Outsourcing and the Invisible Handshake

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April 2005

Abstract. We study a model of long-term employment relationships in which employers attempt to smooth wage fluctuations for risk-averse workers, in effect selling insurance to workers at the same time as they buy their labor. The availability of international outsourcing can sharpen the incentive to renege on these wage-smoothing commitments, thus raising the volatility of wages. However, the cost of this increased volatility is borne in equilibrium by employers, since they must now pay higher expected wages. Employers can thus be made worse off or better off by the effects of outsourcing overall: The indirect effect of the weakened ability to insure workers at least partly negates the direct effect of easier access to labor.

First draft: Preliminary and incomplete.

A key feature of globalization in recent years has been the striking increase in international labor-market integration. This is manifested both in foreign direct investment, which allows a firm access to labor in several countries at once, and also in outsourcing of business services.

A parallel phenomenon has been the rise in income volatility for individual workers. This was documented in Gottschalk, Moffitt, Katz and Dickens (1994). A recent journalistic account with evidence from individual case studies, survey data, and labor-market data is found in Gosselin (2004). By some measures, volatility of individual earnings in the United States has doubled since the 1970's. A key theme in these accounts is the claim that the security of worker's jobs has been diminished, and the loyalty felt by employers to long-term workers is weaker, than in previous eras. Outsourcing, both international and domestic, has often been cited as related to the weaker employment relationships, as in Holstein (2005). Evidence on the growing fragility of employment relationships is reported in Valletta (1999).

We ask in this paper if it is possible that these phenomena may be related, that is, if greater international integration of labor markets may lead to greater volatility of wages.

We explore that possibility in the context of a simple model of risk-bearing in employment relationships in which complete contracts are unavailable for informational reasons. In this environment, the only way for an employer to share risk with an employee is to develop a long-run relationship in which the firm promises to smooth out (partially or completely) shocks to wages, and the worker in turn promises a long-run commitment to the firm. This arrangement is enforceable only through the threat that if one reneges, he or she will lose the benefit of the trust on which the relationship was founded, and will need to suffer the whims of the market and search for a new worker (or employer, as the case may be). Integration of one's country's labor market with another can make it easier or harder to search for a worker (or a job), thus increasing or reducing the potential for risk-sharing relationships, and thus increasing or reducing the volatility of wages as the case may be.

This paper is related to an earlier one by McLaren and Newman (2004), which studied the effect of globalization on risk-sharing in an abstract economy with symmetric agents. Here, by contrast, the asymmetry between workers and employers is the focus, and the distribution of income between workers and managers. In addition, that paper, unlike the current paper, confined attention to stationary risk sharing relationships, which are in general sub-optimal. See Kocherlakota (1996) for an extensive analysis of optimal history-dependant risk-sharing relationships in a similar model. The argument is also related to the literature initiated by Ramey and Watson (2001), showing how improvements in search technology can have perverse effects on incentives.

This exercise is also close in spirit to Thomas and Worrall (1988).[1] They analyze self-enforcing labor contracts between a risk-neutral employer and a risk-averse employee in the presence of an exogenous and randomly fluctuating labor spot market. The employer offers wage smoothing to the employee, implying wages above the spot wage in slumps, and in return the worker accepts a wage below the spot market in booms. Both sides know that if either reneges on this agreement, both will be forced to use the spot market from then on. The presence of the spot market generally puts a binding constraint on the amount of insurance the employer can provide. By contrast, in this

[1]The approach to finding the optimal contract with a risk-averse worker follows that paper. It should be pointed out that this project adds moral hazard, raising issues studied, for example, in MacLeod and Malcomson (1989).

paper, there is no exogenous spot market, but rather a search pool which either employer or employee can enter at any time. The value of entering the search pool is endogenous, since it depends on how easy it is to find a match and also on how well cooperation works with the new partner once a match has been found. Thus, this is a general equilibrium exercise, while the Thomas and Worrall model is partial equilibrium in character. The aim is to ask how improvements in the market mechanism such as an improvement in search technology or an increase in international openness would affect wage-smoothing within the firm.

A related argument has been made by Bertrand (2004). There, it is shown that firms hit with stiff import competition (or anything else that has a negative effect on balance sheets) can effectively have a higher discount rate due to an increased risk of bankruptcy. This leads to tightened incentive-compatibility constraints and thus higher wage volatility within a given employment relationship. The effect is shown to have empirical support. Our paper, by contrast, focuses on factor-market integration rather than trade, and in addition we show how wage volatility can rise even though the firm is doing well – a theme emphasized in some journalistic accounts (for example, Gosselin (2004), whose story is entitled “If America Is Richer, Why Are Its Families So Much Less Secure?” and Holstein (2005)).

In our model, workers are risk-averse, while the employers are risk-neutral. In order for production to occur, a worker must team up with an employer. For this reason, an employer would like to commit credibly to a constant wage, in effect selling insurance at the same time as it purchases labor. Workers without an employer and employers without a worker search until they have a match. In order for production to occur, in each period a worker must put in one unit of non-contractible effort. Because of this, wage compensation is ‘back-loaded’ in equilibrium; a worker always has an incentive to put in effort in order to receive future compensation. For this reason, new workers are always cheaper than incumbent workers. This is the source of the firm's problem: during adverse shocks, when the firm's profitability is low, if it is still paying the same high wage as in good states as promised, it will be tempted to renege, dumping the current worker and picking up a new, cheaper one instead. If it is easy to find a new worker quickly, workers will know not to trust an employer's promise of wage insurance and will demand a high wage in good times.

Thus, globalization, by making it easier for a firm in a labor-scarce economy to hire workers in a labor-abundant economy, can reduce the credibility of wage-smoothing employment relationships in the labor-scarce economy.

For this reason, globalization can introduce volatility into the wages of employed workers. However, this does *not* imply that the worker's welfare has dropped. In fact, when this happens, the workers' *mean* income increases by enough to compensate for the new volatility. This has a number of somewhat surprising implications for income distribution. First, the aggregate incomes of managers and shareholders may actually fall in Home relative to unskilled workers as a result of globalization. This is contrary to the intuitive expectations of many, and contrary, for example, to the prediction of a Feenstra-and-Hanson (1996) type of model. Second, the dependence of Home workers' income on firm-specific shocks would imply a rise in dispersion within the category of unskilled workers, much as has been discussed in the empirical labor economics literature. Third, the absolute profits of any given firm in Home benefit from the greater ease of finding a worker when the firm has a vacancy, but are hurt by the higher insurance premium that must be paid to workers once they are hired. Thus, the effect on firm profits is ambiguous.

In Foreign, all effects take the opposite sign.

1. The Model.

Consider first a closed-economy model with two types of agent, 'workers, ' of which there are a measure W, and 'employers,' of which there are a measure E. We will later examine the case of an open economy. The workers are risk-averse, with increasing, differentiable and strictly concave utility function μ, while the employers are risk-neutral. There is a finite lower bound $\mu(0)$ to workers' utility (or, equivalently, there is some exogenous source of consumption on which workers can rely even if they are unemployed). Workers maximize expected discounted lifetime utility, and employers maximize expected discounted lifetime profits. All agents discount the future at the constant rate $\beta \in (0, 1)$. In order for production to occur, a worker must team up with an employer. We will call a given such partnership a 'firm.' Workers without an employer and employers without a worker are 'unemployed' and 'with vacancy' respectively, and all of them search until they have a match.

Search follows a specification of a type used extensively by Pissarides (2000). If a measure n of workers and a measure m of employers search in a given period, then $\Phi(n, m; \phi)$ matches occur, where Φ is a function increasing in all arguments and homogeneous of degree 1 in its first two arguments. The parameter ϕ is a measure of the effectiveness of the search technology. It is convenient to denote by P the steady-state probability that a vacancy will be filled in any given period, or in other words, $P = \Phi(m, n, \phi)/m$. Similarly, denote by $Q = \Phi(m, n, \phi)/n$ the steady-state probability that an unemployed worker will find a job in any given period. Search has no direct cost, but it does have an opportunity cost: If an agent is searching for a new partner, then she is unable to put in effort for production with her existing partner if she has one. This brings us to the topic of production.

In order for production to occur, in each period a worker and employer must both put in one unit of non-contractible effort. This effort causes a disutility for the worker equal to $k > 0$. Within a given employment relationship, denote the effort put in by agent i by $e^i \in \{0, 1\}$, where $i = W$ indicates the worker and $i = E$ denotes the employer. The revenue generated in that period is then equal to $R = x_\epsilon e^W e^E$, where ϵ is an iid random variable that takes the value $\epsilon = G$ or B with respective probabilities π_ϵ, where $\pi_G + \pi_B = 1$ and $x_G > x_B$. The variable ϵ indicates whether the current period is one with a good state or a bad state for the firm's profitability. The average revenue is denoted by $\bar{x} \equiv \pi_G x_G + \pi_B x_B$. There is also a possibility in each period that a worker and employer who have been together in the past will be exogenously separated from each other. This probability is given by a constant $(1-\rho) \in (0, 1)$.

The sequence of events within each period is as follows. (i) Any existing matched employer and worker learn whether or not they will be exogenously separated this period. (ii) The profitability state ϵ is realized. Within a given employment relationship, this is immediately common knowledge. The value of ϵ is not available to any agent outside of the firm, however. (iii) The wage, if any, is paid, and immediately consumed. (iv) The employer and worker simultaneously choose their effort levels e^i. At the same time, the search mechanism operates. If $e^i = 0$, then agent i can participate in search. (v) The firm's revenue, R, is realized. (vi) For those agents who want a new relationship (including the unemployed) and who have found a new potential partner in this period's search, new partnerships with a new self-enforcing agreement are formed. This is achieved by a take-it-or-leave-it offer made by the employer to the worker.

We will focus on steady-state equilibria. In such an equilibrium, the expected lifetime discounted profit of an employer with vacancy is denoted V^{ES} and the expected lifetime discounted utility of an unemployed worker is denoted V^{WS}, where the S indicates the state of searching. Of course, the values V^{ES} and V^{WS} are endogenous, as they are affected by the endogenous probability of finding a match in any given period and by the endogenous value of entering a relationship once a match has been found. However, any employer will take them as given when designing the wage agreement. Given those values, a self-enforcing agreement between a worker and an employer is simply a sub-game perfect equilibrium of the game that they play together. We assume that the employer has all of the bargaining power, so the agreement chosen is simply the one that gives the employer the highest expected discounted profit, subject to incentive constraints. Without loss of generality, we will assume that the 'grim punishment' is used, meaning here that if either agent defects from the agreement at any time, the relationship is severed and both agents must search for new partners. Thus, the payoff following a deviation would be V^{ES} for an employer and V^{WS} for a worker.

To sum up, risk-neutral employers with vacancies search for risk-averse workers, and when they find each other, the employer offers the worker the profit-maximizing self-enforcing wage contract, which then remains in force until one party reneges or the two are exogenously separated. This pattern provides a steady flow of workers and employers into the search pool, where they receive endogenous payoffs V^{ES} and V^{WS}. These values are then parameters that constrain the optimal wage contract.

We now turn to the form of optimal contracts.

2. The form of optimal contracts.

In general, optimal incentive-constrained agreements in problems of this sort can be quite complex because the specified actions depend on the whole history of shocks and not only the current one. (See Thomas and Worrall (1988) and Kocherlakota (1996).) In analyzing the equilibrium, it is useful to note that in our model the employment contracts offered by employers always take one of two very simple forms. Derivation of this property is the purpose of this section.

The equilibrium can be characterized as the solution to a recursive optimization problem. Denote by $\Omega(W)$ the highest possible expected present discounted profit the employer can receive in a subgame-perfect equilibrium, conditional on the worker receiving an expected present discounted payoff of at least W. Arguments parallel to those in Thomas and Worrall (1988) can be used to show that Ω is defined on an interval $[W_{min}, W_{max}]$ and is decreasing, strictly concave, and differentiable. This function must satisfy the following equation:

$$\Omega\left(W_0\right) = \max_{\{\omega_\varepsilon, \tilde{W}_\varepsilon\}, \varepsilon=G,B} \sum_{\varepsilon=1}^{2} \pi_\varepsilon \left(x_\varepsilon - \omega_\varepsilon + \beta\rho\Omega\left(\tilde{W}_\varepsilon\right) + \beta(1-\rho)V^{ES}\right) \tag{1}$$

subject to

$$x_\epsilon - \omega_\epsilon + \beta\rho\Omega(\tilde{W}_\epsilon) - (1 - \beta(1 - \rho))V^{ES} \geq 0 \tag{2}$$

$$\mu(\omega_\epsilon) - k + \beta\rho\, \tilde{W}_\epsilon + \beta(1 - \rho)V^{WS} \geq \mu(\omega_\epsilon) - \mu(0) + V^{WS}. \tag{3}$$

$$\sum_{\varepsilon=1}^{2} \pi_\varepsilon \left[\mu(\omega_\varepsilon) - k + \beta\rho\tilde{W}_\varepsilon + \beta(1-\rho)V^{WS}\right] \geq W_0 \tag{4}$$

$W_{min} \leq \tilde{W}_\epsilon \leq W_{max}$, and (5)

$\omega_\epsilon \geq 0.$ (6)

The right-hand side of (1) is the maximization problem solved by the employer. She must choose a current-period wage ω_ϵ for each state ϵ, and a continuation utility $\tilde{W}_\epsilon$ for the worker for subsequent periods following that state. Constraint (2) is the employer's incentive compatibility constraint: If this is not satisfied in state ϵ, then the employer will in that state prefer to renege on the promised wage, understanding that this will cause the worker to lose faith in the relationship and sending both parties into the search pool. Constraint (3) is the worker's incentive compatibility constraint. If this is not satisfied, the worker will prefer to shirk by searching instead of working. Constraint (4) is the target-utility constraint. In the first period of an employment relationship, the employer must promise at least as much of a payoff to the working as remaining in the search pool would provide. Thus, in that case $W_0 = V^{WS}$. Thereafter, the employer will in general be bound by promises of payoff she had made to the worker in the past. Finally, (5) and (6) are natural bounds on the choice variables.

Constraint (3) can be replaced by the more convenient form:

$$\tilde{W}_\epsilon \geq \tilde{W}^*, \text{ where } \tilde{W}^* \equiv [(1 - \beta(1-\rho))V^{WS} - \mu(0) + k]/(\beta\rho). \qquad (3)'$$

The value $\tilde{W}^*$ is the minimum future utility stream that must be promised to the worker in order to convince the worker to incur effort and forgo search. Of course, condition (3)′ now makes the lower bound in constraint (5) redundant, so we can replace it with constraint (5)′:

$$\tilde{w}_{\epsilon} \leq \; W_{max\,.} \tag{5$'$}$$

To sum up, in each period the employer maximizes (1), subject to (2), (3)′, (4), (5)′ and (6). In the first period of the relationship, the worker's target utility W_0 is given by V^{WS}, but in the second period it is determined by the values of $\tilde{w}_{\epsilon}$ chosen in the first period and by the first-period state, and similarly in later periods it is determined by choices made for earlier dates. We can now prove that the equilibrium always takes the same simple form: A zero-wage 'apprenticeship' followed by a time-invariant but perhaps state-dependent wage. This will be established by the following two propositions. First, note that for the first period of the relationship, (4) is satisfied by any value of $\tilde{w}_{\epsilon}$ that satisfies (3)′. Therefore, (4) is redundant and may be ignored. In that case, ω_{ϵ} enters into the objective function (1) and the constraints (2) and (6) and nowhere else. A reduction in ω_{ϵ} raises the value of the objective function and loosens constraint (2). Therefore, it is optimal to set ω_{ϵ} equal to 0. Further, note that any reduction in $\tilde{w}_{\epsilon}$ raises the value of the objective function (1) and loosens the firm's constraint (2), so it is optimal to lower $\tilde{w}_{\epsilon}$ until the worker's constraint (3)′ binds. This yields the following.

Proposition 1. In the first period of an equilibrium employment relationship, the wage is set equal to zero in each state and the continuation payoff for the worker in each state is set equal to $\tilde{w}^*$.

Now we can use the fact that the worker's target utility for the second period of the relationship (denoted as W_0 in (1)) is equal to $\tilde{w}^*$ to characterize the equilibrium from that point forward.

Proposition 2. There is a pair of values ω^*_ϵ for ϵ = G, B such that in the second period and all subsequent periods of the employment relationship regardless of history (provided neither partner has shirked), the wage is equal to ω^*_ϵ in state ϵ. In addition, the worker's continuation payoff is always equal to $\tilde{W}^*$.

Proof. First, let the Kuhn-Tucker multiplier for (2) be denoted by ψ_ϵ, the multiplier for (3)′ by ν_ϵ, and the multiplier for (4) by λ. The first-order conditions with respect to ω_ϵ and $\tilde{W}_\epsilon$ respectively are:

$$-\pi_\varepsilon + \lambda\pi_\varepsilon\mu'\left(\omega_\varepsilon\right) - \psi_\varepsilon \leq 0 \tag{7}$$

$$\beta\rho\pi_\varepsilon\Omega'\left(\tilde{W}_\varepsilon\right) + \beta\rho\lambda\pi_\varepsilon + \beta\rho\psi_\varepsilon\Omega'\left(\tilde{W}_\varepsilon\right) + \beta\rho\nu_\varepsilon \geq 0 \tag{8}$$

(Condition (7) is an inequality to allow for the possibility that $\omega_\epsilon = 0$ at the optimum, and (8) is an inequality to allow for the possibility that $\tilde{W}_\epsilon = W_{max}$ at the optimum.) We claim that $\tilde{W}_\epsilon = \tilde{W}^*$ for ϵ = G, B. If $\nu_\epsilon > 0$, then complementary slackness implies that $\tilde{W}_\epsilon = \tilde{W}^*$. Therefore, suppose that $\nu_\epsilon = 0$. This implies that (8) becomes:

$$\Omega'\left(\tilde{W}_\varepsilon\right) \geq \left(-\lambda\right)\left(\frac{\pi_\varepsilon}{\pi_\varepsilon + \psi_\varepsilon}\right) .$$

Since, by the envelope theorem, $-\lambda = \Omega'(W_0)$, and as we recall $W_0 = \tilde{W}^*$, this becomes:

$$\Omega'\left(\tilde{W}_{\varepsilon}\right) \geq \Omega'\left(\tilde{W}^{*}\right)\left(\frac{\pi_{\varepsilon}}{\pi_{\varepsilon} + \psi_{\varepsilon}}\right). \tag{9}$$

If $\psi_\epsilon = 0$, this implies through the strict concavity of Ω that $\tilde{W}_\epsilon = \tilde{W}^*$, and we are done. On the other hand, if $\psi_\epsilon > 0$, (9) then implies that $0 > \Omega'(\tilde{W}_\epsilon) > \Omega'(\tilde{W}^*)$, implying that $\tilde{W}_\epsilon < \tilde{W}^*$. However, this violates (3)$'$. Therefore, all possibilities either imply that $\tilde{W}_\epsilon = \tilde{W}^*$ or lead to a contradiction, and the claim is proven.

Since $\tilde{W}_\epsilon = \tilde{W}^*$, the optimization problem in the third period of the relationship is identical to that of the second period. By induction, the target utility for the worker in every period after the first, regardless of history, is equal to $\tilde{W}^*$, and so the wage chosen for each state in every period after the first, regardless of history, is the same. **Q.E.D.**

To compute the level of wages and worker utility in equilibrium, we need to be able to compute V^{WS}. This can be done as follows.

Proposition 3. Employers pay in equilibrium just enough in each period to compensate workers for the previous period's effort, thus extracting all of the surplus from the relationship. Precisely:

$$\mathrm{E}_{\epsilon}\mu(\omega^*_{\epsilon}) = \mu(0) + k/\beta\rho \tag{10}$$

$$V^{WS} = \mu(0) / (1 - \beta). \tag{11}$$

Proof. A worker's utility in search is as follows:

$$V^{WS} = \mu(0) + Q\rho\beta[\tilde{w}^* - \mathrm{E}_{\epsilon}\mu(\omega^*_{\epsilon}) + \mu(0)] + Q(1-\rho)\beta V^{WS} + [1 - Q]\beta V^{WS} \tag{12}$$

The worker receives default utility, plus utility from a new job if she finds one and is not immediately exogenously separated, and continuation search utility otherwise. Utility from a new job is the same as $\tilde{w}^*$ except that the current wage is zero, rather than ω^*_{ϵ}. This yields the expression in square brackets in the second term.

On the other hand, a worker's utility in a job in equilibrium after the first period is:

$$\tilde{w}^* = \mathrm{E}_{\epsilon}\mu(\omega^*_{\epsilon}) - k + \rho\beta\tilde{w}^* + (1 - \rho)\beta V^{WS}.$$

We also know that $\tilde{w}^* = [(1 - (1-\rho)\beta) V^{WS} - \mu(0) + k] / (\rho\beta)$ by definition. Putting these three equations together gives the result. **Q.E.D.**

In the case of a wage-smoothing agreement, (11) determines the equilibrium wage as the unique solution to:

$$\mu(\omega^*) = \mu(0) + k/\beta\rho. \tag{13}$$

We will henceforth call this the 'efficiency wage,' and denote it by ω^*. In the case of a fluctuating-wage equilibrium, the state-dependant wages will be determined by (11) together with the employer's (binding) bad-state incentive constraint.

We now know that an optimal employment contract is always characterised by a good-state wage ω_G and a bad-state wage ω_B. The natural question is whether or not these two state-dependant wages are equal. The following proposition shows that this depends on whether or not the firm's incentive-compatibility constraint binds.

Proposition 4. There are two possible forms for the optimal employment contract. In the first form, the wage is equal to zero in the first period and then takes a constant positive value for the duration of the relationship. In such a contract, the employer's constraint (2) never binds. In the other form, the wage is equal to zero in the first period and takes a low value in bad states, and a strictly higher value in high states, both values invariant to time and history. In such a contract, the employer's constraint (2) binds in bad states but not in good ones, provided that any positive surplus is realized from the relationship at all.

Proof. We consider each possible case in turn. Consider the optimization problem (1) at any date after the first period of relationship. First, suppose that the employer's constraint does not bind in either state. In this case, $\psi_\epsilon = 0$ for $\epsilon = G, B$. Condition (7) now becomes:

$$- \pi_\varepsilon + \lambda \pi_\varepsilon \mu'\left(\omega_\varepsilon\right) \leq 0 \tag{14}$$

If this holds with strict inequality for some ϵ, then $\omega_\epsilon = 0$. This clearly cannot be true for both values of ϵ, because that would imply a permanent zero wage, and it would not be possible to satisfy (4). (To see this, note that after the first period, the target utility on the right-hand side of (4) is equal to $\tilde{W}^*$. Substituting this into the inequality together with the value of V^{WS} from the previous proposition shows that (4) is violated.) Therefore, for at most one state, say ϵ', can the inequality in (10) be strict. Denote by ϵ'' the state with equality in (10). Then $\mu'(0) < 1/\lambda = \mu'(\omega_{\epsilon''})$. However, given that $\omega_{\epsilon''}$ is non-negative and μ is strictly concave, this is impossible. We conclude that (10) must hold with equality in both states, and therefore $\omega_G = \omega_B$.

Next, consider the possibility that the employer's constraint (2) binds in both states. This implies that in both states the expected present discounted value of the employer's profit is exactly what it would have been if the employer was still searching for an employee:

$$x_\epsilon - \omega_\epsilon + \beta\rho\Omega(\tilde{W}_\epsilon) + \beta(1 - \rho))V^{ES} = V^{ES}.$$

Since we know that $\tilde{W}_\epsilon = \tilde{W}^*$ for $\epsilon = G, B$, this implies that $\omega_G > \omega_B$. However, it also implies that the employer captures none of the surplus from the relationship.

Therefore, the employer's constraint can bind in at most one of the two states. Suppose that we have $\psi_G > 0$ and $\psi_B = 0$, so that the employer's constraint binds only in the good state. We will show that this leads to a contradiction. Recall from the previous proposition that $\tilde{w}_\epsilon = \tilde{w}^*$ for both states, and note that, by assumption, (2) is satisfied by equality for $\epsilon = \text{G}$. Since $x_B < x_G$, we now see that (2) must be violated for $\epsilon = \text{B}$ if $\omega_G \leq \omega_B$. Therefore, $\omega_G > \omega_B \geq 0$. This implies that (7) holds with equality in the good state. Applying (7), then, we have:

$$\mu'(\omega_G) = \frac{1}{\lambda}\left(1 + \frac{\psi_G}{\pi_G}\right) > \frac{1}{\lambda} \geq \mu'(\omega_B),$$

which contradicts the requirement that $\omega_G > \omega_B$. This shows that it is not possible for the employer's constraint to bind in the good state.

Finally, suppose that we have $\psi_G = 0$ and $\psi_B > 0$, so that the employer's constraint binds only in the bad state. Suppose that $\omega_G \leq \omega_B$. This implies that $\omega_B > 0$, so that (7) holds with equality in the good state. Then, from (7):

$$\mu'(\omega_B) = \frac{1}{\lambda}\left(1 + \frac{\psi_B}{\pi_B}\right) > \frac{1}{\lambda} \geq \mu'(\omega_G),$$

which implies that $\omega_G > \omega_B$. Therefore, we have a contradiction, and we conclude that $\omega_G > \omega_B$.

We have thus eliminated all possibilities aside from the two listed in the statement of the proposition. **Q.E.D.**

To sum up, if the employer's incentive constraint does not bind, the worker goes through an 'apprenticeship period' at the beginning of the relationship, followed by a constant wage. If the employer's constraint ever binds, then it binds only (and always) in the bad state. In this case, after the 'apprenticeship period,' the wage fluctuates with the current state.

Now, the natural question is under which conditions the employer's bad-state incentive constraint will bind. We address this next.

3. Conditions for wage smoothing.

Here, we show that for given parameters if it is sufficiently difficult for an employer to find a new worker, the equilibrium involves wage smoothing. Otherwise, it involves a fluctuating wage.

First, note that the wage-smoothing agreement is preferred by the employer whenever it is feasible. Therefore, if we assume a wage-smoothing equilibrium and then compute the values V^{ES} and $\Omega(\tilde{w}^*)$ that it implies, then applying those to the bad-state employer's incentive constraint gives a necessary and sufficient condition for wage-smoothing to occur.

We can now find V^{ES} as follows:

$$V^{ES} = P\rho\beta[\Omega(\tilde{w}^*) + \omega^*] + P(1 - \rho)\beta V^{ES} + [1 - P]\,\beta V^{ES} \tag{15}$$

Note in addition that:

$$\Omega(\tilde{w}^*) = [\,\bar{x} - \omega^* + (1 - \rho)\beta V^{ES}] / (1 - \rho\beta). \tag{16 }$$

If we substitute (16) into (15), we get:

$$V^{ES} = P\rho\beta\,[(\bar{x} - \rho\beta\,\omega^*) / (1 - \rho\beta)] + \beta\,[1 - (P\rho(1 - \beta) / (1 - \rho\beta))]\,V^{ES}$$

Rearranging and simplifying, we have a useful form for the employer payoff in search:

$$V^{ES} = \{P\rho\beta / [(1 - \beta)[1 - \rho\beta(1 - P)]]\}(\bar{x} - \rho\beta\,\omega^*) \tag{17}$$

It is easy to verify that this is increasing in P:

$$\partial V^{ES} / \partial P = \{\rho\beta(1 - \rho\beta) / [1 - \rho\beta(1 - P)]^2\}[(\bar{x} - \rho\beta\,\omega^*) / (1 - \beta)] > 0 \tag{18}$$

Now, the employer's incentive constraint in the bad state is:

$$x_B - \omega^* + \rho\beta\,\Omega(\tilde{w}^*) - (1 - (1 - \rho)\beta)\,V^{ES} \geq 0$$

Substituting in (16), this becomes:

$$x_B - \omega^* + \rho\beta(\bar{x} - x_B) \geq (1 - \beta)\,V^{ES}, \text{ or}$$

$$x_B - \omega^* + \rho\beta\,\pi_G[x_G - x_B] \geq (1 - \beta)\,V^{ES}. \tag{19}$$

Inequality (19) can be understood as follows. Suppose for the moment that the employer's incentive constraint binds in the bad state. Then in that state the employer's payoff is equal to V^{ES}. The employer's average payoff is therefore equal to $\pi_B V^{ES} + \pi_G (V^{ES} + [x_G - x_B]) = V^{ES} + \pi_G [x_G - x_B]$. In the bad state, then, the employer's payoff if it does not renege is equal to $x_B - \omega^* + \rho\beta(V^{ES} + \pi_G[x_G - x_B]) + \beta(1-\rho) V^{ES}$. The payoff if the firm reneges is V^{ES}. Equating these two gives (19) as an equality. Thus, if the employer's incentive constraint binds in the bad state, (19) will hold exactly. If we then raise the penalty terms or lower the benefit terms, the inequality will hold strictly. Therefore, the employer's incentive constraint is satisfied in the bad state if and only if (19) holds.

Now, knowing that V^{ES} is increasing in P, the following is immediate:

Proposition 5. There is a value $P' \in [0, 1]$, such that if $P \in [0, P']$ a wage-smoothing equilibrium can be sustained, while if $P \in (P', 1]$ it cannot.

It is instructive to look at the limiting cases. Using (17) in (19), we can see that in the limit as $P \to 1$, wage smoothing is sustainable if and only if:

$$x_B \geq (1+\rho\beta)\,\omega^*.$$

(Thus, if this condition is satisfied, $P' = 1$.) This can be interpreted as follows. If an employer can find a new worker immediately, reneging involves paying no wage now, receiving no output now, and starting a new relationship with a new worker next period. The loss from doing this is current output, x_B. The benefit is the current wage that is saved, *plus the next period wage that is saved* *because the new worker will be in her apprenticeship period.* Because new workers are cheaper than old ones, there is a temptation to renege even if the worker's productivity in the bad state exceeds her wage. If $\beta\rho$ is close to unity, the bad-state productivity must be close to double the wage to deter reneging in a wage-smoothing equilibrium.

Similarly, from (17) and (19), we can see that in the limit as $P \to 0$, wage smoothing is sustainable if and only if:

$$x_B + \rho\beta\pi_G[x_G - x_B] \geq \omega^*.$$

(Thus, if this condition is satisfied strictly, $P' > 0$.) Given that the employer cannot find another worker at all, the wage-smoothing equilibrium can be sustained even if the employer makes losses in the bad state (that is, even if $x_B < \omega^*$). Recalling that ω^* is determined by parameters through (14), we assume that:

$$\omega^* < x_B < (1+\rho\beta)\,\omega^*.$$

This guarantees that $P' \in (0, 1)$, and also ensures that it is socially optimal to produce in both good and bad states.

To sum up, we find that a wage-smoothing equilibrium can be sustained if it is sufficiently difficult for an employer to find a new worker ($P \leq P'$), but if it is easier to find a new employee the only possible equilibrium is of the fluctuating-wage kind. We turn to those next.

4. Fluctuating-wage equilibria.

In a fluctuating-wage equilibrium, the two state-dependant wages are determined by (11) and the employer's binding bad-state incentive constraint.

$$x_B - \omega_B^* + \rho\beta\,\Omega(\tilde{W}^*) - (1 - (1-\rho)\beta)\,V^{ES} \geq 0 \tag{20}$$

This is illustrated in Figure 1. The figure measures the bad-state wage ω_B on the vertical axis and the good-state wage ω_G on the horizontal axis. The downward-sloping curve *WW* shows the combinations of state-dependent wages that satisfy the worker's incentive compatibility constraint, or condition (11). This curve is strictly convex due to the worker's risk aversion. The intersection of *WW* with the 45°-line is the efficiency wage, ω^*, and any movement along the curve toward that point represents an increase in the employer's profits, because it implies a lower expected wage. The downward-sloping line *EE* is the employer's incentive-compatibility constraint in the bad state. This is linear in ω_G and ω_B, as can be seen by developing expressions for V^{ES} and $\Omega(\tilde{W}^*)$ analogous to (17) and (16) and substituting them into (20). Any equilibrium pair of wages must lie on or above *WW* and on or below *EE*.

We are focussing here on the fluctuating-wage case, so by assumption, the constant-wage outcome is not sustainable. Therefore, we know that the intersection of *EE* with the 45°-line occurs below the intersection of *WW* with the 45°-line. Further, since we have shown that in equilibrium the good-state wage is never below the bad-state wage, the two curves must intersect below the 45°-line. Given the concavity of *WW* and the linearity of *EE*, there will clearly be two such intersections, but the one that will be chosen by the firm is the one closest to the 45°-line, as shown, because it will offer the lowest expected wage consistent with the constraints. This means that at the point of intersection that determines ω_B and ω_G, *EE* is flatter than *WW*. As a result, it is clear that anything that shifts the *EE* line down will raise ω_G and lower ω_B.

Since, by (18), a rise in *P* will shift the *EE* down, we have the following:

Proposition 6. If the equilibrium has fluctuating wages, an increase in *P* will raise ω_G and lower ω_B, in the process raising average wages.

Thus, an improvement in the ease with which an employer can find a new worker has a negative indirect effect on profits in the form of higher expected wages, in addition to the positive direct effect.

5. Globalization.

Suppose that we now have two countries. Call the first the ‘US’ and the second ‘India.’ The US has *E* employers and *W* workers, while India has E^* employers and W^* workers. Assume that

$$E/W > E^*/W^*,$$

so that workers are relatively abundant in India.

First, we will consider the steady-state under autarky, which here means simply that American employers can match only with American workers and Indian employers can match only with Indian workers.

We need to derive the equilibrium value of P. Total number of employers searching for a worker in any one period is m. Total number of workers searching for a new employer is n. In any period $\Phi(n,m;\phi)$ matches occur. Therefore, the fraction of searching employers who find workers is $\Phi(n,m;\phi)/m$. The steady state level of searching employers therefore must satisfy the following equation:

$$m = m\,(1 - \Phi(n,m;\phi) / m\,) + (1 - \rho\,)(\,E - m\,) + ((1 - \rho\,)\,m\,(\,\Phi(n,m;\phi) / m\,).$$

The first term on the right-hand side represents vacancies for which no worker was found; the second represents firms currently with workers who are exogenously separated from them; and the last term represents firms that find a worker to fill a vacancy but are immediately exogenously separated from her.

This can be simplified to:

$$m = E - (\,\rho\,/\,(1 - \rho\,))\;\Phi(n,m;\phi)\;. \tag{21}$$

Similarly,

$$n = W - (\,\rho\,/\,(1 - \rho\,))\;\Phi(n,m;\phi)\;. \tag{22}$$

This can be used to show the following.

Proposition 7. For any value of E/W, the steady-state value of n/m is uniquely determined. We can thus write $n/m(E/W)$. Further, $n/m(E/W)$ is strictly decreasing, with $n/m(E/W) > (<) (=) 1$ as $E/W < (>) (=) 1$.

Proof. If we subtract (22) from (21), we get:

$$E - W = m - n .$$

Suppose that $E > W$. Divide both sides by W and using (22), we find:

$$E / W = \{(m - n) / [(\rho / (1 - \rho)) \Phi(n,m;\phi) + n]\}+1, \text{ so:}$$

$$E / W = \{(1 - (n / m))/[(\rho / (1 - \rho)) (\Phi(n/m, 1; \phi)) + (n / m)]\}+1. \quad (23)$$

The right-hand side of (23) exceeds unity iff $n/m < 1$. Clearly, the right-hand side of (23) needs to be greater than unity, so n/m must be less than unity. Therefore, at an equilibrium, the right-hand side of (23) is strictly decreasing in n/m, so the equilibrium level of n/m is uniquely determined for a given value of E/W, ρ, and ϕ. Furthermore, n/m is a locally decreasing function of E/W for given values of the other parameters.

Now, if $E < W$, a parallel argument can be developed by dividing through by n instead of m

and later by E instead of W. **Q.E.D.**

Thus, holding other parameters constant, increasing E/W will lower the value of $\Phi(n/m, 1; \phi) = \Phi(n, m; \phi)/m = P$. When workers are more scarce, it is more difficult for an employer to find one to match with.

Thus, the value of P will be lower in the autarkic US than in autarkic India. Therefore, wages will be weakly more volatile, and expected wages higher, in autarkic India than in the aurarkic US.

Further, when globalization occurs, the two economies will combine to form one large one with $E + E^*$ employers and $W + W^*$ workers. The ratio between the two will necessarily be between E/W and E^*/W^*, so:

Proposition 8. Globalization causes an increase in volatility of wages in the US, with an increase in the good-state wage, a drop in the bad-state wage, and a concomitant increase in expected wage that leaves workers' welfare unchanged. It has the oppositive effects in India.

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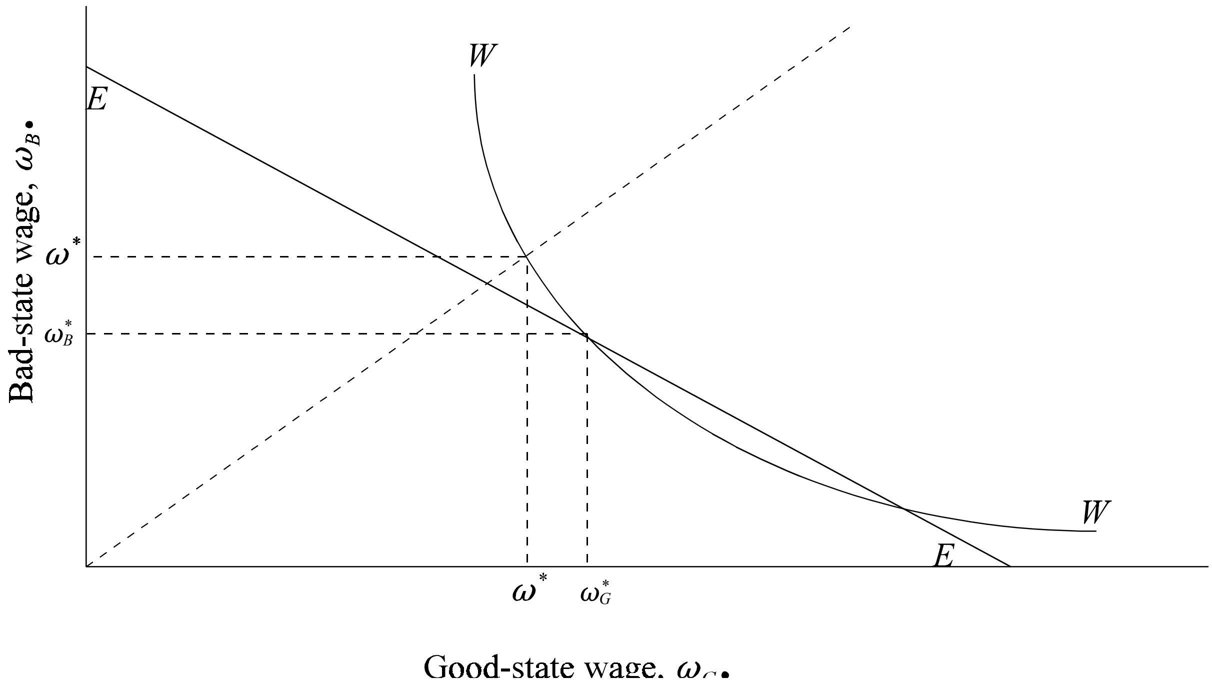

W
E
ω^*
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Bad-state wage, ω_B
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