MONOPOLY, EXTERNALITIES AND NON-PROFIT MAXIMISING FIRMS

David Kelsey¤   Frank Milne

Department of Economics   Department of Economics

The University of Birmingham, England   Queens University, Canada.

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Abstract

This paper provides a theory of a monopolist in general equilibrium. We assume that the ...rm's decisions are based on the preferences of shareholders and/or other stakeholders. We show that the monopolist will charge less than the pro...t-maximising price, since shareholders su¤er part of the cost of a price rise if they are also consumers. If price discrimination is possible, the resulting equilibrium will be Pareto e¢cient. We use the model to examine the e¤ects of increasing stakeholder representation in ...rms. A related result shows that a non-pro...t ...rm will produce fewer negative externalities.

Address for Correspondence   David Kelsey, Department of Economics, The University of Birmingham, Birmingham, B15 2TT, ENGLAND.

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1   INTRODUCTION

1.1   Background

Traditionally it has been assumed that ...rms maximise pro...ts. However this assumption should be justi...ed. In the presence of market distortions, it is not typically the case that owners will wish ...rms to maximise pro...ts. The usual justi...cation for pro...t maximisation is the Fisher Separation Theorem (see Milne (1974), Milne (1981)), which says that if there are no externalities, the ...rm has no market power and ...nancial markets are complete, all shareholders will wish to maximise the value of the ...rm. This result does not apply if there are externalities between the ...rm and its shareholders. In this case, shareholders will not just care about the ...rm's decisions via their e¤ect on shareholder wealth but will also care about direct (externality) e¤ects of the ...rm's decisions upon their utility. For instance, the shareholder who lives near a factory with a smoking chimney, will want less production than the pro...t maximising level and less production than a shareholder who lives further away. Thus we see both disagreement between shareholders and deviations from pro...t maximisation.

Although we use pollution as an example of an externality, it is not the most important one. Another is the dislike that many people have from investing in ...rms which behave in socially irresponsible ways, such as supporting repressive regimes or damaging the environment. Alternatively the externality could be interpreted as private bene...ts of control, perquisites (see Jensen & Meckling (1976)) or other services not captured by market variables. These are the externalities discussed most often in the corporate control literature. We suspect that these are important factors in proxy ...ghts and takeover contests. Other examples are the ...rm-speci...c investments that are provided by members of the control group (see section 7.2).

If there is imperfect competition, the Fisher Separation Theorem breaks down in two ways. Firstly, in general, there will be disagreement between di¤erent shareholders about the policy of the ...rm. Secondly, typically, no shareholder will wish to maximise pro...ts. The Fisher Separation Theorem does not apply if there is imperfect competition, since in that case, a change in the ...rm's production plan will a¤ect

prices as well as shareholders' wealth. Hence typically the old budget set will not be a proper subset of the new one and no unambiguous comparisons can be made.

1.2   Modelling Firm's Decisions

In this paper, we consider an economy with monopoly or externalities. As we argue above, there is a strong case against assuming pro...t maximisation when markets are distorted. However, it is not clear what the alternative should be. At present there is no widely accepted economic model of the internal decision-making of ...rms. To resolve this, in the present paper, we propose a relatively general model of the ...rm. Despite the generality, our model is able to make a number of predictions concerning equilibrium behaviour and to throw some light on policy questions. The ...rm is modelled as a collection of individuals, each of whom is maximising his/her utility. Firms' decisions are made by a process of aggregating the preferences of a group of decision-makers within the ...rm.[1]

One approach, which has been used in the past, is to model decisions as being made by a majority vote of shareholders, see for instance Hart & Moore (1996) or Renstrom & Yalcin (1997). If the ...rms' choice is one-dimensional (e.g. price), it will be determined by the median shareholders' preference. However one can object to shareholder voting models by arguing that, in practice, management have more in‡uence than shareholders. To model this, we assume that the ...rm's decisions are made by a group of individuals, which we shall refer to as the control group. For example, the control group could consist of the shareholders and senior management. As another example, consider a ...rm with no shareholders, but is a partnership. This case is common in legal, accounting, ...nance and professional ...rms, where the ...rm produces services that are a function of human capital and individual and team e¤ort. However, to preserve generality, we shall not explicitly describe the criteria for membership of the control group.

At present there is no widely accepted theory of the internal structure of the ...rm

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[1]Examples of such procedures would be the Nash bargaining solution used by Hart & Moore (1990), alternating o¤ers bargaining, de DeMeza & Lockwood (1998), Bolton & Xu (1999) or the voting models used by De Marzo (1993), Kelsey & Milne (1996) and Sadanand & Williamson (1991).

(for recent surveys of the governance literature see Shleifer & Vishny (1997), Allen & Gale (2000) and Tirole (2001)). For this reason we use an abstract model. We make, what we believe to be the mild assumption, that the firm's procedures respect unanimous preferences within the control group. Such rules would include, inter alia, those which give a major role for management. Note that many familiar forms of governance can be seen as special cases, for instance producer cooperatives, consumer cooperatives, including worker representatives on the board (as in Germany) and many types of non-profit organisation.

In a discussion of firm structures, Hansmann (1996) provides many examples of firms that are cooperatives, partnerships and non-corporate forms. Some are complex non-profit forms, where the services provided appear to require more subtle forms of organisation than the simple corporate form assumed in basic text books. It follows that any general model of the firm should be flexible in abstracting from details that are specific to particular situations and should deal instead with the abstract decision-making process.

Some theories of the firm use bargaining models to determine the relative power of different individuals. By varying the bargaining game, it is possible to induce different outcomes to the management-control mechanism or game. Although some of these games have some semblance to reality, we feel they are highly stylized. We prefer to abstract from the details of the bargaining process and simply assume that whatever the bargaining or management game, the process leads to an efficient outcome. If one believes that in certain situations, that the outcome is inefficient, then it would be important to explain the source of the inefficiency. One could think of our model as the outcome of a process to design an efficient mechanism. If this is infeasible then we are dealing with inefficient mechanisms. As we are dealing with an open theoretical question, we simply by-pass it by assuming an efficient mechanism exists and explore the consequences of that assumption. We briefly discuss how our results would be affected by inefficient mechanisms in the conclusion, (see also Tirole (1999)).

Another major point of this paper is to emphasize the connection between traditional public economics concerns and the theory of the firm. We can think of the firm

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as an entity which provides local public goods, e.g. profits and private benefits of control to shareholders and/or employees (see Holmstrom (1998)). This establishes a connection between our model of a firm and the theory of a public project in an economy with symmetric information and real or pecuniary externalities.

Finally, observe that our model does not deal with asymmetric information or competing oligopolistic firms. To incorporate asymmetric information we would require a general equilibrium model with asymmetric information. Such models exist (see Prescott & Townsend (2000)) but address the issues in terms of competitive clubs. Oligopolistic models require additional assumptions to ensure existence, and introduce the possibility of collusion or strategic behaviour across firms or coalitions of control groups. These extensions are beyond the scope of the present paper.

1.3 Monopoly and Externalities

As argued above, in the presence of market distortions, shareholder unanimity cannot be guaranteed. However it is still the case that there are decisions on which all members of the control group will agree. Firstly we show that, under some assumptions, for any plan which is not productively efficient, there will be some production plan which is unanimously preferred. Hence the equilibrium will be productively efficient. Secondly, we show that a firm, which has a monopoly, will charge less than the profit maximising price. Thirdly all members of the control group will agree that the firm should produce less/more than the profit-maximising level of negative/positive externalities. Thus conventional profit-maximising models may have overstated the size of the distortions due to monopoly and externalities.

These arguments provide a possible rationale for controls on foreign ownership and may explain popular suspicion of foreign owned firms. Assume that the control group of a foreign owned firm neither pays the domestic price nor suffers externalities in the domestic economy. Then such a firm would charge the full monopoly price and would produce the profit-maximising level of externalities. Hence there may be a case for regulating foreign owned firms more strictly. Even within a single country, there may be reasons for preferring relatively small locally owned firms to large national

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companies. Similarly our analysis of the pollution problem, suggests that there may be advantages in having waste disposed of close to its place of production. This increases the chance that, those a¤ected by negative externalities, will have some in‡uence on the ...rm's decision.

Hansmann (1996) cites a number of examples where ...rms are owned either by those who purchase their outputs or those who supply inputs to the ...rm. He argues that, in most cases, this is to counter monopoly or monopsony power. This practice is very common among ...rms, which supply inputs to or buy produce from farms. Presumably in relatively remote rural areas, it is easier to establish a local monopoly. These are the kind of e¤ects which our model aims to capture.

It has been argued that co-operatives will tend to be unstable see, for instance, Farrell (1985). Consider a monopoly, which is selling below the pro...t-maximising price, since customers are also consumers. Farrell shows that a raider (who is not a consumer) could buy up shares at the current value and then make a pro...t by increasing the product price to the pro...t maximising level, thereby increasing the value of his/her shares. He argues that there is a free riding problem. Each existing shareholder will ignore the e¤ect of his/her decision on the product price and hence will sell to a higher o¤er by the raider. However we believe that this argument needs to be modi...ed, since there is a similar free riding problem with respect to the stockmarket value of the ...rm, see for instance Grossman & Hart (1980). Balancing the two e¤ects, we do not believe that a monopolist with consumers in the control group is particularly vulnerable to takeover.

It has been suggested that in addition to shareholders, other parties a¤ected by a ...rm's activities should be given in‡uence in the ...rm's decisions. These would include inter alia representatives of workers, customers and the local community. This paper is able to throw some light on this proposal. Suppose a ...rm has monopoly power, which cannot be removed by other means. Our model implies that up to a point, increasing customer in‡uence on the ...rm's decision will reduce distortions.

Organisation of the Paper   In section 2 we prove existence of equilibrium in a general equilibrium model with monopoly. We then show that, under some reasonable

conditions the equilibrium is productively e¢cient. In section 3 we consider the price and quantity decisions of a uniform pricing monopolist. In section 4 we study non-uniform pricing. We show that perfect price discrimination implies Pareto e¢ciency and that the ...rm's preferred pricing system can be implemented with two-part tari¤s. Section 5 presents some related results about externalities. In section 6 we consider whether a non-pro...t ...rm is vulnerable to takeover. Section 7 discusses another interpretation of our model, where the ...rm is a monopsonist or externalities ‡ow between the ...rm and a supplier. Section 8 summarises our conclusions and sketches the implications of ine¢cient decision procedures. In particular we consider the e¤ects of hold-up problems within the ...rm. The appendix contains proofs of those results not proved in the text.

2 EQUILIBRIUM

In sections 2-4 we consider a general equilibrium model with monopoly but no externalities. Here, we introduce the model and prove an existence result. We also begin the characterisation of equilibria, by showing that the equilibrium is independent of the choice of numeraire and ...nding conditions for productive e¢ciency. We have chosen a relatively simple model to illustrate the issues, which arise from endogenising decision-making within ...rms. It has been adapted from Edlin, Epelbaum & Heller (1998) to suit our purposes.

2.1 Model

There is a single ...rm, ...rm 0 with market power, which we shall refer to as the monopolist. There is in addition a fringe of competitive ...rms, $1 \leqslant f \leqslant F$.

2.1.1 Markets

The model has $J + 1$ goods. Goods 0 to $\bar{\jmath}$ are competitive goods, while goods $\bar{\jmath} + 1$ to J are monopoly goods. Thus we can write a vector of goods as $x = \hbar x_c; x_m i$ to denote the competitive and monopoly goods separately. There are markets in all goods. There is no market in shares. Since there is no uncertainty, diversi...cation is

not a possible motive for trading shares. We shall use $p_m \in R^{J_i j}$ and $p_c \in R^{J+1}$ to denote respectively the price vectors for monopoly goods and competitive goods. We shall assume that good 0 is numeraire i.e. $p_{c0} = 1$: Let $p = hp_c; p_m i$ denote the price vector. Let $P = R^J_+$ be the space of all price vectors.

Assumption 2.1 All economic agents are price-takers for competitive goods.

This assumption may be rigorously justi...ed as follows. Consider an economy where the group of competitive goods are always desired by consumers and are produced by a competitive ...rm (or industry). Assume the ...rm(s) uses a linear technology, which uses the numeraire as an input. As the commodities are always desired in positive amounts, they will be produced and their prices will be set equal to the constant marginal cost in terms of the numeraire. Thus these commodities' prices will be invariant to the monopolist's decision.

2.1.2 Firms

We require ...rms to satisfy the following assumptions.

Assumption 2.2 Firm f has production possibilities described by a production function $Á^f : R^{J+1} \, ! \, R$; i.e. $Y^f = {}^{©}y^f \in R^{J+1} : Á^f {}^i y^f {}^¢ > 0^a$; for $0 \, \mathbf{6} \, f \, \mathbf{6} \, F$. Moreover,

1. the function $Á^f$ is assumed to be continuous and concave,

2. the production set, Y^f; is compact and non-empty.

Let $Y = {}^{©}hy_0; ::::; y_F i : y^f \in Y^f; 0 \, \mathbf{6} \, f \, \mathbf{6} \, F^a$ denote the aggregate production set.

Assumption 2.3 (Free Disposal) If $y \in \mathbf{P}^F_{f=0} Y^f$ then $_i y^+ \in \mathbf{P}^F_{f=0} Y^f$; where $y^+ = hmax f0; y_0 g; ::::; max f0; y_F gi$:

This says that any unwanted outputs can be disposed of at no cost.

Assumption 2.4 Firm f is a competitive ...rm for $1 \, \mathbf{6} \, f \, \mathbf{6} \, F$: These ...rms are price-takers for all goods. They neither produce monopoly goods nor use them as inputs, $y = hy_c; y_m i \in Y^f =) \; y_m = 0$; for $1 \, \mathbf{6} \, f \, \mathbf{6} \, F$.

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Firm 0 is a monopolist and is able to set the price for monopoly goods. However it is a price-taker in the market for competitive goods. One can motivate this by observing that, while some firms are big enough to set some prices, it is unlikely that any given firm would have sufficient market power to set prices for all goods.

2.1.3 Consumers

There are H consumers $1 \le h \le H$. We assume that the consumer h has consumption vector x_h, which lies in a consumption set $X^h \subseteq R^L$.

Assumption 2.5 X^h is non-empty, convex and contains the non-negative orthant for all $h \in H$.

Assumption 2.6 Consumer h has a quasi-linear utility function: $u^h = x_0^h + W^h\left(x_c^h, x_m^h\right)$; where W^h is continuous, strictly concave and increasing in all arguments.

Assumption 2.7 Individual h has endowments ω_c^h of competitive goods, ω_m^h of monopoly goods and μ_h^f of shares in firm f; where $0 \le \mu_h^f \le 1$ and $\sum_{h=1}^H \mu_h^f = 1$. We assume $\forall y \in Y$, $\omega_h + \sum_{f=0}^F \mu_h^f y_f \in \text{int } X^h$, where $\omega_h = \left(\omega_c^h, \omega_m^h\right)$.

Individual h has a budget constraint:

$$x_0^h + p_m \cdot x_m^h + p_c \cdot x_c^h \le p_m \cdot \omega_m^h + p_c \cdot \omega_c^h + \sum_{f=0}^F \mu_h^f p \cdot y^f. \tag{1}$$

Assuming an interior solution, this generates demand functions $x_m^h(p_m, p_c)$ and $x_c^h(p_m, p_c)$. Define the corresponding aggregate demand functions, $x_m(p_m, p_c) = \sum_{h=1}^H x_m^h(p_m, p_c)$ and $x_c(p_m, p_c) = \sum_{h=1}^H x_c^h(p_m, p_c)$. The maximised utility is given by: $u^h = \omega_0^h + p_m \cdot \omega_m^h + p_c \cdot \omega_c^h + \sum_{f=0}^F \mu_h^f \pi_f - p_m x_m^h - p_c x_c^h + W^h\left(x_m^h, x_c^h\right)$; where π_f denotes the profits of firm f.

Definition 2.1 Define $v^h(p, y) = \max_{x^h \in X^h} u^h\left(x^h, y\right)$ subject to (1). For a given p, the function v^h represents individual h's induced preferences over the production plan and pricing decision of the firms.

2.1.4 Firms' Decisions

We assume that the decisions of ...rm f are made by a group of individuals C^f ½ $f1; ::::; Hg$, which we shall refer to as the control group of ...rm f:

Assumption 2.8 For $f \, 6 \, \hat{f}; C^f \setminus C^{\hat{f}} = ;:$

This says that there is no overlap between the control groups of di¤erent ...rms. We make this assumption to avoid issues of collusion, which are beyond the scope of the present paper. In section 2.4, we shall also need the following assumption, which says that at least one member of the control group has a positive shareholding.

Assumption 2.9 There exists an individual h such that $\mu_f^h > 0$ and $h \, 2 \, C^f$:

As already noted, there are problems with pro...t maximisation. For this reason we assume that the ...rm's behaviour may be represented as maximising a preference relation $<^f$; de...ned on $P \, \pounds \, Y$. This binary relation will arise from some process of aggregation of the preferences of the control group. As is well known from the social choice literature, group preferences are likely to be incomplete or intransitive or both, (see for instance Sen (1970)). Because of this, we do not assume completeness and/or transitivity.[2]

We assume that the ...rm's preferences are a function $<^f = \gg \, hv_h i_{h2C^f} ; \mu_1^f; ::::; \mu_H^f$[3] of the preferences of the control group and shareholdings. Note that we do not exclude the possibility that individuals, who are not shareholders (e.g. managers), are able to in‡uence the ...rm's preferences. We shall not model the internal decision making of the control group explicitly but simply assume that whatever procedure is used, respects unanimous preferences. Hence, our results do not depend very sensitively on the exact composition of the control group.

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[2]However social choice problems may not be as great as they appear at ...rst sight. Hansmann (1996) argues that the control groups of ...rms have relatively homogenous preferences. Hence the assumption of unrestricted domain commonly used in social choice theory does not apply. This is true both of conventional investor-controlled ...rms and of various kinds of non-pro...t ...rms and cooperatives.

Assumption 2.10 The firm f's preferences satisfy the Strong Pareto Principle i.e. $\forall h \in C^f, v_h(p, \hat{y}) > v_h(p, y)$ and $\nexists \hat{h} \in C^f, v_{\hat{h}}(p, \hat{y}) > v_{\hat{h}}(p, y) \Rightarrow (p, \hat{y}) \hat{A}^f (p, y)$.

Equivalently, we are assuming there is costless Coasian bargaining within the control group.[3] A number of familiar decision rules have this property.[4]

Assumption 2.11 The firm's strict preference relation, $\hat{A}^f$, has open graph.

This is a continuity assumption and is largely technical in nature. We do not need to assume completeness or transitivity of the firm's preferences. However to prove existence of equilibrium we need the following assumption.

Assumption 2.12 The firm's preferences satisfy $\left\{ y : y \, \hat{A}^f \, x \right\}$ is convex for $0 \leq f \leq F$.

2.2 Existence

In this section we present our definition of equilibrium and demonstrate its existence. First we take the output of the monopolist as exogenous and define an equilibrium for the competitive sector of the economy.

Definition 2.2 An equilibrium $\left(x^{\alpha}, p^{\alpha}, y^{\alpha i \neq 0} | y^0 \right)$ relative to monopoly production vector $y^0 \in Y^0$, consists of an allocation x^{α}, a vector of production plans for competitive firms $y^{\alpha i \neq 0}$ and a price vector p^{α}, such that:

1. $\sum_{h=1}^{H} x_h^{\alpha} \leq \sum_{h=1}^{H} \omega_h + y^0 + y^{\alpha i \neq 0}$;

2. x_i^{α} maximises $u_i \left(x_i; y^0, y^{\alpha i \neq 0} \right)$ subject to $p \cdot x_i \leq p \cdot \omega_h + \mu_h^0 p^{\alpha} \cdot y^0 + \sum_{f=1}^{F} \mu_h^f p^{\alpha} \cdot y^{\alpha f}$;

3. there does not exist $\hat{y}^f \in Y^f$ such that $\left(\hat{y}^f, p^{\alpha} \right) \hat{A}^f \left(y^{\alpha f}, p^{\alpha} \right)$ for $1 \leq f \leq F$.

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[3] We could instead use the weak Pareto principle in which case we would need to strengthen the assumptions on the production function to strict concavity.

[4] For instance: allowing a single individual to run the firm (dictatorship); a group of individuals electing a CEO who then has full executive power, (which is equivalent to the citizen candidate model of Besley & Coate (1997) and Osborne & Slivinski (1996)), running the firm by a committee whose decisions must be unanimous, Dreze (1985) or making decisions by a median vote of shareholders, Geraats & Haller (1998), Hart & Moore (1996) and Roemer (1993).

Note that y^0 is taken as given and the consumers and the competitive ...rms take prices as given.

De...nition 2.3 A managerial equilibrium $hx^\pi; y^\pi; p^\pi i$ consists of an allocation, x^π, a production plan for each ...rm y^π; and a price vector p^π; such that:

1. $\bar{x}^\pi; y^{\pi i \ 0}; p^\pi j y^{0^\circledR}$ is a competitive equilibrium relative to $y^{\pi 0}$;

2. there does not exist $hx; y; pi$ such that:

   (a) $\bar{x}; y i \ 0; pj y^{0^\circledR}$ is an equilibrium relative to y^0;

   (b) $\bar{y}^{0}; p^\circledR \hat{A}^0 \bar{y}^{\pi 0}; p^{\pi \circledR}$:

The concept of pro...t maximisation is not well-de...ned as the Fisher Separation Theorem fails (for more detail see Milne (1981)). The following example indicates the problem.

Example 1 Consider an economy with two consumers and two commodities. Each has the non-negative orthant in R^2 as a consumption set and owns half the total endowment and production set. The production set is closed and convex. Thus both consumers have identical budget sets given any choice of y. However, since they have di¤erent preferences, they can have di¤erent rankings of the production vectors with price making by the monopolist, (see diagram 1).

Insert diagram 1 about here

Theorem 2.1 Provided consumers that satisfy Assumptions 2.5, 2.6 and 2.7 and ...rms satisfy Assumptions 2.2, 2.3, 2.8, 2.10, 2.12 and 2.11, a managerial equilibrium exists.

Consider the competitive case where the mapping from the ...rm's production to the equilibrium is trivial. Then it is easy to see that pro...t maximisation will be the unanimous outcome for all shareholders and all non-shareholders will be indi¤erent.

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2.3 E¤ect of Changing the Numeraire

If ...rms are pro...t maximisers and there is imperfect competition, the real equilibrium will depend on the choice of numeraire or more generally the price normalisation rule, see for instance Böhm (1994). The intuition is clear: if a ...rm maximises pro...ts in terms of a given numeraire, its decisions depend upon that numeraire. In a pure exchange economy, if one individual was given an objective, which depended on the numeraire, then changes in the numeraire could change the real equilibrium. A similar problem arises in an economy with production, if the ...rm's objective is to maximise pro...ts in terms of the numeraire.

This problem does not arise in our model, since production decisions are based on utility maximisation by individuals. Hence the ...rm has a real objective. For instance, suppose that decisions of the ...rm are made by a majority vote of shareholders. Each shareholder will have preferences which only depend on real consumption, hence the ...rm's decisions and consequently the equilibrium will be independent of the numeraire. Below we show that with our de...nition, equilibrium is independent of the choice of numeraire or more generally the price normalisation rule.

Theorem 2.2 The set of managerial equilibria does not depend on the price normalisation rule.

2.4 Productive E¢ciency

In our model, we can show that, when the ...rm's decision rule respects unanimity, it will not choose an ine¢cient production plan.

Theorem 2.3 Under Assumptions 2.1, 2.2, 2.6, 2.9 and 2.10, the equilibrium will be productively e¢cient.

The following example shows that if the ...rm is not a price-taker in at least one input market, then an owner-manager may choose to be productively ine¢cient.

Example 2 Ine¢cient and E¢cient Monopoly   Consider an economy with two consumers A and B; who have utility functions over two commodities, $u_i(x_{1i}; x_{2i})$;

where $i = A, B$. Assume that consumer A has an endowment of an input L and wholly owns a production technology, where the input produces commodity 1 via a neoclassical production function $f(l)$. Consumer B has an endowment of commodity 2.

We can construct an Edgeworth Box, where the height is commodity 2 and the length is commodity 1. By varying the amount of l that consumer A puts into the firm she can alter the length of the box. Thus if consumer A's firm is a monopoly supplier of commodity 1, then it is possible that by reducing her input of l and freely disposing of the remainder she can make herself better off, if the relative prices move sufficiently in her favour.[5] The free disposal story can be modified to eliminate the inefficiency so long as we make the stronger assumption on preferences, Assumption 2.6 (quasi-linearity). This allows the consumer to consume the excess input without disturbing the relative prices.

Alternatively, consider A's firm to be a perfect price discriminator, where A sets a non-linear price schedule that curves around B's base indifference curve. Assuming that A supplies inputs $l = L$, then we have a standard result, where the allocation is Pareto efficient. All the gains from trade are obtained by A. Consumer B is indifferent between trading or merely consuming his endowment of commodity 2. Clearly, in this case A will not reduce her input below L because that will reduce her welfare to a less preferred point on the contract curve.

Notice that the reason for the inefficiency of the first case is induced by the monopolistic distortion in prices. This in turn implies inefficiency in production input supply.

2.5 Durability

Suppose that a monopolist produces a durable good. Consumers only care about the number of hours use they get from the good. Under these assumptions Swan (1970) showed that, a profit-maximising monopolist would produce goods of the socially optimal durability. We show that this conclusion will hold for any reasonable objective

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[5]This is an example, in reverse, of the classical immiserising growth argument in international trade, see Dixit & Norman (1980), Ch.5.

function for the ...rm. This is a corollary of the above result that a monopolist is productively e¢cient.

Firms The ...rm produces a single monopoly good, x_m, which is durable and lasts for s hours. Inputs $c(s)x_m$ are required to produce quantity x_m of durable good. Thus production costs are linear in quantity but possibly non-linear in durability. Pro...ts are given by $\frac{1}{4} = p_m \cdot x_m \; | \; p \cdot c(s)x_m$.

Assumption 2.13 Consumer h has utility $u_h = x_0^h + W^h \left[x_c^h, s x_m^h \right]$, where x_m^h is h's consumption of good 0 and x_c^h is h's consumption of all other goods.

This says that consumers only care about the total number of hours' use they get out of the durable good.

Proposition 2.1 Provided that the ...rm is a price taker on input markets and the decision rule satis...es the Pareto principle, a durable goods monopolist will choose the socially optimal durability.

Proof. The consumers' preferences are really over number of hour's use of the good, rather than directly for the good itself. The socially optimal durability is the one which minimises cost per hour's use for the good.

Let $\hat{s}$ and $\hat{x}_1$ denote the equilibrium durability and quantity of good 1. Since the ...rm is a price taker on inputs markets it follows from Theorem 2.3 that it is not possible to produce $\hat{s}\hat{x}_1$ hours use of the durable good, using less of any input 0. This implies that $\hat{s}$ minimises cost per hour's use, which is the durability the social planner would choose. ∎

3 UNIFORM PRICING MONOPOLY

This section shows that, under some fairly general assumptions, a uniform pricing monopolist will produce a greater quantity and sell at a lower price than a conventional pro...t maximising monopolist. The reason being that if those in charge of the ...rm are also consumers, a small price reduction will result in a second order loss of pro...ts but a ...rst order gain in their consumer surplus. The model is as in Section 2.

3.1 Non-Profit Maximising Monopolist

Let $g(x_m; p_c)$ denote the level of inputs of competitive goods required to produce outputs x_m of monopoly goods.

Notation 3.1 We shall assume, without loss of generality, that the control group of the monopolist (firm 0) is $\{h : 1 \leq h \leq M\}$:

Since the objective of firm 0 respects unanimous preferences of the control group, the optimal point can be obtained by maximising a weighted sum $\sum_{h=1}^{M} \gamma^h u^h$ of the utilities of control group members for some non-negative weights γ^h: We may normalise the γ's by requiring $\sum_{h=1}^{M} \gamma^h \mu^h = 1$:[6] A non profit maximising firm chooses p_m to maximise:

$$\sum_{h=1}^{M} \gamma^h u^h = \sum_{h=1}^{M} \gamma^h [\lambda_0^h + p_m \cdot \lambda_m^h + p_c \cdot \lambda_c^h + \mu^h (p_m x_m (p_m; p_c) - p_c \cdot g(x_m(p_m; p_c); p_c))]$$
$$+ \sum_{h=1}^{M} \gamma^h [-p_m \cdot x_m^h - p_c X_c^h + W^h(x_m^h; x_c^h)]:$$

The first order condition for optimal choice of p_{mj} is:

$$x_{mj}(p_m; p_c) + p_m \cdot \frac{\partial x_m(p_m; p_c)}{\partial p_{mj}} - p_c \cdot \sum_{k} \frac{\partial g}{\partial x_{mk}} \frac{\partial x_{mk}}{\partial p_{mj}} = \sum_{h=1}^{M} \gamma^h \left(x_{mj}^h - \lambda_{mj}^h \right): \quad (2)$$

In the special case where there is only one monopoly good, this simplifies to:

$$\frac{p_m - p_c \cdot \frac{\partial g}{\partial x_m}(x_m; p_c)}{p_m} = \frac{1}{\varepsilon} \left(1 - \sum_{h=1}^{M} \gamma^h \left(\frac{x_m^h - \lambda_m^h}{x_m} \right) \right); \quad (3)$$

where ε is the elasticity of demand. As can be seen, the price is given by a modified version of the inverse elasticity rule. If the firm has a single owner-manager, this formula can be further simplified to

$$\frac{p_m - p_c \cdot \frac{\partial g}{\partial x_m}(x_m; p_c)}{p_m} = \frac{1}{\varepsilon} \left(1 - \left(\frac{x_m^1 - \lambda_m^1}{x_m} \right) \right): \quad (4)$$

The price is lower the greater the owner's consumption of the monopoly good. If the owner consumes all of the firm's output then the price will be equal to marginal cost. The following special cases illustrate the optimal pricing rule:

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[6] This normalisation is possible provided $\sum_{h=1}^{M} \gamma^h \mu^h \neq 0$: If this were not satisfied, the claimants of the firm's profit stream would be given no influence over the firm's decisions. We shall not consider this case further, as we believe it to be of little economic interest.

2 If the owner consumes less than his endowment of the monopoly good, $x_m^1 < \omega_m^1$, then the price is above the pro...t maximising level. In this case, in addition to the usual monopoly e¤ects, the owner takes into account the fact that a price rise will increase the value of his/her endowment.

2 If $x_m^1 - \omega_m^1 > x_m$, i.e. the consumption of the owner is greater than the sum of his/her endowment and the ...rm's output, price is below marginal cost. This is the reverse of the usual monopoly argument. In this case the owner takes into account that any price reduction will reduce the price of the infra-marginal units he purchases from other individuals. E¤ectively the owner is a monopsonist.

We included these two extreme cases since they illustrate some properties of the rule. In practice it would be rare for shareholders to have signi...cant endowments of the goods produced by the ...rms they own. In this case, the optimal price is between marginal cost and the pro...t maximising level. When the control group has multiple members, other things equal, the price will be lower the greater the weight given to members of the control group who are high consumers of the good.

Assume now the ...rm has a single owner-manager, who does not consume its output. Then the optimal pricing rule may be expressed as:

$$\frac{p_m - p_c \cdot \frac{\partial g}{\partial x_m}(x_m, p_c)}{p_m} = \frac{1}{\varepsilon}, \tag{5}$$

This is the familiar inverse elasticity rule i.e. the proportionate mark-up of price over marginal cost is inversely proportional to the elasticity of demand. [7]

3.2 Stakeholder Representation

In this section we use our model to examine the desirability of giving in‡uence or representation to stakeholders. We interpret a stakeholder to be an individual who owns no shares but is a worker or consumer. Consider the case where there are two

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[7]The problem of a monopolist with some consumers in the control group has been previously considered by Farrell (1985), who assumed unanimity as the ...rm's decision rule or Hart & Moore (1996) and Renstrom & Yalcin (1997), who used the median voter rule. Our results are more general since we do not restrict attention to a speci...c decision procedure for the ...rm. However, due to the generality of the model, we do not obtain conditions for Pareto optimality, unlike the earlier papers.

individuals in the control group. Individual 1 is the sole owner. Individual 2 is a "stakeholder" who has no ownership share but may nevertheless have in‡uence on the ...rm's decisions.

Our normalisation of the μ's implies that $\nu^1 = 1; 0 \leq \nu^2 < 1$: Under these assumptions (3) becomes,

$$\frac{p_m - p_c \cdot \frac{\partial g}{\partial x_m}(x_m; p_c)}{p_m} = \frac{1}{\eta}\left[1 - \mu\left(\frac{x_m^1 - \bar{x}_m^1}{x_m}\right) - \nu^2 \mu\left(\frac{x_m^2 - \bar{x}_m^2}{x_m}\right)\right]: \qquad (6)$$

Increasing the in‡uence of stakeholders would correspond to increasing ν^2. By equation (6) this will lower the price of the monopoly good. Hence if competition is impossible, a ...rm with some stakeholder representation would be preferable to a pro...t-maximising monopolist. However, note that if the power of stakeholders is made too great, price could be reduced below marginal cost, which would be ine¢-cient.[8]

Assume $x_m^1 + x_m^2 = x_m$ i.e. there are no consumers other than the owners and the stakeholders. Since we have quasi-linear utility, Pareto optimality requires that price be equal to marginal cost, i.e. $p_m = p_c \cdot \frac{\partial g}{\partial x_m}(x_m; p_c)$: By Equation (6) this implies $1 - \frac{x_m^1 - \bar{x}_m^1}{x_m} - \nu^2 \frac{x_m^2 - \bar{x}_m^2}{x_m} = 0$; which can be solved to give $\nu^2 = 1$: This implies the ...rm should maximise the unweighted sum of utility of shareholders and stakeholders. This could be implemented in practice, by voting over pricing and giving an equal number of votes to shareholders and stakeholders. In this case the median voter's preference would be for setting price equal to marginal cost. The above analysis investigates the e¤ect of giving representation to consumers. However, it can be seen that similar issues arise from giving representation to workers.

4 PRICE DISCRIMINATION

When a uniform pricing monopolist raises the price, those within the ...rm lose consumer surplus. This suggests that the ...rm would like to practice price discrimination, selling at marginal cost to members of the control group, while charging outsiders

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[8] It could be argued that the current crisis in the Californian electricity industry has been caused by giving too much weight to stakeholder interests, resulting in a price below marginal cost.

the monopoly price.[9] In practice, discounts for sta¤ are common and discounts for shareholders are not unknown. Hence there is a case for investigating price discrimination with non-pro…t maximising …rms. We focus on the extreme case of perfect price discrimination. Our main results are that, the outcome will be Pareto optimal and can be implemented by two-part tari¤s. This extends some results of Edlin et al. (1998) to general objective functions for the …rm.

4.1 Model

The main features of the model are as described in Section 2.4. For a …rm to be able to practice perfect price discrimination it is necessary that households should not be able to trade in the goods it produces. Hence we shall require that no individual has any endowment of monopoly goods throughout this section. Moreover individuals are not able to trade monopoly goods among themselves, hence there are no resale prices for these goods.

4.1.1 Consumers

Consumers satisfy Assumption 2.6. Let R^h be the total amount which individual h pays for monopoly goods. Individual h's income, net of payment to the …rm is $p_c \cdot !^h_i - R^h$. To prove existence we need to make two additional assumptions.

Assumption 4.1 The indi¤erence curve through the endowment lies in the interior of the consumption set.

Assumption 4.2 All individuals have zero endowment of monopoly goods, $!^h_m = 0$, for $1 \leqslant h \leqslant H$:

This says that the …rm is the only source of monopoly goods.

De…nition 4.1 De…ne the indirect utility function of individual h by, $V^h\left(x^h_m; R^h; p_c\right) = \max_{x_c} u^h\left(x^h_m; x_c\right)$ such that $p_c \cdot x_c \leqslant p_c \cdot !^h_i - R^h$:

Since utility is quasi-linear,

$$\frac{\partial V^h}{\partial R^h} = -\frac{\partial u^h}{\partial x_0}.$$

(7)

De...ne $\hat{u}^h(p_c) = \max_{x_c} u^h(0; x_c)$ such that $p_c \cdot x_c \leq p_c \cdot \omega^h$. Thus $\hat{u}^h(p_c)$ is the reservation utility, which consumer h can obtain if (s)he does not trade with the monopolist. Since we assume that the monopolist is a price-taker for competitive goods, $\hat{u}^h(p_c)$ can be taken as given by him/her.

4.1.2 Firm

The ...rm satis...es Assumption 2.1. We retain the assumption of symmetric information, hence we do not need to consider incentive compatibility problems. For the usual reasons, we restrict attention to take it or leave it o¤ers. The ...rm o¤ers to supply individual h with a bundle x_m^h of monopoly goods in exchange for (gross) payment R^h. As before, we may represent the ...rm's behaviour as the solution to the following optimisation problem. Choose $\langle x_m^1; ....; x_m^H; R^1; ....; R^H; y_c \rangle$ to maximise $\sum_{h=1}^{M} \gamma^h V^h \left(x_m^h; R^h; p_c \right)$ for some positive constants γ^h subject to the constraints:

$$V^h \left(x_m^h; R^h; p_c \right) = \hat{u}^h(p_c); \quad \text{for } M+1 \leq h \leq H;$$

$$\Lambda \left(\sum x_m^h; y_c \right) = 0;$$

$$\sum_{h=1}^{H} R^h + p_c \cdot y_c = 0.$$

(8)

The ...rst constraint says that non-members of the control group must achieve at least as much utility as they could obtain by not trading with the ...rm. The second restricts the ...rm to using feasible production plans. The ...nal constraint is the ...rm's budget balance condition. The Lagrangian for the ...rm's optimisation problem is:

$$L = \sum_{h=1}^{M} \gamma^h V^h \left(x_m^h; R^h; p_c \right) + \sum_{h=M+1}^{H} \gamma^h \left[V^h \left(x_m^h; R^h; p_c \right) - \hat{u}^h(p_c) \right]$$

$$+ \eta \Lambda \left(\sum x_m^h; y_c \right) + \mu \left(\sum_{h=1}^{H} R^h + p_c \cdot y_c \right).$$

(9)

4.2 Existence

Below we modify our de...nition of equilibrium to allow for the possibility of price discrimination.

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Definition 4.2 A PDM (price discriminating monopoly) equilibrium consists of a profile of take it or leave it offers, allocations of competitive goods, a production plan for the firm and a price vector for competitive goods, $\langle R^{\alpha}; x_m^{\alpha}; x_c^{\alpha}; y_m^{\alpha}; y_c^{\alpha}; p_c^{\alpha}\rangle$; such that:

1. $\langle R^{\alpha}; x_m^{\alpha}; y_m^{\alpha}; y_c^{\alpha}\rangle$ solves the firm's optimisation problem (8);

2. $y_c^{\alpha} + \sum_{h=1}^{H} x_c^{\alpha h} = \sum_{h=1}^{H} \omega^h$;

3. $u^h\left(x_m^{\alpha h}; x_c^{\alpha h}\right) > u^h\left(x_m^{\alpha h}; x_c^h\right)$; for all x_c^h such that $p_c^{\alpha} \cdot x_c^h \leq p_c^{\alpha} \cdot \omega^h - R^{\alpha h}$; for $1 \leq h \leq H$;

4. $u^h\left(x_m^{\alpha h}; x_c^{\alpha h}\right) > \tilde{u}^h(p_c)$ for $1 \leq h \leq H$:

Theorem 4.1 Given consumers that satisfy Assumptions 2.5, 2.6 2.7, 4.1 and 4.2 and firms satisfy Assumptions 2.2, 2.3, 2.8, 2.10, 2.12 and 2.11; a PDM equilibrium exists.

Proof. Let $x_m = \overline{\langle x_m^1; ....; x_m^H\rangle}$ and $R = \overline{\langle R^1; ....; R^H\rangle}$: By Assumption 4.1 after accepting the firm's offer, all consumers will be in the interior of their consumption sets. Given x_m and R, which satisfy the participation constraint, we can apply the same type of argument as Lemma A.1 to obtain a competitive equilibrium relative to $\langle x_m; R\rangle$. Since the set of attainable allocations is compact, we may assume that R and x are chosen from compact sets. Note that the monopolist's feasible production set is compact and his/her objective is continuous. The Weierstrass Theorem guarantees the existence of a maximum and thus a PDM equilibrium. ∎

4.3 Efficiency

We shall now demonstrate that the equilibrium is efficient and can be implemented by a 2-part tariff, which consists of a personalised hook-up fee and a per unit price equal to marginal cost. The intuition is that total surplus can be maximised by setting price equal to marginal cost. Since surplus is maximised, the resulting equilibrium is efficient.

De…nition 4.3 We say that the …rm uses marginal cost pricing if it sets a tari¤, $T^h\left(x_m^h\right) = t^h + p_m \cdot x_m^h$; where $p_m = \left(\dfrac{\partial A}{\partial y_{m1}} = \dfrac{\partial A}{\partial y_0}; \ldots; \dfrac{\partial A}{\partial y_{mn}} = \dfrac{\partial A}{\partial y_0}\right)$ and $T^h\left(x_m^h\right)$ denotes the total amount consumer h pays for quantity x_m^h.

Theorem 4.2 A PDM equilibrium is Pareto e¢cient and can be implemented by a 2-part tari¤, in which the …rm uses marginal cost pricing.

This result may have some applications for regulation. Regulated (or nationalised) …rms are unlikely to be pro…t maximisers. It is useful to know that their preferred pricing structure will consist of a two-part tari¤. It is not surprising that the …rm will wish to present outsiders with a 2-part tari¤, since this pricing scheme is capable of extracting all their surplus. The …rm also wishes to use a 2-part tari¤ with members of the control group. The reason is that, within the control group, it is desirable to allocate goods e¢ciently by using marginal cost pricing. Any redistribution between control group members can be achieved in a lump-sum manner by adjusting the hook-up fees. To clarify, for non-members of the control group the hook-up fee is equal to the total surplus. For the control group, the hook-up fee is not necessarily equal to total consumer surplus. Instead it is determined by a bargaining process or game within the control group. A good example of such bargaining would be partnerships in accounting or law …rms where salaries and bonuses are determined by various formulae and bargaining in the group. Observe that such …rms have partners (members of the control group) and non-partners. We have not modelled the determination of the control group. For further discussion see section 5.2.

5 EXTERNALITIES

In this section we show that non-pro…t maximising …rms produce less than the pro…t-maximising level of negative externalities. This extends an earlier result by Roemer (1993), since it applies to any decision rule which respects unanimity. Our model is also di¤erent because it has multiple …rms and variable labour supply. By similar reasoning we may show that a non-pro…t maximising …rm will produce more positive externalities than a pro…t maximising …rm.

5.1 Model

There are two traded goods, a consumption good y and labour L: In addition there is a negative externality, e.g. pollution z; which is not traded but enters into the utility and production functions. We shall normalise the price of y to 1. The price of labour is denoted by w:

Consumers

Assumption 5.1 There are H consumers, $1 \leq h \leq H$: Individual h has utility function: $u^h = y - c^h(\cdot) - D^h \left(\sum_{f=1}^{F} d^h \left(z^f \right) \right)$; where $D^{h\prime} > 0; D^{h\prime\prime} > 0; d^{h\prime} > 0;$ $d^{h\prime\prime} > 0$ and z^f denotes the level of externality produced by ...rm f: Consumer h has an endowment $\bar{\cdot}^h$ of labour.

This utility function has two familiar special cases. First where the externality is a pure public bad, $u^h = y - c^h(\cdot) - D^h \left(\sum_{f=1}^{F} z^f \right)$: Secondly where utility is additively separable between the externalities produced by di¤erent ...rms, $u^h = y - c^h(\cdot) - \sum_{f=1}^{F} d^h \left(z^f \right)$: Since the consumer's utility is quasi-linear, the aggregate labour supply can be written in the form $L^S = L^S(w)$:

Firms There are F identical ...rms, which produce the consumption good from labour according to the production function $y = g(L; z)$; where $g_L > 0; g_z > 0; g_{LL} < 0; g_{zz} < 0$; where g_L denotes $\frac{\partial g}{\partial L}$ etc. Firms are assumed to be price-takers on both input and output markets. We assume that all ...rms use the same internal decision rule. As usual, we impose no assumptions on this rule other than that it respects unanimity. Individuals are not, however, assumed to be identical. Hence the ...rm faces a non-trivial collective choice problem. To preserve symmetry between ...rms, we require that consumers all su¤er the same disutility from the externalities produced by any given ...rm.

All individuals are assumed to have an equal number of shares in each ...rm. We assume that individuals do not coordinate their voting across di¤erent ...rms. Thus they cannot implement a collusive outcome by reducing output at all ...rms simultaneously.[10] We shall only consider symmetric equilibria.

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[10] This may be rigorously justi...ed in a model with many types of consumer, where all consumers

Theorem 5.1 For any decision rule which satis...es unanimity, in symmetric equi-librium, there will less than the pro...t-maximising level of negative externality.

Although we have shown unambiguous results, the reader will have noticed that we required strong assumptions on preferences and production. This should not be surprising as we are dealing with an abstract second best setting, where apparently perverse comparative static results can occur. To see this more clearly, observe that our pro...t-maximising model above can be thought of as an economy, where there are no Lindahl prices for externalities. In contrast the non-pro...t maximising ...rm has marginal conditions that mimic Lindahl prices for externalities ‡owing to the control group. Thus our problem is comparing distorted and less distorted economies, neither of which are ...rst best.

Consider a partial equilibrium world, where the output and input prices are held constant. If a ...rm is faced with additional Lindahl shadow prices for the externality from the control group, it will reduce output of a negative externality, for the usual revealed preference reasons. This intuitive result requires no feedback e¤ects through prices induced from the general equilibrium conditions. It is these e¤ects that can overturn the partial equilibrium intuition.

5.2 Expanding The Control Group

Our preceding observations on Second Best results, imply that it is di¢cult to make unquali...ed assertions about the welfare implications of expanding the control group. For example, in a related literature in incomplete asset markets it is well-known (see Hart (1975), Milne & Shefrin (1987)) that introducing more markets for asset trading can be welfare reducing. Other examples of counter-intuitive comparative statics occur in international trade, taxation etc. and are well known in the public economics literature (see La¤ont (1988)).

Therefore any increase in the control group, that moves the economy from one sec-ond best equilibrium to another, could, in principal, have any welfare result. Clearly

of a given type have the same preferences and endowment of goods. The distribution of shares over types is the same for all ...rms. However no individual owns shares in more than one ...rm, hence there is no possibility for coordinating voting between di¤erent ...rms.

if the original control group can choose to add or veto the addition of new members, they will only introduce new members that enhance the welfare of both old and new members. Notice that our non-profit objective model allows for transfers, so that new members could compensate existing members for the benefits of entry. In an abstract way this encapsulates the bargaining that occurs in takeovers and mergers, where side-payments and conditions are negotiated by shareholders, management and key employees.

One deficiency in this theory is that there is no obvious limit to the size of the control group. In general it could be possible to include all agents in an efficient allocation for the economy and compensate all potential losers. In short, the control group would be equivalent to some efficient, all inclusive planning agency. Clearly this is unrealistic as we have omitted any costs of bargaining within the firm or with potential new members of the control group. Thus we could allow for bargaining costs that rise with the size of the control group. This cost, limiting the size of the control group, is similar to crowding or congestion costs in the theory of clubs, where such costs limit the size and composition of clubs.[11]

6 STABILITY OF NON-PROFIT FIRMS

In this section we argue that a firm with consumer representation in the control group is not vulnerable to takeover by an outsider. Consider a cooperative of M individuals, $1 \leq i \leq M$:[12] In the initial situation, assume that individual i gets benefits $\pi_0 + d_i$; from shares in the firm. Here π_0 denotes the current value of the firm's profits and d_i denotes either a positive externality or the value of being able to purchase the good below the monopoly price. These benefits are experienced, whether or not the individual owns shares in the firm. Assume that the cooperative's decisions are made

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[11]There are obvious parallels with our theory of the firm and club theory, see Prescott & Townsend (2000) for an explicit connection in a general equilibrium model with asymmetric information. See Cornes & Sandler (1996), for a survey; and Conley & Wooders (2001) and Ellickson, Grodal, Scotchmer & Zame (1999) for recent formulations of endogenous clubs embedded in a private market system.

[12]We assume that M is odd, so that there is a well-defined median voter.

by majority rule, so a change will be introduced if at least half the members approve.

In a cooperative, decisions can be distorted due to the difference in preferences between the median voter and the mean voter. To exclude this effect, we shall make the following assumption. If it is seriously violated, there is little case for having this good supplied by a cooperative, since only a minority of members would get a benefit from it.

Assumption 6.1 The median value of d_i is greater than or equal to the mean value. i.e. $\forall i : d_i > \bar{d} > \frac{M}{2}$; where $\bar{d}$ denotes the mean value of d_i:

We consider the following model of a takeover attempt. First a raider decides whether or not to offer to purchase the shares from members at price p: Then the existing shareholders decide simultaneously and independently whether or not to accept the offer. If the raider is successful, (s)he will increase profits to π_1 by raising price or eliminating positive externalities. We assume that $\pi_0 + \bar{d} > \pi_1 > \pi_0$: If this assumption were not satisfied the raider's policies would be approved by a majority vote of the existing members and there would be no need for a takeover.

The following result implies that the cooperative is not in fact vulnerable to a takeover.

Proposition 6.1 There does not exist a subgame perfect equilibrium in pure strategies, in which the raider succeeds in taking over the firm.

6.1 Discussion

Grossman & Hart (1980) argue that firms have incentives to overcome the free-rider problem by adopting constitutions, which allow raiders to either compulsorily purchase minority shares or dilute the rights of minority shareholders. Alternatively it may be desirable for government to introduce legislation allowing compulsory purchase of minority shares (as in the UK). In the present context, the raider's behaviour is undesirable to existing shareholders and possibly society in general. It is in the interest of the cooperative to introduce a constitution, which gives strong protection to minority rights. This will make free-riding easier and consequently reduce the

chances of a hostile takeover. Hansmann (1996) shows that most consumer cooperatives allocate voting rights in proportion to the fraction of the output purchased. This would be one way to protect against takeovers. This may explain why most governments o¤er separate laws dealing with cooperative and business ...rms. Protection against takeover may be more desirable for cooperatives.

7 INPUT MARKETS

Our theory so far has emphasised the involvement of consumers in ...rms' decisions. But our theory is symmetric, so that we could assume the ...rm is a monopsonist in some input markets or that there are externalities ‡owing between the ...rm and a supplier of inputs. The most common examples are farm-owned marketing organisations or where the ...rm is owned by suppliers of a particular form of labour.

So long as the ...rm acts competitively in all markets, except those for its own inputs, then our arguments on productive e¢ciency continue to apply. Now let us turn to speci...c cases, where the supplier of the input can be in‡uential in the decisions of the ...rm.

7.1 Monopsony

We could rewrite the model in section 3 to allow for monopsony on an input market. It is not di¢cult to see that the model would have similar interpretations, except that the ...rm would be a monopsonist and the stakeholders would be suppliers of the input. For example, if the ...rm has an owner-manager who is the sole supplier of the input, then input demand will be undistorted. Conversely, if the suppliers of the input are excluded from the decision process then as usual we will obtain an ine¢cient low input price. In intermediate cases, the interests of the di¤erent stakeholders are traded-o¤. Our construction in section 4 can be modi...ed to accommodate monopsony rather than monopoly. The reinterpretation is straightforward, the supplier of inputs will be o¤ered a two-part tari¤ to induce their supply of inputs in an e¢cient manner. If the supplier is a member of the control group, the same rules apply and transfers are implemented to redistribute the surplus according to the welfare weights.

7.2 Externalities

Assume that there are negative externalities between the firm and suppliers of inputs. Then, as before, a non-profit maximising firm will produce less of such externalities. A special case of an externality arises from the hold-up problem. Assume that suppliers of inputs may make firm-specific investments, which are non-contractible, e.g. in human capital. Then, ex-post, the firm can appropriate these investments. This imposes a negative externality on the suppliers of inputs and hence reduces the incentive to provide firm specific inputs.

With competitive firms there will be too little firm-specific human capital in equilibrium. However as already noted a non-profit maximising firm will produce fewer negative externalities. Thus the hold-up problem will be reduced, and input suppliers will be more willing to supply firm-specific inputs, which brings about a Pareto improvement. It would be desirable to include all the suppliers so long as they are productive and add to the group's welfare. Observe that the control group of the firm benefits from including agents that suffer from the externality or benefit from the supply of firm specific human capital, given appropriate transfers.

This case relates directly to some recent papers on the theory of the firm (see Hart & Moore (1990), Hart & Moore (1996) and Roberts & Steen (2000), where the initial members of the control group find it advantageous to include suppliers of firm specific human capital). But the general principles operate whether we are considering externalities or suppliers of firm-specific inputs.[13]

8 CONCLUSION

8.1 Summary

It has been argued that firms produce profits at the expense of such factors as the well being of the community or the environment Defenders of capitalism have argued that,

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[13] Notice that we assume that there exists an control mechanism that ensures efficient production rules. If for some reason we assume that such a mechanism cannot be used, then the control group will be constrained to use an inefficient (in the first best sense) mechanism. This is the central message of Bolton & Xu (1999), Hart & Moore (1990) and Roberts & Steen (2000).

pro...t maximisation is compatible with broader objectives. A ...rm which neglects the local community or the environment will not make the highest pro...t in the long-run, since relations with suppliers, workers, customers, etc. will be damaged. We take this argument one stage further. Where there are signi...cant externalities or market power, pro...t maximisation is not in the interest of the ...rm, even in the short run. This arises because the ...rms' decisions are made by individuals who are also members of the community. In part, they bear the consequences of their own decisions. As argued in Hansmann (1996), economic institutions emerge endogenously to cope with market power, externalities or asymmetric information.

The hypothesis of pro...t maximisation has been criticised both on empirical and theoretical grounds. Although this paper has found that there are a number of important di¤erences between pro...t maximising and non-pro...t maximising ...rms, we have also shown that some well-known results are independent of the objective function of the ...rm. This suggests that many existing results on economics of ...rms and industries do not crucially depend on pro...t maximisation.

The examples of reducing negative externalities and lowering of monopoly prices, suggest that increasing economic democracy is likely to be helpful. However in some cases a shareholder controlled ...rm may be less socially desirable. For instance, suppose that all the ...rms in a Cournot oligopoly have the same shareholders who are not consumers. Then they will unanimously agree that each ...rm in the industry should produce its share of the collusive output. Hence the ...nal price to consumer will be the monopoly price. This will be detrimental to social welfare for the usual reasons.

Another case where pro...t-maximising behaviour may be socially desirable, is durable goods monopoly. Coase (1972) argued that if initially, a monopolist sold a durable good at the monopoly price, then subsequently it would be pro...table to sell additional units at a lower price. If consumers anticipated this, demand will be reduced in the ...rst period, hence the ...rm will not be able to achieve the full monopoly price. Under some assumptions, it can be shown that if the good is in...nitely durable and consumers have perfect foresight then, in equilibrium, the monopolist will sell the good at marginal cost.

It seems unlikely that this argument can be extended to non-profit maximising firms. If the firm cuts price in the second period then it imposes a negative externality on those who purchased in the first period. As argued in section 5, a non-profit maximising firm will produce less negative externalities. Hence there will be less incentive to cut price in future periods if shareholders or workers were also purchasers of the good in the first period. Consequently a non-profit maximising firm would set a higher price for a durable good. This will result in price above marginal cost which is socially undesirable for the usual reasons.

More generally we believe that there needs to be a rethinking of many results from industrial organisation to allow for more detailed modelling of the internal organisation of the firm.

8.2   Inefficient Mechanisms

One possible criticism of our model is that we restrict attention to efficient decision-procedures within the firm, while, inefficiency appears to be common. In practice, there are many kinds of friction, which may arise in intra-firm bargaining. Despite this we believe similar analysis to the present paper can be used for most plausible mechanisms which are not fully efficient. It is virtually impossible to prove general results for all inefficient mechanisms, since there are too many possible sources of inefficiency. We shall illustrate our arguments by considering a specific example, the hold-up problem.

We may modify our model to allow for the possibility of a hold-up as follows. There are two time periods, $t = 0, 1$: At time $t = 0$ each member i of the control group can make a relationship-specific investment, e_i for $1 \leq i \leq M$. The investment is only of use in the current firm and reduces the cost of production. It is observable but not verifiable. At $t = 1$ the model is like that in the present paper. The firm is assumed to use a decision procedure at $t = 1$; which is ex-post efficient. In general the members of the control group will not choose the efficient level of investment at $t = 0$ because they will not receive the full marginal benefit. The extent of under-investment depends upon the particular decision rule used. In this case, all the results

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of the present paper will apply for a given level of ex-ante investments. In particular, if the ...rm can practice perfect price discrimination, the resulting equilibrium will be ex-post but not ex-ante Pareto e¢cient and it will be possible to implement the equilibrium by means of a two-part tari¤.

In the special case, where the ex-ante investments only a¤ects ...xed costs, our previous results still apply despite the ex-ante ine¢ciency. A uniform pricing monopolist will charge less than the pro...t-maximising price. The equilibrium level of pollution will be reduced, relative to the case where ...rms are pro...t maximisers.

Consider again a uniform pricing monopolist and assume now that the ...rm-speci...c investments reduce marginal cost. Then the under-investment tends to increase marginal cost relative to the ...rst-best, while the managerial ...rm will have a smaller mark-up over marginal cost than a pro...t-maximising ...rm. These two e¤ects are working against one another and in general it will not be possible to provide an unambiguous comparison. Assume instead the ...rm-speci...c investment increases the marginal bene...t of pollution. (Possibly the managers learn ...rm-speci...c ways to evade government controls.) Then both e¤ects work in the same direction and we can be sure that the non-pro...t maximising ...rm will produce less pollution.

APPENDIX

A Existence

This appendix contains some technical results and proofs relating to the existence of equilibrium. To prove existence we shall need the following result, which is a generalisation of the Weierstrass theorem, see Border (1985), Corollary 7.5.

Proposition A.1 Let $K \subseteq R^m$ be compact and let $\prec$ be a binary relation on K satisfying:

1. $x \notin \{y : y \hat{A} x\}$ for all $x \in K$;

2. $\{y : y \hat{A} x\}$ is convex for all $x \in K$;

3. $\{y : y \hat{A} x\}$ is open in $K \pounds K$:

Then the $\prec$-maximal set is non-empty and compact.

As a ...rst step we show that for any given production vector of the monopolist, a Walrasian equilibrium exists for the competitive sector of the economy.

Lemma A.1 Given consumers that satisfy Assumptions 2.5, 2.6 and 2.7 and ...rms satisfy Assumptions 2.2, 2.3, 2.8, 2.10, 2.12 and 2.11; then for any $y^0 \in Y^0$ there exists a competitive equilibrium relative to y^0.

Proof. The proof is an adaptation of Theorem 7.21 of Ellickson (1993). ∎

Proof of Theorem 2.1 If we normalise prices to lie in the unit simplex, the set of ordered pairs $\left(\bar{y}^0; p \right)$, for which there exists $x \in X; y^{i\,0} \in Y^{i\,0}; $ such that $\left(\bar{x}; y^{i\,0}; p \right)$ is a competitive equilibrium relative to $y^0;$ is bounded. If we can show that the set is also closed, then Proposition A.1 implies that $\prec$ has a maximum over this set. It is easy to check that such a maximum is a managerial equilibrium.

Thus it is su¢cient to demonstrate that the set is indeed closed. Let $\left(\bar{y}_n^0; p_n \right)$ be a sequence of points from this set, which converges to limits $\left(\bar{y}^0; \bar{p} \right):$ Let y_n and x_n denote the corresponding vectors of equilibrium production and prices. Note that the

attainable set is compact. By taking convergent subsequences, if necessary, we may assume that y_n and x_n converge to limits $\bar{y}$ and $\bar{x}$ respectively.

We claim that $\langle \bar{x}; \bar{y}; \bar{p} \rangle$ is a managerial equilibrium. Since $\sum_{h=1}^{H} x_{nh} \leq \sum_{h=1}^{H} \omega_h + y_n^0 + y_n^i{}^0$; for all n; $\sum_{h=1}^{H} \bar{x}_h \leq \sum_{h=1}^{H} \omega_h + \bar{y}^0 + \bar{y}^i{}^0$: Suppose, if possible, there exists $\bar{y}^f \in Y^f$ such that $\left(\bar{y}^f; \bar{p} \right) \hat{A}^f \left(\bar{y}^f; \bar{p} \right)$; for $0 \leq f \leq F$: Since the graph of $\hat{A}^f$ is open there exists $\varepsilon > 0$ such that if $\|p - \bar{p}\| < \varepsilon$ and $\left\| \mathring{y}^f - y^f{}^\circ \right\| < \varepsilon$; $\left(\bar{y}^f; p \right) \hat{A}^f \left(\bar{y}^f; p \right)$: For all sufficiently large n, $\|p_n - \bar{p}\| < \varepsilon$ and $\left\| \mathring{y}_n^f - y^f{}^\circ \right\| < \varepsilon$ hence $\left(\bar{y}^f; p_n \right) \hat{A}^f \left(y_n^f; p_n \right)$: However this contradicts the fact that ...rm f is maximising its preferences in the equilibrium $\langle x_n; y_n; p_n \rangle$: A similar argument shows in $\langle \bar{x}; \bar{y}; \bar{p} \rangle$ consumers are maximising their preferences. It follows that $\langle \bar{x}; \bar{y}; \bar{p} \rangle$ is indeed a managerial equilibrium. ∎

Proof of Theorem 2.2 A competitive equilibrium for a given level of output y^0 is a Walrasian equilibrium in a particular exchange economy. Since the set of Walrasian equilibria does not depend on the price normalisation, it follows that the set of competitive equilibria relative to a given output y^0 is also independent of it. Thus, for any given normalisation rule, the ...rm will have the same set of price-quantity combinations to choose from. Since the ...rm's preferences are de...ned over real variables, it will choose the same quantities. The result follows. ∎

Proof of Theorem 2.3 By concavity, it is sufficient to show that all ...rms are on the frontiers of their respective production sets and all ...rms have the same marginal rates of transformation between any pair of goods. Since the equilibrium price vector is positive, the competitive ...rms will be efficient by standard arguments.

Now consider the monopolistic ...rm, $f = 0$: Suppose, if possible, the monopolist chooses an inefficient production plan $\bar{y}^0 \in Y^0$; such that $\exists y^0 \in Y^0$ with $y^0 > \bar{y}^0$: Then by assumptions 2.6 and 2.9, there exists a member of the control group, $\hat{h}$; who is a shareholder. Since $y^0 > \bar{y}^0$; $\mu_{\hat{h}}^0 p \cdot \left(y^0 - \bar{y}^0 \right) > 0$: We can think of $\mu_{\hat{h}}^0 p \cdot \left(y^0 - \bar{y}^0 \right)$ as being the transfer to consumer $\hat{h}$. Hence by strict monotonicity of $W^{\hat{h}}$; $\hat{h}$ prefers y^0 to $\bar{y}^0$. But this violates Assumption 2.10, that the ...rm's preferences satisfy the Pareto principle.

Since all ...rms are price-takers for competitive goods, their marginal rates of transformation between any pair of competitive goods are equal. Hence, by the usual

reasoning it is not possible to produce more of any competitive good with the given inputs. It is also not possible to produce more of any monopoly good, since these goods are only produced by the monopolist and we have already established that the monopolist is on the frontier of his/her production set. ∎

B Price Discrimination

Proof of Theorem 4.2   Let $\langle x^{\pi}; y^{\pi}; p^{\pi}; R^{\pi} \rangle$ be a PDM-equilibrium. The first order conditions for the firm's optimisation problem are,

$$\lambda^h \frac{\partial V^h}{\partial x_{mj}^h} + \mu \frac{\partial \Lambda}{\partial y_{mj}} \;=\; 0 \text{ for } 1 \leq h \leq H; \hat{J} + 1 \leq j \leq J; \tag{10}$$

$$\iota \lambda^h \frac{\partial V^h}{\partial I^h} + \pm \;=\; 0 \text{ for } 1 \leq h \leq H; \tag{11}$$

$$\mu \frac{\partial \Lambda}{\partial y_{cj}} + \pm p_{cj} \;=\; 0; \text{ for } 0 \leq j \leq \hat{J}: \tag{12}$$

By the envelope theorem, $\frac{\partial V^h}{\partial x_{mj}^h} = \frac{\partial u^h}{\partial x_{mj}^h}$: From (7), (10), (11), and (12),

$$\frac{\partial u^h}{\partial x_{mj}^h} = \frac{\partial u^h}{\partial x_0^h} = \frac{\partial u^k}{\partial x_{mj}^k} = \frac{\partial u^k}{\partial x_0^k}; \text{ for } 1 \leq h; k \leq H; \hat{J} + 1 \leq j \leq J: \tag{13}$$

From the consumer's first order condition,

$$\frac{\partial u^h}{\partial x_{cj}^h} = \frac{\partial u^h}{\partial x_0} = \frac{\partial u^k}{\partial x_{cj}^k} = \frac{\partial u^k}{\partial x_0}; \text{ for } 1 \leq h; k \leq H; 0 \leq j \leq \hat{J}: \tag{14}$$

From (11), $\mu \frac{\partial \Lambda}{\partial y_{cj}} = \iota \lambda^h \frac{\partial u^h}{\partial x_0} p_{cj}$: From (10), $\mu \frac{\partial \Lambda}{\partial y_{mj}} = \iota \lambda^h \frac{\partial u^h}{\partial x_{mj}^h}$: Dividing $\frac{\partial \Lambda}{\partial y_{mj}} = \frac{\partial \Lambda}{\partial y_{cj}} = \frac{\partial u^h}{\partial x_{mj}^h} = \frac{\partial u^h}{\partial x_0} p_{cj}$: From the consumer's first order condition, $p_{cj} = \frac{\partial u^h}{\partial x_{cj}^k} = \frac{\partial u^h}{\partial x_0}$; hence

$$\frac{\partial \Lambda}{\partial y_{mj}} = \frac{\partial \Lambda}{\partial y_{ck}} = \iota \frac{\partial u^h}{\partial x_{mj}^h} = \frac{\partial u^h}{\partial x_{ck}}; \tag{15}$$

which implies that the marginal rate of substitution is equal to the marginal rate of transformation. By (12),

$$\frac{\partial \Lambda}{\partial y_{cj}} = \frac{\partial \Lambda}{\partial y_{c`}} = \frac{p_{cj}}{p_{c`}}: \tag{16}$$

By concavity, (13), (14), (15) and (16) are sufficient conditions for Pareto optimality.

Implementation by 2-Part Tariffs Now assume that the firm offers consumers the 2-part tariff, $T^h \left(x^h_m \right) = t^h + p_m \cdot x^h_m$, where $p_m = \left[\frac{\partial \acute{A}}{\partial y_{m1}} = \frac{\partial \acute{A}}{\partial y_o}; \dots; \frac{\partial \acute{A}}{\partial y_{mn}} = \frac{\partial \acute{A}}{\partial y_o} \right]$: The consumer's first-order condition is:

$$\frac{\partial u^h}{\partial x^h_{mj}} = \frac{\partial u^h}{\partial x_{ck}} = \frac{p_{mj}}{p_{ck}} = \frac{\frac{\partial \acute{A}}{\partial y_{mj}} = \frac{\partial \acute{A}}{\partial y_o}}{p_{ck}} = \frac{\frac{\partial \acute{A}}{\partial y_{mj}}}{\frac{\partial \acute{A}}{\partial y_{ck}}}; \qquad (17)$$

where the third equality follows from equation (12). By concavity, the first order condition is sufficient. From the firm's first order condition, $\frac{\partial \acute{A}}{\partial y_{ck}} = \frac{\partial \acute{A}}{\partial y_o} = p_{ck} = p_o = p_{ck}$ or $\frac{\partial \acute{A}}{\partial y_o} = \frac{\partial \acute{A}}{\partial y_{ck}} = p_{ck}$: Making this substitution we see that (17) is equivalent to (15), which establishes that the PDM equilibrium can be implemented by the 2-part tariff.[14] ∎

C Externality Model

This appendix contains the proof of the comparative statics result for our externality model. In symmetric equilibrium with profit-maximising firms the following conditions are satisfied:

$$g_L \left(\hat{L}; \hat{z} \right) = \hat{w}; \qquad (18)$$

$$g_z \left(\hat{L}; \hat{z} \right) = 0; \qquad (19)$$

$$F \left(\hat{L} \right) = L^S (\hat{w}) : \qquad (20)$$

Equations (18) and (19) are respectively the first order conditions for profit maximising choice of pollution and labour input, while equation (20) is the labour-market equilibrium condition.

The non-profit maximising firm's choice of inputs may be characterised by the solution to the following optimisation problem:

$$\max \sum_{h=1} \gamma^h u^h = \sum_{h=1} \gamma^h \mu^h \left[g \left(L^f; z^f \right) - w L^f - \sum_{h=1} \gamma^h D^h \left(\sum_{j=1} d^h \left(z^j \right) \right) \right]; \qquad (21)$$

subject to $L^f > 0$; $z^f > 0$:[15]

Proof of Theorem 5.1   Consider the following problem,

$$\max_{L;z} \left\{ g\left(L^f; z^f\right) - wL^f - \circledR \left[\sum_{h=1}^{M} \gamma_h D^h @\left(\sum_{j=1}^{F} d^h\left(z^j\right)\right) \right] \right\}: \tag{22}$$

If $\circledR = 0$; the solution to (22) gives the pro...t maximising values of L^f and z^f; while if $\circledR = 1$ this is the non-pro...t maximising ...rm's optimisation problem.

The ...rst order conditions for (22) are:

$$g_L\left(L^f; z^f\right) = w; \tag{23}$$

$$g_z\left(L^f; z^f\right) = \circledR \sum_{h=1}^{M} \gamma_h D^{h\prime} @\left(\sum_{j=1}^{F} d^h\left(z^j\right)\right) d^{h\prime}\left(z^f\right): \tag{24}$$

The Hessian of this problem is $H_{\frac{1}{4}} = @\begin{pmatrix} g_{LL} & g_{Lz} \\ g_{Lz} & g_{zz} - \circledR \acute{A} \end{pmatrix}$; where

$\acute{A}\left(z^f\right) = \sum_{h=1}^{M} \gamma_h D^{h\prime\prime}\left(\sum_{j=1}^{F} d^h\left(z^j\right)\right) d^{h\prime}\left(z^f\right)^2 + \sum_{h=1}^{M} \gamma_h D^{h\prime}\left(\sum_{j=1}^{F} d^h\left(z^j\right)\right) d^{h\prime\prime}\left(z^f\right):$

The second order condition is that $H_{\frac{1}{4}}$ must be negative semi de...nite at the optimum, which implies that its determinant must be positive, hence

$$g_{LL}\left(g_{zz} - \circledR \acute{A}\right) - \left(g_{Lz}\right)^2 > 0: \tag{25}$$

We shall look for a symmetric equilibrium where $L^f = L(\circledR)$; $z^f = z(\circledR)$ for $1 \leqslant f \leqslant F$: The conditions for such an equilibrium are:

$$g_L(L; z) = w; \tag{26}$$

$$g_z(L; z) = \circledR \tilde{A}(z); \tag{27}$$

$$F L = L^S(w); \tag{28}$$

where $\tilde{A}(z) = \sum_{h=1}^{M} \gamma_h D_h^{\prime}(F d_h(z)) d_h^{\prime}(z):$ Let the symmetric solution be $L(\circledR)$; $z(\circledR)$; $w(\circledR)$: Substituting (26) into (28),

$$L^S(g_L(L; z)) = F L(\circledR): \tag{29}$$

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[15]We do not need to consider corner solutions where $L^f = z^f = 0$; since in this case, it is trivially true that the ...rm produces less pollution than the pro...t maximising level.

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Di¤erentiating (27) and (29) with respect to ®; we obtain:

$$g_{Lz}L^0(®) + g_{zz}z^0(®) = ®\tilde{A}^0(z) z^0(®) + \tilde{A}(z);$$

$$L^{S0}(g_L(L;z))^£ g_{LL}L^0(®) + g_{Lz}z^0(®)^¤ = FL^0(®):$$

Solving $L^0(®) = \frac{i L^{S0}g_{Lz}z^0(®)}{L^{S0}g_{LL} i F}$: Substituting $i \frac{L^{S0}g_{Lz}^2 z^0(®)}{L^{S0}g_{LL} i F} + g_{zz}z^0(®) = ®\tilde{A}^0(z) z^0(®) + \tilde{A}(z)$: Hence $z^0(®) = \frac{\tilde{A}(z)[L^{S0}g_{LL} i F]}{L^{S0}[(g_{zz} i ®\tilde{A}^0(z))g_{LL} i (g_{Lz})^2] i [g_{zz} i ®\tilde{A}^0(z)]}$: Note that from the stated assumptions on the derivatives of D, d and g we have,

$\tilde{A}^0(z) = F P_{h=1}^M {}_{\text{,}}{}^h D^{h00} {}^i Fd^h(z)^¢ d^{h0}(z)^2 + P_{h=1}^M {}_{\text{,}}{}^h D^{h0} {}^i Fd^h(z)^¢ d^{h00} > 0; \tilde{A}(z) >$

$0; L^{S0}g_{LL} i F < 0$ and $g_{zz} i ®\tilde{A}^0(z) < 0$:

Since, $\acute{A}(z) = P_{h=1}^M {}_{\text{,}}{}^h D^{h00} {}^i Fd^h(z)^¢ d^{h0}(z)^2 + P_{h=1}^M {}_{\text{,}}{}^h D^{h0} {}^i Fd^h(z)^¢ d^{h00}(z)$, in symmetric equilibrium $\tilde{A}^0(z) > \acute{A}(z)$: From the second order condition, $g_{LL}(g_{zz} i ®\acute{A}) i (g_{Lz})^2 > 0$; hence $g_{LL}{}^i g_{zz} i ®\tilde{A}^0{}^¢ i (g_{Lz})^2 > 0$: Therefore $z^0(®) < 0$: Letting ® vary between 0 and 1, shows that, in the equilibrium with non-pro...t maximising ...rms, pollution is below the pro...t maximising level. ∎

D   Stability

This appendix shows that a non-pro...t ...rm is not vulnerable to takeover by a pro...t maximising outsider.

If $p > \frac{1}{4}_1$; the raider can never make a positive pro...t, hence we may assume $\frac{1}{4}_1 > p > \frac{1}{4}_0$: Let $L = fi;\frac{1}{4}_0 + d_i 6 pg$ be the set of individuals whose total bene...t from the co-operative is less than the raider's o¤er. Let ` = jLj; by Assumption 6.1 $m > `$:

Lemma D.1 In any pure strategy Nash equilibrium of the subgame following the raider's o¤er precisely m individuals accept. In particular all members of L accept the o¤er.

Proof. First we shall check that such a pro...le is indeed an equilibrium. A member who accepts the o¤er will get pay-o¤ $p + d_i$: This would fall to $\frac{1}{4}_0 + d_i$ if (s)he rejected the o¤er. A member who rejects the o¤er will get pay-o¤ $\frac{1}{4}_0 + d_i$: Since every individual who rejects the o¤er is pivotal, this would fall to p if (s)he accepts. (Recall

by construction, no member of L rejects the offer and hence $v_0 + d_i > p$). It follows that this profile of strategies is indeed an equilibrium.

Now to demonstrate that there are no other pure strategy Nash equilibria. We shall consider all other possible profiles in turn and show that in each case at least one individual has a profitable deviation. First consider profiles in which there are $r > m + 1$ acceptances. In this case the raider will take control of the firm and raise the share value to v_1: Consider an individual who accepts the raider's offer. Currently (s)he receives pay-off p: If instead (s)he rejected the raider's offer, the bid would still succeed. Hence his/her payoff would be $v_1 > p$:

Secondly consider the case where there are $r = m + 1$ acceptances. Since $m > \ell$; there exists an individual $\ell \in L$ who accepts the raider's offer: Note that such an individual is pivotal. If instead (s)he rejected the raider's offer as before his/her pay-off would be $v_0 + d_i > p$:

Thirdly consider a profile, in which there are $r = m$ acceptances and there exists $\ell \in L$; who does not accept the offer. Then ℓ's current payoff is $v_0 + d_i$: This would increase to p if ℓ instead accepted the offer.

Finally consider a profile, in which there are $r < m - 1$ acceptances. Consider an individual who currently is rejecting the raider's offer. His/her current pay-off is $v_0 + d_i$: If (s)he changed her strategy and accepted the raider's offer (s)he would receive $p + d_i$: ∎

Proposition 6.1   There does not exist a pure strategy subgame perfect equilibrium in which the raider succeeds in taking over the firm.

Proof of Proposition 6.1   By Lemma D.1, if the raider made an offer she would not get enough acceptances in the second round to gain control of the firm. Hence the raider would make a loss of $(k - 1)(v_0 - p)$: It follows that making a take-over bid is not part of any subgame perfect equilibrium. ∎

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