Pareto Inefficiency of Market Economies: Search and Efficiency Wage Models

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Serious macroeconomists have long been faced with a dilemma: how can one reconcile the seeming inefficiencies associated with the periodic episodes of unemployment and under utilization of capital with those rational, competitive forces which, in our traditional microeconomic paradigm, we argue ruthlessly seek out profitable opportunities, eliminate waste, and weed out incompetent producers. In this quest, economists have identified a number of ways in which our economy differs from the idealization of the Arrow-Debreu model that can explain the existence and persistence of unemployment, among the most important of which are search costs and the dependence of productivity on wages (the efficiency wage hypothesis). Once we recognize the importance of these, then the existence of unemployment need not be evidence of market inefficiency: economic efficiency requires the movement of labor from one job to another, as disturbances change the marginal productivity of workers in different industries; search takes time and resources; even if it were always *feasible* to move labor instantaneously from a low to a high productivity use, with no interim period of unemployment, it may—for some individuals, under some circumstances—be inefficient to devote the resources to search required for such transitions; it may be more efficient to spend a period unemployed. Indeed, the very words we use to describe the resulting unemployment rate, "the natural rate," suggests that there is nothing particular perverse, or inefficient, about this unemployment.

By the same token, if productivity is increased by increasing wages, it is quite plausible that efficiency entails wages at above market-clearing levels.

More broadly, the approach taken by modern macroeconomists, in which the terms of the contracts between workers and employers takes into account not only the absence of income insurance for workers, but also search/mobility costs and efficiency wage considerations, seems to preclude the possibility that any resulting unemployment is inefficient: for the contracts are designed to be "locally efficient," that is, to maximize the firm's expect profits, given the reservation utility levels of workers.

The line of reasoning that we have presented in the preceding paragraph, as persuasive as it may seem, is simply wrong. The fundamental question in which we are interested is, is a decentralized market economy, characterized by search costs, efficiency wages, incomplete insurance markets, or by a variety of other informational imperfections, or that deviates from the standard specification of the competitive model in other ways that seemingly enhance its realism—is such an economy Pareto efficient? In judging the efficiency of the resulting market allocations, we need to take explicitly into account the costs of search or information acquisition; of the factors that make productivity dependent on wages; of the absence of a complete set of insurance markets. We ask, are there feasible government interventions, that respect these aspects of actual market economies, that can make everyone better off. (We do not ask, is it reasonable to

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assume that governments will actually intervene in such a way as to effect a Pareto improvement?) In deference to common usage, when there exist such interventions, we say that the economy is *constrained Pareto inefficient*; in adopting this language, we emphasize that we do not believe that the considerations under examination here, such as information costs, are any less "real" than production costs.

We show here that (for rather different reasons) market economies with search and efficiency wages are, in general, not constrained Pareto efficient. In our earlier work (1986), we proved a general theorem establishing that markets with imperfect information and incomplete markets were constrained Pareto inefficient. An explicit assumption of that analysis, however, was that markets cleared, whereas here we are concerned with situations where markets may not. Though efficiency may indeed entail the presence of some unemployment and that wages are not set at market-clearing levels, there is a presumption that neither the level of unemployment or wages is Pareto efficient.

I. Efficiency Wage Models

The basic hypothesis of the efficiency wage model is that workers' productivity depends on the wage paid; here we generalize the standard formulation by allowing productivity (per hour) to depend also on the number of hours worked. Assume that there are L identical workers. The ith firm's output is simply a function of its effective labor supply, $L_i h_i \Gamma_i(v_i, h_i)$ where v_i is the wage its workers receive (which may differ from the wage the firm pays, w_i, because of taxes) and h_i is the number of hours each of its L_i workers works:

$$(1)\quad Q_i = F_i(L_i h_i \Gamma_i(v_i, h_i)), \quad F_i' > 0,$$
$$\Gamma_1 > 0, \quad \text{and} \quad \Gamma_{11} \lesseqgtr 0 \quad \text{as} \quad w \gtreqless \hat{w}$$

The firm maximizes its profits, $\pi = p_i Q_i - w_i h_i L_i$, subject to the constraint that it must offer a contract that exceeds workers' reservation utility:

$$(2)\qquad U(w_i, h_i; q) \geq \bar{U}$$

where utility is a function of wages and hours, as well as the consumer price vector, q. It is by now well known that the solution may entail the constraint (2) not being binding. We focus on this regime here. The maximized level of profits will be a function of prices and the relationship between wages paid and wages received; with an ad valorem wage tax, $v = w(1-\tau)$, and we write: $\pi_i^* = \pi_i^*(p_i, \tau)$, with the standard result that the derivative of profits with respect to price is equal to the firm's output.[1] (Because wages are set by the firm, they do not appear explicitly in the profit function.)

The fact that wages may exceed market-clearing levels in equilibrium implies that we will need to divide consumers into two groups, the employed and the unemployed. Given consumer prices, q, the level of income (in excess of wage income, if any) required by an individual to attain a level of utility U^* is given by the modified expenditure functions: $E^{ju} = E^j(q, 0, 0, U^*)$ for an unemployed household, and $E^{je} = E^j(q, h_j, v_j, U^*)$ for an employed household working h_j hours and receiving a wage of v_j per hour.

The jth household owns a fraction a_{ij} of the ith firm. If the government imposes a set of taxes that changes p, q, h, or v, then for the jth household to attain utility level U^* requires a compensatory payment of $\Delta E^j - \Sigma a_{ij} \Delta \pi_i^*$, where $\Delta \pi_i^*$ is the change in profits. We denote these compensation by I^j.

Assume the government imposes a set of commodity taxes, so the kth consumer price is now $q_k = p_k + t_k$; an ad valorem wage tax at the rate τ, and a tax per employed worker at the rate μ. The profit function can be modified in a straightforward way to reflect the per employee tax, to read $\pi_i^* = \pi_i^*(p, \mu, \tau)$. Now, if the government can impose a set of taxes that raises revenue, after paying all individuals compensation that allows them to remain at the same level of utility they had attained in the market equilibrium, then the market equilibrium

[1] With the caveat that if productivity depends on consumer prices, then there is an additional term, reflecting the effect of the change in producer prices on consumer prices, and the effect of that on productivity, at any given level of wages and hours.

cannot have been (constrained) Pareto efficient. Government revenue is $R = \Sigma t_k Q_k + \tau \Sigma w^j h^j + \mu L - \Sigma I^j$, where L is aggregate employment, Q_k is aggregate consumption of the kth commodity, and where price are determined at the market-clearing levels (with firms choosing their profit-maximizing levels of inputs and outputs, and households choosing their utility maximizing consumption bundles, constrained, of course, by the availability of jobs). Wages are set at profit-maximizing levels. For simplicity, for the remainder of the paper, we assume h is fixed.

Straightforward differentiation, making use of the standard properties of expenditure and profit functions, establishes that at $t_i = 0, \mu = 0, T = 0$,[2]

$$dR/dt = \{E^{ju} - E^{je}\} dL/dt - L\{dE^{je}/dw\}\{dw/dt\}.$$

Similar expressions hold for changes in τ and μ. We decompose the total effects of the tax into four elements:

(*i*) A direct effect in raising consumer prices and government revenue. These are simply transfer effects—when the government compensates the individual for the increased prices, the two effects (for small taxes) cancel.

(*ii*) A general equilibrium effect on prices; an increase in prices raises profits, and lowers consumers' utility; again this is a transfer effect, and so long as the goods' market clears these effects cancel (recalling that every firm must be owned by someone, i.e., $\Sigma a_{ij} = 1$). (If productivity depends on consumer prices, then there is an additional, nontransfer, effect, from any change in consumer prices, equal to $\Sigma pF^i Lh\Gamma_q \cdot (dq/dt)$.)

(*iii*) An indirect effect on the profit-maximizing level of employment; by the envelope theorem, the effect on profits is zero, but the effect on consumers—since there is job rationing—is positive; the dollar value of this is equal to the difference between the compensation, net of wages received, required for the unemployed to be at the same level of utility as the employed. Because private firms ignore this term, market equilibrium entails too little employment.

(*iv*) An indirect effect on the wage level. Again, by the envelope theorem, the effect on profits is zero, but the effect on consumers' is positive (if wages increase.) Thus, there is a presumption that market wages are too low, even though they are set at above market-clearing levels.

Notice that this formulation not only establishes that there are welfare-enhancing government interventions, but also tells us precisely what kinds of interventions are desirable: those that increase employment and wages. Thus, a small ad valorem wage subsidy, that, at least in the simplest versions of the efficiency wage model, will leave consumer wages unchanged, will increase employment and hence increase welfare. Assume productivity is positively effected by food consumption and negatively affected by alcohol consumption, in such a way that the firm responds to a food subsidy and an alcohol tax by increasing employment, but leaving wages unchanged or increased; in these circumstances a food subsidy and an alcohol tax may be desirable.

II. Search

It has long been recognized that search can give rise to unemployment, particularly if (at least for some individuals) off-the-job search is more efficient that on-the-job search. Although some search unemployment will then clearly characterize market equilibrium, it is again by no means clear that the level of unemployment will be Pareto efficient. We show that it is not, using a framework similar to that employed in our discussion of efficiency wages. Again, there will be employed and unemployed workers, now depending upon which workers successfully obtain jobs. Firms' decisions concern-

[2] This expression holds if all firms are identical and all individuals (*ex ante*) are as well. More generally we write, for small taxes

$$\Delta R \approx \Sigma\left[\delta^j\{E^{ju} - E^{je}\} - \left(dE^{je}/dw\right)\Delta w_j\right]$$

where $\delta^j = 1$ for a worker who was unemployed before the imposition of the tax and is employed after; -1 for a worker who was employed before the tax and is unemployed after; and 0 otherwise.

ing hiring, layoffs, and search and workers' decisions concerning quits and search intensities all generate "search" externalities, affecting the likelihood of a firm finding a well-matched worker and a worker finding a well-matched job.

To see the parallel with the earlier section as clearly as possible, we focus on a special case where all individuals and firms are (*ex ante*) identical, and where, in equilibrium, all firms pay the same wage. The probability of a match is $\Phi(x, y)$, where x is the vector of workers' search intensities, y vector of firms' "hiring" intensities. Employment, L, is just equal to $N\Phi$, where N is the number of potential workers. For simplicity, we partition the vector $x = \{x_j; x^*\}$ where x^* is the search intensity of all other workers. Firms choose wages and hiring intensities to maximize expected profits (taking into account the effect of those decisions on the likelihood of a match); and their maximized value of profits can be represented by $\pi_i^*(p; \tau, \mu; z_i)$, where z_i is a description of the relevant market environment, here, the wages and hiring intensities of all other firms and the search intensities of all individuals. As before, we can write the expenditure function of those who are successful in obtaining a job and those who are not by E^{je} and E^{ju}, respectively, noting now the dependence on the market environment, z_i, which now includes the search intensities of others as well as firms' hiring and wage policies.

An identical argument to that employed before shows that if the government can impose taxes which raises revenue, after compensating individuals, then the market equilibrium is not constrained Pareto efficient. Again, straightforward differentiation yields

$$dR/dt \approx \{E^{ju} - E^{je}\}[dL/dt - N\Phi_x(dx/dt)] - L\{dE^{je}/dw\}\{dw/dt\} + \Sigma(\partial\pi_i^*/\partial z^*)(dz^*/dt).$$

The first term is slightly modified from its earlier form, to reflect the fact that the individual, in deciding on her or his search intensity, takes into account the expected gain in utility from the increased likelihood of employment from additional search; the individual does not take into account the effect of those search decisions on the employment prospects of others, and firms do not take into account the gain in utility of those who do obtain jobs as a result of their increased recruitment activities.

There are two additional terms besides those discussed in the previous section, arising from the "external" effects on profits: An increase in hiring intensity by one firm reduces the likelihood of a match and hence has a negative effect on profits of other firms; similarly for wage changes. (These are, however, total general equilibrium derivatives, and the indirect effect of these perturbations on workers' search intensity, and of that on profits, needs to be taken into account.)

The market failure we have identified here can be given a "missing markets" interpretation. Suppose there is a notional employment agency that pays q_x for search intensity x and q_y for hiring intensity y, and in turn receives payments of q_0 for matches. The expected number of matches N is a function of the vector $\{x^j, y^j\}$. Then the employment agency maximizes $q_0\Sigma\Phi_j(x, y) - q_x x - q_y y$. The function $\Sigma\Phi$ looks like the production function of the employment agency. Since this formulation eliminates the externality, the solution to this problem in conjunction with the maximization problems of households and firms yields the Pareto optimal set of outcomes. Looking at the resulting equilibrium prices paid to the notional employment agency, we obtain the optimal taxes and subsidies that a government would have to impose on search-related activities in the absence of such an agency. And the degree to which the pseudo-production function $\Sigma\Phi$ exhibits decreasing, increasing, or constant returns to scale determines whether these payments will leave a net surplus or deficit.[3]

[3] It is clear that if, upon each transaction, any surplus is divided among the participants, there is no division rule which will result in a Pareto efficient outcome unless the pseudo-production function exhibits constant returns to scale.

It is easy to generalize the results of this model, for instance to implicit contract models, where firms sign contracts with workers to maximize their profits, for a given (reservation) expected utility of workers. The contract will specify firms' retention, hiring and wage decisions as a function of the state of nature Θ; state contingent profit and expenditure functions can again be presented as a function of the market vector z; and a state contingent tax on some commodity i is desirable if

$$dR/dt_i = \{\Sigma \pi_z^* - \Sigma E_z\} \cdot \{dz/dt_i\} \neq 0,$$

where the subscript z denotes a derivative with respect to z. A tax that discourages an individual from searching (say, because it increases the opportunity cost of searching) has positive externalities on other individuals, since, at any fixed level of search intensities on their part, it increases the likelihood that they will find a good (better) job. A tax that encourages firms to search more (by subsidizing new employees) or to retain more workers has positive externalities on workers, since at any fixed level of search intensities on the part of worker, the likelihood that they find a (better) match is increased, but negative externalities on other firms (because of the reduced likelihood of a match.) We conjecture, but have not proved, that normally the first effect dominates the second: there is too little hiring.

Notice that firms, in setting their lay-off rates, take into account the effect of changes in the lay-off rate of the expected utility of its own workers, but not the external effect of the search efforts of its workers on the likelihood of others' obtaining employment.

Such a tax may have a second set of effects on the wages offered by different firms; if firms change their wages for new hires, in response to the changed search intensity, there is a second-order effect on profits, which can be ignored, but a first-order effect on workers' expected utility.

III. Concluding Remarks

In our earlier work, we showed that market equilibrium with competition, in contexts in which all markets clear, but in which there was imperfect information or incomplete markets would not, in general, be Pareto efficient.

Here we have extended those results to incorporate equilibria in which firms are wage setters rather than wage takers, where they set their wage to take into account efficiency wage considerations (including the effect on the cost of recruiting workers and on labor turnover), and where they may set the wage at a level where markets do not clear. We believe that this provides a more accurate characterization of labor markets than is provided by the standard perfect information, market-clearing model.

It should be clear that similar results obtain in other contexts—in labor, product, and capital markets—in which wages, prices, and interest rates affect market behavior, for instance by conveying information. Though efficiency may indeed entail unemployment, credit rationing, or prices exceeding marginal costs of production, there is no presumption that the extent of rationing, and the level of wages, prices, and interest rates in the market equilibrium are efficient. The precise nature of the distortions depends on the exact specification of the model: in the efficiency wage model, there was too little employment, as firms failed to take into account the potentially large discrepancy in utility of the employed and the unemployed.

REFERENCE

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