Lecture notes on economic institutions compared
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PAY, POWER AND EFFORT
The employment relation

Symbol list

N	work force
w	wage
e	work effort
U	utility level
x	production per production unit
L	employment per production unit
q	price to home worker
s	putter-out surplus
b	search and transaction costs
M	number of putters-out
π	employer profit
h	new job search costs
p	probability of contract renewal
V	expected utility
β	discount factor
r	interest rate
ϕ	probability that an unemployed gets a job

2. The setup

There are N workers who are assumed to have utility functions over pay w and efforts e

$$U = U(w, e) \tag{2.1}$$

where $U_w > 0$, $U_e < O$, $U_{ww} \leq O$, $U_{ee} \leq O$ and $U_{we} \geq O$. The last statement captures the reasonable assumption that the higher the effort level, the higher the marginal utility of income. In addition we assume that workers have a reservation level of utilities U^0 which can be thought of as determined by the pay-off obtained by redrawing from the organized economy, $U^0 = U(0, 0)$, or more generally as their best option outside the sector under consideration.

Production x per production unit is given by

$$x = F(L, e) \tag{2.2}$$

where L is employment in the production unit and e is the average work effort of the workers, and where $F_L > 0$, $F_e > 0$, $F_{LL} < 0$, $F_{ee} < 0$ and $F_{Le} > O$. The last statement implies that the higher the marginal product of an extra worker is higher the higher the effort level of workers.

When every worker works for himself (as a home worker in the putting out system) his output is

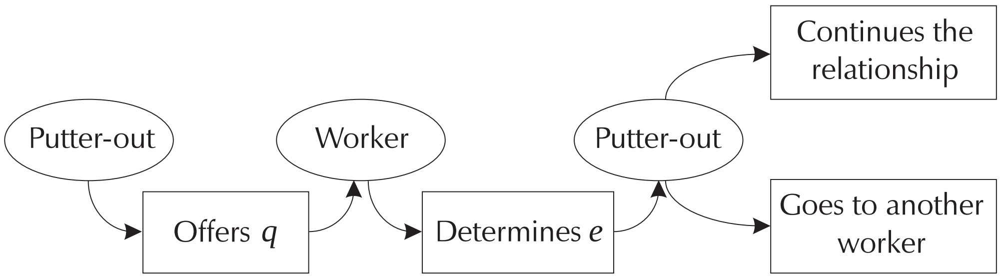
$$x = f(e) \quad \text{where} \quad f'(\cdot) \quad \text{and} \quad f''(\cdot) < 0 \tag{2.3}$$

The case where $F(L, e)/L > f(e)$ for some (L, e), captures positive team-work gains of factory production.

Putting-out system

In the putting-out system dispersed cottage labor were tied to a particular employer, the putter–out, who often was a second rate merchant. He supplied home working hirelings with raw materials to be worked up into finished products. The price of the work to be performed was stipulated in advance and the domestic workers could choose their own work speed (Landes 1966). In this system the putter–out acts as a coordinator. He makes contracts with the individual home workers. He cannot, however, supervise and monitor the work process. The home workers are therefore free to choose the work effort. They do not supply the finished product to a market since they are not individual entrepreneurs but hirelings tied to a particular putter–out.

The decision making structure of the putting out system can be visualized as:



We assume that the putter–out can sell the finished products for a given unit price and we choose units such that the price is equal to 1. The putter out stipulates a price q to each home worker. Accordingly, the pay to each worker is

$$w = qf(e) \tag{3.1}$$

The surplus per worker obtained by the putter-out is correspondingly defined by

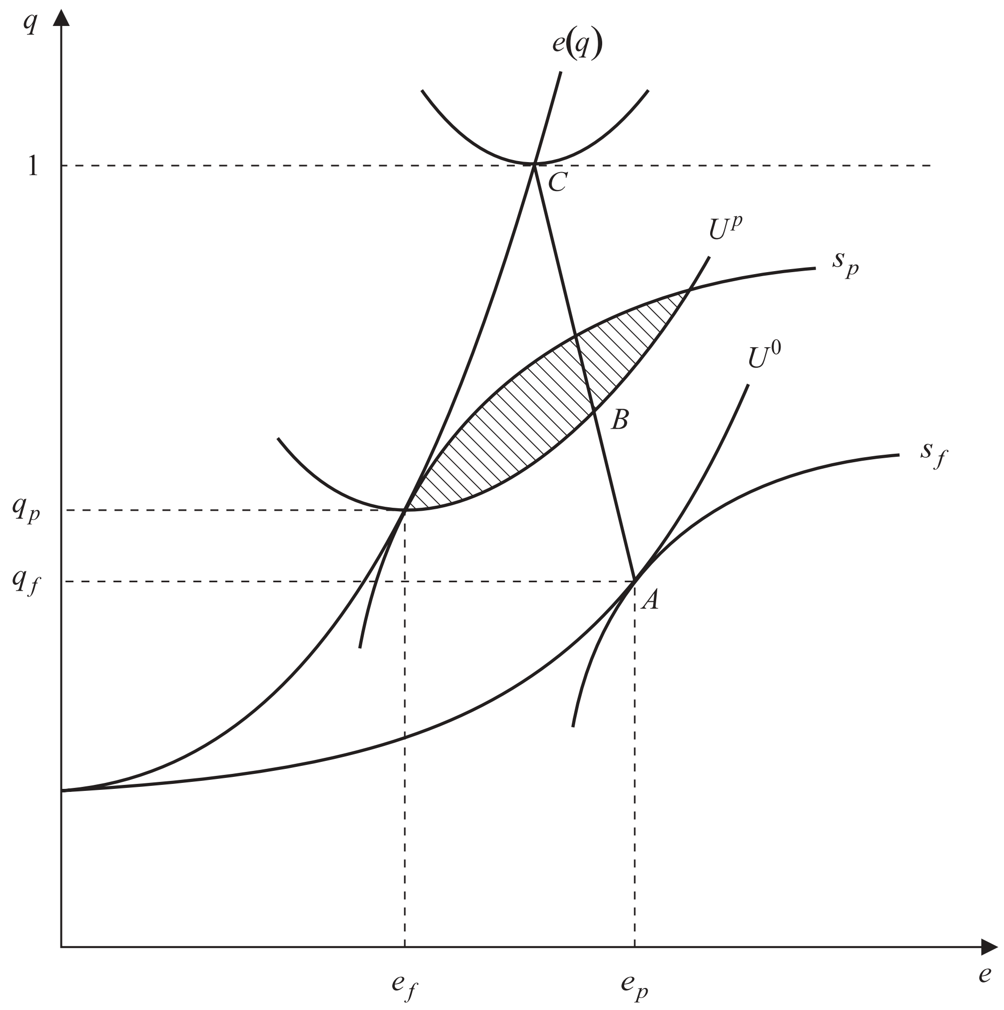
$$s = (1 - q)f(e) \tag{3.2}$$

Given the value of q , the home worker chooses e to maximize $U(qf(e), e)$ which gives us the first order condition

$$qf'(e) = -U_e/U_w \tag{3.3}$$

where f' indicates the derivative of f with respect to e. Condition (3.3) states that in optimum the marginal income equals the marginal rate of substitution between effort and income. Under the stated assumptions the second order condition is fulfilled and (7) defines the optimal effort level as a function of q. This optimal response, denoted by $e(q)$, is drawn in Figure 1 as an increasing function of q. [1]

[1] The assumptions made do not imply $e'(q) > 0$. Just as in the theory of labor supply we cannot, in general, tell which is the strongest of income and substitution effects. Yet the most interesting case for our purpose is the one where the substitution effect dominates.



The putter-out determines the value of q as to maximize

$$s = (1 - q)f(e) \quad \text{given that} \quad e = e(q) \tag{3.4}$$

The first order condition is

$$(1 - q)f'\big(e(q)\big) = f\big(e(q)\big)/e'(q) \tag{3.5}$$

The resulting equilibrium pair (q_p, e_p) is illustrated in Figure 1 by the tangency point between the iso-surplus curve of the putter-out and the effort response of the home worker.

Observe, in Figure 1, that the utility level obtained by the home workers, $U^p = U(w_p, e_p)$, is strictly higher than the utility level obtained as unemployed, U^0. One may wonder why home workers can obtain a net gain $U^p - U^0 > 0$ when faced with putters-out with a monopoly over the supply of necessary imputs. To see why this is a equilibrium outcome, let s^* be the average surplus that putters-out obtain per home worker in the economy. The value of the options of a putter-out who considers to continue his relationship with one of his hirelings can then be derived as follows:

By continuing the relationship he obtains s_p. By quitting the relationship, he obtains s^*, but has to bear search and transaction costs equal to b to find a replacement. After e is set the value of his optimal strategy is therefore equal to

$$s = \max[s_p, s^* - b] \tag{3.6}$$

The surplus obtained elsewhere should not be considered exogenously given. Since all putters-out are identical, $s_p = s^*$ such that from (3.6) we have $s = s_p$. Putters-out cannot credibly threaten to quit established relationships to improve their deals. Therefore their bargaining positions are weak and they are to some extent locked in with their hirelings who need economic incentives to put in the optimal work effort. Therefore putters-out are unable to squeeze home workers down to their reservation utility U^0.

It can also be seen from Figure 1 that the putting out equilibrium is not Pareto optimal. All combinations of (q, e) in the hatched area are preferred by both sides. Such combinations, however, are not incentive compatible and are therefore unobtainable as long as the home workers can choose their own work effort.

One simple hypothesis about the number of home working hirelings within the putting out system, is that it is determined by full employment (of trained workers). If there are M identical putters-out, each of them will have L hirelings such that

$$ML = N \tag{3.7}$$

Observe that as long as $s > 0$ each putter-out becomes better off the more hirelings he employs. So taken literally the model describes a situation with excess demand for home workers.

Capitalist factories

The employer can offer a complete employment contract which stipulates both pay w $(= qf)$ and the required effort e. Pairs of (w, e) which satisfy

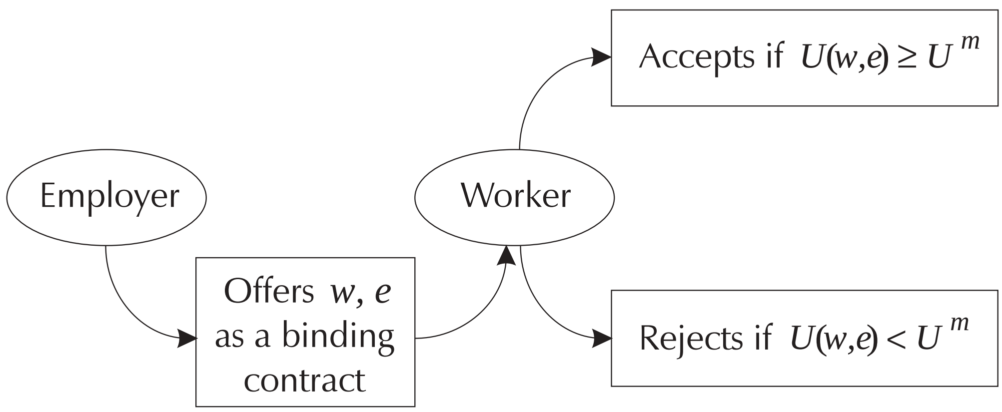
$$U(w,e) > U^p \quad \text{and} \quad s(w,e) > s_p \tag{4.1}$$

are then feasible even without taking possible team-work effects into account (and possible savings of transporting costs). The curve $ABCD$ in Figure 1 is the contract curve between the two. Under the stated assumptions it is downward sloping as drawn in the Figure. Pareto-improving and efficient contracts would be on the segment BC of the contract curve.

Such an outcome might be considered a simplified representation of Alchian and Demsetz's theory of the firm. According to Alchian and Demsetz (1972) the classical firm enhances efficient production in a non-authoritarian way. The capitalist is the residual claiment and the common party to all the employment contracts with the right to renegotiate and renew any such contract. As compared to the putting-out system, contracts along the segment BC in Figure 1 would 1) improve workers' welfare, 2) increase effort and production per worker, 3) increase profits. One may question, however, why workers' welfare in the putting-out equilibrium should constitute the outside option which the capitalist has to meet in designing feasible employment contracts after the factory system is established. [2]

Complete employment contracts

With complete employment contracts both pay and effort is determined when a worker is hired. The decision sequence is as follows



Here $U^m \geq U^0$ is the market value of the job opportunities to workers to be determined below. In their hiring decisions each employer takes U^m as given. Accordingly, each employer has to offer contracts where $U(w, e) \geq U^m$.

When production is concentrated in factories the employer can gain by controlling the work effort and by optimising the employment level in the factory to

[2] Alchian and Demsetz's view does not rely on this comparison. In their approach the Pareto improvements come about as a result of gains from team work.

enchance teamwork benefits along the production function $F(L, e)$. Thus, profits are

$$\pi = F(L, e) - wL \tag{4.2}$$

The problem of the employer can now be described as follows

$$\max_{w,e,L} \pi \quad \text{subject to} \quad U(w, e) \geq U^m \tag{4.3}$$

The first order conditions are

$$F_L(L, e) = w \tag{4.4}$$

$$F_e(L, e)/L = -U_e/U_w \tag{4.5}$$

$$U(w, e) = U^m \tag{4.6}$$

To determine U^m we equate supply and demand in the labor market. With M identical firms this yields

$$LM = N \tag{4.7}$$

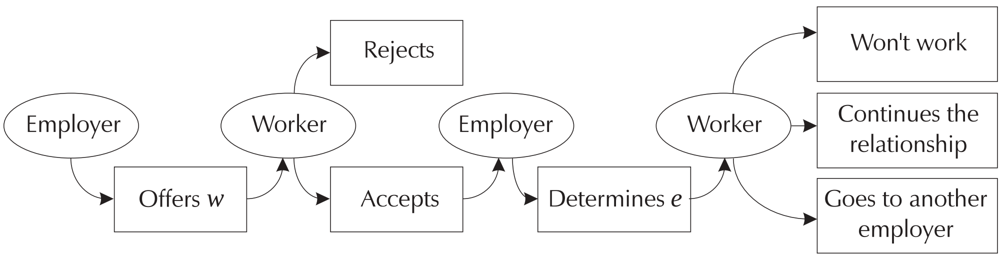
The four equations (4.4)-(4.7) determine L, w, e and U^m. The utility level of workers may be lower or higher than what they obtained in the putting-out system. In the comparisons below, it is assumed that there is enough firms relative to the number of workers such that $U^m > U^0$. The main feature of the equilibrium with complete contracts can be illustrated in figure 1 by translating the wage into a share of value added per worker, i.e. $w = qF(L, e)/L$. Since the equilibrium is Pareto-efficient it must be on the contract curve $ABCD$. Where the equilibrium outcome is located on this curve depends on the equilibrium value of U^m which again depends among other things on the number of workers N and the number of firms M.

4.2 The factory as an Authority Relation

Employment contracts are not likely to be complete as assumed above. It is difficult to stipulate in advance exactly what the workers should do and the intensity of work effort on the different tasks to be performed. When a worker sells his labor power to a factory owner he therefore obtains an agreed-upon wage but has to accept the capitalist's authority regarding work assignments. This is what Williamson (1985 p. 218) calls an authority relation. Joining the factory entails an agreement that the worker accept orders from the capitalist boss with the constraint that these are within the zone of acceptance.

In the model this means that the employer determines the effort level after the worker is employed. In the factory the worker can be subject to detailed supervision. This may easily give rise to a situation where the worker to some extent is locked in as analysed by Manning (1988). In his paper the employer determines e, after the worker is hired at a given wage, subject to the constraint that the worker will choose the option, ex post, which gives him the highest utility level. The worker has three options. He can continue working for the present employer in which case he obtains $U(w, e)$. He can quit and search for alternative jobs. In that case he obtains the going utility level in the factory system U^f but to do this he has to bear search costs h to find a new job. Finally, he can choose to go unemployed with the utility level U^0.

The decision making structure is then:



At the stage when the employer determines e he will set the highest acceptable value of e which is consistent with the requirement that the worker chooses to stay, i.e.

$$U(w, e) = \max(U^f - h, U^0) \tag{4.8}$$

But since all capitalists are identical, $U^f = U(w, e)$ implying that the only utility level which satisfies (4.8) is

$$U^f = U(w, e) = U^0 \tag{4.9}$$

Accordingly, workers' utilities are driven down to the reservation or subsistence level. The presence of search costs h is crucial to the outcome, but the only requirement is that these costs are positive however small.

The maximization problem of the employer is

$$\max_{w,e,L} \pi \quad \text{subject to} \quad U(w, e) = U^0 \tag{4.10}$$

where $\pi = F(L, e) - wL$. The first order conditions are

$$F'_e(L, e)/L = -U_e/U_w \tag{4.11}$$

$$U(w, e) = U^0 \tag{4.12}$$

These two equations determine w and e for a given L. The employer is, however, unable to hire as many workers as he wishes. Since in comparison with the case with complete contracts, he now presses the utility level of workers down to their reservation value, workers are more valuable to the firm. Thus there is excess demand for workers in equilibrium in the sense that $F'_L(L, e) > w$. One may wonder why excess demand does not translate into higher wages until demand for labor equals supply? An employer who tries to attrack more workers by offering a higher wage, would also be interested in increasing the workers' effort after they are employed till $U = U^0$. Thus there is no way that an employer can credibly offer workers a higher effort level than U^0. At that utility level there is excess demand for workers. To determine L we assume equal rationing: each employer obtains the same work force such that

$$L = N/M \tag{4.13}$$

If there were no team-work gains the pair (w, e) coinciding with point A in Figure 1 where $e = e_f$ and $w = q_f f(e_f)$ illustrate the equilibrium outcome with respect to work and pay. As compared to the putting-out equilibrium we easily see that 1) workers' welfare is reduced, $U^f < U^p$; 2) efforts and production per worker have increased, since $e_f > e_p$, 3) profits have increased. All three statements also hold when we compare with the case considered in section 4.1 above.

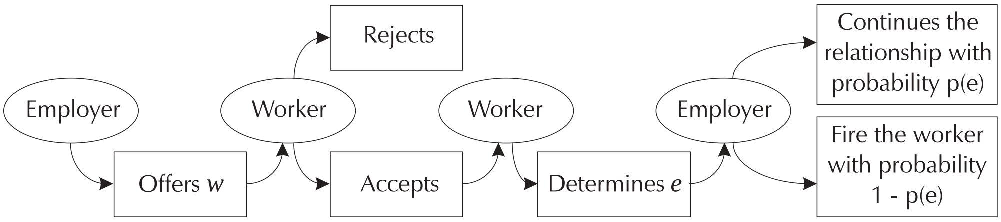
These results corresponds to some extent to the views of Marglin (1974) who says "that the agglomeration of workers into factories was a natural outgrowth of the putting-out system ... whose success had little or nothing to do with the technological superiority of large-scale machinery. The key to the success of the factory, as well as its inspiration, was the substitution of capitalists' for workers' control of the production process; discipline and supervision could and did reduce costs without being technologically superior." (Marglin (1974) p 29)

Observe also that there is a conflict between distribution and efficiency: The factory system is Pareto optimal while the transition from putting-out to the factory system is not a Pareto improvement. Moreover, the wage $w_f = q_f f(e_f)$ may very well be higher than workers' income in the putting-out system $w_p = q_p f(e_p)$, since $e_f > e_p$. Accordingly, the fact that wages increased in some districts of England just after factories were established (Gustafsson (1987) p 31), is not in contradiction with the present theory.

4.3 Contingent renewal

In this case workers can in principle choose their own work effort. The employment contract, however, is renewed only as long as the agent performs according to the wishes of the employer. The employer is assumed to determine the wage followed by the workers' determination of their individual effort levels. Effort is not directly observable and can only be monitored randomly by the employer. Yet the more effort the worker puts in, the higher is the probability of keeping the job in future periods. Let the probability of contract renewal be $p(e)$ which is assumed to be increasing in effort at a decreasing rate, i.e. $p'(e) > 0$ and $p''(e) < 0$.

The decision making structure is as follows:



The present value of expected utility of starting out as unemployed is indicated by V^u. The present value of expected utility of starting out as employed V can then be defined by

$$V = \beta U(w, e) + \beta p V + \beta(1 - p)V^u \tag{4.14}$$

where $\beta = 1/(1+r)$ is the discount factor. It is assumed that wages are paid in the end of each period and that therefore βU is the relevant measure of first period's utilities.

Solving for V in (4.14) and inserting for β gives us

$$V = \frac{U(w, e) + (1 - p)V^u}{1 + r - p} \tag{4.15}$$

Observe that when $p = 1$, the value of V is just the present value of having the job forever U/r. When the worker decides how hard to work, w is given. Accordingly, he wants to maximize (4.15) taking the relationship between p and e into account.

The first order condition is

$$-U_e(w, e) = p'(e)\left[\frac{U - rV^u}{1 + r - p}\right] \tag{4.16}$$

The term $p'(e)$ on the right-hand side indicates the increase in the probability of keeping the job by increasing effort. The term $(U - rV^u)$ is the value per period of keeping the job where rV^u is the average utility per period of an unemployed. Thus $(U - rV^u)$ is the employment rent above the workers fall-back position as unemployed. Accordingly, equation (4.16) says that the disutility of work should equal the increase in the probabilty of keeping the job multiplied by the present value of the employment rent. A positive employment rent $U - rV^u > 0$, presupposes unemployment.

The role of unemployment in inducing effort can be more easily demonstrated by making V^u endogenous. Let us assume that the probability ϕ that an unemployed gets a job depends on the number of unemployed workers competing for jobs, or formally

$$\phi = \phi(N - LM) \quad \text{where} \quad \phi(0) = 1 \quad \text{and} \quad \phi'(\cdot) < 0 \tag{4.17}$$

A worker who starts out as unemployed has a chance ϕ to get employment in the present period and a chance $(1 - \phi)$ to remain unemployed to next period. In the period he waits he obtains a flow of utilities U^0 (which we by the convention introduced above discount by β) and he starts the next period in the same situation as before. Thus the expected present value of utilities of a worker who starts up as unemployed is

$$V^u = \phi V + (1 - \phi)\beta[U^0 + V^u]$$

or by solving for V^u

$$V^u = \frac{\phi V + (1 - \phi)\beta U^0}{1 - \beta(1 - \phi)} \tag{4.18}$$

Observe that with $\phi = 1$, we have $V^u = V$. Equations (4.15) and (4.18) are two equations in V^u and V. Solving for V^u yields

$$V^u = \frac{\phi(1 + r)U + (1 + r - p)(1 - \phi)U^0}{r\,(1 + r - p(1 - \phi))}$$

which inserted in (4.16) yields (after some rearranging)

$$-U_e = p'(1 - \phi)\left[\frac{U - U^0}{1 + r - p(1 - \phi)}\right] \tag{4.19}$$

From this expression it is clear that a positive effort level requires $U_e < 0$ and therefore $\phi < 1$ which according to (4.17) means that $N > ML$, or simply unemployment. In the words of Bowles and Gintis, employers are on the short side of the market in the sense that they can purchase any desired amount of labor, while workers who may become involuntarily unemployed are on the long side of the market. "When ...the institutional enviroment is such that the threat of sanctions by the short–sider may be instrumental to further his or her interests, the principle of short–side power holds: Agents of the short side of the market have power over agents on the long side with whom they transact." (Bowles and Gintis 1990, p 183.)

Equation (4.16) (or equivalently equation (4.19)) defines effort e as a function of the wage rate w, i.e. $e(w)$. By differentiating of (4.16) we obtain

$$-\left[p''(U - rV^u) + (1 + r - p)U_{ee}\right] e'_w = p'U_w + (1 + r - p)U_{ew} \tag{4.20}$$

which demonstrates that $e'(w) > 0$.

The problem of the employer is as before to maximize profits defined by

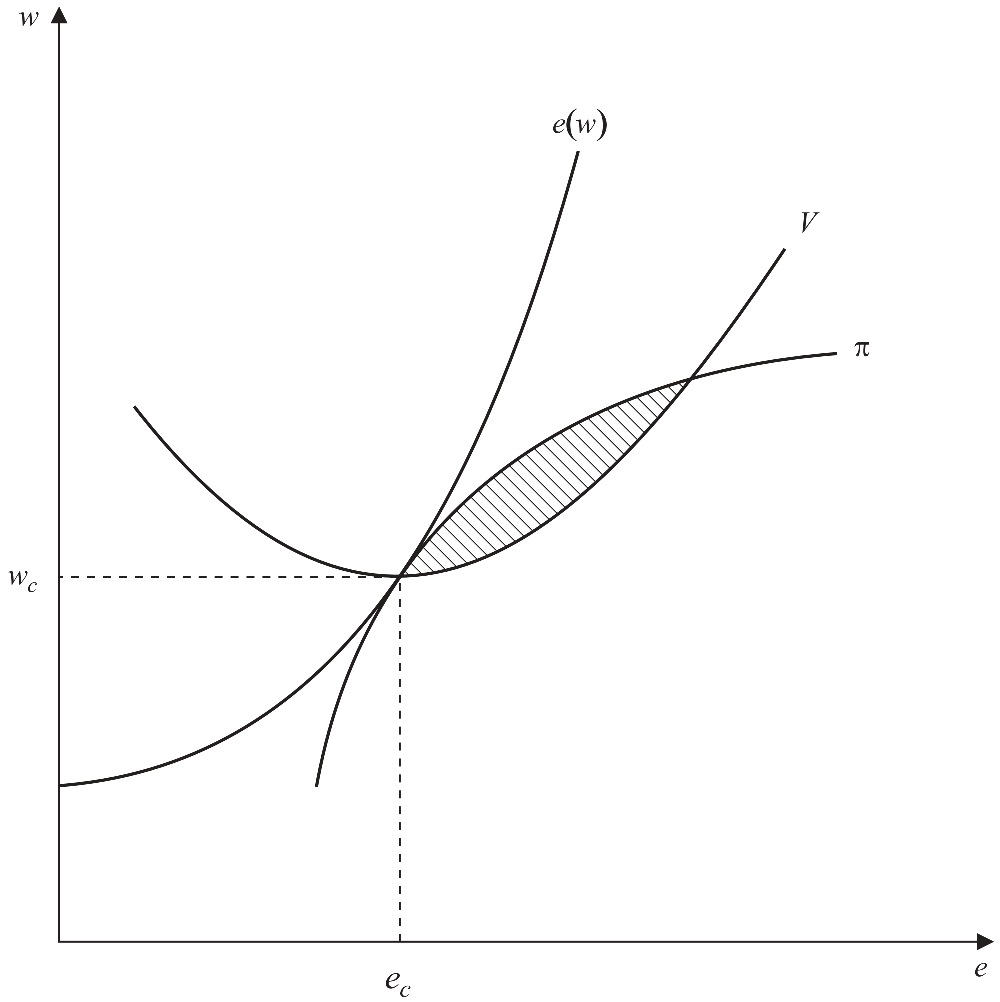
$$\pi = F(L, e) - wL \quad \text{subject to} \quad e = e(w) \tag{4.21}$$

which gives us the following first order conditions

$$F_L = w \tag{4.22}$$

$$F_e/L = 1/e'(w) \tag{4.23}$$

Equations (4.17), (4.19), (4.22) and (4.23) determine e, L, w and ϕ. As in the putting–out system the equilibrium is not Pareto–optimal as illustrated in Figure 2. Pairs of w and e within the hatched area constitute Pareto–improvements that cannot be sustained as equilibrium outcomes.



Comparisons

The main conclusions of these notes are summerized in the table below:

	Who decides effort	*Pareto efficient*	*What kind of unbalance*	*Employment rent*	*Capitalist power*
Putting-out	Worker	No	Irrelevant	Yes	?
Complete contracts	Agreed before employed	Yes	None	Yes	No
Authority relation	Employer	Yes	Excess demand	No	Yes, direct
Contingent renewal	Worker	No	Excess supply	Yes	Yes, indirect

Appendix

Let N_s be the given supply of skilled workers. Thus the use of skilled workers is constrained by

$$ML_s \leq N_s \tag{5.1}$$

Every worker may take unskilled jobs such that

$$ML_s + ML_u \leq N \tag{5.2}$$

where N as before is the total number of workers.

All workers have the same preferences over pay and effort

$$U(w_i, e_i).$$

The idea is now that unskilled workers do routine jobs that are easy to monitor and that skilled workers do jobs that are difficult to monitor. Thus the employment contract of unskilled workers will be modelled as an "authority relation". Skilled workers, however, need to be paid effort inducing wages modelled as a contingent employment contract. Accordingly we have

$$U(w_u, e_u) = U^0 \tag{5.3}$$

and

$$-U_{e_s} = p'(1-\phi)\left[\frac{U(w_s, e_s) - U^0}{1 + r - p(1-\phi)}\right] \tag{5.4}$$

where $\phi = \phi(N_s - ML_s)$. Equation (5.4) defines $e_s = e_s(w_s)$.

Each firm maximizes profits defined by

$$\pi = F(L_s, L_u, e_s, e_u) - w_s L_s - w_u L_u \tag{5.5}$$

subject to $U(w_u, e_u) = U^0$ and $e_s = e_s(w_s)$. This yields the first order conditions

$$U^0 = U(w_u, e_u) \tag{5.3}$$

$$\frac{F_{e_u}}{L_u} = -\frac{U_{e_u}}{U_{w_u}} \tag{5.6}$$

$$\frac{F_{e_s}}{L_s} = \frac{1}{e_s'(w_s)} \tag{5.7}$$

$$F_{L_s} = w_s \tag{5.8}$$

$$F_{L_u} > w_u \tag{5.9}$$

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