitive markets, as they typically do in the manufacturing sector in developing countries, scale economies can provide a substantial disincentive to shift work.

While the discussion has stressed the factors affecting the profitability of shift work, it must also be recognised that the preferences of the manager may have a decisive weight in the decision. In a small company, shift work may involve either an unwelcome delegation of authority to a second-shift supervisor or an excessive risk for the manager of being disturbed during his

[1] The theory of the shift work decision when there is *ex post* substitutability of machines and labour is analysed in C. Clague: *The theory of capital utilization and the putty-rubber production function* (College Park, University of Maryland, 1975; mimeographed).

hours of leisure. In this connection it is interesting that Thoumi [1] found shift work in Colombia to be positively associated with the corporate as opposed to the family form of organisation. In Yugoslavia, under the system of workers' management, double-shift operation is much more common than in any of the capitalist countries for which we have seen data (see the section below entitled " Some data on shift work ").[2] This may be partly due to the reduced role of the manager's preference in the shift work decision.[3]

Divergences between private and social costs

In the modern manufacturing sector of developing countries the price of fixed capital is typically held below its social cost by such policies as tax incentives linked to fixed investment, duty-free importation of machinery, and government-subsidised loans for the purchase of fixed capital. On the other hand, the wage rates paid usually exceed the social cost of labour, partly as a result of governmental and union pressure and probably partly because modern and profitable firms choose to pay above-market wages. As mentioned above, if σ is less than one, an increase in the ratio of wages to the price of capital will reduce θ, the capital share. Now there is considerable uncertainty among development economists about the typical values of σ, but there is probably a majority view that σ is normally less than one. If so, then the divergences between the prices and the social costs of labour and fixed capital make θ lower than it would otherwise be and in many cases this may be enough to tip the balance against shift work.

A number of other divergences may contribute to the same result. The night-wage premium is sometimes set by government legislation or union demands far in excess of that justified by workers' preferences. Night-time transportation is far less convenient and safe than it could be made if shift work were more prevalent. In addition the tax treatment of depreciation, by not making any allowance for the rate of utilisation, usually tends to discourage shift work.[4]

Shift work will often result in a larger total output for the factory. In imperfect markets the firm's private marginal revenue is below the marginal social benefit of the product, i.e. it does not pay the firm to increase output. This divergence also discourages shift work. In many countries it is frequently

[1] F. Thoumi: " The utilization of fixed industrial capital in Colombia: some empirical findings ", in R. Berry (ed.): *Essays on Industrialization in Colombia* (forthcoming).

[2] The theory of the shift work decision of the labour-managed firm is analysed in R. Betancourt and C. Clague: *The determinants of capital utilization in labor-managed enterprises* (College Park, University of Maryland, 1975; mimeographed).

[3] Shift work is also more common in centrally planned economies. See M. Kabaj: " Shift work and employment expansion ", in *International Labour Review*, Jan. 1965, pp. 47-62; and idem: " Shift work and employment expansion: towards an optimum pattern ", *ibid.*, Sep. 1968, pp. 245-274.

[4] D. M. Schydlowsky: " Influencia del mercado financiero sobre la utilización de capacidad instalada ", in *Desarrollo Económico* (Buenos Aires), July-Sep. 1974, pp. 269-288.

socially efficient but privately unprofitable to export manufactured goods; if the divergence were eliminated and firms were able to export in perfectly competitive markets, the scale barrier to shift work would disappear entirely.

Imperfections in the capital market may also make shift work privately unprofitable even when it is socially efficient.[1] Firms can usually obtain loans more easily and at lower interest rates for fixed capital than for working capital. Banks find it privately profitable to make this differentiation because machinery is a more secure collateral than inventories. Perhaps more important are government subsidies for fixed-capital loans and the tendency of government-run or government-influenced banks to regard loans for working capital as unproductive (or perhaps even harmful, since they may permit speculation in commodities).

When a firm hires a worker, it must not only pay the wages he earns; it must also bear the interest cost on his wages from the time he is paid to the time the firm receives payment for the goods he has produced. If this interval is four months and the interest rate on working capital i (or the opportunity cost of the firm's own funds used for working capital) is 30 per cent, then the interest costs are 10 per cent ($0.333 \times 0.30 = 0.10$) of the wage bill. An increase in i operates just like an increase in the wage rate; if $\sigma < 1$, they both reduce the profitability of shift work. Similarly, an excess of i over the social cost of capital makes shift work less profitable privately than it is socially.

There is yet another reason why shift work may be socially desirable even when it is privately unprofitable: shift work may increase employment. Some writers consider employment as a very legitimate objective in a social welfare function.[2] If this is so, the employment-generating effects of shift work could be of far greater importance from the social point of view than the efficiency gains achieved by eliminating divergences between opportunity costs and market prices of factors. The employment-creating effects of shift work, however, are not necessarily as large as they appear to be at first sight. This point, which will be explained more fully in the next section, derives from the use of a long-run rather than a short-run theoretical framework.

Employment and shift work

From a short-run perspective, in which the capital stock is taken as given, the addition of a shift with no new investment obviously increases employment per unit of capital stock. In the long-run framework, on the other hand, the matter is more complicated because if the entrepreneur knows that his factory will be working shifts, he may decide to buy a more sophisticated

[1] Schydlowsky, op. cit.; R. Betancourt and C. Clague: *Working capital and shift work in imperfect capital markets* (College Park, University of Maryland, 1976; mimeographed).

[2] For an excellent discussion of employment as an objective see A. Sen: *Employment, technology and development* (Oxford, Clarendon Press, 1975), Chs. 9 and 10. This is a study prepared for the ILO.

type of machine. Consider the following example. Under system 1 the firm would buy bulldozers costing $10,000 apiece, each operated by a single worker. Under system 2 it would purchase a smaller number of bulldozers costing $15,000 apiece (which work faster), each operated by one worker on each shift. The ratio of employment to capital stock goes from 1/10,000 to 2/15,000 (on a two-shift operation), which is an increase of only 33 per cent, instead of the increase of 100 per cent which would have occurred if the same bulldozer had been used for both systems.

Why does the firm buy a more expensive type of machine under system 2? Since the labour savings of the more sophisticated bulldozer occur on two shifts instead of one, this machine may be less costly (per unit of output) under system 2 even when it would not have been under system 1.

Suppose the firm purchased bulldozers worth $25,000 for its double-shift operation. Then employment per unit of capital stock would actually fall. While this outcome is not very likely [1], the fact that it is a possibility is a reminder that the increase in employment per unit of capital stock is apt to be substantially less than the naïve estimate that one would make without considering the phenomenon of substitution.

Nevertheless, shift work probably would increase employment per unit of capital stock in most industries. Hence this advantage may be added to the efficiency considerations mentioned in the previous section. Policies for the promotion of shift work will be discussed in the final section. The next section will provide further background for that policy discussion by presenting some data on the prevalence of multiple shifts.

Some data on shift work

Curiously, shift work is more prevalent in the United States than it is in Europe. For the manufacturing sector as a whole in 1960 (including the continuous-process industries and of course single-shift enterprises) the ratio E of total production workers to workers on the first shift was about 1.30 in the United States, about 1.11 in the United Kingdom, the Netherlands, Norway and France, and about 1.19 in Italy.[2] The reasons for this disparity probably

[1] According to the theory of capital utilisation presented in Winston: "Capital utilization and optimal shift work", loc. cit., Betancourt and Clague: "An economic analysis of capital utilization", loc. cit., and P. Millan: *The intensive use of capital in industrial plants: multiple shifts as an economic option*, PhD thesis (Cambridge (Massachusetts), Harvard University, 1975), there is a critical value of σ, above which employment per unit of capital stock would be reduced by shift work. This value is given by $\log 2/\log(2+\alpha)$, which is about 0.85 for a night-shift premium (α) of 25 per cent. This formula for the critical value, however, is derived under the assumption of no wear-and-tear depreciation. Incorporating wear-and-tear depreciation tends to raise the critical value of σ (thereby making it less likely that shift work would reduce employment per unit of capital stock). Under plausible assumptions about wear-and-tear depreciation the critical value of σ would exceed one. See C. Clague: *The theory of capital utilization: some extension* (College Park, University of Maryland, 1975; mimeographed).

[2] E. Denison, assisted by J.-P. Poullier: *Why growth rates differ* (Washington, Brookings Institution, 1967), pp. 153-154 and 173.

include a greater willingness of US workers to work at night and the smaller importance of the scale barrier to shift work.

Since the ratio E could in principle go as high as three, the figures presented above indicate that shift work is rather uncommon. But different measures paint a somewhat different picture. The present authors have been working with some data collected by UNIDO on France, Japan, Israel, India and Yugoslavia. Unfortunately the samples are not designed to be representative; the factories were selected to serve as data sources for industrial programming. The sample overweights large and well-run factories and tends therefore to overstate the prevalence of shift work. If these qualifications are borne in mind, however, some interesting comparisons of different measures of shift work can be made (see the accompanying table). Of these measures U_1 is the unweighted average of shifts per factory; this measure reflects the fact that in the French, Japanese and Kenyan [1] samples well over half the factories work only one shift. But in these same samples, a large portion of the capital stock is found in factories working two or three shifts. This is revealed by U_2, which weights the number of shifts per factory by the factory's capital stock. U_2 is higher than U_1 because of a positive association between shift work and θ, or capital intensity (in all countries), and a positive association between shift work and factory size (in Israel, India and Kenya).[2] For purposes of comparison the ratio E is also presented for our samples. (Note that E for the French sample is 1.23, which is higher than the 1.11 figure for French

Measures of shift work in selected countries

Country	U_1	U_2	E
France	1.65	1.95	1.23
India	2.28	2.79	2.00
Israel	2.34	2.80	1.40
Japan	1.51	2.26	1.16
Kenya	1.30	2.24	.
Yugoslavia	2.77	2.93	1.59

U_1 = mean number of shifts per factory (unweighted).
U_2 = mean number of shifts per factory, weighted by factory's fixed capital stock.
E = total number of production workers divided by production workers on first shift.

Sources: For Kenya, Baily, op. cit. For the other countries, UNIDO: *Profiles of manufacturing establishments*, Vols. I and II (New York, 1967 and 1968). UNIDO data are for 1963 or 1964; Kenya data are for 1971.

[1] The Kenyan data were collected by M. Baily for her PhD dissertation *Capital utilization in Kenya manufacturing industry* (Cambridge, Massachusetts Institute of Technology, 1974).

[2] For a statistical analysis of these relationships in France, Japan, India and Israel see R. Betancourt and C. Clague: "An econometric analysis of capital utilization", in *International Economic Review* (Philadelphia), forthcoming; for Kenya see Baily, op. cit.

manufacturing as a whole.) These figures indicate that firms working shifts tend to employ fewer workers on each of the second and third shifts than on the first. This occurs in part because the more labour-intensive processes are not operated at night.

Policy implications

There are two ways in which shift work could be promoted. One, which might be called the macroeconomic approach, would arrange for a sharp increase in the demand for factories' production while simultaneously giving firms the incentive to respond by adding shifts rather than by installing new fixed capital. A leading proponent of this idea is Daniel Schydlowsky of Boston University, who along with others is researching the implications of such a policy package. A second conceptual approach, which might be called *microeconomic*, would leave aside changes in market demand curves and would increase the profitability of shift work through tax incentives, credit policies, regulations involving night work, and so forth.

The macro package arises naturally out of a short-run theoretical framework. If firms cannot increase their fixed capital stock immediately, or the government does not permit the installation of new fixed capital, then the only way firms can increase output in response to an increase in demand is to increase the utilisation of installed capacity, which will at some point in the expansion require additional shifts. But in the long run, firms must be given financial or other incentives to work shifts, or else they will go back to single-shift operation as they increase their investment. Thus a set of micro policies, designed to change the incentives that have led to single-shift operation in the past, appears to be an essential part of a proper shift work strategy.

The macro package is a very ambitious policy proposal. While the benefits of successful implementation may be large, unsuccessful implementation might be very costly and success appears to require a high degree of executive skill and co-ordination on the part of the government. The increased output must find a market and the increased inputs of materials and intermediate products must be made available. Schydlowsky proposes to create incentives by which enough of the additional output would be exported to generate the foreign exchange to buy the needed additional inputs. Serious doubts may be raised about the feasibility of increasing manufactured exports in the magnitudes required. Moreover, if such an expansion of manufactured exports is feasible through fiscal incentives, it would probably be worth while to provide these incentives entirely apart from a shift work policy package.

A less ambitious but more prudent strategy would be to change the microeconomic incentives for shift work on the one hand and for exports on the other, and then to see how well the measures work. As shift work becomes more prevalent (this is likely to be a gradual process, the speed and ultimate extent of which will be difficult to predict in advance), the capital/output ratio in the industries affected will tend to fall (provided that $\sigma < 1$)

and hence savings will be freed for use elsewhere. At this point macro policies regulating aggregate demand become important, to ensure that the freed savings are in fact invested.

Under the heading of microeconomic policies, the elimination of subsidies to fixed capital deserves prominent mention. Since this is a familiar policy proposal in discussions of employment promotion[1], all that needs to be added here is that part of the benefits of such elimination would come from its encouragement of shift work. Other policies to encourage shift work can easily be devised, yet they are rarely mentioned in discussion of employment promotion.[2] Governments might remove legal prohibitions against night work for women[3] and legal minima for night-wage premiums, and consider improving transportation and police services at night in certain locations. They might also promote shift work by using their considerable influence over the banking sector to increase the availability and lower the interest rates on loans for working capital.

It is probably not politically feasible in most countries to remove entirely the market-price bias against shift work. This is particularly true of the excess of the market price of labour over its social cost. This excess might in theory be corrected by reducing taxes on payrolls (or even offering tax rebates proportional to employment)[4], but in practice the excess is not likely to be eliminated. Moreover, as suggested earlier, employment creation may be a goal, even a high-priority goal, of public policy entirely apart from efficiency in resource allocation. Hence an extra incentive for shift work may be desirable. A simple device would be to provide a subsidy or tax credit for each worker employed on a second or third shift. This in effect reduces the night-wage premium (α) from the point of view of the firm. If α were reduced to zero, shift work would become profitable in all processes except where the capital share is very low or the cost elasticity very high.

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[1] See, for example, A. Peacock and G. K. Shaw: *Fiscal policy and the employment problem in less developed countries* (Paris, OECD, 1971), pp. 86-90; R. Berry: "Factor proportions and urban employment in developing countries", in *International Labour Review*, Mar. 1974, pp. 217-233; and A. P. Gupta: "Public finance and employment: the Indian case", ibid., Oct. 1975, pp. 279-290.

[2] For exceptions see Arlèa, op. cit., pp. 74-79; E. Costa: "Maximising employment in labour-intensive development programmes", in *International Labour Review*, Nov. 1973, p. 377; L. Emmerij: "A new look at some strategies for increasing productive employment in Africa", ibid., Sep. 1974, p. 205. For a discussion of capacity taxation see S. Cnossen: "Capacity taxation: the Pakistan experiment", in *Staff Papers* (Washington, International Monetary Fund), Mar. 1974, pp. 127-169.

[3] The question of the revision of existing ILO standards concerning night work by women has been under consideration in the ILO since 1972, but a variety of views have been expressed by the governments, employers and workers of member States on this matter. In November 1975 the Governing Body requested the International Labour Office to complete the documentation available in the light of recent studies and developments in member States and subsequently to submit proposals for holding a tripartite meeting of experts on the subject.

[4] For a discussion of such policies see ILO: *Fiscal measures for employment promotion in developing countries* (Geneva, 1972), especially the papers by G. E. Lent and A. R. Prest.

If we compare a subsidy linked to shift work with a subsidy on total employment of the firm, it is apparent that a major difficulty with the latter is that most of the subsidy would be paid in respect of workers who would have been employed anyway.[1] This objection applies with less force to a subsidy linked to shift work, especially if industries with continuous production processes or heavy capital intensity (these industries will normally be working shifts anyway) are excluded from the scheme.[2] Hence the number of jobs created per dollar of revenue lost would be greater if the subsidy were linked to shift work rather than to total employment.

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The main message of this article is that the policies followed in developing countries have usually discouraged shift work and that proper policies could make a significant contribution to the provision of employment opportunities. We have listed a number of ways in which market prices bias the decisions of firms against shift work: interest rates on loans for fixed capital investment are lower, and those on loans for working capital are higher, than they need be; the premiums for night work are often higher than would be necessary to attract workers; and wages in general (whatever their level by social welfare standards) may be higher than the social opportunity cost of labour and thus frustrate the public policy goal of increasing jobs in the modern manufacturing sector. While in theory the desired results could be achieved by pricing all the factors correctly, we suggest that a more practical measure might be the direct subsidisation of shift work.

[1] It is possible to link a subsidy to the *increase* in employment over some base period. Such a scheme could not be used very often, however, because it would lead to perverse reactions on the part of employers as they anticipated the scheme's introduction. See R. A. Musgrave, A. C. Harberger and A. Kervyn: "Some practical suggestions", in ILO: *Fiscal measures for employment promotion in developing countries*, op. cit., pp. 337-342.

[2] The subsidy or tax credit would require periodic inspection of factories by the tax authorities to prevent cheating.