CAPITALISTS AND WORKERS: KNOWLEDGE AND THE STRATEGIC ROLE OF INVESTMENT WITHIN THE FIRM

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No.395

WARWICK ECONOMIC RESEARCH PAPERS

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*This paper was presented at the 1992 ESRC Warwick Economics Summer Research Workshop on 'Industrial Strategy, Efficiency and Economic Democracy.' (ESRC Award No.W100-26-1051).

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Abstract

Does the ownership of capital confer a strategic advantage within the firm? The formation of a firm frequently represents an attempt by an individual to secure a return on knowledge and we demonstrate that, in this context, there can be an incentive to precommit capital before contracting with other members of the firm - that is, to be the "capitalist". Results are also obtained on the investment level and wage rate. The key ingredient of the model is emergence of a product market entry threat from within the firm. This contrasts with the anonymous external potential entrant prevalent in the literature.

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Part of this research was undertaken during the tenure of a Jean Monnet Fellowship at the European University Institute, Florence. I am very grateful to James Malcomson, Alistair Ulph, workshop participants at the University of Southampton, the University of Warwick, the London School of Economics and the European University Institute, and to anonymous referees, for valuable comments and suggestions.

1. Introduction

Production typically requires cooperation between individuals and the acquisition of physical capital. But only rarely do all of the individuals concerned share in ownership of the capital. This distinction between those who own capital and those who do not - "capitalists" and "workers" - has long been a focus of attention in economics, with controversy surrounding both the reasons behind the concentration of ownership and its implications for efficiency and welfare. In this paper we address these issues by asking: Can the ownership of capital confer a strategic advantage within the firm?

The starting point is a recognition that the formation of a firm frequently represents an attempt by an individual to secure a return on an asymmetry of knowledge. At its simplest it is just being the first to spot an opportunity - what Kirzner (1973) refers to as "pure entrepreneurship". Alternatively the knowledge may be more complex in nature, concerning, for example, the technology or organisation of production. But for the individual to make a profit there must be some limitation on the acquisition or use of the knowledge by others. The characteristics of these potential acquirers and users will vary from case to case, but in many instances they will be other members of the firm rather than outsiders. This is the situation that we analyse here.

Indications of the significance of the potential threat posed by employees come in a variety of forms. First, it is not uncommon for employees to leave a firm and set up a rival enterprise. Well-known examples include Rudolf Dassler, who left Adidas to set up Puma, Henri Strzelecki, who worked for a succession of clothing manufacturers before founding Henri-Lloyd, and

Steve Jobs and Steve Wozniak, who left Atari and Hewlett-Packard respectively, to form Apple Computer. With regard to the U.S. computer industry more generally, Brock (1975) noted that "Employees of computer firms have shown a high propensity to switch employment - and in particular to form their own firms or join new firms." (p. 63). In the case of Britain, Kelly (1987) found that almost fifty percent of the founders of a sample of computer firms were previously employed in the same industry. Second, a survey of high-level research and development managers in the U.S. by Levin, Klevorick, Nelson and Winter (1987), found that "Conversations with employees of innovating firm" and "Hiring R & D employees from innovating firm" were among the most effective means of learning about new products and processes. Third, Marglin (1974, 1984), in his widely-cited critique of "capitalist production", has argued that the increasing specialisation of labour that occurred in the eighteenth and nineteenth centuries can be explained, in part, by the desire on the part of the "bosses" to prevent workers acquiring the knowledge necessary to set up production themselves. For example, he cites the following diary entry by Henry Ashworth Jr., the managing partner of a cotton producer, concerning the practices of one of his competitors: "...his manager Henry Hargreaves knows nothing about the mixing or costs of cotton so that he can never take his business away from him - all his Overlookers ['] business [sic] are quite separate from each other and then no one knows what is going on but himself." (1984, pp. 155-156). Finally, we can point to the frequent use by employers of covenants designed to prevent employees using any knowledge that they might acquire. If this system worked perfectly then of course the problem for the employer would be resolved. But the protection afforded by such covenants is severely limited. In the U.K., for example, the courts are aware of the potential efficiency losses due to trade restrictions and therefore protection from competition is not, of itself, a legitimate objective. Covenants can be used where the rationale is specifically to safeguard trade secrets or - in certain cases - to prevent the soliciting of customers, but they can not be used to prevent the employee using general skills, knowledge (including details of how production is organised) and experience acquired in the course of production.[1] Moreover, the courts will take a view on whether the scope of any restriction - in terms of the time period or market coverage - is "reasonable" and so, as Crump (1980) points out, it is often difficult for employers to predict whether a covenant will be enforced.[2]

This paper is concerned with situations where contracts cannot prevent an employee from leaving to set up a rival concern. Furthermore, it will be assumed that the knowledge in question *inevitably* passes to an employee once production is underway. Given this inevitability, what role might the initial asymmetry play? We suggest that it implies a natural ordering of moves: the initial advantage may enable an agent to be the first to undertake some action. The action that we focus on is investment. In particular, we examine whether there is any incentive to purchase assets before attempting to contract with other parties. In other words, is there any strategic advantage to being the capitalist?

The model predicts that there will be situations where there is such a first-mover advantage and others where there is not. This contrasts with

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[1]With regard to trade secrets, covenants provide additional protection to that afforded by patents and copyright - which can be useful given the delays and costs involved with the latter systems - but may still be side-stepped if the employee can differentiate his or her invention from the original. For discussion of the limitations of patents and copyright see Besen and Raskind (1991).

[2]See Selwyn (1991) for further discussion of the limits to the effectiveness of covenants and examples of contracts that have been declared void.

Grout's (1984) finding that, faced by a trade union, a firm is always worse off if it has to commit capital before the wage is negotiated. The intuition for Grout's result is straightforward. The sinking of capital constitutes a deterioration in the firm's status quo point, hence it receives a smaller share of the surplus from the ensuing Nash bargain. In our model, however, there is an additional effect to consider: a capital precommitment, through its influence on the product market, lowers the value of the knowledge acquired by the co-workers. Within the bargaining setting this can outweigh the adverse effect on the status quo position. As in Williamson (1975), the scope for bargaining over the surplus arises because, during the course of the production relationship, an initially competitive situation is transformed into one involving bilateral monopoly, or, more generally, "small-numbers exchange". But whereas in Williamson the transformation occurs due to relationship-specific investments, the mechanism at work here is a (limited) dispersion of knowledge - before production commences the employer can recruit from a competitive labour market, but at the contract renewal stage the employee, having acquired the knowledge, is no longer identical to other workers in the market.

This paper is not the first to focus on the potential for employees to acquire knowledge which would enable them to establish rival enterprises. Pakes and Nitzan (1983) consider the situation of an entrepreneur wishing to engage a scientist to undertake a research project, and demonstrate that the optimal wage contract generally involves the payment of a bonus by the entrepreneur to dissuade the scientist from leaving. The key differentiating feature of our analysis is that there is an additional instrument, investment, available to the entrepreneur. We find that a bonus is sometimes, but not always, paid.

The paper begins with a description of the model. Section 2.1 provides an overview and this is followed, in section 2.2, by a description of the production process and product market competition. The bargaining framework is presented in section 2.3 and the final element, the impact of capital precommitment, is discussed in section 2.4. Analysis and results on the precommitment strategy are contained in section 3.1, and implications for the payment to the employee in section 3.2. A brief summary and conclusion completes the paper.

2. Model description

2.1 Overview

An individual, the *entrepreneur* (E), has some private knowledge which requires production if it is to yield a return. The problem facing E is that production requires two individuals and during its course the knowledge in question will inevitably be acquired by the *accomplice* (A).

The model, whose basic framework is depicted in figure 1, comprises two production periods. At time t = 0, just before the start of the first period, all workers, apart from E, are identical and currently employed elsewhere at the competitive wage rate, $\bar{w}$. An accomplice is recruited at a wage w^o for the first period. At time t = 1, when the wage, w, for the second and final period of production is determined A is no longer identical to other potential employees. Specifically, having now acquired the knowledge initially confined to E, A has the ability to set up a rival enterprise. In this event E and A

would recruit two other workers from the labour market. The other options for A are to continue to work with E or to return to the labour market.

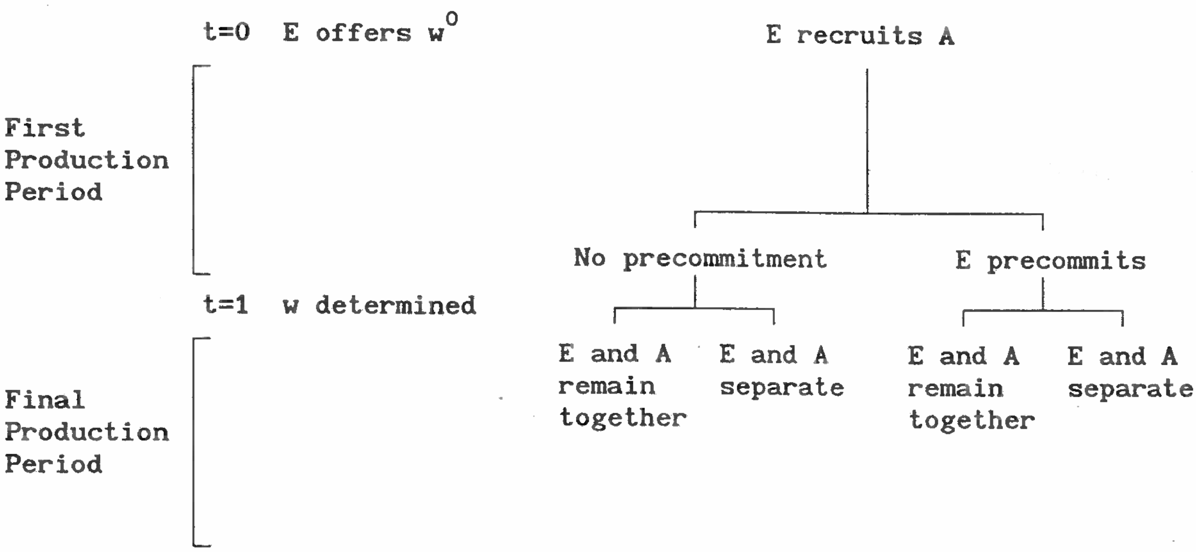

Figure 1

Consider now the issue of capital ownership. This is going to be important when it involves sunk costs. Most investment will have an element of sunk cost, either because it is to some degree firm-specific or industry-specific, or due to installation and other transactions costs. The sunk investment can take a variety of forms including, for example, specialised machinery, buildings, or marketing and distribution investments. Given the initial asymmetry of knowledge we ascribe to E the option of sinking capital first. In the interests of simplicity the links between the two periods will be kept to a minimum. This is achieved by assuming first, that capital only lasts for one period and second, that *A* cannot purchase capital before the end of the first period. The precommitment decision by *E* is therefore made at the end of the first period and direct consequences confined to the final period. To investigate *E*'s optimal strategy we begin by looking at final period production.

2.2 *Final period production*

If the entrepreneur and accomplice continue to work together then total *industry* profit will be

$$\Pi = \begin{cases} p(q_E)q_E - r_E\bar{k}_E - f - 2\bar{w}, & q_E \leq \bar{k}_E\,, \quad (1.1) \\ p(q_E)q_E - r_Eq_E - f - 2\bar{w}, & q_E > \bar{k}_E\,, \quad (1.2) \end{cases}$$

where p denotes the product price, q_E is the output and f is the fixed per period cost. The opportunity cost to each of *E* and *A* is given by the competitive wage, $\bar{w}$. The cost per unit of capital (capacity) is r_E and $\bar{k}_E$ is the capacity installed just prior to the second period. This capacity can subsequently be increased - equation (1.2) - but not reduced. To link the capacity decision to equilibrium in the product market we will draw on Dixit (1980).

If the two parties were to separate then there would be the potential for competition in the product market. We assume this would take the form of Cournot competition between homogeneous products and that the inverse market demand curve is linear:

$$p = a - b(q_E + q_A). \qquad (2)$$

Now, the ability to precommit capacity means that in the event of separation E's second period total cost function[3] has two components:

$$T_E = \begin{cases} r_E \bar{k}_E + f + 2\bar{w}, & q_E \leq \bar{k}_E\,, \quad (3.1) \\ r_E q_E + f + 2\bar{w}, & q_E > \bar{k}_E\,, \quad (3.2) \end{cases}$$

while A's total cost function is simply

$$T_A = r_A q_A + f + 2\bar{w}. \quad (4)$$

The crucial point is that marginal cost of production for E shifts from zero to r_E at $\bar{k}_E$ and so the ability to precommit affords some degree of control over the Cournot equilibrium. In particular, subject to the restriction that marginal revenue is not negative,[4] the Cournot output of E will be

$$q_E^c = \max \{ q_E^o\,, \bar{k}_E \}, \quad (5)$$

where q_E^o is the Cournot equilibrium that would emerge in the absence of a precommitment. In some circumstances A may not be able to acquire all of E's knowledge in the time available and may therefore be less efficient in the event of separation. We capture this possibility through the cost of capital ($r_E \leq r_A$). Note also that if entry were to result in negative profit for A then the best-response to q_E^c would be $q_A = 0$.

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[3]Note that the new co-worker required can be hired at the competitive wage because, with the market lasting only two periods, the knowledge that he or she will acquire has no value.

[4]This is satisfied in the numerical example below.

2.3 Bargaining

If the entrepreneur and accomplice remain together they will share a total net revenue:

$$\Omega = \begin{cases} p(q_E)q_E - r_E\bar{k}_E - f, & q_E \leq \bar{k}_E\,, \quad (6.1) \\ p(q_E)q_E - r_E q_E - f, & q_E > \bar{k}_E\,. \quad (6.2) \end{cases}$$

Drawing upon developments of Rubinstein's alternating offers bargaining game by Binmore, Rubinstein and Wolinsky (1986) and Sutton (1986) we take the share of the net revenue accruing to *E* to be

$$I_E = \begin{cases} S_E + \frac{1}{2}(\Omega - S_E - S_A) & \text{if } Z_E \leq S_E + \frac{1}{2}(\Omega - S_E - S_A), \text{ and } Z_A \leq S_A + \frac{1}{2}(\Omega - S_E - S_A), \quad (7.1) \\ Z_E & \text{if } Z_E > S_E + \frac{1}{2}(\Omega - S_E - S_A), \text{ and } Z_A \leq S_A + \frac{1}{2}(\Omega - S_E - S_A), \quad (7.2) \\ \Omega - Z_A & \text{if } Z_E \leq S_E + \frac{1}{2}(\Omega - S_E - S_A), \text{ and } Z_A > S_A + \frac{1}{2}(\Omega - S_E - S_A), \quad (7.3) \end{cases}$$

where S_E and S_A denote the *status quo* utilities of *E* and *A* respectively, and Z_E and Z_A their *outside options*. Status quo utilities are the utilities received during the course of bargaining. In the absence of precommitment we assume that $S_E = S_A = S$. The outside options are the incomes that *E* and *A* would receive were they to break off negotiations and separate. This is the income from production if profit is positive, and the competitive wage otherwise.

If there were no outside options the payoffs would be given by (7.1) and so, in the absence of any precommitment, the surplus would be split equally: $I_E = w = \frac{1}{2}\,\Omega$, where w denotes the second period wage received by *A*. The outside options enter the bargain in a discontinuous fashion - to influence the outcome they must exceed the payoffs given by (7.1). This is because taking up an outside option involves breaking off negotiations. Only if this threat is credible - that is, it yields more than would be expected from continued negotiation in the absence of outside options - will it influence the outcome.

2.4 The precommitment decision

Suppose first that *E* does not precommit any capacity. Total industry profit is maximised if production is undertaken by a single firm that sets price and output at the standard monopoly levels. Let Ω^m denote the resulting net revenue. In the absence of precommitment the status quo levels are equal and so, if the outside options happened to play no role, each party would receive an income of $\frac{1}{2}\,\Omega^m$. This would, for example, be the outcome in the equal efficiency case ($r_E = r_A$) because the sum of Cournot duopoly profits is less than monopoly profit, and hence Cournot income (profit plus opportunity cost) is less than half monopoly income. To influence the bargain an outside option must generate an income in excess of $\frac{1}{2}\,\Omega^m$, which can occur if there is a sufficient efficiency differential.

Now consider the effect of a capacity precommitment. Both the size and distribution of industry net revenue may be influenced. Total profit and net revenue will be unaffected for precommitments below the standard monopoly output level, but if taken beyond this point then industry profit and net revenue will be reduced. The distributional consequence of a precommitment operates through the status quo levels and outside options. The status quo point of *E* will become S - $\bar{k}_E$, whilst that of *A* remains S. Ignoring the outside options this would, from (7.1), generate an income for *E* of $\frac{1}{2}(\Omega - r_E\bar{k}_E)$. Thus, even if total industry profit was unaffected *E* would be worse off. Intuitively, the cost of $\bar{k}_E$ is sunk and so does not form part of the cake to be divided between the two parties. This is the central point of the paper by Grout (1984) referred to earlier.

If precommitment is to be worthwhile, then, it must be because of the impact on outside options. Two types of precommitment strategy can be distinguished. First, *E* could install sufficient capacity to make entry by *A* unprofitable. Alteratively the precommitment could be below the entry-deterring level so that, in the event of entry, both firms would make a profit. In the following section we demonstrate that both *deterrence precommitment* and - perhaps more surprisingly - *accommodation precommitment* can be optimal.

3. Analysis and results

3.1 Incentive to precommit capital

There are three strategies open to the entrepreneur: no capital precommitment (*NP*), deterrence precommitment (*DP*) and accommodation precommitment (*AP*). We derive expressions (details are contained in the appendix) for the income generated for the entrepreneur under each and then demonstrate that all three are potential equilibrium strategies. An important point to bear in mind is that entry will never actually occur because, with Cournot competition, it would be inefficient from the producers' point of view. The importance of the incomes in the event of separation - the outside options - lies in their potential impact on the distribution of the industry net revenue.

In the absence of a capacity precommitment industry output will be chosen to maximise industry profit. From (1.2) and (2) we obtain output:

$$q_E^m = \frac{a - r_E}{2b}, \tag{8}$$

and industry net revenue:

$$\Omega^m = \frac{(a - r_E)^2}{4b} - f. \tag{9}$$

If the the outcome of the bargain were given by (7.1) then this net revenue would be split equally between the two parties so that *E* would receive

$$\frac{1}{2}\,\Omega^m = \frac{(a - r_E)^2}{8b} - \frac{f}{2}. \tag{10}$$

We assume that production at the monopoly level is profitable, that is, $\frac{1}{2}\,\Omega^m$ exceeds $\bar{w}$. Equation (10), then, will be the outcome of the bargain unless either party would be able to generate more than $\frac{1}{2}\,\Omega^m$ by producing independently. As independent firms *E* and *A* would maximise, respectively:

$$\Pi_E = p(q_E + q_A)q_E - r_E q_E - f - 2\bar{w}, \tag{11}$$

$$\Pi_A = p(q_E + q_A)q_A - r_A q_A - f - 2\bar{w}. \tag{12}$$

Under the Cournot assumption, and using (2), the duopoly outputs are:

$$q_E^o = \frac{a - 2r_E + r_A}{3b}, \tag{13}$$

$$q_A^o = \frac{a - 2r_A + r_E}{3b}, \tag{14}$$

which yield duopoly profits:

$$\Pi_E^o = \frac{(a - 2r_E + r_A)^2}{9b} - f - 2\bar{w}, \tag{15}$$

$$\Pi_A^o = \frac{(a - 2r_A + r_E)^2}{9b} - f - 2\bar{w}. \tag{16}$$

Our interest lies with situations where entry would be profitable for *A* in the absence of any precommitment by *E*. Thus if *E* does not precommit, his or her outside option would be $Z_E^o = \Pi_E^o + \bar{w}$ (outside options have been defined in terms of income rather than profit). But we shall demonstrate below that, in the event of a separation, *E* can always generate a larger outside option than Z_E^o by undertaking a precommitment. Thus to ascertain whether precommitment is optimal we simply compare the outside option thereby generated with $\frac{1}{2}\,\Omega^m$.

A decision to precommit capacity $\bar{k}_E$ will, as noted earlier, generate a

Cournot output of max { q^o_E , $\bar{k}_E$ }. A *DP* strategy involves a $\bar{k}_E$ that is just sufficient to deter entry by *A*. In the appendix this is shown to be

$$\bar{k}^d_E = \frac{a - r_A - 2\sqrt{b(f + 2\bar{w})}}{b} \quad . \tag{17}$$

If this is at or below the standard monopoly output level - entry is "blockaded" - then *DP* is obviously optimal because *E* secures all of the monopoly profit. In the remainder of the paper we address the case where a precommitment at the monopoly level is not sufficient to deter entry. The outside option generated by *DP* is then:

$$Z^d_E = \frac{\left[\left(a - r_A - 2\sqrt{b(f + 2\bar{w})}\right)\left(r_A - r_E + 2\sqrt{b(f + 2\bar{w})}\right) \right]}{b} - f - \bar{w}. \tag{18}$$

Under the *AP* strategy *E* selects the capacity level that generates the best *duopoly* equilibrium (for *E*) along *A*'s Cournot reaction function. If this is a corner solution where *A* would make zero profit then *DP* must be a superior strategy (a slight increase in capacity ensures $q_A = 0$) and so the outside option would be given by (18). Alternatively the best duopoly equilibrium may generate strictly positive profits for *A*. In this case capacity is set at the standard Stackelberg leadership level:

$$\bar{k}^s_E = \frac{a - 2r_E + r_A}{2b}, \qquad \bar{k}^s_E < \bar{k}^d_E \tag{19}$$

and the resulting outside option would be

$$Z^s_E = \frac{(a - 2r_E + r_A)^2}{8b} - f - \bar{w}. \qquad \bar{k}^s_E < \bar{k}^d_E \tag{20}$$

Notice that this outside option exceeds that in the absence of a precommitment (15) and so, as suggested earlier, the former will not feature in the bargaining. Thus the optimal strategy for E can be found by comparing incomes in (10), (18) and (20) or, equivalently, the respective profits:

$$NP: \frac{(a - r_E)^2}{8b} - \frac{f}{2} - \bar{w}. \tag{21}$$

$$DP: \frac{\left[\left(a - r_A - 2\sqrt{b(f + 2\bar{w})}\right)\left(r_A - r_E + 2\sqrt{b(f + 2\bar{w})}\right) \right]}{b} - f - 2\bar{w}. \tag{22}$$

$$AP: \frac{(a - 2r_E + r_A)^2}{8b} - f - 2\bar{w}. \tag{23}$$

We shall focus attention on the role of the fixed cost, f, the competitive wage, $\bar{w}$, and the relative efficiency of firms operated by E and A (captured through r_E and r_A). In the appendix the boundaries between pairs of the three strategies are solved for. These are depicted in figures 2 and 3 for illustrative parameters: $a = 2250$, $b = 1000$, $r_E = 1000$, $r_A = 1000\text{-}1200$, $f = 0\text{-}12$, $\bar{w} = 0\text{-}12$ ($\bar{w}$ is set to zero in figure 3 and $f = 0$ in figure 4).

The first point to note - the main result of the paper - is that it can be optimal for the entrepreneur to precommit capital. The positive impact of precommitment on the outside option can, but will not always, outweigh the Grout-type effect operating through the status quo point. Second, in some situations capacity may be precommitted to a level which prevents profitable entry by *A* but in others a lower level, which would permit profitable entry, will be chosen. Of course entry will not actually occur in the latter case but, as will be shown below, the two types of precommitment strategy do have different implications for the second period wage paid to *A*.

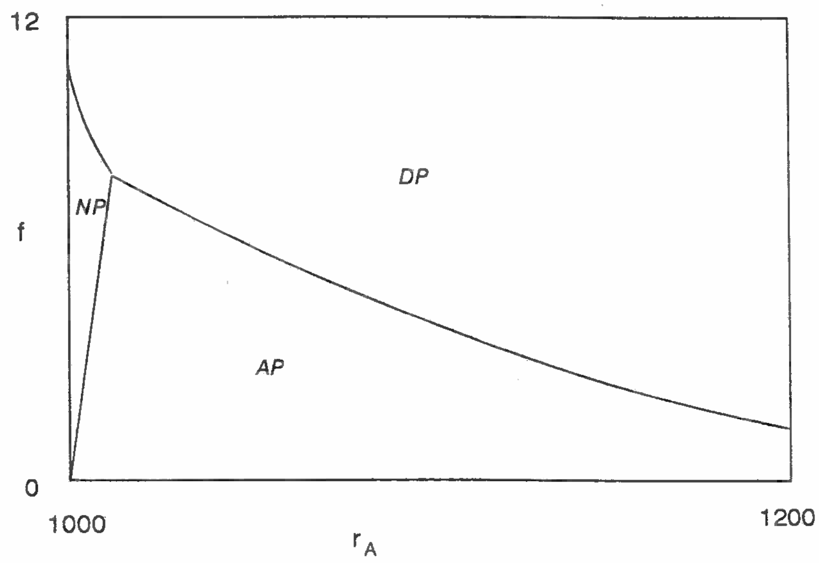

Figure 2

To understand the forces at work in figure 2 consider first the case where *A* could produce as efficiently as *E* in the event of a separation (r_A = 1000). The Cournot model with linear demand and constant marginal costs has the property that the standard Stackelberg leadership profit is exactly a half of monopoly profit if there are no fixed costs. In this limiting case, then, *E* is indifferent between *NP* and *AP*. But for any positive fixed cost *NP* will be strictly preferred because Stackelberg income, given by (20), falls by the full amount of any fixed cost whereas one half of monopoly income, equation (10), is reduced by only a half of the amount. By contrast the outside option generated by *DP*, equation (18), can be shown to be increasing in fixed cost. This is because its negative direct impact is outweighed by the fact that the fixed cost also represents a cost of entry for *A* and hence serves to reduce the entry-deterring capacity level (other things being equal, it is costly to install capacity above the standard monopoly level). Turning now to the effect of relative efficiency, an increase in r_A has no effect on *E*'s income from *NP* because the outside options do not come into play, but does raise both Z^s_E and, to a greater extent, Z^d_E, thereby increasing the incentive to precommit.

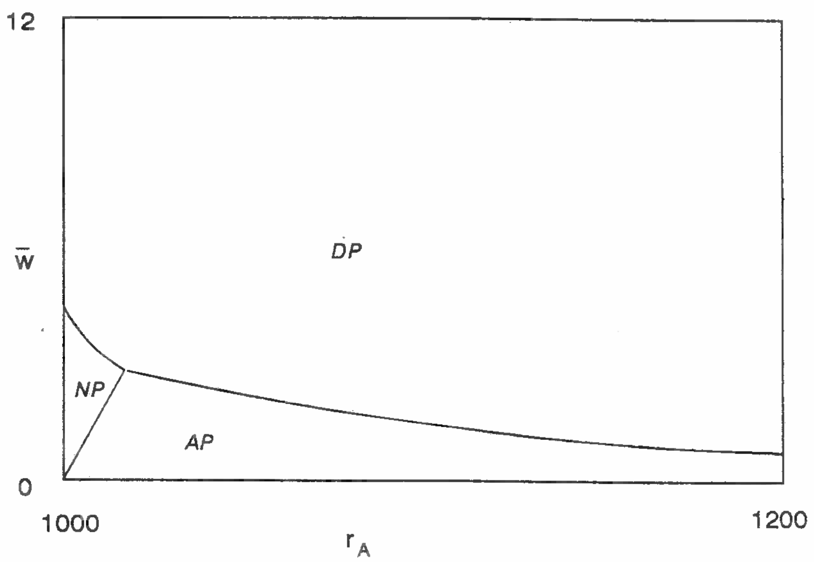

Figure 3

In figure 3 the competitive wage, $\bar{w}$, replaces the fixed cost on the vertical axis. Since labour is an overhead in the model it is not surprising that figures 2 and 3 are similar. With regard to the impact on the *AP* outside option, $\bar{w}$ and f are identical. An increase in $\bar{w}$ means that *E* and *A* would have to pay more to their respective co-workers, which is just like a fixed cost increase. On the other hand $\bar{w}$ has no effect on the relevant income generated by *NP*; *E* and *A* implicitly pay themselves the competitive wage so while profit falls their income remains unchanged at $\frac{1}{2}\ \Omega^m$. Higher levels of $\bar{w}$ therefore increase the attractiveness of *NP* relative to *AP*. Once gain, however it is the relative attractiveness of *DP* that increases most. Indeed the effect is more marked than for an increase in f because not only does $\bar{w}$ reduce the income to *A* from entry, it also increases the income from the alternative of returning to the labour market.

The outcomes above can be compared with those in Dixit (1980). Assuming that deterrence is feasible, Dixit's incumbent will precommit capacity either at the entry-deterring level or at the Stackelberg leadership level. These are also possible equilibrium strategies in the model here. Moreover, the resulting profits, and therefore relative attractiveness of the strategies, are the same for *E* and the incumbent. There are, however, two differences between the predictions of the models. First, *E* may adopt a third strategy, no precommitment, in preference to deterrence or Stackelberg accommodation. Figure 4 depicts the boundaries between each pair of strategies for the illustrative parameters used in figure 2.

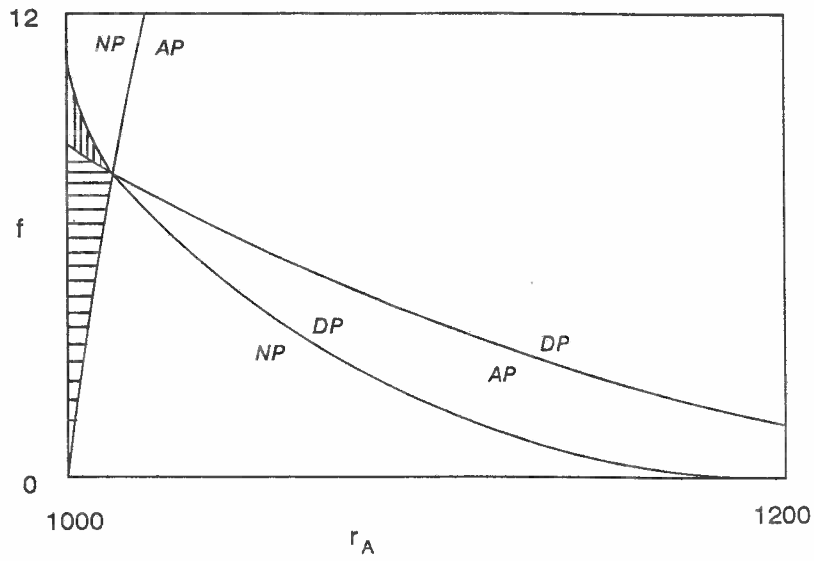

Figure 4

The vertically shaded area represents parameter values where *E* selects *NP* and Dixit's incumbent *DP*, and the horizontally shaded area is where *E* chooses *NP* and the incumbent *AP*. There are therefore situations where we predict industry output at the standard monopoly level whereas in Dixit the output would be higher.[5] Second, although *AP* generates identical profits for *E* and the incumbent, the industry profit is larger in our model. This is because entry does not take place - industry output is just the Stackelberg leader's output. This means that, once again, industry output is more restrictive, and also, the accomplice here receives more than does Dixit's potential entrant.

[5]Entry is not blockaded in our example.

3.2 Wage received by accomplice

The wage, w, paid to the accomplice in the second period will depend, in part, upon the entrepreneur's strategy. In the case of *NP* the parties split monopoly net revenue equally between them. A capital precommitment, whether *DP* or *AP*, generates an income equal to the outside option for *E*, leaving *A* with the difference between this and the actual net revenue associated with the precommitment (equation (7.2)). Letting Ω^d and Ω^s denote these net revenues under *DP* and *AP* respectively, the wage received by *A* will be:

$$NP:\ w = \frac{1}{2}\ \Omega^m, \tag{24.1}$$

$$DP:\ w = \Omega^d - Z^d_E = \bar{w}, \tag{24.2}$$

$$AP:\ w = \Omega^s - Z^s_E = \frac{a^2 - 4r^2_E + 6r_E r_A - 3r^2_A}{8b} + \bar{w}. \tag{24.3}$$

The first possible outcome, then, is that there is no precommitment and *A* receives a second period payment in excess of the competitive wage. This resembles the outcome in Pakes and Nitzan (1983) referred to earlier. On the other hand, if *DP* is the optimal strategy then *A* fails to attain an advantage over other workers in the labour market and so receives the competitive wage. The third possibility here, *AP*, involves a wage bonus combined with a capital precommitment - the latter serving to reduce the size of the bonus paid. In both *NP* and *AP* the accomplice will, in anticipation of the bonus to follow, be prepared to accept a wage below the competitive level in the first period, and so a rising wage profile over time will be observed.

Finally, we consider the influence of the fixed cost, relative productive efficiency and the competitive wage on the payment to *A*. This is quite complex because all three parameters interact to determine the strategy selected by *E*. The following figures are illustrative, depicting situations in which all three strategies would successively come into play. The underlying parameters are the same as in the earlier figures so that, for example, figure 5 shows the variation in the wage along a vertical slice through figure 2.

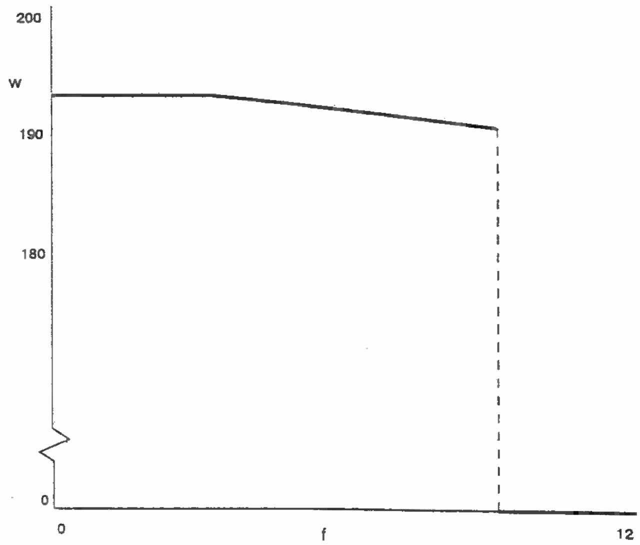

Figure 5

For low fixed costs the entrepreneur selects *AP*. The accomplice receives the difference between Ω^s and Z^s_E and so is not affected by variations in the fixed cost. For intermediate fixed costs the strategy switches to *NP* where the fixed cost is divided equally between the two parties and so generates a range over which the wage falls with increasing fixed cost. At high levels of fixed cost the entrepreneur adopts a *DP* strategy thereby capturing the entire industry profit and forcing *A*'s income down to the competitive wage.

Figure 6 depicts the effect of r_A on the wage for an intermediate fixed cost level. For low r_A , where the strategy is *NP* (see figure 2), the wage does not vary with r_A. This is because all of the output is produced at a unit capacity cost of r_E and the resulting net revenue shared equally. When strategy switches to *AP* then higher r_A both increases Z_E^s and lowers Ω^s so that the wage falls. Finally, at high levels of r_A *DP* is adopted and so the wage falls to $\bar{w}$.

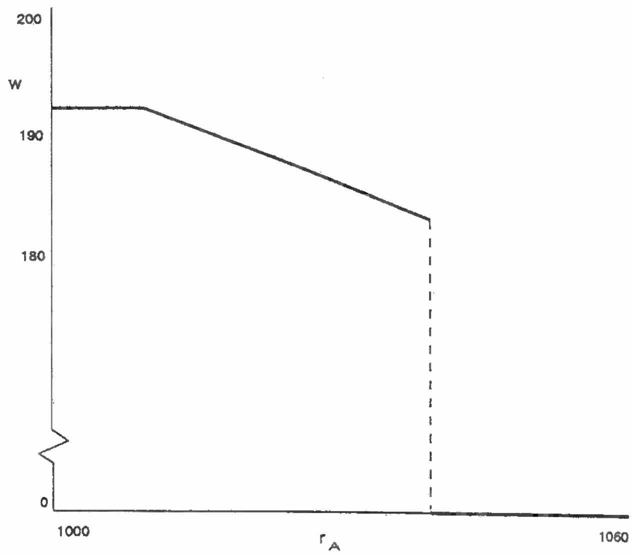

Figure 6

The effect of the competitive wage on the income of the accomplice is perhaps the most interesting. For the parameters selected the optimal strategy moves from *AP*, through *NP* to *DP* as $\bar{w}$ increases (see figure 3). At low levels of $\bar{w}$ there is therefore a positive relationship between w and $\bar{w}$ as shown in figure 7. This is followed by a band where the payment to the accomplice is unresponsive to $\bar{w}$ but then, somewhat perversely, a further increase in $\bar{w}$ induces a discontinuous fall in w to the competitive level. This occurs because, as noted in *3.1* above, there is a negative relationship between $\bar{w}$ and the profitability of entry for *A*.

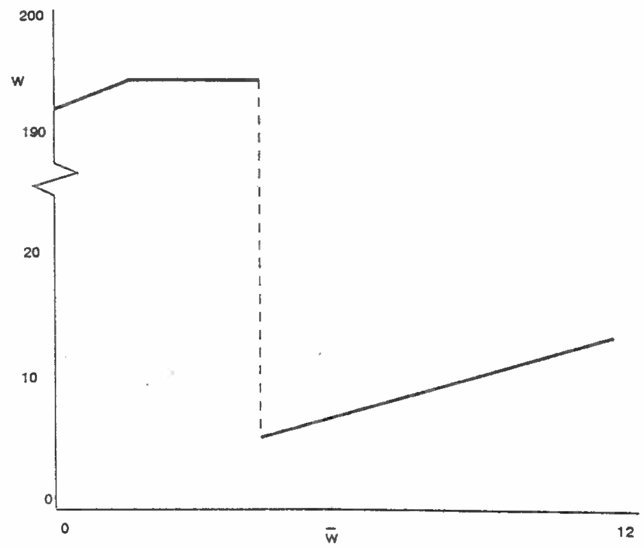

Figure 7

4. Summary and concluding remarks

We have considered an individual - the entrepreneur - contemplating the formation of a firm to generate a return on some knowledge. The problem facing the entrepreneur is that production requires a second individual and, over time, this accomplice will acquire the knowledge in question and hence the ability to leave and set up a rival enterprise. The main result is that there can be an incentive for the entrepreneur to precommit capacity and thus take on the role of the capitalist when contracting with the accomplice.

Such precommitment is not always optimal. Other things being equal it weakens a bargaining position, and if capacity is taken beyond the monopoly level there is an efficiency loss. But this can be outweighed by a positive impact on bargaining strength operating through the product market. The most obvious case would be a precommitment which ensured that a rival could not enter profitably. In our model this is most likely when the fixed costs are high and hence entry can be deterred with a relatively small capacity. Less obviously, it was demonstrated that precommitment can be optimal even where a rival's potential post-entry profit would remain positive. Implications for the wage rate were also examined. In cases where precommitment rendered entry unprofitable the accomplice received the competitive wage, but if there was no precommitment, or it fell short of the entry deterrence level, the optimal strategy incorporated a wage bonus to prevent a separation. Strategic action in the face of potential entry is of course a familiar theme in the industrial organisation literature. The distinctive feature of our analysis is that the entry threat comes from within the firm and so, in contrast with the usual situation of an anonymous potential entrant, the parties here are in a position to negotiate over the share-out of the surplus from production.

An important feature of the model is that entry would be inefficient from the producers' point of view, and therefore never occurs in equilibrium. But in practice individuals do sometimes leave to set up rivals and an obvious topic for future research is to explain why such separations occur. One possibility is that the accomplice, as well as learning from the entrepreneur, might acquire new knowledge. By leaving to set up a new firm, the accomplice might be able to keep this knowledge private, and this advantage could outweigh the fall in industry profits due to product market competition. An alternative explanation, suggested by Pakes and Nitzan (1983), is that at some point an outsider might independently acquire the expertise necessary to become a potential entrant, and separation is then a means of pre-empting such third-party entry. This is similar to the use of divisionalisation to deter entry (see Schwartz and Thompson, 1986) and would require the model here to be modified to make deterrence by a single entity more difficult or costly. A further direction in which the model could be extended would be to allow for more than a single accomplice. A difficulty is that the bargaining framework does not extend beyond the two-person case in a straightforward manner. Osborne and Rubinstein (1990, pp 63-67) point out that a three-person game is qualitatively different, and that the issue of how to move beyond two bargainers is currently an active area of research. Informally, one might conjecture that increasing the number of accomplices will reduce the entrepreneur's profit if no precommitment is undertaken, but leave the profit from either type of precommitment strategy unchanged. This is because, in the absence of a precommitment, all workers are identical at the start of the second period and, if monopoly surplus is therefore divided equally, the entrepreneur's profit will decline as the number of accomplices rises. On the other hand, the best response of the accomplices as a group to a capital precommitment is to collude and act exactly as would a single accomplice, therefore leaving the precommitment outcomes, from the entrepreneur's viewpoint, unchanged.

Finally, we can briefly return to Marglin's (1974, 1984) analysis of "capitalist production", referred to in the introduction. Marglin argues that the hierarchical structure characteristic of capitalist production did not arise due to superior efficiency, but rather because it benefited one group, "capitalists", at the expense of another, "workers". Why, then, don't the workers leave and set up by themselves? Marglin's answer, the subject of the 1984 paper, is that only capitalists possess the organisational knowledge required to operate the firm and that it is through hierarchy that this advantage is maintained. Thus it is knowledge and not capital which underpins his analysis of the "capitalist" firm. In this paper we have suggested that capital may, after all, be important.

Appendix

Deterrence

To just deter entry E installs capacity that generates a duopoly equilibrium with zero profit for A. From (2) and (12) A's Cournot reaction function can be obtained:

$$q_A = \frac{a - r_A - bq_E}{2b}. \tag{A1}$$

Combining this with (12) and setting profit to zero gives an expression for the output of E, q_E^d, in this zero profit equilibrium:

$$b^2(q_E^d)^2 - 2b(a - r_A)q_E^d + (a - r_A)^2 - 4b(f + 2\bar{w}) = 0.$$

Solving this quadratic:

$$q_E^d = \frac{a - r_A - 2\sqrt{b(f + 2\bar{w})}}{b}. \tag{A2}$$

From (5) notice that this output can be secured in equilibrium by precommitting capital at the same level. The resulting income and hence outside option is obtained by inserting q_E from (A2) and $q_A = 0$ into (11) and recalling that profit, Π, is income less the opportunity cost, $\bar{w}$. Note: With zero post-entry profit A is strictly speaking indifferent between entry and staying out, therefore to guarantee deterrence capacity must be slightly above that in (A2).

Accommodation

The Stackelberg leadership output is obtained by substituting (A1) and (2) into (11) and then maximising profit with respect to q_E. This yields

$$q_E^s = \frac{a - 2r_E + r_A}{2b}, \tag{A3}$$

and then, from (A1):

$$q_A^s = \frac{a + 2r_E - 3r_A}{4b}. \tag{A4}$$

From (5) this equilibrium can be secured by precommitting capital to the level given in (A3). The resulting income for *E* is obtained by substituting (A3), (A4) and (2) into (11), and then adding $\bar{w}$ as for the deterrence case.

Boundaries between strategy pairs

NP and DP: Equating (21) and (22) and defining $\alpha \equiv \sqrt{b(f + 2\bar{w})}$ we obtain:

$$8r_A^2 - 8(a + r_E - 4\alpha)r_A - 8\left[(2a + 2r_E)\alpha - ar_E - 4\alpha^2\right] + (a - r_E)^2 + 4\alpha^2 = 0,$$

$$\text{or} \quad r_A = \frac{-\beta + \left[\beta^2 + 32\left(\gamma - (a - r_E)^2 - 4\alpha^2\right)\right]^{1/2}}{-16},$$

where $\beta \equiv 8(a + r_E - 4\alpha)$,

and $\gamma \equiv 8\left[(2a + 2r_E)\alpha - ar_E - 4\alpha^2\right]$.

NP and AP: Equating (21) and (23) gives:

$$f = \frac{(a - 2r_E + r_A)^2 - (a - r_E)^2}{4b} - 2\bar{w}.$$

DP and AP: Equating (22) and (23):

$$9r_A^2 - (\beta - 2a + 4r_E)r_A - \gamma + a^2 - 4ar_E + 4r_E^2 = 0,$$

or,

$$r_A = \frac{-(\beta - 2a + 4r_E) + \left[(\beta - 2a + 4r_E)^2 + 36(\gamma - a^2 + 4ar_E - 4r_E^2)\right]^{1/2}}{-18}.$$

Second period wage of accomplice

DP: $w = \Omega^d - Z_E^d$,

where $\Omega^d = p(q_E^d\ , 0)q_E^d - r_E q_E^d - f$,

and $Z_E^d = p(q_E^d\ , 0)q_E^d - r_E q_E^d - f - \bar{w}$.

Therefore, $w = \bar{w}$.

AP: $w = \Omega^s - Z_E^s$,

where $\Omega^s = p(q_E^s\ , 0)q_E^s - r_E q_E^s - f$,

and $Z_E^s = p(q_E^s\ , q_A^s)q_E^s - r_E q_E^s - f - \bar{w}$.

Therefore $w = [p(q_E^s\ , 0) - p(q_E^s\ , q_A^s)]q_E^s + \bar{w}$, and then by using (2): $w = bq_E^s q_A^s + \bar{w}$. Substituting the quantities from (A3) and (A4) then yields (24.3).

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