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John Thanassoulis

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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

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I study the incentive of firms to be unethical in competitive markets, by conducting practices which illicitly harm stakeholders (consumers, workers, the environment) so as to raise profits. I offer a theoretical analysis which embeds consistent philosophical concerns (utilitarian, Kantian, and in some settings, Rawlsian) to evaluate the moral dilemma managers face of cheating stakeholders for profit in a model of competition with regulatory oversight. I characterise sufficiency conditions which apply broadly and which yield the result that more competition raises the equilibrium level of malpractice in Nash Equilibria of the competition game. If agents reason more deontologically, professing a duty-ethic, then oligopoly is linked to malpractice. I explore how firm level changes impact equilibrium malpractice drawing predictions for some aspects of FDI and for behavioural changes as firms approach the technological frontier.

JEL Classification: N/A

Keywords: Competition, Malpractice, Ethics, Moral Dilemma

John Thanassoulis - john.thanassoulis@wbs.ac.uk
Warwick University and CEPR

The I.O. of ethics and cheating when consumers do not have rational expectations*

John Thanassoulis†

September 10, 2018

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†Warwick Business School, University of Warwick; CEPR; Competition and Markets Authority. john.thanassoulis@wbs.ac.uk

1 Introduction

Corporate scandals are widespread. The financial crisis of 2008-09 is littered with examples of questionable behaviour towards customers. Cases which have been prosecuted and resulted in fines being levied include the mis-selling of derivative products such as in the 'Abacus' deal, and the mis-selling of mortgage related products.[1] Consumers are not the only group to be adversely impacted, and Finance is not the only industry to be affected. In Europe the 'horse-meat' scandal saw a number of producers of burgers in multiple countries illicitly substitute horse-meat for beef. In the oil industry BP sadly offers separate examples of harm caused to the environment, and also harm caused to workers, both partly due to alleged cost cutting on safety: respectively the Deepwater Horizon Oil spill, and the Texas City Refinery Disaster a decade earlier which tragically left 15 workers dead.

In each case the individual senior managers who authorised the behaviour which ran the risk of such scandals would have been trading off a number of considerations. These no doubt included the competitive pressure of losing business or having margins reduced. Second, the profit increasing action in each case was questionable and so had to be conducted in secret. So there exists a risk an authority may find out and succeed in levying a fine. Finally the decision maker is human, and as such will face ethical qualms in pursuing such a course of action.

My objective is to embed consistently and comprehensively ethical considerations in a model of product competition. I am not the first to observe the desirability of introducing moral reasoning into economic modeling (Arrow (1973), Hausman and McPherson (1993)), however I believe this is the first attempt to try to interact ethical decision making with Nash competition. The model can then be interrogated to study the relationship between product competition and the potential for malpractice towards stakeholders in the production process: consumers, workers, or the environment. I will therefore offer an answer to the question of whether competition encourages, or deters, unethical firm behaviour.

I build on the discrete choice model of competition first proposed by Perloff and Salop (1985), and subsequently used effectively in Industrial Organisation questions (e.g. Zhou (2017)). I study multiple symmetric firms competing in prices who can simultaneously also decide to engage in some malpractice. The malpractice raises profits by lowering production costs, but harms one of the other stakeholders in the production process. Consumers are unaware that the product is, or even might be, less good than described. Thus consumers do not have rational expectations. The model is broader still however, and also applies if consumers do have rational expectations but are uncaring of potential abuses towards distant workers, or far-off environments. Thus I am not offering a signal

[1] For details on this and the subsequent cited cases see Table 1.

sender-receiver model between firms and consumers over product quality (e.g. Rhodes and Wilson (2018)), nor a model of reputation construction (e.g. Ely and Välimäki (2003)). My approach here is quite different. I consider each firm as being run by an owner-manager with only one departure from classical economics: I allow the owner-managers to be subject to ethical qualms in the face of the moral dilemma of whether to raise profits via secret malpractice. A market regulator or authority can potentially detect malpractice with sufficient evidence to fine, and the probability that this happens grows in the extent of malpractice an individual firm undertakes.

I study subgame perfect pure strategy Nash Equilibria which are symmetric across all firms. I characterise how a stable such equilibrium behaves (Dixit (1986), Anishchenko et al. (2014)). Even restricting to stable equilibria however, the available analytic tools do not allow us to derive comparative static results as the action space is multi-dimensional for each firm (price and level of malpractice). The issue is that the equations characterising the symmetric equilibrium are an amalgam of the first order conditions for all the players, and the second order conditions implied by stability do not aggregate appropriately. I develop an extension to stability theory which allows the critical eigenvalue results to be extended to the system of equations defining the symmetric equilibrium. This in turn allows me to offer clear comparative static results between competitive pressure and malpractice.

The contention that human decision makers have moral qualms is, I believe, not controversial. However how humans reason about ethical dilemmas is far from settled, notwithstanding the considerable reflection applied to the problem by scholars over many centuries. There are three main philosophical ethical theories which philosophers believe are most relevant to dilemmas faced in the context of the production and sale of goods and services (Cavanagh et al. (1981)). Each of these theories has prominent proponents, and each has numerous detractors. The first of these are the utilitarian theories associated mostly with Jeremy Bentham (Bentham (1789)) and John Stewart Mill (Mill (1863)). This tradition identifies an action as right if it increases aggregate surplus. In classical economics we often teach that welfare is the sum of consumer and producer surplus. This is a Benthamite notion. Thus a utilitarian firm manager is consequentialist: a right action can be identified, in principle, by amassing empirical data as to its consequences. The second main tradition is deontological as opposed to consequentialist. This holds that some actions are wrong *a priori* – typically because they deny the humanity in other people by using them as a means only, rather than as an end in themselves. This tradition is most famously captured by Kant whose Categorical Imperative is that an ethical agent should "act only according to that maxim whereby you can, at the same time, will that it should become a universal law." (Kant (1785)) The final prominent notion of ethics is justice based and is closely associated with Rawls (1971). Here a manager would judge an ethical action to be one which minimises inequality by delivering the greatest benefit to the least advantaged.[2]

Drawing on these theories from philosophy allows me to construct and offer a model which embeds managerial ethical decision making in market outcomes in a consistent way. But which of these theories can be thought of as being most relevant in any practical market context? And so which theory is the most important one to model?

One insight into this question uses survey techniques to ask business managers how they reason about real-life dilemmas (mis-selling, bribery, safety lapses). Fritzsche and Becker (1984) and Premeaux (2004), amongst others, pursue this approach and find evidence for the prevalence of act utilitarian reasoning. Alternatively one can appeal to laboratory experiments to discern typical human preferences. A prominent example is the ultimatum game: one player offers a split of a monetary sum to another, if the second player refuses both players get nothing, if she agrees then the deal is struck. That players make offers close to equally sharing the pie, and reject offers far from this benchmark, suggests that proposers anticipate that offers which appear to take advantage of receivers will not be accepted. This game has been used to show that people value fairness (Rabin (1993), Fehr and Schmidt (1999), Bolton and Ockenfels (2000), Camerer and Thaler (1995), Cooper and Kagel (2016), Charness and Rabin (2002)). And it is not fair to use the receiver merely as a means for the proposer to secure big rewards: hence such results are consistent with Kantian reasoning.[3] Both survey and experimental approaches have their limitations, but taken together they suggest the existence of a variety of moral codes in practice. I will remain agnostic as to which moral code applies, and construct a model which embeds both Kantian (deontological) and utilitarian traditions, and in some settings, Rawlsian reasoning also.

Solving the competition model when owner-managers have ethical qualms reveals that the relationship between the number of competing firms and the equilibrium levels of malpractice depends upon whether the upper-tail of the consumers' taste distribution is log-concave or log-convex. Both of these distribution types are possible, though perhaps not equally probable; and so we can say more. Some of the most widely known distributions have log-concave upper tails (including the uniform, normal and extreme value distributions). In these cases I show that the equilibrium level of malpractice grows in the number of competitors; and the mechanism by which this happens is new to the literature.

The analysis has the corollary of demonstrating that revenue based sanctions and profit based sanctions are not perfect substitutes. In a material sense, revenue based

[2]The first Rawlsian principal, which dominates even a preference for reduced inequality, is the right to basic liberties such as freedom of speech and freedom of assembly. In the model of a market offered here, these fundamental liberties will not play a role.

[3]One might also be tempted to infer Rawlsian inequality aversion in these experimental results. However as the inequality involves game payoffs rather than total wealth I am not convinced that it is compelling evidence of Rawlsian reasoning.

sanctions are superior. Under revenue based sanctions a high enough fine can deliver no-malpractice as the equilibrium outcome under any taste distribution and with any number of competitors. This is not the case with profit based sanctions.

The deontological approach I pursue is to establish a *duty-ethic*. Such a duty-ethic allows agents to feel worse the more suffering they inflict on stakeholders through malpractice. If owner-managers are fully Kantian, then if an action towards stakeholders is unethical, there is no diminution in distaste achieved by harming only a small number of stakeholders, as opposed to a large number. We allow for this by postulating a discontinuous utility function for Kantian owner-managers whereby a large negative utility penalty is incurred for *any* positive level of malpractice. This has the implication of morphing the "*competition-bad practice*" result into an "*oligopoly-bad practice*" result.

I extend the analysis to asymmetric firm settings in the duopoly case. Thus the modeling offers answers to two salient questions: (i) if more ethical owners can be encouraged to enter a market, perhaps by 'good' MNCs[4] acquiring firms in more corrupt emerging markets, will malpractice in the whole market be improved, or will the rival's corruption pollute the actions of the more ethical entrant? (ii) As firms approach the technological frontier and lower their marginal costs of production, does the changed competitive landscape lead to more malpractice, or perhaps less?

The comparative statics results above are all shown to be robust to repetition of the game. Hence reputational concerns are not required for the results, nor do they alter the economic intuitions. Further one might worry that comparative statics results characterise an equilibrium, they do not prove its existence. Existence proofs in the generality afforded by the discrete choice framework are challenging. However, in the case of taste distributions with a log-concave upper tail, we can say more. With an appropriate bound to the action sets we can ensure that the action space is a lattice, and show that the game is supermodular, yielding existence of pure-strategy equilibria.

Related Economics Literature

There is a small, but growing, literature which seeks to understand how humans' ethical concerns will affect economic outcomes. A prominent strand of this literature has focused on contracts in a Principal-Agent relationship. For example Bénabou and Tirole (2006) consider how a desire to be seen as ethical may alter the optimality of incentive schemes; while Morrison and Thanassoulis (2017) study how a principal may optimally decide to use incentive contracts to induce a culture of malpractice amongst ethical agents within the firm. Carlin and Gervais (2009) also study the principal-agent problem focusing on a setting in which agents may be virtuous in that they always exert effort. Besley and Ghatak (2005) offer a model of hiring when agents have a sense of mission which will raise their productivity if they share it with their employer, while Hart and Zingales (2017) consider ethical shareholders and study whether through voting

[4]MNC: Multinational corporation.

they can alter the behaviour of the firm away from profit maximisation. Bénabou and Tirole (2011) argue that agents may behave in ethical ways so as to signal that morality is given more weight than money in their utility function. None of these works studies a model of product market competition, as I do here.

Competition is crucial to the well-functioning of markets. It lowers dead weight loss, prevents X-inefficiency, and often fosters innovation. Here we identify one negative effect which can be important in some circumstances: competition can increase the propensity to conduct malpractice. There are other mechanisms linking competition to unwanted outcomes, but none involve a role for ethics and malpractice. An important setting in which competition has been linked to unwanted outcomes concerns the relationship between competition and financial stability. Beck et al. (2006) offers a discussion on the empirical evidence for this association. Keeley (1990), Becker and Milbourn (2011), Bar-Isaac and Shapiro (2013) rely on the negative impact competition has on future profits to generate their results. The core model I study is a single stage game, which is then extended to repeated settings; the mechanism is therefore quite different as it does not hinge on valuing the future. An alternative relationship between competition and financial instability is described by Allen and Gale (2004). This work studies the link between competition and the required interest rate necessary to attract deposits; which in turn affects the competing banks' costs. This mechanism does not speak to the propensity for unethical behaviour and hence the occurrence of scandals as described above. I will try and do this through a new theoretical model.

2 The Model

I first introduce the model of competition and then describe how ethical considerations are woven into the analysis.

2.1 The Competition Model

I study the following two-stage game:

2.1.1 First Stage – Price Setting and Malpractice

There are $n \geq 2$ competing firms indexed by i. Each firm has marginal cost c of production. The firms discover a new (unethical) practice by which they can raise profits, but at potential cost to one or more stakeholders. I will describe such malpractice shortly. The firms are each run by an owner-manager.[5] Each owner-manager simultaneously decides on an amount of unethical practice $y_i \in [0, \bar{y}]$ with $\bar{y} < c$, and on a retail price p_i.

[5]This standard modelling convention allows me to circumvent principal-agent issues within the firm. For more on ethics within the firm see Morrison and Thanassoulis (2017).

Malpractice The unethical practice lowers the marginal cost of firm i to $c - y_i$. The unethical practice harms one of the stakeholders in the production process: consumers, workers or the environment. Examples of such unethical practices are misselling, risking workers by altering costly safety processes, or risking the environment by saving costs. Specific examples of each of these cases is given in Table 1:

Table 1: Examples of Unethical Practices

Unethical practice aimed at:	Examples
Consumers	Miss-selling products, e.g. horse-meat in burgers scandal;[6] abacus scandal (Goldman Sachs);[7] Miss-selling techniques, e.g. PPI Insurance for mortgages scandal;[8] Market manipulation, e.g. Forex fix;[9] LIBOR fix;[10] Consumer credit-score manipulation scandal in Brazil.[11]
Workers	Saving on safety costs, e.g. BP's Texas City Refinery disaster;[12] Sweat shop conditions for foreign staff, e.g. Adidas child labour scandal.[13]
The environment	Cost cutting leading to environmental disaster, e.g. BP Deepwater Horizon Oil Spill;[14] The Bhopal Disaster.[15]

Consumers are assumed to be unaware of, or indifferent to, the possibility of the bad practice. So consumers are assumed not to form rational expectations as to the losses they, or others (to the extent they care), might suffer. This captures many of the examples above: for example the horse-meat scandal prior to which consumers had no inkling that their beef-burger might contain horse; or the PPI scandal prior to which consumers believed that the insurance sold would indeed pay out in the circumstances the sales-person had claimed. In these examples, once consumers are made aware of the widespread malpractice, it stops. Sellers move on to a new unethical practice, of which consumers remain ignorant.

This model would also fit situations in which consumers, though aware, decline to alter

[6]https://www.theguardian.com/uk-news/2013/oct/22/horsemeat-scandal-guardian-investigation-public-secrecy

[7]http://uk.reuters.com/article/us-goldmansachs-abacus-factbox/factbox-how-goldmans-abacus-deal-worked-idUSTRE63F5CZ20100416

[8]https://www.ft.com/content/d9f0050a-739c-11e7-aca6-c6bd07df1a3c

[9]http://www.bbc.co.uk/news/business-30003693

[10]https://www.ft.com/content/6ca75526-890d-11e7-8bb1-5ba57d47eff7

[11]Giannetti et al. (2017)

[12]See the report of the B.P. U.S. Refineries Independent Safety Review Panel, January 2007.

[13]https://www.theguardian.com/uk/2000/nov/19/jasonburke.theobserver

[14]https://www.brookings.edu/blog/planetpolicy/2016/04/20/6-years-from-the-bp-deepwater-horizon-oil-spill-what-weve-learned-and-what-we-shouldnt-misunderstand/

[15]https://en.wikipedia.org/wiki/Bhopal_disaster

their purchasing decisions. For example, if drivers were not assessing the probability that BP was skimping on workers' safety when making their fuel purchase decisions then the model's assumptions would be satisfied. Even if consumers do profess to care, frequently they fail to be willing to pay more to make good on their concerns; this is known as the *intentions – behaviour gap* in marketing science (Auger and Devinney (2007), Carrington et al. (2010)).

In situations where the existence of unethical behaviour in the industry is not a secret and some consumers do care about it and are really willing to act on this concern, perhaps such as the potential use of child labour in sports clothing manufacture, the model would still apply in settings where consumers naïvely fail to link firm price changes to changes in unethical behaviour.

The owner-managers estimate that had the injured parties been aware of the malpractice at level y, their utility would have been reduced by αy per unit produced with $\alpha > 0$ a constant. If $\alpha = 1$ then the injury is dollar for dollar commensurate with the seller's gain; this is the case with theft for example.

The utility loss is consciously experienced by the stakeholder in some cases, such as the mandation of unethical working practices for distant workers. However, in many prominent cases, such as those involving consumer harm, the loss need not be consciously experienced by the stakeholder. Thus a borrower in Brazil might mistakenly assume her inability to get credit was for good reasons as opposed to bank fraud.[16] The firm owner-manager will however be aware that her actions have harmed a stakeholder and the magnitude of this effect is captured by αy.

Price Competition I model competition in prices with differentiated goods using the discrete choice random utility framework of Perloff and Salop (1985). I assume that there exists a unit measure of consumers who desire one unit of the good. The n firms each sell a substitutable good. The firms are horizontally differentiated so that X^j is the random match utility of a consumer for firm j. The X^j are assumed to be iid across firms so that the firms are ex ante symmetric. The variables X^j are distributed according to a cumulative distribution function $F(x)$ with support $[\underline{x}, \bar{x}] \subseteq \mathbb{R}$, and bounded and differentiable density function $f(x)$. As this is a discrete choice framework, each consumer buys at most one product. In common with much of the analysis using this framework, I assume that the market is fully covered so that all consumers purchase.

The analysis will focus on symmetric equilibria. Let p^e denote the symmetric equilibrium price. Suppose firm i deviates to p_i. Consumers, as noted above are either unaware of the malpractice or indifferent to it, and so they do not infer the existence, or use, of

[16] See Table 1 and especially footnote 11.

the malpractice technology from this price change. The demand for firm i's product is,

$$q_i\left(p_i\right) = \Pr\left[X^i - p_i > \max_{k \neq i} X^k - p^e\right] = \int_{\underline{x}}^{\bar{x}} \left[1 - F\left(x + p_i - p^e\right)\right] dF\left(x\right)^{n-1} \tag{1}$$

Note that $\Pr\left(\max_{k \neq i} X^k \leq x\right) = F(x)^{n-1}$ so that $F\left(x\right)^{n-1}$ is the cumulative distribution of the highest match utility amongst $n-1$ firms.

Observe that in equilibrium each firm has demand:

$$\begin{aligned} q_i\left(p^e\right) &= \int_{\underline{x}}^{\bar{x}} \left[1 - F\left(x\right)\right] dF\left(x\right)^{n-1} \\ &= \left[\left(1 - F\left(x\right)\right) F\left(x\right)^{n-1}\right]_{\underline{x}}^{\bar{x}} + \int_{\underline{x}}^{\bar{x}} f\left(x\right) F\left(x\right)^{n-1} dx \\ &= \left[\frac{1}{n} F\left(x\right)^n\right]_{\underline{x}}^{\bar{x}} \\ &= 1/n. \end{aligned} \tag{2}$$

where we have used an integration by parts in the second line. Thus confirming that in equilibrium each firm serves an n^{th} of the market.

In this analysis the rate of change of demand with respect to price will play a prominent role in analysing the incentive to deviate from equilibrium. To express this cleanly we define the function

$$P\left(n\right) := n \int_{\underline{x}}^{\bar{x}} f\left(x\right) dF\left(x\right)^{n-1}. \tag{3}$$

This allows us to write the derivative of demand with respect to firm i's price at the equilibrium price level p^e, using (1), as

$$q_i'\left(p^e\right) = -\int_{\underline{x}}^{\bar{x}} f\left(x\right) dF\left(x\right)^{n-1} = -\frac{P\left(n\right)}{n}. \tag{4}$$

Define the *single-good demand function* for firm j at x to be $\Pr(X^j \geq x) = 1 - F(x)$. In words, the single-good demand function for good j is the probability that a consumer would be willing to pay x for good j, absent any other substitutable goods. We now state an important Lemma proved elsewhere in the literature:

Lemma 1 ***[Anderson et al. (1995) (Proposition 1), and Zhou (2017) (Lemma 1)]*** *If the single-good demand function $1 - F\left(x\right)$ is log-concave then $P\left(n\right)$ increases in n. If the single-good demand function $1 - F(x)$ is log-convex then $P\left(n\right)$ decreases in n.*

Appealing to the results on log-concavity and log-covexity collected in Bagnoli and Bergstrom (2005) we note that both cases considered in Lemma 1 are present with standard taste distribution functions. We have log-concave single-good demand functions for the uniform, normal, exponential and logistic taste distributions amongst many others.

Whereas the Pareto, and for some parameter values the Weibull and Gamma distributions, yield log-convex single-good demand functions.

I conclude this presentation of the first stage of the competition model with a comment defending further my modelling choices as opposed to textbook Cournot competition, perhaps with a binary malpractice choice. Though the results of this paper are obtainable in Cournot competition with linear demand, general results are obscured in the Cournot setting due to the intractability of the first order conditions. By contrast the Perloff and Salop (1985) competition model will allow the competitive malpractice outcome to be characterised crisply. In doing so I will use differentiability which is made possible by the assumption of a scale of malpractice; and would be hampered by a coarsening of the action space to restrict firms to only choose whether or not to commit malpractice, and not how much malpractice they are willing to risk.

2.1.2 Second Stage – Regulatory Sanction

If malpractice is discovered with sufficient evidence to convict, then the authorities usually levy a fine. The fines for the cases of malpractice in Table 1 are listed in Table 2. In the European Union, guidelines suggest that fines under competition law should be of the order of 30% of the value of all affected sales.[17]

I assume in this model that the regulator has the right to inspect firms and the technology to detect malpractice. The probability of a regulator identifying malpractice with sufficient evidence to levy a fine (or convict) is assumed to be an increasing function of how much malpractice is being conducted:

$$\Pr(\text{detection with enough evidence to fine}) = \delta(y) \tag{5}$$

where $\delta(0) = 0, \delta(\bar{y}) \leq 1, \delta' > 0$, and $\delta'' \geq 0$. So detection becomes increasingly likely the more malpractice is being conducted. I do not assume that the probability of detection is a function of the volume of production as once a firm has decided to implement a level of unethical behaviour, then one or more processes will need to be established to put the decision into effect, and these processes are independent of volumes. For example, the creation of a training regime for sales people in *'disturbance techniques'* to ensure PPI is sold aggressively;[24] instructions given to foremen as to how frequently production should

[17] See http://ec.europa.eu/competition/cartels/overview/factsheet_fines_en.pdf

[18] https://www.sec.gov/litigation/litreleases/2010/judgment-pr2010-123.pdf

[19] https://www.theguardian.com/business/2016/apr/26/uk-big-four-banks-face-19bn-compensation-fines-legal-costs-libor-ppi

[20] http://www.businessinsider.com/libor-rigging-criminal-charges-and-fines-2015-5?IR=T

[21] https://www.theguardian.com/business/2010/aug/12/bp-texas-city-explosion-fine

[22] https://www.usatoday.com/story/money/2016/07/14/bp-deepwater-horizon-costs/87087056/

[23] http://www.telegraph.co.uk/news/worldnews/asia/india/7807904/Bhopal-managers-face-prison-for-role-in-Union-Carbide-gas-disaster.html

[24] See *PPI exposée: how the banks drove staff to mis-sell the insurance* in The Guradian, 8 November

Table 2: Magnitude of Regulatory Fines for Unethical Practices

Unethical practice aimed at:	Misconduct	Regulatory Fine
Consumers	Miss-selling products, e.g. horse-meat in burgers scandal	Aware of no major fines
	Abacus scandal (Goldman Sachs)	SEC fine of \$550 million (disgorgement \$15m and civil penalty \$535m)[18]
	Miss-selling techniques, e.g. PPI Insurance for mortgages scandal	£19 billion for largest 4 UK banks.[19]
	Market manipulation, e.g. Forex fix; LIBOR fix;	\$5.8 billion fines in US for both scandals for 6 large banks.[20]
	Consumer credit-score manipulation scandal in Brazil	Aware of no major fines
Workers	Saving on safety costs, e.g. BP's Texas City Refinery disaster	\$80 million fine.[21]
	Adidas child labour scandal	Aware of no direct fines
The environment	Cost cutting leading to environmental disaster, e.g. BP Deepwater Horizon Oil Spill	\$62 billion of fines.[22]
	The Bhopal Disaster	\$470 million out of court fine.[23]

be stopped to allow safety checking, and so on. Regulatory authorities will seek evidence of the existence of such processes to substantiate a fine.

The detection technology function $\delta(\cdot)$ is exogenous to the model. An outcome of this analysis will be whether a regulator can improve ethical standards by linking enforcement effort to the industrial structure, captured here by the level of competition. We will return to answer this question later in this study.

In case of detection the model explores two possible regimes:

1. Revenue based sanctions – fines are a multiple Φ^{rev} of revenues.

2. Profit based sanctions – fines are a multiple Φ^{prof} of profits.

I assume that only one of Φ^{rev} or Φ^{prof} is positive. Firms are not granted limited liability – thus it is as if they are part of a holding group which can be made liable.

We will have stark results when the malpractice technology is such that Assumption 1 holds:

Assumption 1:

$$\delta(\bar{y})\left(\Phi^{rev} + \Phi^{prof}\right) \leq 1. \tag{6}$$

2012.

In this study I will assume the parameter values are such that Assumption 1 holds. This condition is immediate if $\Phi^{rev}, \Phi^{prof} \leq 1$. Otherwise we require the authority's ability to detect and acquire evidence of wrong-doing to not be too great.

2.2 Ethics

In the first part of the study, I assume that each owner-manager has a common utility function. This is relaxed in the duopoly analysis in Section 6. We will consider an economic and mathematical interpretation of two prominent ethical codes: act utilitarianism; and a deontological approach resulting in a duty not to harm stakeholders. These approaches to moral dilemmas and ethical decision making are designed to mirror long-standing approaches within philosophy to ethical judgments, which I will discuss as I present the utility function below.

Suppose firm i sets prices p_i and selects malpractice y_i, generating, in equilibrium, stage 1 financial profits of π_i^1 and generating a volume of sales equal to q_i. The profit π_i^1 allows for the cost savings from the malpractice, but as it captures stage 1 cashflow it is gross of any subsequent fine payments to the regulator.

Denoting the utility of the owner manager of firm i as U^i, I capture the utility function as:

$$\begin{aligned} U^i\left(p_i, y_i\right) = \pi_i^1 - \delta\left(y_i\right)\left[\Phi^{prof}\pi_i^1 + \Phi^{rev} q_i p_i\right] & \qquad \text{(Homo-economicus)} \\ + \omega^{act}\Delta S\left(y_i\right) - \omega^{duty} q_i \alpha y_i & \qquad \text{(Ethics)} \end{aligned}$$

Some explanation for this utility function is immediately in order:

The top line, (Homo-economicus), is standard in that it considers the purely financial aspects of the firm's performance. The owner-manager will enjoy her profits of π_i^1 unless the regulator discovers evidence of any malpractice. The probability of being detected is $\delta\left(y_i\right)$. In this case a fine which is either proportional to profits or revenues is extracted.

The second line (Ethics) captures the ethical component of the owner-manager's preferences:

- The term $\omega^{act}\Delta S\left(y_i\right)$ captures act utilitarian reasoning. The expression $\Delta S\left(y_i\right)$ captures the change in aggregate surplus caused by the act of raising the malpractice from zero to y_i, leaving all other decision variables, including the price, unchanged. We therefore have

$$\Delta S\left(y_i\right) = \left(1-\alpha\right) y_i q_i$$

  as the malpractice raises profits by $y_i q_i$ but simultaneously lowers the stakeholders' utility by $\alpha y_i q_i$. The change in surplus is pre-multiplied by the agent's willpower, $\omega^{act} \geq 0$. An agent's willpower measures their propensity to act in accordance with their moral reasoning (Roberts (1984)).

This formulation of act utilitarianism captures situations in which the agent believes it is ethically justified to consider both the potential harm done to a stakeholder as well as the potential cost savings to the firm. As an example consider a financial advisor who markets an actively traded fund to her client, but once the mandate is secured, seeks to avoid trading costs by purely following an index. (This is not a solely academic example.[25]) The financial manager might reason that this secret switch in approaches is ethically justified as the saving in trading costs outweighs the likely reduction in the investment return. Such ethical reasoning which sets firm benefits against the costs imposed on others is consistent with that professed by many business managers (Premeaux (2004)). The act utilitarian approach is therefore important. Observe however that such moral reasoning gives no special weight to the fact that the financial advisor lied: she secured the investment mandate with a promise to be an active fund, but she will subsequently not hold to that promise. The formulation of duty ethics below will capture this.

A second observation on this formulation of act utilitarianism is that the fine paid does not form part of the aggregate surplus calculation. The fine is part of the utility function, see the top line (Homo-economicus) and will play a prominent role in the equilibrium, but the payment of a fine per se is seen entirely as a transfer to the government and so nets out of the surplus calculation. Thus it is not the case that an owner-manager reasons that government spends money wisely in support of the public good, and so a payment of a fine is a positive ethical act. Such reasoning could counter-intuitively encourage the firm to more malpractice against consumers at the margin so as to increase the chance of receiving a fine. Neither is the opposite reasoning permitted, under which the firm would see the government as profligate and wasteful, and so the payment of fines as unethical; such reasoning would encourage the firm to behave more ethically as the fine hurts financially and ethically due to the subsequent waste of money.

- The term $\omega^{duty} q_i \alpha y_i$ captures deontological reasoning: it is taken as given that lying to the consumer, or risking workers, or damaging the environment is *a priori* wrong. This term captures the disutility the owner-manager suffers from harming the stakeholders – it is not moderated by any considerations of firm profit. For every unit sold stakeholders are harmed by an amount αy_i, and q_i units are sold. The aggregate harm done to stakeholders is therefore $q_i \alpha y_i$, and the owner-manager includes this in her utility function with a weight ω^{duty}. This term grows in the harm done, and so in this respect is distinct philosophically from Kant's reasoning. A more faithful representation of Kant's logic is analysed in Section 5.

The duty ethic described captures that an owner-manager feels it is wrong to use a stakeholder as a means purely for their own financial gain. This formulation is consistent

[25] https://next.ft.com/content/d0c93bfa-c997-11e5-a8ef-ea66e967dd44

with the second formulation of Kant's Categorical Imperative, namely: "*Act in such a way that you treat humanity, ... , never merely as a means to an end, but always at the same time as an end.*" (Kant (1785))) If an owner-manager misleads customers to increase her profit then she is denying each customer the chance of making an informed choice, and so is treating the customer as a means and not as an end. Thus the financial advisor described above would, if she professed a duty ethic, believe that lying to the customer as to the nature of the investment strategy was unethical, even if the trading costs saved were substantial.

The formulation of ethics here respects the Rawlsian concern for inequality in some settings. Suppose that the owner-managers are wealthy and the stakeholders, the consumers or workers or locals near to the sites of production, are poor. In this case lowering the utility of the stakeholders further is, under a Rawlsian tradition, unethical. The duty ethic formulation is consistent with this observation. However the mapping to a Rawlsian approach is incomplete in situations in which the customers are wealthier than the service providers, for example firms of cleaners or nannies serving a wealthy clientèle. A Rawlsian approach could be argued to permit lowering costs illicitly to improve the financial gain of the (relatively poor) service providers.

The model offered captures the moral dilemma faced by owner-managers by which they can increase profits by illicitly harming one of the stakeholders: consumers, workers or the environment. The model is not, in my view, a close fit to the debate surrounding the merits of *Corporate Social Responsibility* (CSR) for three reasons. Firstly note that CSR, interpreted as the corporation practicing good deeds, is not a legal requirement; failure to conduct CSR does not result in a fine. This differs from the setting here. Secondly, on the ethical requirement to conduct CSR, Bowie (2017) argues that a firm has only an imperfect duty to conduct good deeds, but a perfect duty to maximise long-run profit.[26] The concept of *imperfect duty* is a Kantian one: it requires the agent to act on the duty on some but not all occasions. This suggests that if CSR is not profit maximising then the agent can ethically forgo it. If one accepts this argument then the moral dilemma modeled in (Homo-economicus) & (Ethics) falls away. Finally, and consistent with the debate that CSR does not pose an ethical dilemma, CSR is typically modelled, and defended, as an action which increases profits (Albuquerque et al. (2018), and Edmans (2012)). Thus abstaining from such CSR would lower profits, implying that there is no tension between CSR and profit maximisation. Once again this differs from the setting here where an owner-manager who confines herself to ethical behaviour forgoes some profits.

[26] Bowie (2017), p.142-3.

2.3 Solution Concept

We search for Subgame Perfect Pure Strategy Nash equilibria which are symmetric across the n firms. In the main part of the paper we will study the characteristics of such equilibria which satisfy the further condition of asymptotic stability (Dixit (1986), Anishchenko et al. (2014) Chapter 2). An equilibrium is asymptotically stable if, were each firm to alter its actions at a rate proportional to the local first order gain, then small deviations from equilibrium would be damped and lead the system back to the equilibrium values. If such stability were not present, then there exist some small deviations which would lead the path of firms' actions to diverge from the equilibrium permanently.

Stability of the n player game will yield conditions on the symmetric equilibrium which permit direct analysis of the comparative statics of the model.

3 The Model Solution

The ethical terms in the owner-managers' utility functions (Ethics) can be combined into

$$\Omega := (1-\alpha)\,\omega^{act} - \alpha\omega^{duty} \tag{7}$$

The parameter $\Omega \in \mathbb{R}$ measures the ethical contribution to the owner-managers' utility per unit of volume served, and per unit of malpractice committed. The more negative Ω is, the more disutility the owner-manager experiences from conducting an extra bit of malpractice.

Suppose we are at a symmetric equilibrium at which every firm takes the actions (p^e, y^e). If firm i deviates the owner-manager's utility is

$$U^i(p_i, y_i)|_{p_{j\neq i}=p^e} = \left[q_i(p_i)|_{p_{j\neq i}=p^e}\right]\cdot\left((p_i - c + y_i) - \delta(y_i)\left[\Phi^{prof}(p_i - c + y_i) + \Phi^{rev} p_i\right] + \Omega y_i\right). \tag{8}$$

Which is a rewrite of (Homo-economicus) and (Ethics).

We first state the main result of this section. We will prove it in Section 3.1, and offer some intuition to the result in Section 3.2. In Section 3.3 we will then discuss the result in relation to typical demand characteristics, we will offer some empirical predictions, and we will link the result to the existing literature on the relationship between demand shapes and price.

Theorem 2 *Any symmetric stable equilibrium of the competition game is characterised by a critical threshold, n^*, of competing firms:*

1. *If the single-good demand function $1 - F(x)$ is log-concave then the level of malpractice is positive and increasing in the number of competing firms for $n > n^*$; and there is no malpractice if few enough firms compete ($n \leq n^*$).*

2. *If the single-good demand function $1 - F(x)$ is log-convex then the results are reversed: no malpractice for $n > n^*$; and a positive level of malpractice which declines in the number of competing firms when $n \leq n^*$.*

The critical threshold n^* is the solution to:

$$P(n^*) = \frac{\delta'(0)(\Phi^{prof} + \Phi^{rev})}{1 + \Omega - c\delta'(0)\Phi^{rev}} \tag{9}$$

And n^* is unique if the single-good demand function $1 - F(x)$ is either log-concave or log-convex. n^* may lie below 2, or at infinity, in which case the relevant region applies for all $n \geq 2$.

Recall, as noted in the Introduction, that many of the most standard distributions used by econometricians and others to model consumers' tastes, such as the extreme value, the logistic, the normal, and the exponential, all fit into the first case of Theorem 2. In all such cases we establish that equilibrium malpractice increases in the number of competing firms, above a uniquely defined threshold.

3.1 Proof of Theorem 2

An interior symmetric equilibrium (p^e, y^e) must satisfy firm i's first order conditions at the equilibrium values:

$$U^i_{y_i}(p^e, y^e) = 0 \text{ and } U^i_{p_i}(p^e, y^e) = 0. \tag{10}$$

Variables in subscripts denote partial differentiation.

Taking differentials of the first order equality conditions (10) with respect to dy^e, dp^e and the parameter of interest, dn, we can write:

$$\underbrace{\begin{pmatrix} \left(U^i_{y_i}(p^e, y^e)\right)_{y^e} & \left(U^i_{y_i}(p^e, y^e)\right)_{p^e} \\ \left(U^i_{p_i}(p^e, y^e)\right)_{y^e} & \left(U^i_{p_i}(p^e, y^e)\right)_{p^e} \end{pmatrix}}_{=\mathcal{H}} \begin{pmatrix} dy^e \\ dp^e \end{pmatrix} = \begin{pmatrix} -\left(U^i_{y_i}(p^e, y^e)\right)_n \\ -\left(U^i_{p_i}(p^e, y^e)\right)_n \end{pmatrix} dn. \tag{11}$$

Comparative static analysis hinges on the behaviour of the Hessian matrix, $\mathcal{H}$.

As U^i given in (8) is not a function of others' malpractice ($\{y_{j\neq i}\}$) we have that

$$\left(U^i_{y_i}(p^e, y^e)\right)_{y^e} = U_{y_i y_i}(p^e, y^e) < 0 \tag{12}$$

The inequality follows from the second order condition for firm i. The second order conditions for each individual firm do not offer further insights into $\mathcal{H}$ as the matrix is an amalgamation of the first order effects from all the n competing firms.

Lemma 3 below offers an extension to asymptotic stability theory by showing that the Hessian matrix $\mathcal{H}$ inherits useful structure from the stability of the full n player game:

Lemma 3 *If an interior symmetric equilibrium of the n firm competition game is stable, then all the eigenvalues of the 2×2 matrix $\mathcal{H}$ have negative real parts, and in particular* $\det \mathcal{H} > 0$.

Proof. See Appendix A. ■

The assumption of stability is that if firms individually adjust their actions in proportion to their first order gain, any deviations from the equilibrium values will be damped (Dixit (1986)). As each of the n firms have 2 actions, a price and a level of malpractice, there are $2n$ variables. Using Taylor expansions, the speed of change of each variable depends on changes in each of the $2n$ game variables. This yields a $2n \times 2n$ transition matrix, denoted $\mathcal{A}$, which shares many terms in common with the Hessian of interest, $\mathcal{H}$.

Stability implies that the transition matrix $\mathcal{A}$ has negative eigenvalues (Anishchenko et al. (2014)). The proof of Lemma 3 proceeds by assuming, for a contradiction, the existence of an eigenvector of $\mathcal{H}$ with positive eigenvalue. If such an eigenvector exists, then the main work of the proof is to construct an eigenvector of the transition matrix $\mathcal{A}$ which shares the same eigenvalue. Once this is done stability yields the sought-after contradiction. And the lemma is proved.

We are now in a position to prove Theorem 2.

In regions where the equilibrium is interior, the first order condition with respect to malpratcice is

$$U^i_{y_i}(p^e, y^e) = \frac{1}{n}\left(\Omega - p^e\delta'(y^e)\left(\Phi^{prof} + \Phi^{rev}\right) + (c - y^e)\delta'(y^e)\Phi^{prof} + 1 - \delta(y^e)\Phi^{prof}\right) \tag{13}$$

And the first order condition with respect to prices is:

$$\begin{aligned} U^i_{p_i}(p^e, y^e) \quad = \quad & -\frac{P(n)}{n}\left(\Omega y^e + p^e\left(1 - \delta(y^e)\left(\Phi^{prof} + \Phi^{rev}\right)\right) - (c - y^e)\left(1 - \delta(y^e)\Phi^{prof}\right)\right) \\ & + \frac{1}{n}\left(1 - \delta(y^e)\left(\Phi^{prof} + \Phi^{rev}\right)\right) \end{aligned} \tag{14}$$

Where we have used (2) and (4) to substitute for $q_i(p^e)$ and $q_i'(p^e)$.

To derive the comparative statics, we will invert the differential equation, (11). This is made easier to follow by first simplifying the right hand side of (11) by observing that

$$\left(U^i_{y_i}(p^e, y^e)\right)_n = -\frac{1}{n}U^i_{y_i}(p^e, y^e) = 0$$

and

$$\left(U^i_{p_i}(p^e,y^e)\right)_n = \underbrace{-\frac{1}{n}U^i_{p_i}}_{=0} - \frac{P'(n)}{n}\left(\Omega y^e + p^e\left(1-\delta(y^e)\left(\Phi^{prof}+\Phi^{rev}\right)\right) - (c-y^e)\left(1-\delta(y^e)\,\Phi^{prof}\right)\right)$$

$$= \frac{P'(n)}{P(n)}\left(\underbrace{U^i_{p_i}(p^e,y^e)}_{=0} - \frac{1}{n}\left(1-\delta(y)\left(\Phi^{prof}+\Phi^{rev}\right)\right)\right)$$

$$=_{\text{sign}} -P'(n) \text{ under condition (6).} \tag{15}$$

Now inverting (11), and substituting in (3.1), yields

$$\frac{dy^e}{dn} = \frac{1}{\det\mathcal{H}}\begin{pmatrix} \left(U^i_{p_i}(p^e,y^e)\right)_{p^e} & -\left(U^i_{y_i}(p^e,y^e)\right)_{p^e} \end{pmatrix}\begin{pmatrix} 0 \\ -\left(U^i_{p_i}(p^e,y^e)\right)_n \end{pmatrix}$$

$$=_{\text{sign}} -\left(U^i_{y_i}(p^e,y^e)\right)_{p^e}\cdot P'(n) \tag{16}$$

where we have used Lemma 3 and (15) to establish the sign equivalence.

From (13) we establish that

$$\left(U^i_{y_i}(p^e,y^e)\right)_{p^e} = -\frac{1}{n}\delta'(y)\left(\Phi^{prof}+\Phi^{rev}\right) < 0 \tag{17}$$

And so we establish that

$$\frac{dy^e}{dn} =_{\text{sign}} P'(n)\,. \tag{18}$$

We now invoke Lemma 1 to establish the required comparative static linking malpractice with number of competitors at an interior equilibrium.

To complete the proof of the characterisation of the equilibrium we now study the boundaries of malpractice, $y=0$ or $y=\bar{y}$. At any equilibrium, prices will be interior and so the first order condition (14) is identically zero. This yields

$$1-\delta(y^e)\left(\Phi^{prof}+\Phi^{rev}\right) = P(n)\left(\Omega y^e + p^e\left(1-\delta(y^e)\left(\Phi^{prof}+\Phi^{rev}\right)\right) - (c-y^e)\left(1-\delta(y^e)\,\Phi^{prof}\right)\right) \tag{19}$$

And so we have p^e as a function of the other variables. If y^e is at a boundary point then the left hand side of (19) is a constant in n. So $P(n)$ and p^e move in opposite directions, given (6). Suppose therefore that with $\tilde{n}$ firms competing the equilibrium has no malpractice, $y^e=0$. This implies that

$$U^i_{y_i}(p^e|_{\tilde{n}}, y^e=0) \leq 0.$$

Consider $n<\tilde{n}$. If the single-good demand function is log-concave then $P(n)<P(\tilde{n})$ and so $p^e|_n > p^e|_{\tilde{n}}$. This in turn would ensure that $U^i_{y_i}(p^e|_n, y^e=0)$ remains negative, using (13) and the fact that $\delta' > 0$. The result follows. The analysis at $\bar{y}$ is analogous.

The critical threshold n^* is given by the solution of the first order conditions (10) at $y^e = 0$. Algebraic manipulation using (13) and (14) yields (9). If $1 - F(x)$, is either log-concave or log-convex, then $P(n)$ is monotonic in n (Lemma 1) and so multiple solutions n^* to (9) cannot exist.

3.2 Intuition to Theorem 2

Consider first the incentive an owner-manager has to deviate away from a competitive equilibrium without malpractice. The change to utility from increasing malpractice marginally up from zero is given by $U^i_{y_i}|_{y^e=0}$, and this can be written from (13) as follows:

$$U^i_{y_i}\Big|_{y^e=0} = \frac{1}{n}\left\{\Omega + 1 - \underbrace{\delta'(0)\left(p^e - c\right)\left(\Phi^{prof} + \Phi^{rev}\right)}_{(\dagger)} - \underbrace{\delta'(0)\, c\Phi^{rev}}_{(\ddagger)}\right\} \tag{20}$$

Expression (20) allows us to consider the incentive to increase malpractice up from zero. The scaling factor $1/n$ is the volume served by each firm in equilibrium. The incentive to increase malpractice, ignoring the sanctions regime, comes from the balance of the ethical consideration (the term Ω in (20)) against the direct increase in profits which can be achieved through lowering costs (the term 1 in (20)). Both of these terms grow proportionally with volumes: an extra unit of malpractice raises profits by 1 and lowers utility by Ω, both per consumer served. As these effects are proportional to volumes, their relative ranking is not altered as the number of competing firms rises or falls.

In equilibrium the net incentive to increase malpractice from direct profit and ethical considerations is set against the expected cost of the regulatory sanction. In a repeated version of this model one could also add the expected reputational cost. We will study this case in Section 7.1 below. The change in regulatory sanction is captured by the terms $(\dagger)$ and $(\ddagger)$. The second of these, $(\ddagger)$, is a correction term for the case of revenue based sanctions. It is proportional to volumes being served. Therefore its size relative to the ethical and direct profit considerations is unchanging in the number of competing firms. We therefore set it aside and consider the first term, $(\dagger)$.

The term $(\dagger)$ measures the change in the part of the regulatory sanction which is proportional to the profit earned. As the number of firms competing increases, the margins achieved by a sale $(p^e - c)$ alter. As profits equals volumes times margin, the relative importance of the sanctions regime as competition changes depends upon the relationship of the margin to the number of competing firms. If increasing the number of competitors acts to lower margins in equilibrium, then profits fall more rapidly than volumes do with increases in the number of competitors. So the deterrence of the profit part of the sanctions regime will decline more rapidly than the other parts of the utility function. It follows that in this case, competitive markets will increase the relative attractiveness of malpractice to the owner-manager.

Thus the impact of the competitive structure on whether malpractice commences in equilibrium turns on whether competition increases or decreases margins. To establish the equilibrium margins under no malpractice, we evaluate the first order condition (14) at a no-malpractice equilibrium: (14), becomes

$$U^i_{p_i}\Big|_{y^e=0} = \frac{P(n)}{n}\left(\frac{1}{P(n)} - (p^e - c)\right) \tag{21}$$

At an equilibrium the first order condition in prices will be binding and so (21) will equal zero.

It follows that margins in the no-malpractice equilibrium are inversely proportional to $P(n)$. The function $P(n)$ in turn depends upon the shape of the distribution of consumers' tastes according to Lemma 1. Hence we have established a connection between the pattern of consumers' valuations, the margins charged in a no-malpractice equilibrium, and the incentive to begin malpractice.

This intuition does not, as yet, explain the result of Theorem 2 at positive levels of malpractice. To explain this, consider inverting (11) which, suppressing the arguments (p^e, y^e), yields:

$$\begin{pmatrix} dy^e \\ dp^e \end{pmatrix} = \frac{1}{\det \mathcal{H}} \begin{pmatrix} \bullet & \underbrace{-(U^i_{y_i})_{p_e}}_{(\alpha)} \\ \bullet & \underbrace{(U^i_{y_i})_{y_e}}_{\beta} \end{pmatrix} \begin{pmatrix} \cancelto{0}{-(U^i_{y_i})_n} \\ \cancelto{=_{\text{sign}} P'(n)}{-(U^i_{p_i})_n} \end{pmatrix} dn \tag{22}$$

In (22) we observe that $(U^i_{y_i})_n = 0$, that is there is no direct effect on firm i's optimal level of malpractice from a change in the number of firms. At given prices, a change in the number of competing firms only alters the volumes each firm serves. But, as explained above, the cost savings and the ethical harm accrued by malpractice to the owner-manager's utility grow and shrink at the same rate in volumes. So the derivative of utility with respect to malpractice also changes in proportion to volumes; but at equilibrium it was zero, and so remains at zero.

It follows that the change in behaviour occurs only through the equilibrium price channel. As the firms are at equilibrium, second order conditions imply that the matrix entry β is negative, and so $dp^e/dn =_{\text{sign}} -P'(n)$. Thus in the interior equilibrium, the equilibrium price-cost margin is inversely proportional to $P(n)$, as it was at the no-malpractice boundary; at least in a stable equilibrium.

Next observe that terms α and β differ in sign (using (17)). Hence the equilibrium level of malpractice moves in the opposite direction to the equilibrium prices, for the

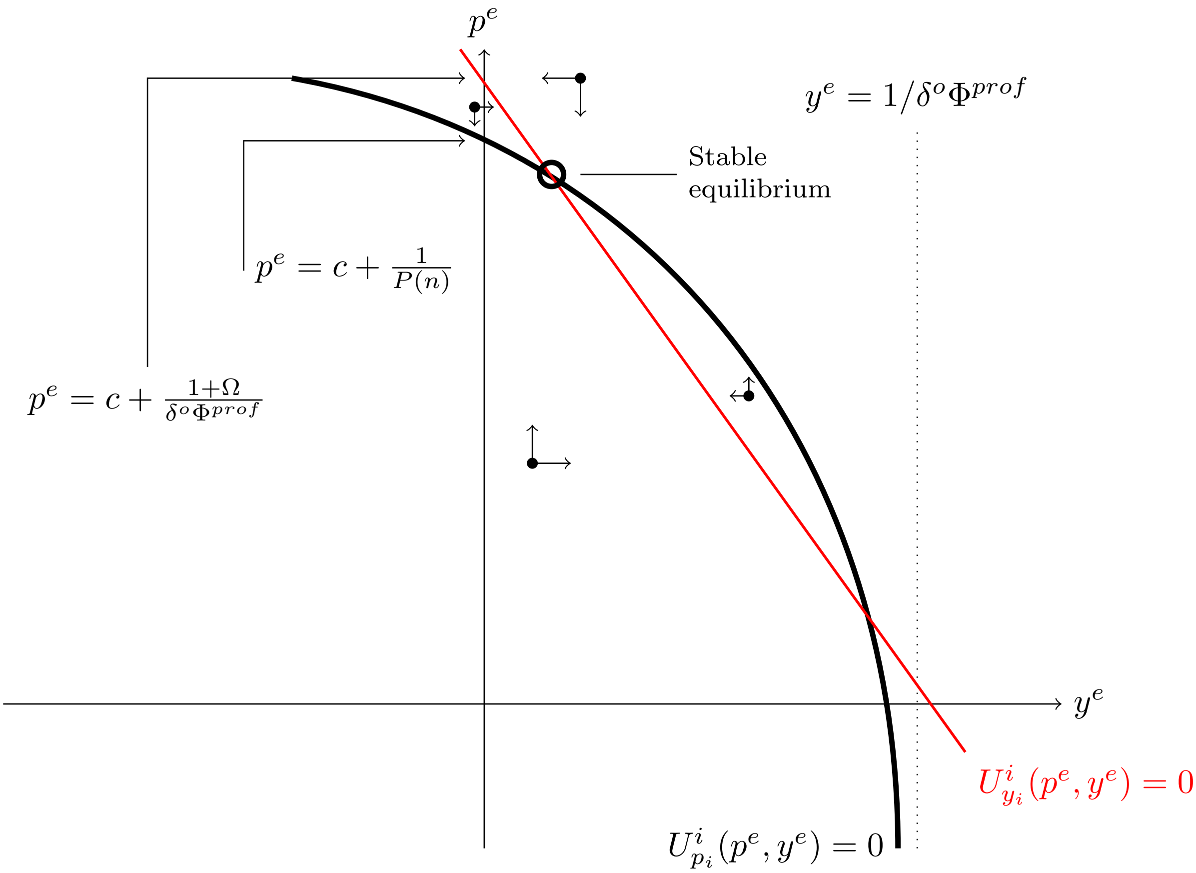

Figure 1: Graph of the first order conditions $U^i_{y_i}(p^e, y^e), U^i_{p_i}(p^e, y^e)$ with the off-equilibrium paths of malpractice and prices

Notes: Assumes a linear detection technology with profit based sanctions. Calculations in Appendix B.

same reasons as in the boundary no-malpractice case.

Finally note that stability is important here. The first order conditions (13) and (14) form a system, and so zero points of the system may not be unique. The stability requirement allows us to select the solutions with the greatest economic relevance. This can be seen explicitly for the case of a linear detection technology ($\delta(y) := \delta^o y_i$) with a profit based sanction. The first order conditions for this case, and the dynamic laws of motion for the system, are depicted in Figure 1. It can be seen that there are two solutions to the system of first order equations, and stability allows us to pick out one uniquely. The calculations underlying the figure are contained in Appendix B.

3.3 Discussion

3.3.1 Typical Demand Characteristics and Equilibrium Malpractice

Theorem 2 has established that the relationship between the equilibrium level of malpractice and the number of competing firms hinges on whether the shape of the single-good demand function $(1 - F(x))$ is log-concave or log convex. The discussion highlighted that the shape of the single-good demand function determined the relationship between the level of competition and margins; and via this channel impacted equilibrium malpractice. Bagnoli and Bergstrom (2005) show that log-concavity holds for a long list of well-known distributions, including the normal, uniform, and logistic. However they also show that a number of distributions instead generate a single-good demand function which is log-convex. We extend Bagnoli and Bergstrom (2005) in Table 3 (Appendix C) to establish the functional forms for $P(n)$, where these are available.

Theorem 2 established that if consumers' taste functions generated log-concave single-good demand then malpractice rises as competition increases; and the intuition section explained that concurrently price-cost mark-ups fall. This link between entry and declining margins tallies with our intuition gained from competition models such as Cournot. Under log-convex single-good demand however, the reverse relationship would hold: prices rise as firms enter. Prices rising in response to entry is perhaps not common, but it is also not rare. Ward et al. (2002) document cases in which entry caused incumbent brands to raise their prices in the retail food industry; Perloff et al. (2006) present similar findings in the pharmaceutical industry (anti-ulcer drugs), a study which corroborates the findings of entry driving prices up from an earlier study on a wider set of drugs (Grabowski and Vernon (1992)). The observation that entry can cause prices to rise has also been made in theoretical models (Chen and Riordan (2008)) and in simulation models (Thomadsen (2007)). If consumers' taste distributions generated log-convex single-good demand therefore, entry would lower the extent of malpractice, as well as raise prices.

3.3.2 Empirical Predictions

To link Theorem 2 directly to an empirical prediction requires a joint test of the shape of consumers' valuation function, and the propensity of market participants to engage in malpractice as competition varies. It may be more practical to test the hypothesis that prices and malpractice vary inversely to each other in the number of competitors. Such a test would need to hold other factors constant: the regulatory and sanctions regimes; owner-managers' average level of ethical observance; consumer tastes; and the size of the market. These final requirements suggest that a test would likely need an exogenous cause of a change in the number of competing firms within a market.

A possible candidate might therefore be a market whose operators require a license from the authorities; the natural experiment occurring when the authorities alter the number of licenses available. For example taxi companies, and in some countries pharmacies also, require a license to open in a given locale. This model predicts that if the number of licensed competitors within a city or market were to grow, then prices and the level of malpractice should move in opposite directions. For example, if consumers' single-good demand is log-concave, the case of the more standard taste distributions, then increasing the number of licenses and so the number of rivals should lower prices but also increase the equilibrium level of malpractice.

A second candidate would be markets in which sudden changes in external tariffs on over-seas competitors resulted in some firms being effectively barred from the market. For example, at the time of writing the European Union is threatening retaliation to tariff increases from the United States, with a 25% tariff on a specific set of products, including, for example, Bourbon whisky. The entire EU product target list of targets is available.[27] Such changes in the import tariff regime will likely reduce the number of competitors in European markets. This model would then predict that the equilibrium prices and level of malpractice in the affected markets would move in opposite directions.

3.3.3 Intuition behind the role of log concavity

Bagnoli and Bergstrom (2005) demonstrate that log-concavity of the density function $f(x)$ implies log-concavity of the single-good demand function $1 - F(x)$. And we repeat that log-concavity of the single-good demand function plays a prominent role in Theorem 2 as it ensures that prices fall as the number of competitors rise; and this impacts the equilibrium level of malpractice. Gabaix et al. (2016) demonstrate that with large enough n in the Perloff and Salop (1985) competition model, the equilibrium price is proportional to the expected gap between the highest and the second highest draw from the taste distribution.[28] Intuitively each competing firm will only make a sale to a consumer if the consumer likes their product the most, that is has the highest taste draw; and the amount which will be charged is equal to the expected gap between this valuation and the valuation the consumer has for the next best product – that is the second highest taste draw. If the tails of the taste distribution F are fat then this gap is increasing in n. The thickness of the tails can be captured by the expression $\lim_{x\to\bar{x}} \frac{d}{dx}\left(\frac{1-F(x)}{f(x)}\right)$. But log concavity of $1 - F(x)$ is nothing other than the sign of the inverse of this expression: $\frac{d}{dx}\left(1\Big/\left(\frac{1-F(x)}{f(x)}\right)\right)$. Hence log concavity of the single-good demand function in the limit of large n is measuring the thickness of the tails of the taste distribution, and therefore the expected gap between the highest and next highest valuation, and therefore captures the relationship between equilibrium prices and entry.

4 Equilibrium Analysis – Comparative Statics

4.1 Comparative Static in Ethics

As ethics become more pronounced one would expect behaviour to improve. This proposition is delicate to show however as one needs to be careful as to what is meant by

[27] See http://trade.ec.europa.eu/doclib/docs/2018/march .

[28] Compare the limit in Gabaix et al. (2016) Proposition 2 to that in their Theorem 1.

'ethics'. Let us begin by studying the comparative static of the equilibrium with respect to the ethical parameter Ω defined in equation (7).

The comparative static of the level of malpractice y^e when it is interior, with respect to Ω, requires some more machinery to establish. Analogously to the derivation of (16) we have

$$dy^e = \frac{1}{\det \mathcal{H}} \begin{pmatrix} \left(U^i_{p_i}(p^e, y^e)\right)_{p^e} & -\left(U^i_{y_i}(p^e, y^e)\right)_{p^e} \end{pmatrix} \begin{pmatrix} -\left(U^i_{y_i}(p^e, y^e)\right)_{\Omega} \\ -\left(U^i_{p_i}(p^e, y^e)\right)_{\Omega} \end{pmatrix} d\Omega$$

From (13) and (14) we have

$$\left(U^i_{y_i}(p^e, y^e)\right)_{\Omega} = \frac{1}{n} \text{ and } \left(U^i_{p_i}(p^e, y^e)\right)_{\Omega} = -\frac{P(n)}{n} y^e$$

And so as $\det \mathcal{H} > 0$ at a stable equilibrium by Lemma 3,

$$\frac{dy^e}{d\Omega} =_{\text{sign}} -\frac{1}{n} \left(U^i_{p_i}(p^e, y^e)\right)_{p^e} - \left(U^i_{y_i}(p^e, y^e)\right)_{p^e} \frac{P(n)}{n} y^e \tag{23}$$

We have that $\left(U^i_{y_i}(p^e, y^e)\right)_{p^e} < 0$ by (17). The complication lies in the first term. To sign this we must extend Lemma 3. Following Dixit (1986) stability of equilibrium must hold even if the adjustment speeds of the n players are not proportional to unity. Thus the equilibrium must be stable even if $\dot{p}_i = s \cdot U^i_{p_i}$ for some constant $s > 0$, and similarly $\dot{y}_i = \tilde{s} \cdot U^i_{y_i}$ for a potentially different constant $\tilde{s}$. Repeating the proof of Lemma 3 we establish the corollary that the matrix

$$\tilde{\mathcal{H}} := \begin{pmatrix} \tilde{s} \cdot \left(U^i_{y_i}(p^e, y^e)\right)_{y^e} & \tilde{s} \cdot \left(U^i_{y_i}(p^e, y^e)\right)_{p^e} \\ s \cdot \left(U^i_{p_i}(p^e, y^e)\right)_{y^e} & s \cdot \left(U^i_{p_i}(p^e, y^e)\right)_{p^e} \end{pmatrix}$$

must have eigenvalues with negative real parts for all $s, \tilde{s} > 0$. This implies that the trace is negative for any values of $s, \tilde{s} > 0$, and so $\left(U^i_{p_i}(p^e, y^e)\right)_{p^e} < 0$. Hence we establish that at a stable equilibrium

$$\frac{dy^e}{d\Omega} > 0.$$

We are now in a position to link this result to the philosophical traditions underlying the agents' ethics in our model.

Suppose first that the owner-managers' commitment to duty ethics becomes stronger. Thus ω^{duty} grows. Observe from (7) that $d\Omega/d\omega^{duty} = -\alpha < 0$. It follows that Ω falls. Therefore the equilibrium level of malpractice unambiguously falls in this case. It also follows that the region of n within which the equilibrium contains malpractice, shrinks. To see this note that if with low ω^{duty}, parameters are such that the equilibrium is interior with $y^e = 0_+$, then as ω^{duty} grows, y^e moves into the boundary of no malpractice.

Suppose next that the owner-managers' commitment to act utilitarian ethics becomes stronger. Thus the parameter ω^{act} grows. Note that $d\Omega/d\omega^{act} = 1 - \alpha$. Therefore the relationship between increased owner-manager ethics and malpractice when the owner-managers profess an act-utilitarian tradition hinges on whether the managers believe the malpractice is overall surplus enhancing.

Consider the case in which the managers believe the unethical practice harms the stakeholder(s) by more than the profits which are generated; that is $\alpha > 1$. The managers believe the practice is surplus reductive, even ignoring the fact that they are deceiving customers. In this case a more ethical owner manager in the sense of act utilitarianism will cause Ω to fall, and so the equilibrium level of malpractice declines and the region within which the no-malpractice equilibrium exists expands.

However suppose that the owner-managers assess that the unethical practice harms the stakeholders by less, in dollar terms, than the profits which are generated. This is a setting in which the managers determine that *the ends justify the means*; i.e. the managers, ignoring the deception practised on the consumers, see the practice as aggregate surplus enhancing. In this case more ethical owner managers lead to the equilibrium level of malpractice growing, and the region within which no-malpractice can be sustained shrinking.

4.2 Analysis of the Sanctions Regime

In the model studied here, the regulatory authorities are not strategic. They do not, for example, alter their detection technology based on the market structure. Indeed, how they should do so is not clear. Theorem 2 provides some insight into this problem. In the leading case of consumers' tastes being log-concave,[29] malpractice is increasing in the number of competitors, above a threshold. Thus, as an example, financial advice supplied by large numbers of IFAs to the mass market would be a more propitious arena for malpractice than financial advice supplied by a small number of firms to niche consumers.[30] So this model suggests benefits to a regulator of channelling resources disproportionately towards the former rather than the latter financial markets, so as to remain commensurate with the risk of malpractice.

Further analysis of the model reveals a second dimension upon which regulatory outcomes might be improved. This is the insight that sanctions on revenue or on profit are not directly substitutable.

Proposition 4 *Given a small infringement detection sensitivity, $\delta'(0)$:*

1. *If a revenue sanction regime ($\Phi^{rev} > 0 = \Phi^{prof}$) is strict enough ($\Phi^{rev}$ large enough), then the no-malpractice equilibrium can be sustained for all n under all consumer*

[29] Implying the single-good demand is log-concave (Bagnoli and Bergstrom (2005)).

[30] At least in the case of IFAs, malpractice is an endemic feauture of the sector in the US (Egan et al. (2016)).

taste distributions permitting an equilibrium.

2. *Under a profit sanction regime ($\Phi^{prof} > 0 = \Phi^{rev}$) there exist density functions such that the no-malpractice equilibrium cannot be sustained for some levels of competition.*

Proof. For the first result, substitute $y^e = 0$ into (13) and (14) to establish that in a no-malpractice equilibrium $p^e = c + 1/P(n)$ and therefore

$$U^i_{y_i}\Big|_{y^e=0} = \frac{1}{n}\left\{1 + \Omega - \delta'(0)\Phi^{rev}(c + 1/P(n))\right\}$$

Therefore if $\Phi^{rev} > (1+\Omega)/(c\delta'(0))$ we have $U^i_{y_i}\Big|_{y^e=0} < 0$. This implies an absence of a profitable deviation, and so $y^e = 0$ is an equilibrium as it is at the boundary of permitted values of malpractice.

For the second result, suppose that $\Phi^{rev} = 0 < \Phi^{prof}$ then suppose $y^e = 0$ for a contradiction. Substituting $y^e = 0$ into (13) and (14) and simplifying yields

$$U^i_{y_i}\Big|_{y^e=0} = \frac{1}{n}\left\{1 + \Omega - \delta'(0)\Phi^{prof}/P(n)\right\}$$

and so a firm has a profitable deviation to increase malpractice up from zero if $1 + \Omega > 0$ and $P(n)$ is large enough. To demonstrate this is possible, consider a large number of competitors, so n is large, and suppose the tastes are drawn from a uniform distribution. From Table 3 we see that $\lim_{n\to\infty} P(n) \to \infty$ in this case, proving the result.[31] ■

The fact that penalties in revenues and in profits are not directly substitutable is perhaps unexpected. When competition is strong, so that a large number n of firms compete, the profits of any individual firm will be small as the firm will sell small volumes for low margins. Fines related to profits therefore lose their sting. Revenues will of course also be small as small volumes are sold. However for each unit sold, non-negative costs are incurred, and so the fines in a revenue regime fall less quickly with the number of competing firms. As a result it is possible to find a level of fines on revenues, which can be applied to any industry, and which ensures no-malpractice regardless of the shape of demand or the number of competitors. This is not possible when the sanctions are based on profit multiples; to ensure no malpractice fines would need to differ depending on the industry.

The comparative static between the level of malpractice, when this is positive, and the level of sanction is not clear. It is evident that a higher level of sanction has a direct effect in lowering the expected utility from malpractice. However there is a countervailing indirect effect via prices. If rival firms are less willing to conduct malpractice,

[31]The same result can be shown without letting n grow large if consumers' tastes are drawn, for example, from the Pareto distribution.

then they will be less aggressive in responding to a price cut as they will be less willing to moderate falls in margins via malpractice. Hence the incentive to cut prices can grow with an increase in the sanctions regime, and if so the incentive to malpractice can rise to try and maintain own margins. These competing forces will balance themselves out in equilibrium, and general results do not seem to be available.

4.3 Increasing Dispersion in Consumer Tastes

We now study how malpractice changes in equilibrium when consumer tastes become more dispersed. The ranking which is most amenable to study here is the dispersive order (Shaked (1982)). Following Shaked we state that $F \overset{disp}{<} G$ if

$$F^{-1}(t_2) - F^{-1}(t_1) \leq G^{-1}(t_2) - G^{-1}(t_1) \text{ when } 0 < t_1 < t_2 < 1. \tag{24}$$

In words, condition (24) implies that if G is a more disbersed distribution than F then the gap between the t_2^{th} percentile and the t_1^{th} percentile is larger for G than it is for F. Note that (24) implies that

$$\frac{dF^{-1}(t)}{dt} \leq \frac{dG^{-1}(t)}{dt} \text{ for all } t. \tag{25}$$

Shaked notes, for example, that the larger the shape parameter in the Gamma distribution, the more dispersed the distribution becomes. This is depicted in Figure 2.

To analyse the effect on malpractice of small changes in dispersion consider the distribution function $H_\sigma(x)$ defined by its inverse such that

$$H_\sigma^{-1}(t) := (1-\sigma) F^{-1}(t) + \sigma G^{-1}(t) \text{ for } \sigma \in [0,1]. \tag{26}$$

When the parameter $\sigma = 0$ then $H_0(\cdot)$ coincides with $F(\cdot)$. As σ grows the distribution becomes more dispersed as $\frac{dF^{-1}(t)}{dt} \leq \frac{dH_\sigma^{-1}(t)}{dt} \leq \frac{dG^{-1}(t)}{dt}$.

Proposition 5 *Increasing dispersion in tastes in the sense of the dispersion ordering decreases the level of malpractice at an interior equilibrium:* $dy^e/d\sigma \leq 0$ *when* $y^e \in (0, \bar{y})$.

Proof. If tastes are captured by the distribution H_σ the $P(n)$ function given in (3) can be written

$$\begin{aligned} P_{H_\sigma}(n) &= n \int_{\underline{x}}^{\overline{x}} h_\sigma(x)\, dH_\sigma(x)^{n-1} \\ &= n \int_0^1 h_\sigma\left(H_\sigma^{-1}(t)\right) dt^{n-1} \text{ using the change of variables } t = H_\sigma(x) \\ &= n \int_0^1 \frac{1}{\frac{dH_\sigma^{-1}(t)}{dt}} dt^{n-1} \end{aligned}$$

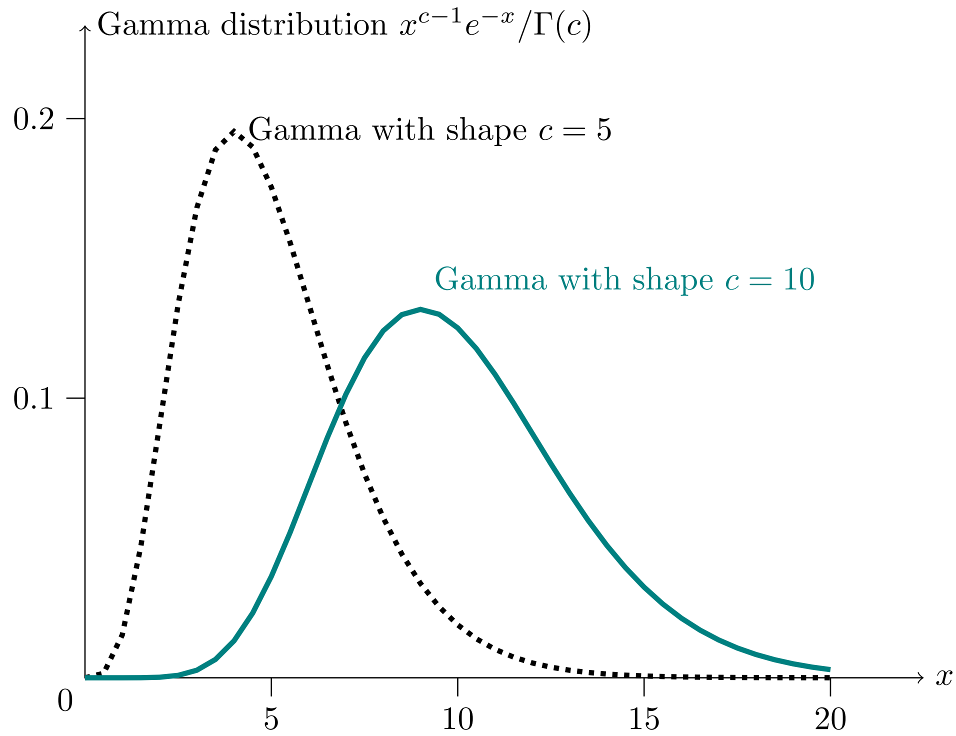

Figure 2: Dispersion increases with the shape parameter

The last line follows as given $H_\sigma\left(H_\sigma^{-1}(t)\right) = t$ we have, by differentiation, $h_\sigma\left(H_\sigma^{-1}(t)\right) = 1/\left(dH_\sigma^{-1}(t)/dt\right)$. It therefore follows that

$$\frac{\partial}{\partial\sigma}P_{H_\sigma}(n) =_{\text{sign}} -\frac{d}{d\sigma}\left[\frac{dH_\sigma^{-1}(t)}{dt}\right] \leq 0 \text{ using (25) and (26).}$$

We can now follow the method of proof of Theorem 2. We see from (13) that $\left(U_{y_i}^i(p^e, y^e)\right)_\sigma = 0$. Following the steps in (15) we have that

$$\left(U_{p_i}^i(p^e, y^e)\right)_\sigma =_{\text{sign}} -\frac{\partial}{\partial\sigma}P_{H_\sigma}(n) \geq 0,$$

as $U^i \geq 0$ at equilibrium, so the bracketed term in (8) must be positive as production must be positive in equilibrium, and the inequality then follows from (14). Therefore, using (17),

$$\frac{dy^e}{d\sigma} =_{\text{sign}} \left(U_{y_i}^i(p^e, y^e)\right)_{p^e} \cdot \left(U_{p_i}^i(p^e, y^e)\right)_\sigma \leq 0.$$

as claimed. ■

We have shown that deformations in the shape of demand which increase dispersion lead to reduced levels malpractice. The key to understanding this result is to reflect on the link between the dispersion of consumer tastes and the margins firms can sustain in equilibrium. As consumer taste dispersion grows, the likely gap between the highest valuation and the next highest, expands. Hence the firms can sustain higher prices and so capture higher margins in equilibrium. If rivals raise their prices, then the incentive to take risks with malpractice, so as to be price-competitive, declines. In addition, as own price-cost margins grow, then the deterrent effect of profit and revenue sanctions are strengthened. These two effects reinforce each other and lower the equilibrium level of malpractice.

4.4 Stakeholders' Surplus

Per unit delivered to the market, the consumers receive utility $E(M_n) - p^e$ where M_n is the maximum of n draws from the taste distribution F. However stakeholders, which may be the consumers, but might be the workers or the environment, lose utility αy^e for every unit produced. As the number of competing firms rises, the match quality improves and so $E(M_n)$ rises. However there are always countervailing effects as dy^e/dn and dp^e/dn are of opposite sign; either the equilibrium level of malpractice rises with the number of competing firms, or the equilibrium price does. I have not been able to find a characterisation for the total level of stakeholders' surplus with respect to the number of competing firms n. This is perhaps best as such an assertion would suggest that it is ethically defensible for a policy maker to tolerate unrecompensed harm to some stakeholders (e.g. lying to consumers, safety lapses) so as to gain a sufficient drop in the prices consumers pay. A true Benthamite would be comfortable with this, but other philosophical traditions would not.

5 Agents having a Kantian Categorical Imperative and the dangers of oligopoly

Our analysis has analysed both act utilitarian ethics and a duty based ethical framework. Both approaches have the feature that the disutility term grows in the number of consumers (or stakeholders) who are (or may be) harmed. Thus it feels even worse to the owner-manager to cheat on many people, than it does to cheat on a few. This may seem natural on casual inspection. But it is a contentious assumption. Agents who were truly Kantian and professed a Categorical Imperative would consider that malpractice is wrong full stop; it would not matter if the malpractice was practised on large or on small numbers of stakeholders.

Taken to its logical conclusion, ethical agents would be immune from all pecuniary temptation: they would be different creatures in that they would never engage in even an iota of malpractice, for any reward. Carlin and Gervais (2009) take this approach and call such employees *virtuous*. As Solomon (1993) suggests in his treatment of business ethics, quoting from a New York Times article:

> "Bicyclists don't have to think about which way to lean and honest men don't have to think about how to answer under oath." (Solomon (1993) p4)

I approach this concern by creating a substantial utility difference between no-malpractice and any non-zero level of malpractice. To this end consider adding in a Kantian disutility term for malpractice, $\mathcal{K}$:

$$U^i = q_i \left(p_i - c + y_i + \Omega y_i - \delta \left(y_i\right) \left[\Phi^{prof} \left(p_i - c + y_i\right) + \Phi^{rev} p_i\right]\right) - \mathcal{K} \mathbb{I}_{y_i > 0}$$

The function $\mathbb{I}_{y_i>0}$ is the indicator function taking the value 1 if the owner-manager of firm i engages in any malpractice at all. If the Kantian term, $\mathcal{K}$, in the utility function is large then the owner-manager will not engage in any malpractice. If $\mathcal{K}$ were infinite then we would recover the pure Kantian Categorical Imperative. However, with a finite $\mathcal{K}$ value it is possible that the utility gain from engaging in malpractice is great enough to outweigh the Kantian dislike for behaving unethically. In this case the utility function is as analysed above, merely shifted down by the Kantian term.[32]

If an interior positive malpractice equilibrium exists in this case, then it will coincide with the non-Kantian case analysed above as the first order conditions are unchanged. In particular the relationship in Theorem 2 between the level of malpractice and the number of competing firms at an interior equilibrium holds.

Let us consider the case of $1-F(x)$ being log-concave. In this case we have $dp^e/dn \leq 0$ which was derived in the discussion under (22). Hence $p^e \leq p^e|_{n=2}$. In equilibrium each firm serves $1/n$ consumers and so

$$U^i \leq \frac{1}{n} \left(p^e|_{n=2} - c + \max\left\{\left(1+\Omega\right) \bar{y}, 0\right\}\right) - \mathcal{K} \mathbb{I}_{y_i > 0}$$

It is immediate that if $y^e > 0$ then $\lim_{n\to\infty} U^i = -\mathcal{K}\mathbb{I}_{y_i>0} < 0$. However this is a contradiction, as deviating to no malpractice would allow a positive utility to be derived. We have shown that:

Corollary 6 *If $1-F$ is log concave and owner-managers have Kantian elements to their utility then a positive malpractice equilibrium can only exist under oligopolistic market structures with n firms competing where $n \in [\underline{n}, \bar{n}] \subsetneq [n^*, \infty)$.*

Proof. We know a positive malpractice equilibrium does not exist for $n \leq n^*$ from prior working. By continuity a positive malpractice cannot exist at n^* as the Kantian term will cause the utility to be negative. From discussion above the equilibrium also cannot exist for n large. ■

[32] Whether the owner-manager decides to engage in malpractice or not, the price will always be set to maximise profits conditional on the level of malpractice. In this sense the manager's actions are consistent with a Kantian perfect duty to maximise profits, if such a duty exists. Bowie (2017) argues that it does.

Hence in the prominent case of $1-F$ log-concave, we establish that malpractice is most likely for oligopolies: if there are many firms competing the profits available from malpractice are too small to outweigh the Kantian distaste for engaging in malpractice. If there are few firms competing then the margins are large and the authority's sanction is enough to deter malpractice. However at intermediate levels of competition it is possible for malpractice equilibria to exist.

6 Ethics and Asymmetric Competition

Thus far we have considered a setting in which all owner-managers shared the same ethical stance; and all firms were equally efficient. We relax both of these restrictions in this section, albeit in a duopoly setting. This section therefore studies the market outcomes when an ethical owner-manager competes with one less ethical; and we study how malpractice will be distributed between firms with differing cost bases.

Consider a duopoly with firms $i \in \{1,2\}$; firm i has marginal cost c_i and ethical parameter Ω_i. The objective function of firm i follows from the benchmark case (8) with the personalisation of costs and ethics:

$$U^i := q_i\left(\underline{p}\right) \cdot \left(p_i - c_i + y_i + \Omega_i y_i - \delta\left(y_i\right)\left[\Phi^{prof}\left(p_i - c_i + y_i\right) + \Phi^{rev} p_i\right]\right).$$

We will characterise equilibrium behaviour and so in this section we make the following assumption:

Assumption A: In equilibrium both firms are active ($q_i > 0$) and equilibrium is at an interior level of malpractice: $y_i \in (0, \bar{y})$.

Assumption A rules out settings where one of the firms is excluded from the market, and further the assumption delivers that at equilibrium values $\left(\underline{p}^e, \underline{y}^e\right)$ the first order conditions apply:

$$U^i_{y_i}\left(\underline{p}^e, \underline{y}^e\right) = 0 = U^i_{p_i}\left(\underline{p}^e, \underline{y}^e\right) \tag{27}$$

Assumption A therefore allow us to use local analysis techniques to establish comparative static results.

Each firm is optimising against the rival, and so the second order conditions are satisfied. These require the Hessian for each firm to be negative definite. Evaluating at equilibrium we have:

$$U^i_{y_i y_i} < 0, U^i_{p_i p_i} < 0 \tag{28}$$

$$U^i_{y_i y_i} \cdot U^i_{p_i p_i} - (U^i_{p_i y_i})^2 > 0 \tag{29}$$

Beyond the second order conditions, the structure of our problem yields some further relations. As in the symmetric case $U^i_{y_j} = 0$ for $j \neq i$. This captures that malpractice of rival firms does not have a direct effect on an owner-manager's objective function. The effect is indirect via any concurrent changes in prices. Secondly observe that at an equilibrium with positive production by both firms, the condition $U^i_{y_i} = 0$ requires

$$\frac{\partial}{\partial y_i}\left(p_i - c_i + y_i + \Omega y_i - \delta\left(y_i\right)\left[\Phi^{prof}\left(p_i - c_i + y_i\right) + \Phi^{rev} p_i\right]\right)\Bigg|_{\left(\underline{p}^e, \underline{y}^e\right)} = 0 \qquad (30)$$

It follows that $U^i_{y_i p_j} = 0$ for $i \neq j$ at equilibrium prices.

We now invoke the assumption that the equilibrium is stable. This requires that the Hessian matrix for the whole system evaluated at the equilibrium values $\left(\underline{p}^e, \underline{y}^e\right)$, is negative definite. Labeling this matrix $\tilde{\mathcal{A}}$ and ordering the variables by firm, we have:

$$\tilde{\mathcal{A}} := \begin{pmatrix} U^1_{y_1 y_1} & U^1_{y_1 p_1} & 0 & 0 \\ U^1_{y_1 p_1} & U^1_{p_1 p_1} & 0 & U^1_{p_1 p_2} \\ 0 & 0 & U^2_{y_2 y_2} & U^2_{y_2 p_2} \\ 0 & U^2_{p_2 p_1} & U^2_{y_2 p_2} & U^2_{p_2 p_2} \end{pmatrix} \qquad (31)$$

where we have used the insights above to replace some Hessian entries with zeros.

Now taking differentials of the first order conditions (27) and focusing on the marginal costs and ethics of firm 2 we have:

$$\begin{aligned} \tilde{\mathcal{A}} \begin{pmatrix} dy^e_1 \\ dp^e_1 \\ dy^e_2 \\ dp^e_2 \end{pmatrix} &= - \begin{pmatrix} U^1_{y_1 c_2} \\ U^1_{p_1 c_2} \\ U^2_{y_2 c_2} \\ U^2_{p_2 c_2} \end{pmatrix} dc_2 - \begin{pmatrix} U^1_{y_1 \Omega_2} \\ U^1_{p_1 \Omega_2} \\ U^2_{y_2 \Omega_2} \\ U^2_{p_2 \Omega_2} \end{pmatrix} d\Omega_2 \\ &= - \begin{pmatrix} 0 \\ 0 \\ q_2 \delta'(y_2) \Phi^{prof} \\ \frac{\partial q_2}{\partial p_2}(-1 + \delta(y_2)\Phi^{prof}) \end{pmatrix} dc_2 - \begin{pmatrix} 0 \\ 0 \\ q_2 \\ y_2 \frac{\partial q_2}{\partial p_2} \end{pmatrix} d\Omega_2 \end{aligned} \qquad (32)$$

To evaluate the comparative statics we therefore need to invert the Hessian matrix $\tilde{\mathcal{A}}$. We use the result that the inverse of a matrix can be expressed in terms of its adjoint: $\tilde{\mathcal{A}}^{-1} = \frac{1}{\det \tilde{\mathcal{A}}} \cdot \operatorname{adj}(\tilde{\mathcal{A}})$ (§2.6, Theorem 1, Lancaster and Tismenetsky (1985)). Hence we have:[33]

[33] The adjoint, $\operatorname{adj}(\tilde{\mathcal{A}})$, is the transposed matrix of cofactors of $\tilde{\mathcal{A}}$ (§2.6 of Lancaster and Tismenetsky (1985)). The cofactor is the minor M_{pq} multiplied by $+1$ or -1 according to whether the sum $p+q$ is even or odd (p33, Lancaster and Tismenetsky (1985)). The minor M_{pq} is the determinant of the submatrix of $\tilde{\mathcal{A}}$ obtained by striking out the p^{th} row and q^{th} column (§2.3 of Lancaster and Tismenetsky (1985)).

$$\tilde{\mathcal{A}}^{-1} = \frac{1}{\det \tilde{\mathcal{A}}} \begin{pmatrix} \cdot & \cdot & M_{31} & -M_{41} \\ \cdot & \cdot & -M_{32} & M_{42} \\ \cdot & \cdot & M_{33} & -M_{43} \\ \cdot & \cdot & -M_{34} & M_{44} \end{pmatrix} \tag{33}$$

Where $\pm M_{ij}$ is the cofactor of the Hessian $\tilde{\mathcal{A}}$ evaluated at matrix entry $\{i, j\}$ (cf. footnote 33). Given the zero entries in the right hand side of equation (32) we do not need to calculate all the terms of the inverse of $\tilde{\mathcal{A}}$, and so the expression in (33) is simplified. Note that by the assumption of stability of the equilibrium we have $\det \tilde{\mathcal{A}} > 0$.

For the avoidance of doubt, let us evaluate the final column in equation (33) above. The cofactors of $\tilde{\mathcal{A}}$ can be calculated as:

$$-M_{41} = -\begin{vmatrix} U^1_{y_1p_1} & 0 & 0 \\ U^1_{p_1p_1} & 0 & U^1_{p_1p_2} \\ 0 & U^2_{y_2y_2} & U^2_{y_2p_2} \end{vmatrix} = U^1_{y_1p_1} \cdot U^1_{p_1p_2} \cdot U^2_{y_2y_2} \tag{34}$$

$$M_{42} = -U^1_{y_1y_1} \cdot U^1_{p_1p_2} \cdot U^2_{y_2y_2} \tag{35}$$

$$-M_{43} = -U^2_{y_2p_2} \cdot \left(U^1_{y_1y_1} \cdot U^1_{p_1p_1} - (U^1_{y_1p_1})^2\right) \tag{36}$$

$$M_{44} = U^2_{y_2y_2} \cdot \left(U^1_{y_1y_1} \cdot U^1_{p_1p_1} - (U^1_{y_1p_1})^2\right) \tag{37}$$

Our model allows us sufficient structure to sign almost all the entries of the matrix $\tilde{\mathcal{A}}^{-1}$. This is an important step in establishing the comparative statics of prices and malpractice to marginal costs and ethical preference.

Lemma 7 *The signs of the entries in the matrix $\tilde{\mathcal{A}}^{-1}$ satisfy:*

$$M_{43} < 0, M_{34} < 0, M_{44} < 0$$

$$M_{31} =_{sign} M_{41} =_{sign} M_{32} =_{sign} M_{42} =_{sign} -\frac{\partial^2 \ln q_1}{\partial p_1 \partial p_2}$$

The sign of M_{33} is ambiguous.

Proof. See Appendix A. ■

The expression $\partial^2 \ln q_1 / \partial p_1 \partial p_2$ captures whether the log of firm 1's realised demand has increasing differences in prices. If this second derivative is positive then should firm 2 raise her price, $\partial \ln q_1 / \partial p_1$ will increase. As this derivative is negative, this implies that the log of realised demand becomes less sensitive to firm 1's own prices. If consumers' tastes generate a log-concave single-good demand function $(1 - F(x))$, the perhaps more prominent case from the discussion of Section 3.3.1, then we can appeal to Quint (2014), Theorem 1, to establish that the log of each firm's realised demand does have increasing differences in prices in the discrete choice model studied here, so that $\partial^2 \ln q_1 / \partial p_1 \partial p_2 > 0$. However I will not restrict to this case in the analysis which follows.

6.1 Market Impact of a More Ethical Firm

Let us suppose that the owner-manager's ethics at firm 2 change slightly. It follows that the ethical parameter Ω_2 will change. As a first step in our analysis let us therefore determine the effect of a change in the ethics parameter Ω_2 on the equilibrium prices and levels of malpractice.

Consider first the rival, firm 1. Using (32) and (33) we have

$$\frac{dy_1^e}{d\Omega_2} = -\frac{1}{\det \tilde{\mathcal{A}}}\left(q_2 M_{31} - y_2 \frac{\partial q_2}{\partial p_2} M_{41}\right)$$

Using Lemma 7 we establish that

$$\frac{dy_1^e}{d\Omega_2} =_{\text{sign}} \frac{\partial^2 \ln q_1}{\partial p_1 \partial p_2}$$

Building on such arguments we can establish that:

Proposition 8 *The comparative statics in duopoly competition with respect to Ω_2 satisfy:*

$$\frac{dp_2^e}{d\Omega_2} < 0 \quad \textit{and} \quad \frac{dy_1^e}{d\Omega_2} =_{sign} -\frac{dp_1^e}{d\Omega_2} \begin{cases} > 0 & \textit{if } 1 - F(x) \textit{ is log-concave} \\ =_{sign} \frac{\partial^2 \ln q_1}{\partial p_1 \partial p_2} & \textit{otherwise} \end{cases} \tag{38}$$

$$\frac{dy_2^e}{d\Omega_2} > 0 \tag{39}$$

Proof. See Appendix A. ■

Let us suppose that the owner-manager of firm 2 places greater weight on the duty-ethics approach to morality in business. Or suppose the owner-manager places a greater weight on behaving consistently with an act-utilitarian tradition and believes the malpractice is more harmful than the costs saved ($\alpha > 1$). Either of these ethical changes would cause the parameter Ω_2 to decline. Such a more moral firm 2 owner-manager will raise her retail prices. This is because the increased morality causes the owner-manager to dislike her existing level of malpractice and the harm she is doing to the firm's stakeholders. This increased subjective distaste for malpractice is as if the owner-manager has incurred a higher cost of production. This drives the manager to bring down volumes by raising her price, and so reduce the harm done.

Firm 2's level of malpractice moves in the opposite direction to her prices. The explanation parallels the logic in the symmetric firm case discussed above. Because the equilibrium dynamics cause firm 2's prices to rise, margins grow. The regulatory sanctions turn on profits, even if the sanction is revenue based. And profits equal volumes times margin, while the cost savings and ethical distaste from malpractice turn on volumes only. As margins rise the effect of the sanctions becomes more prominent in the decision calculus. Hence the owner-manager of firm 2 lowers her level of malpractice.

The rival firm 1's behaviour is now readily signed. Given firm 2 responds to her increased morality by raising retail prices, she becomes a less effective competitor. As a result firm 1 seeks to alter her price to increase her profits. The direction in which prices change depends upon whether firm 1's log demand displays increasing differences, or otherwise.

In the prominent setting of consumer tastes coming from the class of log-concave density functions (e.g. $f(x)$ normal, double exponential, uniform, etc.), then the log of firm 1's realised demand would display increasing differences in the two firms' prices. In this case prices become strategic complements: an increase in firm 2's price therefore results in firm 1 raising her price also.

Firm 1's level of malpractice moves in the opposite direction to her prices as described above. Thus in the prominent setting of consumers' tastes coming from the set of log-concave density functions, malpractice at firm 1 declines as firm 2 becomes more ethical.

Discussion: If a less corrupt, or more ethical, owner should acquire a competitor in a perhaps corrupt local market, will the ethical newcomer raise the ethical conduct of rivals, or will her own ethical conduct become polluted? This is an open question, and an important one as it has implications for the desirability of globalisation.[34] The analysis above offers some insight into this question. In the prominent setting of consumers' tastes being drawn from the class of log-concave densities, the acquisition by a more ethical owner of firm 2 will lower malpractice at both the rival firm 1, and the newly acquired firm 2. This is consistent with evidence, such as Kwok and Tadesse (2006), which argues that entry into a market of a (more ethical) multinational lowers corruption and malpractice amongst home firms.

However, does corruption spread and damage the behaviour of the 'ethical' firm 2? Kartner and Warner (2015) argue through a case study of Siemens that corruption does indeed spread to the incoming multinational. Hence thinking of Siemens's as an example of an ethical MNC, its behaviour in corrupt markets fell to below the levels it would tolerate elsewhere. This is consistent with Proposition 8 as in studies such as Kartner and Warner (2015) one is comparing a MNC's behaviour in one market (abroad) to its behaviour in another (home). These markets would be expected to have different levels of equilibrium malpractice as, by assumption, the ethics of the competing firms differ between the home and abroad markets, and indeed the level of competition between home and abroad would also often differ.

In the US, the Financial Advisory market is bifurcated with some firms employing clean advisors, and others " *'specialising' in misconduct*" (Egan et al. (2016)) in that they hire advisers with a misconduct record. This paper offers the hypothesis that such

[34]Prominent economics commentators, such as Wolf (2004), argue that opening economies up to competitive global forces will lower corruption in the markets which see international entry (see p. 73).

an industrial structure lowers the malpractice perpetrated by the firms employing the compromised advisors compared to what it would be absent the clean rivals: clean firms can charge a higher price for their advice, this allows the margins to grow in the rival advisory firms with the compromised advisors, these greater profits raise the importance of sanctions in their decision calculus, and this in turn lowers malpractice even though the advisors may well be less ethical.

6.2 Impact on Malpractice as Rivals Approach the Technological Frontier

The effect of changes in costs on the equilibrium outcomes when the regulator applies profit based sanctions is ambiguous as the cofactor M_{33} in (33) cannot be signed (Lemma 7). However, in the case of a revenue-based sanctions regime, full clarity is available. Simplifying (32) using (33), and restricting to the revenue-based sanctions case,

$$\begin{pmatrix} dy_1^e \\ dp_1^e \\ dy_2^e \\ dp_2^e \end{pmatrix} = -\frac{1}{\det \tilde{\mathcal{A}}} \begin{pmatrix} \cdot & \cdot & \cdot & -M_{41} \\ \cdot & \cdot & \cdot & M_{42} \\ \cdot & \cdot & \cdot & -M_{43} \\ \cdot & \cdot & \cdot & M_{44} \end{pmatrix} \begin{pmatrix} 0 \\ 0 \\ 0 \\ -\frac{\partial q_2}{\partial p_2} \end{pmatrix} dc_2$$

Now applying Lemma 7 proves:

Proposition 9 *Under a revenue based sanctions regime, the comparative statics with respect to firm 2's marginal cost c_2 are:*

$$\frac{dy_2^e}{dc_2} < 0 < \frac{dp_2^e}{dc_2} \quad \textit{and} \quad -\frac{dy_1^e}{dc_2} =_{sign} \frac{dp_1^e}{dc_2} \begin{cases} > 0 & \textit{if } 1 - F(x) \textit{ is log-concave} \\ =_{sign} \frac{\partial^2 \ln q_1}{\partial p_1 \partial p_2} & \textit{otherwise} \end{cases}$$

We are therefore in a position to describe the evolution of the equilibrium variables in the event that firm 2 approaches the technological frontier by lowering her marginal cost of production, c_2. In this scenario firm 2 lowers her price as one would expect from an improvement in efficiency. In turn this lowers the revenue secured by the firm, and so weakens the effect of the revenue based sanctions. At the margin therefore firm 2 increases the level of malpractice she perpetrates. Hence as firm 2 approaches the technological frontier she behaves less ethically.

Firm 1 is now faced with a more aggressive rival, and her price response depends upon whether the log of her demand displays increasing differences or decreasing differences in prices. In the prominent case of consumers' tastes being drawn from standard distributions, such as the normal, then consumers' single-good demand function is log-concave and so firm 1's realised demand has increasing differences in own and rival's prices. In this case firm 1 responds to the more aggressive rival by copying in lowering the price she charges. But by lowering revenues the regulatory sanction is weakened at the margin. It therefore follows that firm 1, in this scenario, raises her level of malpractice.

We therefore arrive at the prediction that in an equilibrium with positive levels of malpractice and where log demand displays increasing differences, as firms approach the technological frontier the extent of malpractice in the industry rises amongst both firms present, even though headline prices will be declining.

If however firms' demands do not display increasing differences in own and rival price, as evidence suggests applies in the pharma industry (see references on page 22), then the market bifurcates: firm 2, approaching the technological frontier, raises her level of malpractice and lowers her price. However firm 1 strategically responds by lowering her level of malpractice whilst raising her price in an attempt to target just those consumers who value the match with firm 1 highly.

7 Robustness: Repetition and Existence

In this section we consider the robustness of the central model of Section 2 to repetition, and demonstrate the existence of equilibrium.

7.1 A Repeated Game

In the one-shot analysis above the firms only risked one period's profits or revenues, there was no sense in which they could be disciplined by the loss of future business. Thus the value of the firm's reputation did not play a role in the work thus far. And so it is reasonable to ask if reputation effects alter the results. We test the robustness of our results to this concern here.

Suppose therefore that both stages of the competition game are repeated at every time $t = 1, 2, \ldots$. Thus each time period t contains two sub-periods. Price and malpractice choices, and consumer demand occur in the first sub-period. Then there follows a second sub-period in which an authority may detect malpractice with sufficient evidence to fine. Suppose also that all market participants discount payoffs one period ahead by e^{-r}; there is no discounting between sub-periods.[35] I assume that if evidence is found that an owner-manager was guilty of malpractice at time t then she pays the resultant penalty, and further, she is replaced for all future periods. Thus she has to relinquish the firm's assets to another owner-manager who will run the firm from $t+1$ onwards. An example of such an outcome would be if a regulatory authority determines the former owner-manager is not a *"fit and proper person"* to run the enterprise.[36] These assumptions imply that

[35]Gill and Thanassoulis (2016) embed a two-stage competition model in a repeated interaction in an analogous manner.

[36]Such fit and proper tests are common as detailed by Boskovic et al. (2010). In Europe the test is a subjective one undertaken by the competent authorities, for example through MiFID requirements (see

the utility gained by the initial owner-manager would cease after time t, though there would continue to be n firms competing.

The utility function of the owner-manager of firm i in a stationary equilibrium in this setting is given by

$$V^i(p^e, y^e) = U^i(p^e, y^e) + e^{-r}(1 - \delta(y^e)) V^i(p^e, y^e)$$

as the owner-manager of firm i loses control of her firm with probability $\delta(y_i)$. Thus the probability of the game continuing for a given owner-manager becomes endogenous in this formulation. It follows that at equilibrium values:

$$V^i(p^e, y^e) = \frac{U^i(p^e, y^e)}{1 - e^{-r}(1 - \delta(y^e))}. \tag{40}$$

The first order condition with respect to price p_i for firm i is proportional to that in the single-stage game. However the first order condition with respect to malpractice, y_i, is more complicated:

$$V^i_{y_i}(p^e, y^e) = \frac{U^i_{y_i}(p^e, y^e)}{1 - e^{-r}(1 - \delta(y^e))} - V^i(p^e, y^e)\frac{e^{-r}\delta'(y^e)}{1 - e^{-r}(1 - \delta(y^e))}. \tag{41}$$

Taking differentials of the first order conditions yields:

$$\underbrace{\begin{pmatrix} \left(V^i_{y_i}(p^e, y^e)\right)_{y^e} & \left(V^i_{y_i}(p^e, y^e)\right)_{p^e} \\ \left(V^i_{p_i}(p^e, y^e)\right)_{y^e} & \left(V^i_{p_i}(p^e, y^e)\right)_{p^e} \end{pmatrix}}_{\tilde{\mathcal{H}}} \begin{pmatrix} dy^e \\ dp^e \end{pmatrix} = \begin{pmatrix} -\left(V^i_{y}(p^e, y^e)\right)_n \\ -\left(V^i_{p_i}(p^e, y^e)\right)_n \end{pmatrix} dn \tag{42}$$

Once again we observe that at a stable equilibrium we have that the $2n \times 2n$ Hessian matrix formed from the FOCs, such as (41), has negative eigenvalues (e.g. Dixit (1986)). The proof of Lemma 3 applies directly to this setting.[37] This yields that the eigenvalues of the 2×2 matrix $\tilde{\mathcal{H}}$ are negative. Hence $\det \tilde{\mathcal{H}} > 0$ allowing (42) to be inverted.

We are therefore in a position to extend Theorem 2:

Theorem 10 *Any symmetric stable equilibrium of the repeated game is characterised by a unique critical threshold, $n^{*repeat}$:*

1. *If $1 - F(x)$ is log-concave then the level of malpractice is positive and increasing in the number of competing firms for $n > n^{*repeat}$; and there is no malpractice if few enough firms compete ($n \le n^{*repeat}$).*

https://www.handbook.fca.org.uk/handbook/FIT.pdf). The US has a rules based approach in which evidence of specific malpractice is required to bar individuals from some sectors.

[37]Replace the U^i terms by V^i and observe that $V^i_{y_j} = 0 \forall j \neq i$ as $U^i_{y_j} = 0 \forall j \neq i$.

2. If $1 - F(x)$ is log-convex then the results are reversed: no malpractice for $n > n^{*repeat}$; and a positive level of malpractice which declines in the number of competing firms when $n \leq n^{*repeat}$.

The critical threshold $n^{*repeat}$ is the solution to

$$P\left(n^{*repeat}\right) = \frac{\delta'(0)\left(\Phi^{prof} + \Phi^{rev} + \frac{e^{-r}}{1-e^{-r}}\right)}{1 + \Omega - c\delta'(0)\Phi^{rev}}$$

And furthermore $n^{*repeat}$ is unique if $1 - F(x)$ is either log-concave or log-convex. The critical threshold may lie below 2, or at infinity, in which case the relevant region applies for all $n \geq 2$.

Proof. See Appendix A. ■

Theorem 10 may seem surprising as it demonstrates that equilibrium malpractice has fundamentally the same dependence on numbers of competitors in a market whether competition is a repeated game, or a one-shot interaction. When competition is a repeated game, malpractice in one period increases the risk to the owner-manager of the loss of all future utility. In future iterations of the market, firm i expects to serve an n^{th} of the consumers, and if this period's malpractice is not discovered she will in each period secure the equilibrium utility which also applies this period. Hence the contribution of future utility adds a term proportional to current utility to the owner-manager's utility. Furthermore, the constant of proportionality applying to this term only depends upon the level of malpractice, not the prices, as the former determines the probability of continuing to run the firm. This implies that the relationship between the first order conditions with respect to price, and the number of competitors, is not altered in sign, only in magnitude. But the impact of firm numbers on malpractice levels in equilibrium only operates through the indirect price channel; there is no direct channel. Therefore considerations of the future do not alter the comparative static of malpractice with respect to the number of competing firms; the structure of the equilibrium characterisation remains unchanged.

We conclude this section by noting that the market is more ethical in the repeated model than in the one-shot variant in the following sense:

Corollary 11 *Repetition of competition expands the set of competing firms which can sustain the no-malpractice equilibrium.*

Proof. Suppose that the one-shot game sustains no malpractice as an equilibrium, so that $U^i_{y_i}(p^e, y^e)|_{y_e=0} \leq 0$. By inspection of (41) we have $V^i_{y_i}(p^e, y^e)|_{y_e=0} < 0$ yielding the result. ■

It follows that if $1 - F(x)$ is log-concave than $n^* \leq n^{*repeat}$, while if consumer tastes are such that $1 - F(x)$ is log-convex then $n^{*repeat} \leq n^*$.

7.2 Existence of Equilibrium

So far we have characterised the properties of a stable equilibrium, when it exists; and we have explicitly constructed the equilibrium in the setting of Figure 1. Figure 1 permitted any distribution of consumer demand but assumed a linear malpractice detection technology and profit based sanctions. General equilibrium existence conditions are challenging in the setting of the Perloff and Salop (1985) discrete choice model. This is why Perloff and Salop (1985) do not prove existence for their general n firm game; and Zhou (2017) notes that little analytical progress has been made towards existence proofs in this setting.[38]

In this section we will derive conditions under which our game is a supermodular game on a lattice. This will allow us to use existing results concerning such games to prove equilibrium existence. We proceed by analysing the log-utility of each owner-manager. Thus the log-utility of firm i, which we will denote Θ^i, is:

$$\Theta^i\left(\underline{p}, y_i\right) := \ln q_i\left(\underline{p}\right) + \ln \varepsilon\left(p_i, y_i\right)$$

where

$$\varepsilon\left(p_i, y_i\right) := \left(p_i - c + y_i\right) - \delta\left(y_i\right)\left[\Phi^{prof}\left(p_i - c + y_i\right) + \Phi^{rev} p_i\right] + \Omega y_i$$

We require the objective function Θ^i to be well defined. The demand function $q_i\left(\underline{p}\right) \geq 0$ for all price vectors by the model construction given in (1). We require $\varepsilon\left(p_i, y_i\right) \geq 0$. This requires that (p_i, y_i) satisfy

$$p_i\left(1 - \delta(y_i)(\Phi^{prof} + \Phi^{rev})\right) \geq c - (1+\Omega)y_i - \delta(y_i)\Phi^{prof}(c - y_i) \tag{43}$$

Recall that by (6), $\delta(y_i)(\Phi^{prof} + \Phi^{rev}) \leq 1$ for all $y_i \in [0, \bar{y})$. Thus the log-utility of each owner-manager is well defined under the following assumption:

Assumption 2: Action sets are restricted such that

$$p_i > \frac{c - (1+\Omega)y_i - \delta(y_i)\Phi^{prof}(c - y_i)}{(1 - \delta(y_i)(\Phi^{prof} + \Phi^{rev}))} \tag{44}$$

We will not require an upper bound on the prices. If one were willing to assume this, then the action space would be a compact interval in both prices and in malpractice for each firm, given Assumptions 1 and 2. A symmetric mixed-strategy Nash equilibrium would then per force exist by Theorem 1 of Becker and Damianov (2006).

We look for conditions under which our game is a supermodular game in $(p_i, -y_i)$. Under such conditions a symmetric Nash equilibrium in pure strategies exists by Theorem 5 of Milgrom and Roberts (1990). To prove the game is supermodular we must

[38] See the discussion in Zhou (2017) after Proposition 8.

demonstrate assumptions $(A1)$-$(A4)$ in Milgrom and Roberts (1990) hold. $(A1)$ requires that each player's action set is a complete lattice. As the payoff functions in our game are continuous, assumptions $(A2)$-$(A4)$ can be simplified to assumptions $(A2')$-$(A4')$ in Milgrom and Roberts (1990).[39]

By inspection Θ^i is twice differentiable where it is defined, and so $(A2')$ is immediate. Now turn to assumption $(A3')$. Note that

$$\begin{aligned}\frac{\partial^2\Theta^i}{\partial p_i \partial(-y_i)} &= -\frac{\partial}{\partial p_i}\left(\frac{1+\Omega-\delta(y_i)\Phi^{prof}-\delta'(y_i)\left[\Phi^{prof}(p_i-c+y_i)+\Phi^{rev}p_i\right]}{\varepsilon(p_i,y_i)}\right) \\ &= \frac{1}{\varepsilon(p_i,y_i)^2}\left(\begin{array}{c}\varepsilon(p_i,y_i)\,\delta'(y_i)\left[\Phi^{prof}+\Phi^{rev}\right] \\ +\left(\begin{array}{c}1+\Omega-\delta(y_i)\Phi^{prof} \\ -\delta'(y_i)\left[\Phi^{prof}(p_i-c+y_i)+\Phi^{rev}p_i\right]\end{array}\right)\left(1-\delta(y_i)\left(\Phi^{prof}+\Phi^{rev}\right)\right)\end{array}\right)\end{aligned}$$

After substituting for $\varepsilon(p_i,y_i)$ and then performing some algebraic manipulation we can show that $\frac{\partial^2\Theta^i}{\partial p_i\partial(-y_i)} \geq 0$ if and only if

$$\left[\begin{array}{c}-\delta'(y_i)\Phi^{rev}(c-y_i)+\Omega y_i\delta'(y_i)\left[\Phi^{prof}+\Phi^{rev}\right] \\ +\left(1-\delta(y_i)\left[\Phi^{prof}+\Phi^{rev}\right]\right)\left(1+\Omega-\delta(y_i)\Phi^{prof}\right)\end{array}\right] \geq 0. \tag{45}$$

We will be able to guarantee that the inequality (45) holds under the following restriction:

Assumption 3: We assume that

$$\Omega + 1 - \delta'(0)\Phi^{rev}c > 0$$

Assumption 3 is a bound on the ethics of the owner-manager. A very ethical owner manager would have a small, and potentially even a negative value for Ω. This would happen, for example, if the owner-manager professed a duty-ethic and gave no weight to act-utilitarian reasoning. If the ethics are too strong, that is if Ω is sufficiently negative, then an interior equilibrium cannot exist – the owner-manager would not invoke the malpractice in equilibrium.

Under Assumption 3, we can see that (45) holds for y sufficiently small.[40] Let y^a denote the smallest positive root to (45),[41] then we can guarantee $(A3')$ holds under the following final Assumption:

Assumption 4: The scope for malpractice is restricted such that:

$$y \in [0, \min(\bar{y}, y^a)). \tag{46}$$

[39] $(A2')$ requires Θ^i to be twice continuously differentiable. $(A3')$ requires $\partial^2\Theta^i/\partial(-y_i)\partial p_i \geq 0 \forall i$ so that Θ^i is supermodular in own actions. $(A4')$ requires Θ^i to have increasing differences: $\partial^2\Theta^i/\partial p_i\partial p_j \geq 0$, $\partial^2\Theta^i/\partial y_i\partial y_j \geq 0$, and $\partial^2\Theta^i/\partial(-y_i)\partial p_j \geq 0$ for $i \neq j$.

[40] Evaluate (45) at $y_i = 0$ and note it is strictly satisfied given Assumption 3.

[41] And set $y^a \to \infty$ if there is no such root.

Turning to $(A4')$ we note that

$$\frac{\partial^2 \Theta^i}{\partial(-y_i)\,\partial p_j} = \frac{\partial^2 \Theta^i}{\partial(-y_i)\,\partial(-y_j)} = \frac{\partial^2 \Theta^i}{\partial p_i \partial(-y_j)} = 0 \text{ for } j \neq i$$

Next we consider

$$\frac{\partial^2 \Theta^i}{\partial p_i \partial p_j} = \frac{\partial^2 \ln q_i\left(\underline{p}\right)}{\partial p_i \partial p_j}.$$

We appeal to Quint (2014) Theorem 1 which delivers that the log of demand has increasing differences if $1 - F(x)$ is log-concave.[42]

Finally we consider $(A1)$. The action set of any given firm i, S^i, is the set $\{(-y_i, p_i)\}$ with elements satisfying Assumptions 2 and 4. By definition the action set is a complete lattice under the coordinate-wise order if given any subset $T \subset S^i$, $\inf(T)$ and $\sup(T)$ are contained in S^i:

Lemma 12 *The action sets S^i form a complete lattice under Assumptions 1 through 4.*

Proof. Consider two elements of S^i, $\sigma_a := (-y_a, p_a)$ and similarly σ_b. Without loss of generality $y_a \leq y_b$.

$$\sup T = (-y_a, p_a) \vee (-y_b, p_b) = (\max\{-y_a, -y_b\}, \max\{p_a, p_b\}) = (-y_a, \max\{p_a, p_b\})$$

Either $\sup T = \sigma_a \in S^i$, or $p_b > p_a$ in which case $\sigma_a \in S^i \Rightarrow (-y_a, p_b)$ satisfies Assumption 2 (and Assumption 4 trivially) and so $\sup T \in S^i$.

Next observe

$$\inf T = (-y_a, p_a) \wedge (-y_b, p_b) = (\min\{-y_a, -y_b\}, \min\{p_a, p_a\}) = (-y_b, \min\{p_a, p_b\})$$

If $p_b \leq p_a$ then $\inf T = \sigma_b \in S^i$. It remains to consider the case that $p_b > p_a$ implying $\inf T = (-y_b, p_a)$. Denote the lower bound of prices by $\underline{p}(y_i)$ given by the right hand side of (44). If

$$d\underline{p}/dy_i \leq 0 \tag{47}$$

then we have $\underline{p}(y_b) \leq \underline{p}(y_a) \leq p_a < p_b \Rightarrow \inf T \in S^i$. Condition (47) is confirmed by algebraic manipulation. This is shown explicitly in online Appendix E, Lemma 14. ■

The discussion in this section can be captured through the following result:

Theorem 13 *Suppose consumers' single-good demand function, $1-F(x)$, is log-concave, then under Assumptions 1 through 4, the n firm competition game has a symmetric pure strategy Nash equilibrium.*

[42] Quint (2014) allows the consumers to have the option of not purchasing so that the market may not be fully covered. However the proof of the relevant part of Theorem 1 does not use this, and so an identical exposition removing the option labeled $\{0\}$ would yield the required result.

Theorem 13 delivers the existence of at least one pure strategy Nash equilibrium for the central case of consumers' single-good demand function being log-concave, and with malpractice limited to not be too extreme. The theorem does not deliver the existence of a stable equilibrium. As noted above, an equilibrium which is not stable is not likely to have empirical relevance.

8 Conclusion

This paper offers a first attempt at introducing ethical considerations regarding the moral dilemma of cheating stakeholders to raise profits, into a theoretical model of product competition with regulatory oversight. The analysis allows me to offer an argument as to when we should expect competition to encourage unethical firm behaviour.

Bringing opportunities to cheat and ethical qualms into a model of market competition leads to the conclusion that malpractice can arise in some, but not all, competitive structures. The relationship between malpractice and competition hinges on the shape of consumers' taste distribution in a manner which can be characterised. The most standard distributions (normal, uniform, extreme value) yield a positive link between competition and malpractice. Stable competitive equilibria have a threshold property in the number of firms: if the number of firms goes above this threshold then equilibrium must have positive levels of malpractice, and the extent of malpractice grows the larger the number of competing firms. These results are robust whether the competition is one-off or repeated; and holds whether owner-managers profess an act utilitarian standard or a duty ethic.

I have also analysed asymmetric compeition in duopoly. In the prominent case (log-concave distributions of consumer tastes) improved ethics in one firm lowers equilibrium malpractice in both the rival, and the firm with improved ethics. If a firm approaches the technological frontier then prices fall at both firms; but the equilibrium level of malpractice in the industry rises.

The modelling approach towards duty ethics and act utilitarianism assumed that the human decision maker felt worse when harming a larger number of stakeholders. This may seem natural, but it would not be acceptable to Kant. A true Kantian would profess a Categorical Imperative such that harming one stakeholder would be no less bad than harming a multitude. Extending the model to permit such philosophically pure moral reasoning, we establish an *oligopoly – bad practice* result: a double threshold effect obtains whereby malpractice is only possible if the number of competing firms lies between the two thresholds.

A Omitted Proofs

Proof of Lemma 3. It will be helpful to denote, in this proof only:

$$\begin{aligned} a &: = U^i_{p_ip_i}\left(p^e,y^e\right), b := U^i_{p_ip_j}\left(p^e,y^e\right) \text{ for } j\neq i, \breve{c} := U^i_{y_ip_i}\left(p^e,y^e\right) \\ d &: = U^i_{y_ip_j}\left(p^e,y^e\right) \text{ for } j\neq i, e := U^i_{y_iy_i}\left(p^e,y^e\right) \end{aligned}$$

It then follows we can write

$$\mathcal{H} = \begin{pmatrix} e & \breve{c} + (n-1)\,d \\ \breve{c} & a + (n-1)\,b \end{pmatrix}$$

Now consider the requirements of stability (Dixit (1986)). Suppose the firms find themselves at a non-equilibrium point $\{\tilde{p}_j, \tilde{y}_j\}$, which is close to the equilibrium values p^e, y^e. Suppose each firm updates its prices and malpractice proportionally to the first order gain achieved by changing the variable. Using a Tayor Expansion for firm i, for points close to the equilibrium we have:

$$\begin{aligned} \dot{p}_i &:= U^i_{p_i}|_{(\underline{\tilde{p}},\underline{\tilde{y}})} \\ &= \left(\tilde{p}_i - p^e\right) U^i_{p_ip_i}\left(p^e,y^e\right) + \sum_{j\neq i}\left(\tilde{p}_j - p^e\right) U^i_{p_ip_j}\left(p^e,y^e\right) + \left(\tilde{y}_i - y^e\right) U^i_{p_iy_i}\left(p^e,y^e\right) \end{aligned}$$

A similar expression can be established for $\dot{y}_i$:

$$\begin{aligned} \dot{y}_i :=& U^i_{y_i}|_{(\underline{\tilde{p}},\underline{\tilde{y}})} \\ =& \left(\tilde{p}_i - p^e\right) U^i_{y_ip_i}\left(p^e,y^e\right) + \sum_{j\neq i}\left(\tilde{p}_j - p^e\right) U^i_{y_ip_j}\left(p^e,y^e\right) + \left(\tilde{y}_i - y^e\right) U^i_{y_iy_i}\left(p^e,y^e\right) \end{aligned}$$

The system path near to an equilibrium point is therefore captured by the following $2n \times 2n$ matrix:

$$\begin{pmatrix} \dot{y}_1 \\ \dot{p}_1 \\ \dot{y}_2 \\ \dot{p}_2 \\ \vdots \\ \dot{y}_n \\ \dot{p}_n \end{pmatrix} = \underbrace{\begin{pmatrix} e & \breve{c} & 0 & d & 0 & d & \cdots & 0 & d \\ \breve{c} & a & 0 & b & 0 & b & \cdots & 0 & b \\ 0 & d & e & \breve{c} & 0 & d & \cdots & 0 & d \\ 0 & b & \breve{c} & a & 0 & b & \cdots & 0 & b \\ & & \vdots & & & & \vdots & & \\ 0 & d & 0 & d & 0 & d & \cdots & e & \breve{c} \\ 0 & b & 0 & b & 0 & b & \cdots & \breve{c} & a \end{pmatrix}}_{\mathcal{A}} \begin{pmatrix} \tilde{y}_1 - y^e \\ \tilde{p}_1 - p^e \\ \tilde{y}_2 - y^e \\ \tilde{p}_2 - p^e \\ \vdots \\ \tilde{y}_n - y^e \\ \tilde{p}_n - p^e \end{pmatrix}$$

We have denoted the transition matrix $\mathcal{A}$. Stability of the equilibrium at p^e, y^e requires that all the eigenvalues of $\mathcal{A}$ have negative real parts (Dixit (1986), Anishchenko et al.

(2014) Chapter 2).

Suppose now that λ is an eigenvalue of $\mathcal{H}$ with eigenvector $(\omega_1, \omega_2)^T$. Thus

$$\begin{pmatrix} e & \check{c} + (n-1)\,d \\ \check{c} & a + (n-1)\,b \end{pmatrix} \begin{pmatrix} \omega_1 \\ \omega_2 \end{pmatrix} = \begin{pmatrix} e\omega_1 + \omega_2\,(\check{c} + (n-1)\,d) \\ \check{c}\omega_1 + \omega_2\,(a + (n-1)\,b) \end{pmatrix} = \lambda \begin{pmatrix} \omega_1 \\ \omega_2 \end{pmatrix}. \tag{48}$$

We show that λ must be an eigenvalue of the matrix $\mathcal{A}$.

Consider the $2n$ vector

$$W := (\omega_1, \omega_2, \omega_1, \omega_2, \cdots, \omega_1, \omega_2)^T.$$

We have

$$AW = \begin{pmatrix} e & \check{c} & 0 & d & 0 & d & \cdots & 0 & d \\ \check{c} & a & 0 & b & 0 & b & \cdots & 0 & b \\ 0 & d & e & \check{c} & 0 & d & \cdots & 0 & d \\ 0 & b & \check{c} & a & 0 & b & \cdots & 0 & b \\ & & \vdots & & & & \vdots & & \\ 0 & d & 0 & d & 0 & d & \cdots & e & \check{c} \\ 0 & b & 0 & b & 0 & b & \cdots & \check{c} & a \end{pmatrix} \begin{pmatrix} \omega_1 \\ \omega_2 \\ \omega_1 \\ \omega_2 \\ \vdots \\ \omega_1 \\ \omega_2 \end{pmatrix} = \begin{pmatrix} e\omega_1 + \omega_2\,(\check{c} + (n-1)\,d) \\ \check{c}\omega_1 + \omega_2\,(a + (n-1)\,b) \\ e\omega_1 + \omega_2\,(\check{c} + (n-1)\,d) \\ \check{c}\omega_1 + \omega_2\,(a + (n-1)\,b) \\ \vdots \\ e\omega_1 + \omega_2\,(\check{c} + (n-1)\,d) \\ \check{c}\omega_1 + \omega_2\,(a + (n-1)\,b) \end{pmatrix}$$

Invoking (48) we have

$$\mathcal{A}W = \lambda W,$$

as required.

Stability of the system thus implies that λ has negative real parts and so the result is proved. ■

Proof of Lemma 7. The proof uses the second order conditions (28) and (29) arising from the requirement that each firm is optimising against its rivals, and two further results.

The first subsequent required observation arises from the first order conditions (27) combined with (30) which imply that

$$U^2_{y_2 p_2} = q_2 \left(-\delta'(y_2)(\Phi^{prof} + \Phi^{rev}) \right) < 0. \tag{49}$$

And analogously for $U^1_{y_1 p_1}$.

The second observation arises by using the first order condition $U^1_{p_1} = 0$ to substitute into the second derivative term $U^1_{p_1 p_2}$. We have

$$U^1_{p_1 p_2} = \left(1 - \delta(y_1)(\Phi^{prof} + \Phi^{rev})\right) \cdot \left(\frac{\partial^2 q_1}{\partial p_1 \partial p_2} \frac{q_1}{-\frac{\partial q_1}{\partial p_1}} + \frac{\partial q_1}{\partial p_2} \right)$$

Now recalling Assumption 1 and observing that

$$\frac{\partial^2 \ln q_1}{\partial p_1 \partial p_2} = \frac{1}{q_1^2}\left(q_1 \frac{\partial^2 q_1}{\partial p_1 \partial p_2} - \frac{\partial q_1}{\partial p_1}\frac{\partial q_1}{\partial p_2}\right),$$

we have that

$$U^1_{p_1 p_2} =_{\text{sign}} \frac{\partial^2 \ln q_1}{\partial p_1 \partial p_2}$$

The result now follows algebraically by inspection of the cofactors (34)–(37), and similarly for the third column of $\tilde{\mathcal{A}}^{-1}$ in (33). For ease of replication note that

$$M_{31} = -U^1_{y_1 p_1} U^1_{p_1 p_2} U^2_{y_2 p_2} \qquad M_{32} = -U^1_{y_1 y_1} U^1_{p_1 p_2} U^2_{y_2 p_2}$$

$$M_{33} = \left(U^1_{y_1 y_1} U^1_{p_1 p_1} - (U^1_{y_1 p_1})^2\right) U^2_{p_2 p_2} - U^1_{y_1 y_1} U^1_{p_1 p_2} U^2_{p_2 p_1} \qquad M_{34} = U^2_{y_2 p_2}\left(U^1_{y_1 y_1} U^1_{p_1 p_1} - (U^1_{y_1 p_1})^2\right)$$

■

Proof of Proposition 8. The results in line (38) follow as described in the text using Lemma 7. For Line (39) observe that

$$U^i_{y_i} = q_i\left(\underline{p}\right)\left(\Omega_i + 1 - \delta'\left(y_i\right)\left(\Phi^{prof}(p_i - c_i + y_i) + \Phi^{rev} p_i\right) - \delta\left(y_i\right)\Phi^{prof}\right)$$

Now suppose we begin at equilibrium in which the first order condition is satisfied ($U^2_{y_2} = 0$). For a contradiction suppose that $dy^e_2/d\Omega_2 \leq 0$. If Ω_2 were to rise then we know from (38) that at the new equilibrium p_2 is lower, and by assumption y_2 is also weakly lower. Note that these imply that $\delta'\left(y_2\right)$ has shrunk, as has $\delta(y_2)$. But collectively we must then have $U^2_{y_2} > 0$ which is a contradiction to equilibrium. ■

Proof of Theorem 10. The proof proceeds analogously to that used in Theorem 2. We focus here only on elements which are different. First to establish that $(V^i_{y_i}(p^e, y^e))_n = 0$ we use (41) to write:

$$\left(V^i_{y_i}\left(p^e, y^e\right)\right)_n = \frac{\left(U^i_{y_i}\left(p^e, y^e\right)\right)_n}{1 - e^{-r}\left(1 - \delta\left(y^e\right)\right)} - \left(V^i\left(p^e, y^e\right)\right)_n \frac{e^{-r}\delta'\left(y^e\right)}{1 - e^{-r}\left(1 - \delta\left(y^e\right)\right)} \tag{50}$$

We observe that $\left(U^i_{y_i}\left(p^e, y^e\right)\right)_n = -\frac{1}{n} U^i_{y_i}\left(p^e, y^e\right)$ from (13). Also

$$\left(V^i\left(p^e, y^e\right)\right)_n = \frac{\left(U^i\left(p^e, y^e\right)\right)_n}{1 - e^{-r}\left(1 - \delta\left(y^e\right)\right)} = \frac{-\frac{1}{n} U^i\left(p^e, y^e\right)}{1 - e^{-r}\left(1 - \delta\left(y^e\right)\right)} = -\frac{1}{n} V^i\left(p^e, y^e\right)$$

where the second equality uses (8). So substituting back into (50) we have

$$\left(V^i_{y_i}\left(p^e, y^e\right)\right)_n = -\frac{1}{n} V^i_{y_i}\left(p^e, y^e\right) \text{ using (41)} = 0.$$

The final equality follows from the first order condition on the level of malpractice.

Next we sign $\left(V_{y_i}^i\left(p^e,y^e\right)\right)_{p^e}$ by writing

$$\left(V_{y_i}^i\left(p^e,y^e\right)\right)_{p^e}=\frac{\left(U_{y_i}^i\left(p^e,y^e\right)\right)_{p^e}}{1-e^{-r}\left(1-\delta\left(y^e\right)\right)}-\left(U^i\left(p^e,y^e\right)\right)_{p^e}\frac{e^{-r}\delta'\left(y^e\right)}{\left[1-e^{-r}\left(1-\delta\left(y^e\right)\right)\right]^2} \tag{51}$$

(17) confirmed that $\left(U_{y_i}^i\left(p^e,y^e\right)\right)_{p^e}<0$. For the second term

$$\begin{aligned}\left(U^i\left(p^e,y^e\right)\right)_{p^e} &= \frac{\partial}{\partial p^e}\left\{\frac{1}{n}\left(p^e-c+y^e-\delta\left(y^e\right)\left[\Phi^{prof}\left(p^e-c+y^e\right)+\Phi^{rev}p^e\right]+\Omega y^e\right)\right\}\\ &= \frac{1}{n}\left(1-\delta\left(y^e\right)\left(\Phi^{prof}+\Phi^{rev}\right)\right)>0 \text{ under condition (6).}\end{aligned}$$

Combining in (51) we establish that $\left(V_{y_i}^i\left(p^e,y^e\right)\right)_{p^e}<0$. So we can write:

$$\begin{pmatrix} dy^e \\ dp^e \end{pmatrix}=\frac{1}{\det\tilde{\mathcal{H}}}\begin{pmatrix} \bullet & \cancel{-(V_{y_i}^i(p^e,y^e))_{p_e}}\ \text{+ve} \\ \bullet & \cancel{(V_{y_i}^i(p^e,y^e))_{y_e}}\ \text{-ve} \end{pmatrix}\begin{pmatrix} 0 \\ -(V_{p_i}^i(p^e,y^e))_n \end{pmatrix}dn$$

Note that $(V_{y_i}^i(p^e,y^e))_{y_e}$ is negative using the second order conditions given owner-manager optimisation.

The next step is therefore to simplify $(V_{p_i}^i(p^e,y^e))_n$:

$$\begin{aligned}\left(V_{p_i}^i\left(p^e,y^e\right)\right)_n &= \underbrace{\frac{-\frac{1}{n}U_{p_i}^i\left(p^e,y^e\right)}{1-e^{-r}\left(1-\delta\left(y^e\right)\right)}}_{=-\frac{1}{n}V_{p_i}^i=0}-\frac{\frac{P'(n)}{n}\begin{pmatrix}\Omega y^e+p^e\left(1-\delta\left(y^e\right)\left(\Phi^{prof}+\Phi^{rev}\right)\right)\\ -\left(c-y^e\right)\left(1-\delta\left(y^e\right)\Phi^{prof}\right)\end{pmatrix}}{1-e^{-r}\left(1-\delta\left(y^e\right)\right)} \quad \text{from (14)}\\ &= \frac{P'\left(n\right)}{P\left(n\right)}\left(\underbrace{V_{p_i}^i}_{=0}-\frac{1}{n}\cdot\frac{1-\delta\left(y^e\right)\left(\Phi^{prof}+\Phi^{rev}\right)}{1-e^{-r}\left(1-\delta\left(y^e\right)\right)}\right)\\ &=_{\text{sign}}-P'\left(n\right)\ \text{ under condition (6).}\end{aligned}$$

The comparative static characterisation result now follows identically to Theorem 2.

Finally the critical threshold for malpractice is derived by setting the first order conditions to equality at no-malpractice. At such a point $n=n^{*repeat}$ where:

$$V_{y_i}^i\Big|_{y^e=0}=\frac{\frac{1}{n}\left(1+\Omega-p^e\delta'(0)\left(\Phi^{prof}+\Phi^{rev}\right)+c\delta'(0)\Phi^{prof}\right)}{1-e^{-r}}-\frac{e^{-r}\delta'(0)}{\left(1-e^{-r}\right)^2}\cdot\frac{1}{n}(p^e-c)=0$$

$$V_{p_i}^i\Big|_{y^e=0}=\frac{1}{1-e^{-r}}\left(-\frac{P(n)}{n}(p^e-c)+\frac{1}{n}\right)=0$$

So in a no malpractice equilibrium we have $p^e-c=1/P(n)$. Hence substituting out for p^e yields $n^{*repeat}$ as given in the statement of Theorem 10. ■

B Worked Example: Linear Detection Technology with Profit Based Sanctions

Assume $\delta(y_i) := \delta^o y_i$, and a profit based sanction: $\Phi^{rev} = 0 < \Phi^{prof}$. Condition (6) requires $\delta^o \bar{y} \Phi^{prof} \leq 1$. The first order condition with respect to the level of malpractice y_i follows from (13) as

$$\begin{aligned} U^i_{y_i}(p^e, y^e) &= \frac{1}{n}\left(\Omega - p^e \delta^o \Phi^{prof} + (c - y^e)\delta^o \Phi^{prof} + 1 - \delta^o y^e \Phi^{prof}\right) \\ &= \frac{1}{n}\delta^o \Phi^{prof}\left(\frac{\Omega + 1}{\delta^o \Phi^{prof}} + c - 2y^e - p^e\right) \end{aligned}$$

The first order condition with respect to each firm's own prices (14) yields

$$U^i_{p_i}(p^e, y^e) = \frac{1}{n}\left(1 - \delta^o \Phi^{prof} y^e - P(n)\begin{pmatrix} \Omega y^e + p^e\left(1 - \delta^o \Phi^{prof} y^e\right) \\ -(c - y^e)\left(1 - \delta^o \Phi^{prof} y^e\right)\end{pmatrix}\right)$$

which can be written

$$U^i_{p_i}(p^e, y^e) = \frac{1}{n}\left(1 - \delta^o \Phi^{prof} y^e\right)\left(1 - P(n)\left(\frac{\Omega y^e}{1 - \delta^o \Phi^{prof} y^e} + p^e - (c - y^e)\right)\right)$$

We plot these first order condition curves in Figure 1, and we add in the dynamic laws of motion given by $\dot{p}_i = U^i_{p_i}(p^e, y^e)$ and $\dot{y}_i = U^i_{y_i}(p^e, y^e)$. This allows us to determine that the stable symmetric equilibrium is given by the smaller of the two roots to the system of equations:

$$\begin{aligned} p^e &= \frac{\Omega + 1}{\delta^o \Phi^{prof}} + c - 2y^e \\ 1 &= P(n)\left(\frac{\Omega y^e}{1 - \delta^o \Phi^{prof} y^e} + p^e - (c - y^e)\right) \end{aligned}$$

Note that inspection of the points at which the curves cross the line $y^e = 0$ yields a necessary condition for an interior stable solution to exist: $\delta^o \Phi^{prof} < P(n)(1 + \Omega)$. Solving the system of equations yields a quadratic whose solution can be explicitly established as:

$$y^e = \frac{2P(n) - \delta^o \Phi^{prof} - \sqrt{\left(2P(n) - \delta^o \Phi^{prof}\right)^2 - 4P(n)\left(P(n)(1 + \Omega) - \delta^o \Phi^{prof}\right)}}{2P(n)\,\delta^o \Phi^{prof}}.$$

C Log-concave and log-convex distribution functions

Table 3: Taste Distributions which generate log-concave and log-convex single-good demand functions, and their expressions for $P(n)$ where available.
NOTES: Working in the Online Appendix and building on Bagnoli and Bergstrom (2005).

Name of taste distribution	Support	Density function $f(x)$	Distribution function $F(x)$	$P(n)$
Log-concave Underlying Demand Function				
Uniform	$[0,a]$	$1/a$	x/a	n/a
Normal	$(-\infty,\infty)$	$\frac{1}{\sqrt{2\pi}}e^{-x^2/2}$	$*$	$*$
Exponential	$(0,\infty)$	$\lambda e^{-\lambda x}$	$1-e^{-\lambda x}$	λ
Logistic	$(-\infty,\infty)$	$\frac{e^{-(x-\mu)}}{\left(1+e^{-(x-\mu)}\right)^2}$	$\frac{1}{1+e^{-(x-\mu)}}$	$\frac{n-1}{n+1}$
Extreme Value	$(-\infty,\infty)$	$\frac{1}{\sigma}e^{-x/\sigma}\exp\left(-e^{-x/\sigma}\right)$	$\exp\left(-e^{-x/\sigma}\right)$	$\frac{n-1}{\sigma n}$
Laplace (Double Exponential)	$(-\infty,\infty)$	$\frac{1}{2}e^{-\lvert x-\mu\rvert}$	$\begin{cases}\frac{1}{2}e^{x-\mu} & \text{if } x<\mu\\ 1-\frac{1}{2}e^{-(x-\mu)} & \text{if } x\geq\mu\end{cases}$	$1-\frac{1}{2^{n-1}}$
Power function $(c\geq 1)$	$(0,1]$	cx^{c-1}	x^c	$\frac{c^2n(n-1)}{nc-1}$
Weibull $(c\geq 1)$	$[0,\infty)$	$cx^{c-1}e^{-x^c}$	$1-e^{-x^c}$	$*$
Gamma $(c\geq 1)$	$[0,\infty)$	$\frac{x^{c-1}e^{-x}}{\Gamma(c)}$	$*$	$*$
Chi-Squared $(c\geq 2)$	$[0,\infty)$	$\frac{x^{(c-2)/2}e^{-x/2}}{2^{c/2}\Gamma(c/2)}$	$*$	$*$
Chi $(c\geq 1)$	$[0,\infty)$	$\frac{x^{c-1}e^{-x^2/2}}{2^{(c-2)/2}\Gamma(c)}$	$*$	$*$
Beta $(\nu\geq 1,\omega\geq 1)$	$[0,1]$	$\frac{x^{\nu-1}(1-x)^{\omega-1}}{B(\nu,\omega)}$	$*$	$*$
Log-convex Underlying Demand Function				
Weibull $(0<c<1)$	$[0,\infty)$	$cx^{c-1}e^{-x^c}$	$1-e^{-x^c}$	$*$
Gamma $(0<c<1)$	$[0,\infty)$	$\frac{x^{c-1}e^{-x}}{\Gamma(c)}$	$*$	$*$
Pareto	$[1,\infty)$	$\frac{\beta}{x^{\beta+1}}$	$1-\frac{1}{x^\beta}$	$*$

References

Ades, A. and R. Di Tella (1999). Rents, competition, and corruption. *American economic review 89*(4), 982–993.

Albuquerque, R. A., Y. Koskinen, and C. Zhang (2018). Corporate social responsibility and firm risk: Theory and empirical evidence. *Management Science*.

Allen, F. and D. Gale (2004). Competition and financial stability. *Journal of Money, Credit, and banking 36*(3), 453–480.

Anderson, S. P., A. De Palma, and Y. Nesterov (1995). Oligopolistic competition and the optimal provision of products. *Econometrica: Journal of the Econometric Society*, 1281–1301.

Anishchenko, V. S., T. Vadivasova, and G. Strelkova (2014). *Deterministic Nonlinear Systems*. Springer.

Arrow, K. (1973). Some ordinalist-utilitarian notes on rawls's theory of justice. *The Journal of Philosophy 70*(9), 245–263.

Auger, P. and T. M. Devinney (2007). Do what consumers say matter? the misalignment of preferences with unconstrained ethical intentions. *Journal of Business Ethics 76*(4), 361–383.

Bagnoli, M. and T. Bergstrom (2005). Log-concave probability and its applications. *Economic theory 26*(2), 445–469.

Bar-Isaac, H. and J. Shapiro (2013). Ratings quality over the business cycle. *Journal of Financial Economics 108*(1), 62–78.

Beck, T., A. Demirgüç-Kunt, and R. Levine (2006). Bank concentration, competition, and crises: First results. *Journal of Banking & Finance 30*(5), 1581–1603.

Becker, B. and T. Milbourn (2011). How did increased competition affect credit ratings? *Journal of Financial Economics 101*(3), 493–514.

Becker, J. G. and D. S. Damianov (2006). On the existence of symmetric mixed strategy equilibria. *Economics Letters 90*(1), 84–87.

Bénabou, R. and J. Tirole (2006). Incentives and prosocial behavior. *American economic review 96*(5), 1652–1678.

Bénabou, R. and J. Tirole (2011). Identity, morals, and taboos: Beliefs as assets. *The Quarterly Journal of Economics 126*(2), 805–855.

Bentham, J. (2007 [1789]). *An introduction to the principles of morals and legislation*. Dover.

Besley, T. and M. Ghatak (2005). Competition and incentives with motivated agents. *The American economic review 95*(3), 616–636.

Bolton, G. E. and A. Ockenfels (2000). Erc: A theory of equity, reciprocity, and competition. *American Economic Review 90*(1), 166–193.

Boskovic, T., C. Cerruti, and M. Noel (2010). *Comparing European and US securities regulations: MiFID versus corresponding US regulations*, Volume 184. World Bank Publications.

Bowie, N. E. (2017). *Business ethics: A Kantian perspective*. Cambridge University Press.

Camerer, C. F. and R. H. Thaler (1995). Anomalies: Ultimatums, dictators and manners. *Journal of Economic perspectives 9*(2), 209–219.

Carlin, B. and S. Gervais (2009). Work ethic, employment contracts, and firm value. *The Journal of Finance 64*(2), 785–821.

Carrington, M. J., B. A. Neville, and G. J. Whitwell (2010). Why ethical consumers dont walk their talk: Towards a framework for understanding the gap between the ethical purchase intentions and actual buying behaviour of ethically minded consumers. *Journal of business ethics 97*(1), 139–158.

Cavanagh, G. F., D. J. Moberg, and M. Velasquez (1981). The ethics of organizational politics. *Academy of Management Review 6*(3), 363–374.

Charness, G. and M. Rabin (2002). Understanding social preferences with simple tests. *Quarterly Journal of Economics 117*(3), 817–869.

Chen, Y. and M. H. Riordan (2008). Price-increasing competition. *The RAND Journal of Economics 39*(4), 1042–1058.

Cooper, D. J. and J. H. Kagel (2016). Other-regarding preferences. *The handbook of experimental economics 2*, 217.

Dixit, A. (1986). Comparative statics for oligopoly. *International economic review*, 107–122.

Edmans, A. (2012). The link between job satisfaction and firm value, with implications for corporate social responsibility. *The Academy of Management Perspectives 26*(4), 1–19.

Egan, M., G. Matvos, and A. Seru (2016). The market for financial adviser misconduct. Technical report, National Bureau of Economic Research.

Ely, J. C. and J. Välimäki (2003). Bad reputation. *The Quarterly Journal of Economics 118*(3), 785–814.

Fehr, E. and K. M. Schmidt (1999). A theory of fairness, competition, and cooperation. *The quarterly journal of economics 114*(3), 817–868.

Fritzsche, D. J. and H. Becker (1984). Linking management behavior to ethical philosophy—an empirical investigation. *Academy of Management Journal 27*(1), 166–175.

Gabaix, X., D. Laibson, D. Li, H. Li, S. Resnick, and C. G. de Vries (2016). The impact of competition on prices with numerous firms. *Journal of Economic Theory 165*, 1–24.

Giannetti, M., J. Liberti, and J. Sturgess (2017). Information sharing and rating manipulation. *The Review of Financial Studies*, hhx050.

Gill, D. and J. Thanassoulis (2016). Competition in posted prices with stochastic discounts. *The Economic Journal 126*(594), 1528–1570.

Grabowski, H. G. and J. M. Vernon (1992). Brand loyalty, entry, and price competition in pharmaceuticals after the 1984 drug act. *The journal of law and economics 35*(2), 331–350.

Hart, O. and L. Zingales (2017). Companies should maximize shareholder welfare not market value.

Hausman, D. and M. McPherson (1993). Taking ethics seriously: Economics and contemporary moral philosophy. *The Journal of Economic Literature 31*(2), 671–731.

Kant, I. (2012 [1785]). *Groundwork of the Metaphysics of Morals.* Cambridge University Press.

Kartner, J. and C. M. Warner (2015). Multi-nationals and corruption systems: The case of siemens. *Working Paper*.

Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking. *The American Economic Review*, 1183–1200.

Kwok, C. C. and S. Tadesse (2006). The mnc as an agent of change for host-country institutions: Fdi and corruption. *Journal of International Business Studies 37*(6), 767–785.

Lancaster, P. and M. Tismenetsky (1985). *The theory of matrices: with applications.* Elsevier.

Milgrom, P. and J. Roberts (1990). Rationalizability, learning, and equilibrium in games with strategic complementarities. *Econometrica: Journal of the Econometric Society*, 1255–1277.

Mill, J. S. (1863). *Utilitarianism.* London: Parker, Son and Bourn.

Morrison, A. and J. Thanassoulis (2017). Ethical standards and cultural assimilation in financial services.

Perloff, J. M. and S. C. Salop (1985). Equilibrium with product differentiation. *The Review of Economic Studies 52*(1), 107–120.

Perloff, J. M., V. Y. Suslow, and P. J. Seguin (2006). Higher prices from entry: Pricing of brand-name drugs.

Premeaux, S. R. (2004). The current link between management behavior and ethical philosophy. *Journal of Business Ethics 51*(3), 269–278.

Quint, D. (2014). Imperfect competition with complements and substitutes. *Journal of Economic Theory 152*, 266–290.

Rabin, M. (1993). Incorporating fairness into game theory and economics. *The American economic review*, 1281–1302.

Rawls, J. (1971). *A Theory of Justice* (Revised (1990) ed.). Oxford, UK: Oxford University Press.

Rhodes, A. and C. M. Wilson (2018). False advertising. *The RAND Journal of Economics 49*(2), 348–369.

Roberts, R. C. (1984). Will power and the virtues. *Philosophical Review 93*(2), 227–247.

Rodriguez, P., K. Uhlenbruck, and L. Eden (2005). Government corruption and the entry strategies of multinationals. *Academy of management review 30*(2), 383–396.

Shaked, M. (1982). Dispersive ordering of distributions. *Journal of Applied Probability 19*(2), 310–320.

Solomon, R. C. (1993). *Ethics and excellence*. Oxf. UP (NY).

Thomadsen, R. (2007). Product positioning and competition: The role of location in the fast food industry. *Marketing Science 26*(6), 792–804.

Uhlenbruck, K., P. Rodriguez, J. Doh, and L. Eden (2006). The impact of corruption on entry strategy: Evidence from telecommunication projects in emerging economies. *Organization science 17*(3), 402–414.

Ward, M. B., J. P. Shimshack, J. M. Perloff, and J. M. Harris (2002). Effects of the private-label invasion in food industries. *American Journal of Agricultural Economics 84*(4), 961–973.

Wolf, M. (2004). *Why globalization works*. Yale University Press.

Zhou, J. (2017). Competitive bundling. *Econometrica 85*(1), 145–172.