Nutrition and Health Investment*

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A longstanding debate in development focusses on the role of changes in health and nutrition in the process of economic development. While it is well recognized that low levels of health and nutrition, as measured, for example, by caloric intake, body size, illness and mortality, are prominent features of many developing countries, there has been substantial debate on three questions: (1) are health and nutrition at sufficiently low levels to importantly affect worker productivity? (2) do health and nutrition respond to increases in income? (3) are resources allocated in such a way as to efficiently capture potential returns to productivity?

In the past decade many empirical studies have examined the first two questions, although for the most part the emphasis has been on nutrition rather than other aspects of health such as illness. Recent summaries of the literature such as that by Duncan Thomas and John Strauss (1995) generally support the notion that nutrition has effects on productivity but remain circumspect about the nature and magnitude of these effects. There is also evidence that calories increase with income, although the effects are smaller than might be expected in the presence of substantial unrealized returns to expenditures on health and nutrition.

Although issues relating to the efficiency of resource allocation have frequently been used as motivation for an analysis of the nutrition-productivity relationship, little of the existing empirical literature directly addresses this issue. Moreover, the substantial theoretical literature examining the nutrition-based efficiency wage (see Dasgupta 1993) focusses on the implications of the model for employment rather than for the efficiency of resource allocation. In this paper I examine recent evidence on the nutrition-productivity relationship that sheds light on the question of whether caloric allocations efficiently capture potential returns to productivity.

I. Model

The model assumes that caloric intake affects both health and productivity and that agricultural labor in developing countries is compensated in a variety of ways. In particular, the model recognizes that, because of the seasonal nature of agricultural production, the demand for labor varies over time and thus the dominant form of employment is casual labor, which may be compensated on a piece or time-rate basis depending on the nature of the activity and the number of workers employed (see Foster and Rosenzweig 1993); in the latter case a worker may be provided with some of his compensation in the form of meals.

The model is used to illustrate a number of potentially important features of agricultural labor markets. Firstly, a significant nutrition-productivity relationship is consistent with low levels and low income elasticities of nutrition. Secondly, caloric intake is responsive to the contractual terms faced by a worker. Thirdly, a potential source of inefficiency in casual labor markets is the fact that employers may not observe the other contracts used by their workers. Fourthly, employer-provided meals may decrease labor market inefficiencies even when a worker has a number of employers.

I assume that workers select calories and labor allocations to maximize utility subject to a budget constraint. The utility function is $u(h,x)=\ln(h)+x$, where $h=c-\eta(l_p+l_m+l_w)$ denotes health, c denotes caloric intake, x denotes consumption of other goods, and l_p, l_m, and l_w denote time spent working under piece rates and time wages with and without meals, respectively. It is assumed that the productivity of a worker who consumes c calories is $\gamma_0+\gamma_c c$ and that productivity is only observed and thus rewarded under piece rates so the budget constraint is

$$(1) \quad p_c c + x = a + p_p(\gamma_0+\gamma_c c)\, l_p + w_m l_m + w_w l_w$$

where p_c is the price of consumption goods, a is non-labor income, p_p is the piece-rate price, and w_m and w_w are the time wages (inclusive of meal costs) with and without meals, respectively. In addition it is assumed that workers provide at most one unit of employment to each employer, that employers do not know the other contracts used by workers, and that relative to labor demand on the part of employers, there are a large number of potential workers with reservation utility determined by utility when not working in the labor market ($l_p=l_m=l_w=0$).

Under these conditions and assuming an interior solution optimal caloric intake from the perspective of the worker is

(2) $c(l_p, l_m, l_w) = \eta(l_p + l_m + l_w) + 1/(p_c - p_p \gamma_c l_p)$

Equation (2) shows that intake may not be responsive to potential labor income or assets even when there are significant effects of intake on productivity. It also shows that intake is affected by labor force participation, particularly in the piece-rate sector, where it is rewarded.

The optimal contract for meal-providing time-wage employers is determined by minimizing with respect to wages and calories the cost per efficiency unit of labor subject to maintaining workers at their reservation utilities. If at most one employer per worker provides meals, such a measure may be constructed by equating utility conditional on consumption and labor allocations to the reservation utility and solving for w_m; this yields the wage that must be paid by an employer that provides c units of meals to attract a worker given l_p and l_w, $w_m^e(c, l_p, l_w)$. The optimal level of meals is determined by minimizing with respect to calories the ratio of this function to productivity given calories.

The equilibrium time wage without meals may be shown to be at the minimum of the corresponding w_m^e function. The intuition is that relative to a time-rate employer that does not provide meals, a meal-providing employer will have to pay a premium to attract the worker because the worker is not allowed to set his own consumption; if the consumption provided by the employer equaled the amount the worker would choose to consume on his own, no premium would be needed.

Figure 1 presents graphs of the curves $w_m^e(c,1,0)$ and $w_m^e(c,0,1)$ along with a series of upwardly sloping lines that represent constant costs per efficiency unit of labor,[1] with lower lines corresponding to lower costs and thus greater efficiency. Points C and D correspond to the time wages needed, in equilibrium, to attract workers employed for one time-rate and one piece-rate or two time-rate spells, respectively. Although the worker with one piece-rate spell (point C) has a higher reservation wage than does a worker who works only for time wages (point D), the cost per efficiency unit of employing the former is lower because he consumes more calories. Thus, if time-wage employers could distinguish the other contracts used by workers, they would choose to employ only those with piece-rate spells; assuming that this is not possible and that the chance that a randomly selected time-rate worker has one piece-rate spell is not high, employers will offer contracts at D and thus only attract workers with no piece-rate spells.

Both C and D exhibit higher costs per efficiency unit of labor than A, which corresponds to the optimal meal-based contract when an individual works one spell for piece-rate and one spell for time-rate wages with meals. This point is also fully efficient: the efficiency cost per unit of work is equal to the piece-rate price and calories are what they would be if only piece-rate wages were paid. This result is due to the fact that intake is fully rewarded when the alternate activity is piece-rate employment. If piece-rate employment were not an option then a meal-providing employer would be limited to contracts at point B, which imply a higher cost per efficiency unit of labor and result in reduced caloric intake.

Finally, it may be shown that introduction into the model of heterogeneity in worker productivity (i.e., variation in γ_0) that is not observable to employers yields a significant additional implication: under these circumstances meals play a role as a screening device. Since more productive workers will tend to spend more time in piece-rate activities, they will consume more. A meal-based contract will thus become even more attractive to employers because only relatively productive workers will, in general, be willing to receive a large share of their wages in the form of meals. Thus even if the level of meals provided is not binding for workers receiving meals, it may be binding for workers who choose other contracts. Moreover, this form of contract may increase the productivity of employed workers even when meals are provided at the end of employment spells.

II. Evidence

A key assumption of the above model is that the returns to caloric intake vary according to the form of payment used. This assumption has been tested by Foster and Rosenzweig (1994) in a rural area of the Philippines, where workers are frequently observed to be engaged in both time and piece-rate employment. In particular, they find that a 10% increase in calories is associated with a 5.1 percentage point increase in piece- relative to time-rate wages. These results are consistent with evidence from a controlled double-blind experiment involving anemic workers: Samir S. Basta *et al* (1979) found that the earnings of workers involved in piece-rate activities, but not of those in time-rate activities, increased when they received supplements.

The model also indicates that caloric allocations should be influenced by the sector in which a worker is employed. Using caloric data for the same individual at different points in time, Foster and Rosenzweig (1994) show that an individual working full time at piece rates is allocated 23% more calories per day on average than when undertaking the reference non-labor market activity, while those working under time wages receive only 5% more calories per day.

If incentive effects importantly affect nutritional allocations, time-rate employers may try to compensate workers using meals. Because there are other reasons that meals may be provided, however, the fact that meals are sometimes provided does not imply that imperfect monitoring importantly influences the calorie-productivity relationship; the implications of the model must be examined more closely. Unfortunately, there are few studies making use of data on compensation in the form of meals.

One exception is provided by Anand Swamy (1993) who shows in a study of permanent workers that the meal cost is approximately 1/3 the wage; however, because the focus of Swamy's study is on testing the nutrition-efficiency wage model it provides little direct insight into the issue being considered here.

One way to establish whether employers use meals as a way of increasing worker productivity is to determine when meals are used. By way of example, I present the results of a regression relating the number of meals per worker (MEALS) provided by agricultural employers in a longitudinal sample from rural Pakistan (see Jere Behrman, Foster and Rosenzweig 1994) to the number of workers employed in the corresponding period and whether high-yielding varieties (HYVs) were grown. The idea is that HYVs make monitoring more difficult because they require more use of fertilizer and pesticides. The results are as follows:

(3) $$MEALS = -1.12\,(1.81)\,HYV + .0125\,(2.294)\,HYV \times WORKERS$$

where t-ratios are in parenthesis. Controls for workers, workers-squared, the daily wage and the sex composition of the workforce and employer-specific fixed-effects were estimated but are not presented. The regression here indicates that at least for larger employers, for whom monitoring issues are likely to be of greater significance, the use of HYVs is associated with more payment in the form of meals.

More direct evidence that meals contracts are binding for at least some workers may be obtained by examining the relationship between worker productivity and the share of time-rate employment spent with employers that provide meals. While it is possible that meal-providing employers choose, for reasons unrelated to nutrition, workers with observed characteristics that predict productivity, the same cannot be said for aspects of the worker that are not observed by the employer; thus if unobserved aspects of worker productivity are correlated with the share of time spent by that worker with meal-providing employers it would seem reasonable to infer that employers provide meals at least in part as a way of increasing the productivity of their workers.

I examine this idea by using an approach developed by Foster and Rosenzweig (1993) to test for unobservable (to the employer) differences in productivity and for adverse selection of more productive workers into the piece-rate sector. The test makes use of the idea that the piece-rate wage is a noisy signal of a worker's true productivity (μ) while the time-rate wage is a noisy signal of a worker's expected productivity given observable characteristics (μ^*). Application of the approach to the meals data in the Philippine data set used by Foster and Rosenzweig (1993,1994) yields

$$(4)\quad l_m/(l_m+l_w) = constant - .464\,(.807)\,\mu^* + .419\,(1.96)\,u$$

where $u=\mu-\mu^*$ and the t-ratios are in parenthesis. These results indicate that the share of time-rate days spent with meal-providing employers is not observed by time-rate employers and that, for given observed characteristics, more productive workers spend more of their time working for meals. This result indicates that meal-based contracts influence worker productivity either directly, by augmenting calories, or indirectly, by screening out low productivity workers as discussed above.

Finally, it is worth noting that the fact that meals are binding for some workers does not imply that a meals contract is fully efficient. The fact that the amount of time spent working for meals is not observed by time-rate employers suggests that intake is not fully rewarded by other employers, which, as noted, is necessary if meal-based contracts are to be fully efficient. Moreover, evidence from Foster and Rosenzweig (1994) and Basta *et al* (1979) suggests that at least some of the observed calorie-productivity relationship is due to unobservable worker effort that is related to caloric intake through its effect on health but need not increase when calories are exogenously increased through employer-provided meals.

III. Conclusion

Although much of the economic literature on health and nutrition has been motivated with reference to nutrition-based efficiency wages, recent evidence suggests that the nutrition-productivity relationship has other important effects. Because of the nature of rural agricultural labor markets, caloric intake and other aspects of health may be incompletely rewarded and thus nutritional allocations are, in general, inefficient relative to what would be the case under perfect information.

Although the work discussed above examines the implications of contractual terms for nutritional allocations, the idea that health and nutritional investment is importantly influenced by the extent to which this investment is rewarded has broader applicability. There are many poorly understood aspects of the health-productivity relationship that are likely to affect the returns to health and nutritional investment including the shape of the relationship (see Dasgupta 1993), the time frame over which nutritional intake affects productivity, the extent to which the body operates as a storage mechanism (Foster 1995), and the seasonality of income for cultivating households (Behrman, Foster and Rosenzweig 1994). These areas need further study.

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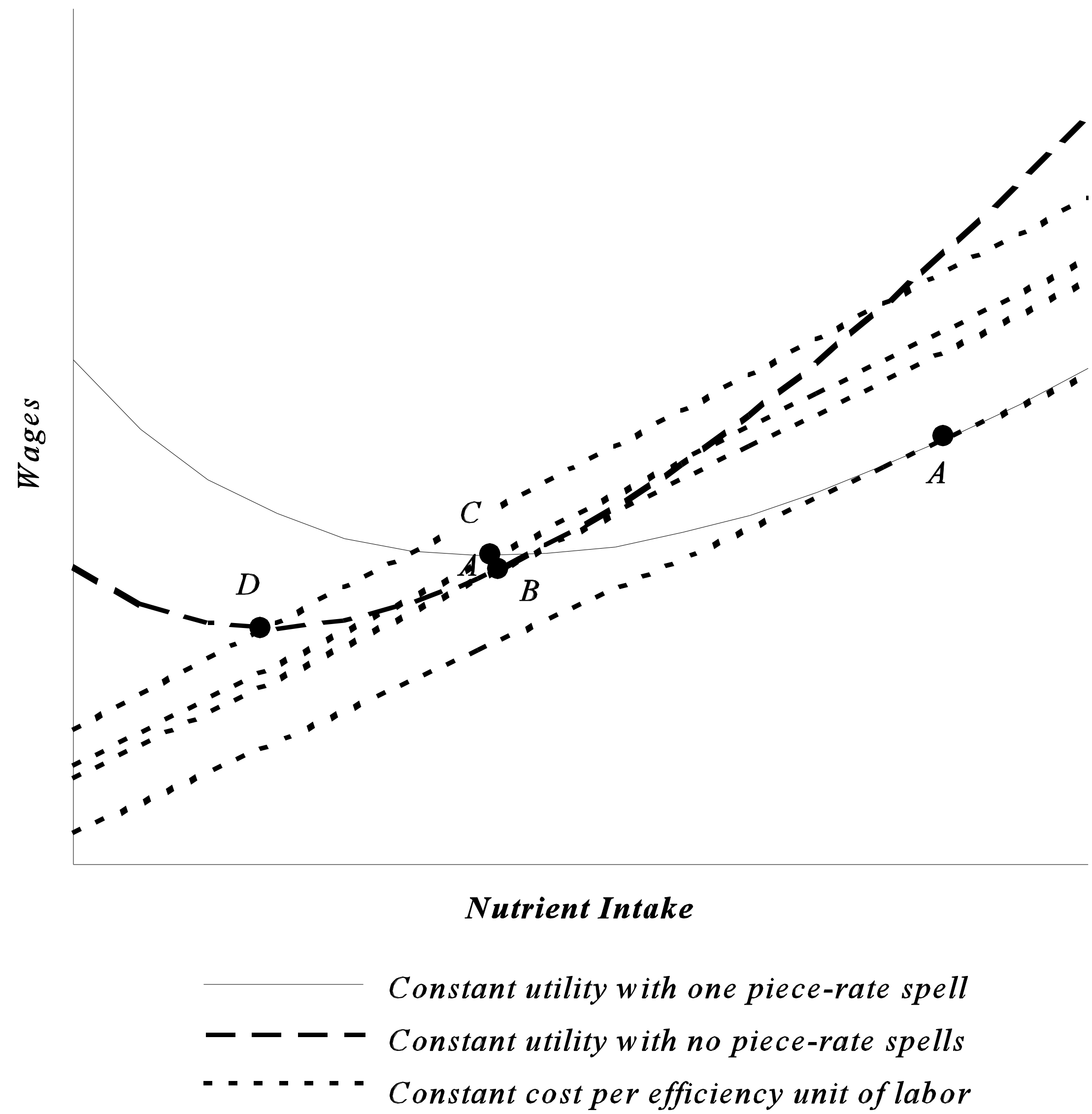

Figure 1: Labor Costs Under Different Contracts

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1. The parameters generating Figure 1 are $\gamma_0=0$, $\gamma_c=1/4$, $p_{ct}=1$ and $\eta=\ln(2)$ with workers assumed to have up to two spells of employment. Details of the model are available from the author on request.