Industry Structure, Executive Pay, and Short-Termism

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June 6, 2012

Abstract

This study outlines a new theory linking industry structure to optimal employment contracts and executive short-termism. Firms hire their executives using optimal contracts derived within a competitive labour market. To motivate effort firms must use some variable remuneration. Such remuneration introduces a myopia problem: an executive would wish to inflate early expected earnings at some risk to future profits. To manage this short-termism some bonus pay is deferred. Convergence in size amongst firms makes the cost of managing the myopia problem grow faster than the cost of managing the effort problem. Eventually the optimal contract jumps from one deterring myopia to one tolerating myopia. Under some conditions the industry partitions: the largest firms hire executives on contracts tolerant of myopia, smaller firms ensure myopia is ruled out.

Keywords: myopia; moral hazard; compensation; bonuses; bankers' pay; deferred pay; vested pay.

JEL Classification: L14, G34, G21.

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I would like to thank the editor, Wei Xiong, and the anonymous referee team for detailed comments which led to significant improvements in this paper. In addition I would like to thank Bruno Biais, Steve Bond, Mike Devereux, Michael Faulkender, Paolo Fulghieri, Alexander Guembel, Christos Ioannidis, Mikko Leppamaki, and Jean Tirole for helpful comments on an earlier draft. I am grateful for comments also from seminar participants at IESE in Barcelona, Bath, the CEPR IO Conference in Cyprus, the FDIC in the US, Oxford, SUERF/Bank of Finland, Leicester, and Toulouse. The hospitality of IDEI, Toulouse whilst I was undertaking much of this project is gratefully acknowledged. This work previously circulated under the title *Bankers' Pay Structure And Risk.*

1 Introduction

A narrative of the recent financial crisis is that remuneration contracts resulted in bankers receiving pay focused too much on short-term revenues. As a result senior policy makers in the US, EU and G20 have criticised the significant risks which built up in the financial system.

The concern that executives put short-term results ahead of long term value creation is not specific to financial services. In the accounting scandals predating Sarbanes-Oxley a compelling narrative was that pressure to deliver short-term results meant profits were booked early and results manipulated, raising the risk of failure and problems in the future.[1] In major accidents in industries such as the oil industry, the narrative was again that pressure for short-term results led to executives at many levels overly discounting possible future costs by cutting back on due testing and delaying safety driven interruptions to production.[2] Similarly in price fixing cartels, executives focus on the short-term when they ignore the potential impact of fines and law suits on future profits by breaking the law and price fixing.

There are therefore many instances across numerous industries when firms seem to act in a short-termist way. This begs the question of why firms would choose to offer remuneration contracts which can induce myopia in the first place. I offer an explanation by studying a model of the contracting problem between properly governed firms and their executives, embedded in a competitive market for executive talent. Understanding why firms might choose to tolerate short-termism inducing pay is important, particularly now in the context of an active policy debate on executive remuneration across all industries in both the US and the UK.[3]

The model I offer has three key parts. First, I consider the labour market for executives to run any given activity undertaken by firms which differ in the size of their resources. Second, the executives are subject to two standard contracting frictions. Executives must be motivated to exert effort; they must also be motivated to avoid myopic behaviour. That is to avoid short-termism in project choice. Such myopia can manifest itself as share-price manipulation (Stein (1989)); by the use of innovative financial products (Foster and Young (2010)); or by relaxing quality control (Landier, Sraer and Thesmar (2010)). The analysis here encompasses all of these. Finally these features are combined into a dynamic analysis. First firms compete to hire executives using dynamic remuneration contracts. Next the executive hired to run a firm's operation makes his effort and business choices and results are realised.

Competition between firms for executives determines a market rate of surplus which executives will secure, and a match between executives and firms. The market rate is determined by the amount of surplus which the marginal competing firm is willing to offer to hire that executive instead of the one it will be hiring in equilibrium. Competition between firms does not force one particular remuneration structure on a firm rather than another, it purely sets the surplus which must be delivered.

[1] See, for example, the speech by SEC Chairman Levitt to the NYU Center for Law And Business, September 28, 1998. Available at http://www.sec.gov/news/speech/speecharchive/1998/spch220.txt

[2] See, for example, the James Baker report into the Texas City Disaster of BP. Report available at http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/SP/STAGING/local_assets/assets/pdfs/Baker_panel_report.pdf The short term focus of executives at BP is described at the bottom of page xii.

[3] The policy debate includes the UK consultation on executive remuneration, and the US 'say on pay' proposals. In addition, focused on finance, are the international FSB guidelines for pay and the Dodd-Frank Act in the US.

To incentivise effort sufficient variable pay needs to be provided. The variable pay can be payable early, or some of it could be deferred and reflect actually delivered results. Paying bonuses based on early performance introduces the myopia, or short-termism, problem. If pay and bonuses can be increased by short-term results then an executive will be incentivised to select myopic actions which increase the firm's expected immediate profits, whilst creating a risk of some larger loss in the future. To mitigate the myopia problem some of the pay must be deferred. Using deferred pay comes at a cost however: the executive discounts the future.

It is therefore possible, in principle, for a firm to hire its executive on a contract which does not tolerate myopia. However the analysis demonstrates that competition between the firms to hire their executives creates a negative externality: firms who actively bid to hire executives which they ultimately fail to hire have the effect of raising the level of remuneration these executives receive. As competition between firms drives up the surplus supplied to hire an executive, the cost of incentivising effort from the executive also rises due to the executive's income effect. The income effect captures that the benefit of shirking (or equivalently of leisure) is a normal good. Thus to motivate the same level of effort from a better paid executive requires greater incentive pay.

What is new in this analysis is that as the surplus which must be supplied to an executive rises, the cost to the firm of managing the myopia problem rises more rapidly than the cost of managing the effort problem. This is because long-term pay is more costly to the firm due to the manager's impatience. The benefit of avoiding myopia to a firm is independent of the market rate executives command. Therefore if the market rate of executives should grow high enough, some firms will find it optimal to use contracts which tolerate the possibility of myopia.

The market rate executives command is endogenous. In particular it depends upon the industrial structure of the competing firms. If firms converge in size then the negative externality inherent in competition will drive up the market rates executives command. To deliver the required surplus and ensure no myopia the employing firm will need to increase the surplus faster still as the deferred portion of pay is partly discounted by the executive. If convergence should become sufficient then the balance of costs and benefits swings: the employing firm, motivated to maximise value, endogenously chooses to jump to a contract form which permits some myopia. Hence the paper identifies and studies a link between industry structure and myopia. Under some conditions I demonstrate that the industry will partition: the largest firms will hire their executives on contracts which over-weight short term incentives and so implicitly tolerate myopia, while smaller firms ensure myopia is ruled out.

This paper therefore demonstrates how changes in industry structure can lead to a firm choosing to move from a no myopia equilibrium to one in which some myopia is tolerated. Such calculations are conducted from the viewpoint of the firm. To the extent that short-termism creates negative consequences for parties other than the firm there is a rationale for regulatory intervention.

Related Literature

To study the link between optimal contracting and industry structure I offer a model of a competitive labour market between firms for executives. This endeavour builds upon and complements the work of Gabaix and Landier (2008), Edmans, Gabaix and Landier (2009),

Tervio (2008) and Acharya and Volpin (2010). In these papers the authors study models of a competitive labour market for CEOs. My contribution is to reformulate these models to allow for both myopia and the need to incentivise effort in a dynamic setting. This extension is key. Without extending the activities of the agent across multiple periods the incentives for short-termism and so the rationale for deferred pay cannot be studied. This extension results in the equilibrium characteristics depending upon the model parameters. For some parameters equilibrium exists without firms allowing myopia. Otherwise the equilibrium changes to one where myopia is tolerated. Thus, unlike these market equilibrium models, I am able to link the jump from one form of the equilibrium to another to the prevailing industry structure.

There has long been a concern that inappropriately designed incentive pay can lead executives to chase short-term results and so take value reducing myopic actions. A foundational work here is Stein (1989). Many have built on Stein's insight (see for example Goldman and Slezak (2006)). In Stein's work, as in much of the work which builds upon it, the link between short-term results and executive pay is exogenous: it is not explained why a firm would choose to implement such pay policies which lead to myopia. Further, the literature which has grown from Stein's contribution has in general not considered competition for managers. Thus the link between industry structure, executive contracts and myopia is not explored.

Stein's seminal work has been extended by a literature which considers the optimal contract a firm should use for its executives given the possibility of myopic actions. Perhaps the most important insight of this literature is that some pay must be deferred to ensure that executives have an incentive to target long-run performance. This is the case in the study I conduct here also. How much pay should be deferred depends on the circumstances under study. Peng and Roell (2011) argue that the amount of deferred pay in an optimal contract should depend upon the propensity of an executive to manipulate results. Laux (forthcoming) argues that deferred pay, though required for long term value alignment, should be limited if the executive can lose his job in the light of short-term results. In this latter case the executive who has to wait till the future to receive his pay will be very keen to avoid being fired in the short-run and so would prefer projects with a more certain short-run return, even if they are value reducing in the long-run.[4] He (forthcoming) calculates numerically the optimal contract if an executive can both save and potentially take myopic actions. Edmans et al. (forthcoming) derive closed form solutions for the optimal design of incentive contracts when the executive can save and take myopic actions. All of these models identify the optimal contract structure, and show that some deferral of pay is part of the optimal contract, in a normative sense. The analyses do not offer a positive explanation as to why one might see too much myopia and insufficient deferral of pay as others have alleged (Bebchuk and Fried (2004), Bhagat and Romano (2009)). The analysis I offer here is distinctive in embedding the contracting problem within a market for executives. This allows me to demonstrate that the equilibrium, and so the optimal contracts supplied, can jump from one in which deferral of pay is sufficient to manage the myopia problem to an equilibrium where myopia is tolerated and the amount of deferred pay is pushed down. The jump between the cases can arise from industry structure, or indeed from other features of

[4]There is a longer literature which considers short-termism in incentives for entrepreneurs due to the need to manage the twin tasks of monitoring, and shutting down poor performers. See von Thadden (1995), Guembel (2005), Biais and Casamatta (1999), and Edmans (2011).

the market technology and executive patience.

My work highlights the different costs of managing the effort and myopia problems arising from the executives' discount rate. This analysis sits alongside other explanations which have been proposed as to why firms would find it optimal to hire executives with contracts which tolerate myopia. Bolton, Scheinkman and Xiong (2006) argue that stock prices include an option element which is increased by short-term firm actions. Current shareholders seeking to maximise their gains from sales to overconfident investors might then use short-term contracts for their CEOs. Froot, Perold and Stein (1992) make a similar argument. Inderst and Pfeil (2009) argue that bankers have both a deal origination role and subsequently a deal vetting role. If a firm will undertake any deal, regardless of quality – perhaps because of the ability to securitise – then it becomes optimal to focus just on deal origination and so high powered short-term incentives result.

Thanassoulis (2012) considers the impact of competition between banks for bankers on banks' risk of default, and the level of bankers' remuneration, not its dynamic structure, and with no consideration of myopia. This work and Thanassoulis (2012) offer comlementary insights into the link between industry structure and the structure and level of executive compensation, and its impact thereby on firm performance.

2 The Model

The model has three parts. First it is a competitive model of firms competing to hire executives. Secondly executives make business decisions and in so doing suffer from both the need to incentivise effort and to prevent myopia. Finally the model is designed to allow us to address the effect on short-termism of the remuneration contracts the industry selects. These parts will be combined into a dynamic stage game in which first firms hire executives with endogenously chosen remuneration contracts; then executives make their business decisions depending on the contracts endogenously selected.

2.1 The Competitive Market For Executives

Suppose there are N different active firms in the market under consideration. Firm i has resources devoted to this area of size S_i. This captures the financial size of the operation for firm i in this sector. The firms are ordered so that $S_1 > S_2 > \cdots > S_N$. Firms are risk neutral, discount profits at the risk free rate which is normalised to zero, and look to maximise the profits generated from their resources. Each firm seeks an individual executive to run its operation in this area.

There are N executives who the firms are competing to hire. The executives differ in their ability. Each executive is of high ability at conducting the specific investment/trade/action required with probability $\mu_i \in (0,1)$. The executives are ordered so that $\mu_1 > \mu_2 > \cdots > \mu_N$. Prior to contracting the ability of each executive, his μ_i value, is publicly known. Each individual executive privately learns his realised ability (high or low) after contracting, but before making his business decision and effort choice. This models an executive discovering his realised ability at, for example, investing in a particular asset class in the current market conditions. The

executives are risk neutral and protected by limited liability. The assumption of risk neutrality on the part of executives is not a key assumption; attitudes to risk do not drive any of the results. The outside option (u) of the executives is determined endogenously.

2.2 Executives' Possible Business Decisions

The executives make their business decisions at the start of time period $t = 1$. These decisions generate returns at the end of period $t = 1$ and again at the end of period $t = 2$.

Consider an executive of publicly known ability μ who is hired by a firm to manage resources of size S. Before making his investment choice the executive privately learns his realised ability as either high or low. If he discovers his realised ability is high then he has a binary choice to make: exert effort or not. Exerting effort is costly, and the cost will be specified in due course. If he exerts effort, then in each period he will generate a profit of ρS with probability $\chi + \alpha$. With probability $1 - (\chi + \alpha)$ the business project will fail that period and generate 0 profit in that period. The realisation of success is independent across periods. ρ is the rate of return in the case of success. The α term is an increase in the probability of success which arises as the executive is of high realised ability. If he does not exert effort then the business project fails for sure and generates 0 profit in both periods.

If the executive discovers his realised ability is low then he has both an effort decision and a myopia decision to make. If he does not exert effort then zero profit is generated in both periods. If he chooses to exert effort then in addition he must decide whether to act myopically (from the firm's point of view), or whether to focus on long-term results. If he focuses on long-term results then he will succeed in the business venture with probability χ in each period. A failure in either period delivers 0 profit to the firm for that period. The realisation of success is independent across periods.

If instead the executive of low realised ability puts in effort and acts myopically then at $t = 1$ he will have success and generate a profit of ρS with probability $\chi + \alpha$ rather than just χ. However, at $t = 2$ he will only generate the profit ρS with probability η. With probability $1 - \eta$ the firm generates a profit of 0. To ensure that this model captures myopia for the firm, I restrict the parameters such that

$$\eta < \chi - \alpha \tag{1}$$

This ensures that the net present value of firm profits are reduced if an executive of low realised ability takes the myopic action. The executive is rational and selects his action to maximise his total utility.

Profits in each period are publicly observable and verifiable. The specific investment undertaken (effort versus not, myopia or not) is private information to the executive. The profits which the executive can generate for the firm are captured in Table 1.

To focus most cleanly on the interaction between the effort problem and the myopia problem, the effort problem is made sufficiently severe that it must always be solved. The model therefore focuses on the interesting case in which myopia is a problem as effort needs to be incentivised.

The model has been simplified to allow only an executive of low realized ability to behave myopically. The model could be extended to allow high ability executives to also be short-termist. Such an extension would not alter the economics or the qualitative results of the

Table 1: Executive's Business Opportunities. Notes: All executives can exert effort or not. If they fail to exert effort then profits are zero in both periods. Executives differ in their ability. An executive of low realised ability can focus on short-term results and deliver myopia (from the firm's point of view), or he can maximise the firm's long-run value. The executive is rational and will choose his action depending on the payoff from his employment contract.

	Profit at $t = 1$	Profit at $t = 2$
High realised ability executive	$\begin{cases} \rho S & \text{with prob } \chi + \alpha \\ 0 & \text{with prob } 1 - (\chi + \alpha) \end{cases}$	$\begin{cases} \rho S & \text{with prob } \chi + \alpha \\ 0 & \text{with prob } 1 - (\chi + \alpha) \end{cases}$
Low realised ability executive – no myopia	$\begin{cases} \rho S & \text{with prob } \chi \\ 0 & \text{with prob } 1 - \chi \end{cases}$	$\begin{cases} \rho S & \text{with prob } \chi \\ 0 & \text{with prob } 1 - \chi \end{cases}$
Low realised ability executive – induced myopia	$\begin{cases} \rho S & \text{with prob } \chi + \alpha \\ 0 & \text{with prob } 1 - (\chi + \alpha) \end{cases}$	$\begin{cases} \rho S & \text{with prob } \eta \\ 0 & \text{with prob } 1 - \eta \end{cases}$
Executive, either ability, exerts 0 effort	0	0

analysis. With or without this extension there is a tension between incentivising effort using performance related pay, and managing myopia by deferring enough of this pay at a discounting cost to the executive. The resolution of this tension would follow the insights which I will describe in this paper.

The production function of the executive is modelled here as multiplicative in firm size. An executive can make larger dollar profits if he manages a larger quantity of resources. This would be true of decisions which scale with firm size such as corporate reorganisations and changes in strategy. Rosen (1992) describes this as the setting in which executives have a "chain letter" effect on firm performance. The multiplicative functional form is a convenient expression of this, and is standard in assignment models of the labour market (Tervio (2008) for example). My analysis would only fail to hold in the polar extreme of a production function in which executives had a purely additive effect on firm value. Empirical evidence against this case is provided by Baker and Hall (2004) who find that "CEO marginal products rise significantly with firm size".[5]

2.3 Executive Remuneration

It is important that the model is detailed enough to allow us to study remuneration over time. Here I allow firms to compete to hire executives using three separate remuneration instruments:

Fixed Wage. $f \geq 0$ is the fixed wage the firm agrees to pay its executive. It is independent of the realised profits in either $t = 1$ or $t = 2$. I assume it is paid out at the end of $t = 1$.

Non Deferred Bonus. $b \geq 0$ is a payment made at the end of $t = 1$ in the event that the business is successful in that period (profits are not zero).

[5]Baker and Hall (2004) offer evidence that the production function is neither perfectly additive, nor perfectly multiplicative. They find an intermediate elasticity of the marginal product of CEO effort with respect to firm size. Hence larger firms can unlock more value from better executives according to this evidence. The multiplicative approach I use in the model is the simplest way of capturing this finding.

Deferred Pay Subject to Performance. $v \geq 0$ is the deferred (or vested) component of pay received if success is achieved at $t = 2$. Executives have a discount rate of $r > 0$. Hence, in end of period 1 dollars, the vested component of pay is worth $v/(1+r)$.

As is standard in dynamic models of financial contracting, the individual's impatience exceeds the risk free rate at which the business discounts the future (DeMarzo and Sannikov (2006), DeMarzo and Fishman (2007), Biais et al. (2010)). The presence of a discount rate for an individual may be motivated by a standard preference for earlier consumption.[6]

I assume that the agent's utility function has the income effect. I opt for the formulation offered by Edmans, Gabaix and Landier (2009). An executive who is paid total remuneration W and exerts effort enjoys a utility equal to remuneration, W. If no effort were exerted then utility rises to $W/(1-\Lambda)$. Hence $\Lambda < 1$ is a parameter capturing the cost of effort. The income effect captures that as remuneration rises, the benefits of shirking also grow. This implies that the benefits of shirking are a normal good – as is usually assumed in consumer theory.[7] Such a formulation is standard in general equilibrium models (Edmans and Gabaix (2011), and Edmans, Gabaix and Landier (2009)). It is also standard in the macroeconomics literature as it implies that as pay rises, labour supply does not rise in an unbounded manner (Cooley and Prescott (1995)). If instead one were to assume a linear functional form for the cost of effort, then the cost of motivating effort would be independent of the executive's outside option. In this case the moral hazard problems could be separated from the level of remuneration; a knife edge result lost with any departure from linearity in effort cost. In the analysis I present here the outside option of individual executives is not taken as given, it is a focus of the analysis as the outside option is endogenised by the industry structure. As I will solve for the market equilibrium, executive pay levels will change meaningfully between firms. As a result it is appropriate to allow for the income effect in utility.

I wish to ensure that a firm would wish to motivate an executive to exert effort whatever his realised ability. To this end the cost of effort, Λ, cannot be too high. In particular I will restrict this analysis to parameter values such that

$$\Lambda \cdot u < (\chi + \alpha + \eta)\, \rho S \tag{2}$$

2.4 The Hiring and Investment Game

The N firms are in competition to hire one of the N executives to run their operation in the market. This competition and subsequent executive business decision is modelled by the following game:

1. **Hiring Stage – occurs at** $t = 0$. Each firm can offer a given executive a targeted remuneration package of the form $\{f, b, v\}$. These offers are executive specific – executives with a higher probability of being high ability (higher publicly known μ_i), can be offered more generous packages. The matching and market remuneration is decided as the outcome

[6] Experimental evidence suggests that the difference between an individual's discount rate and the risk free rate of return which a firm can access may be large (Harrison, Lau and Williams (2002)).

[7] The multiplicative functional form for the income effect is not key. The results only build on the assumption that the cost of incentivising effort increases with the wage.

of a standard simultaneous ascending auction for the executives. As each executive is a substitute for another, such auctions deliver the competitive equilibrium assignment (Milgrom (2000)).[8]

2. **Business Outcomes Stage – occurs over $t = 1$ and $t = 2$.** Once each of the N firms has hired its executive, the executive privately learns the realisation of his ability and he makes his business choice using the available resources S. The returns generated are given by Table 1. The executive receives the remuneration mandated by his contract.

As is standard in dynamic models I search for a Subgame Perfect Equilibrium. This implies that firms use backward induction to anticipate an executive's behaviour if he is hired on any given contract. The time line of the entire game is given in Figure 1.

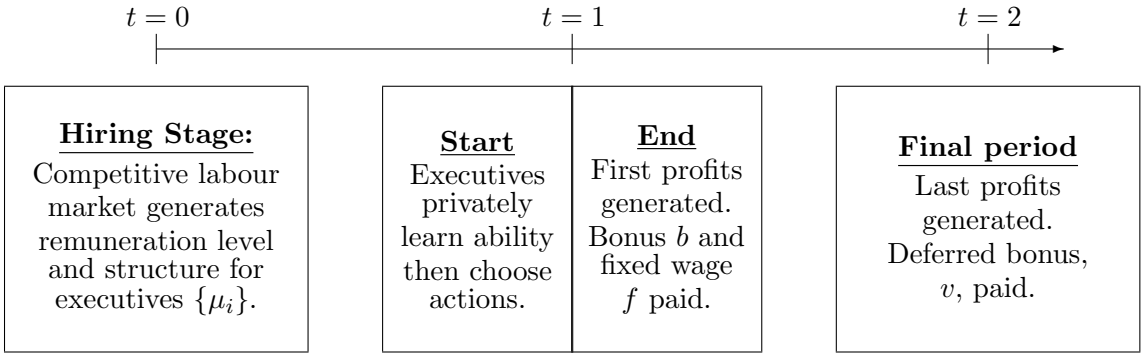

Figure 1: Time line for the model of competition for executives followed by business decisions.

3 Optimising Remuneration For Individual Firms

In a competitive equilibrium in the market for executives, the market will dictate the utility which has to be offered to any given executive to secure his employment. The market will not dictate the exact structure of the contract of employment – this is a decision for the firm. We therefore solve the model using backward induction. We seek the optimal contract $\{f, b, v\}$ a firm would use to hire an executive who had an outside option of u conditional on the firm wishing to rule out myopia; and the optimal contract conditional on the firm being willing to tolerate myopia.

Once these conditionally optimal contracts are determined we will be able to study which type of contract it is most profitable for a firm to offer under what circumstances. This will reveal whether the contracts at market equilibrium are structured to avoid (or not) induced executive myopia.

[8]Milgrom (2000) requires straightforward (that is non-strategic) bidding for the simultaneous ascending auction (SAA) to deliver the competitive outcome. Here, as we have substitutable goods, the competitive equilibrium would always be the outcome (in the absence of collusion between the firms) if we implement the SAA as a standard clock auction (Ausubel and Cramton (2004)). Clock auctions have the bids rising continuously until there is no excess demand for each item. Such an auction is "a practical implementation of the fictitious 'Walrasian auctioneer'." (Ausubel, Cramton and Milgrom (2006)).

Lemma 1 *Suppose the contract* $\{f, b, v\}$ *induces effort from the executive. An executive with low realised ability will not behave myopically if and only if*

$$(\chi - \eta)\, v/\,(1 + r) \geq \alpha b \tag{3}$$

Proof. All proofs are contained in the appendix. ■

If remuneration includes any immediate bonus pay, $b > 0$, then an executive with a low realised level of ability would consider behaving myopically. Such an action would raise the probability of success in period $t = 1$ and so raise the chance of receiving the bonus, b. He would only be deterred from increasing his expected pay in this way if the deferred pay is large enough. Acting myopically lowers the probability of success in the future, $t = 2$, which lowers expected future pay. Only when the loss from the deferred component of pay outweighs the immediate gain to behaving myopically will the executive not take the short-termist action.

3.1 Most Profitable Contract Ruling Out Myopia

I now determine the optimal contract conditional on the firm wishing to rule out myopia. Assume that a firm wishes to hire an executive with ability μ and outside option of u (weakly positive by limited liability) to run resources of size S. Assume that the firm wishes to incentivise effort whatever the realised ability of its executive. The objective function of the firm is to maximise its profit net of payments to the executive. The ability parameter μ captures the probability that the realised ability of the executive will be high. Hence the firm's profit is given by

$$\begin{aligned} & \mu\left[(\chi + \alpha)(\rho S - b) + (\chi + \alpha)(\rho S - v)\right] + (1 - \mu)\left[\chi(\rho S - b) + \chi(\rho S - v)\right] - f \\ = \;& (2\rho S - b - v)(\chi + \alpha\mu) - f \end{aligned} \tag{4}$$

The executive will not behave myopically if (3) holds. He will accept the contract if

$$f + \mu(\chi + \alpha)(b + v/\,(1 + r)) + (1 - \mu)\chi(b + v/\,(1 + r)) \geq u \tag{5}$$

If the executive has low realised ability then he will exert effort if

$$f + \chi(b + v/\,(1 + r)) \geq f/\,(1 - \Lambda) \tag{6}$$

If the executive has high realised ability then he will exert effort if

$$f + (\chi + \alpha)(b + v/\,(1 + r)) \geq f/\,(1 - \Lambda) \tag{7}$$

Proposition 1 *If the firm wishes to ensure that its executive exerts effort, then the optimal contract conditional on an executive with low realised ability not behaving myopically satisfies:*

1. *The deferred bonus is lowered to the point that the no-myopia condition (3) is binding.*

2. The optimal contract is given by:

$$\begin{aligned} f &= \frac{\chi(1-\Lambda)}{\chi+\alpha\Lambda\mu}u \\ b &= \frac{\Lambda(\chi-\eta)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu)}u \\ v &= \frac{\alpha\Lambda(1+r)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu)}u \end{aligned} \tag{8}$$

3. The firm's payoff is:

$$\left(2\rho S - \frac{r\alpha\Lambda}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu)}u\right)(\chi+\alpha\mu) - u \tag{9}$$

The economics of the result can be understood as follows. The firm wishes to ensure that its executive exerts effort. The firm therefore needs to offer some variable remuneration. This is a combination of early bonuses based solely on $t=1$ performance (b), and deferred bonuses based on $t=2$ performance (v).

Deferred bonuses are discounted by the executive as he is impatient to some extent. Therefore it is more expensive for a firm to deliver a given level of utility to an executive using deferred as opposed to immediate bonuses. The total payment would have to increase to counter the executive's impatience. As a result the firm would like to use immediate bonuses rather than deferred bonuses.

The only constraint on using immediate bonuses is the myopia problem (Lemma 1). If deferred pay is lowered too much then an executive of low realised ability will find it optimal to behave myopically to increase the chance of receiving the immediate $(t=1)$ bonus. If this is to be avoided deferred pay can only drop to the point at which the no-myopia constraint becomes binding. Hence we have the first result. The specific contract structure is determined by showing that the participation constraint, and the incentive compatibility condition for an executive of low realised ability are also binding at the optimum.

The terms of the optimal contract (8) can be understood as follows. All payment terms $\{f,b,v\}$ are increasing in the outside option u. As the outside option rises, the total remuneration provided to the executive must rise to satisfy his participation constraint. As the executive's utility includes the income effect, the benefits of shirking also grow with total pay. Therefore to continue to induce effort the variable remuneration must rise: here in proportion as the functional form of the cost of effort is multiplicative. To manage the myopia problem both immediate and deferred bonuses $\{b,v\}$ must also rise. Next note that the more impatient the executive, (the larger is r), the greater deferred pay must be. If the cost of effort, Λ, rises then variable pay must rise to manage the moral hazard problem. To manage the myopia problem the condition of Lemma 1 requires the ratio of discounted bonus pay $(v/(1+r))$ to immediate bonus (b) to be at least $\alpha/(\chi-\eta)$. The factor of $(\chi-\eta)/(\chi-\eta+\alpha)$ in the expression for the immediate bonus (b), and the factor of $\alpha/(\chi-\eta+\alpha)$ in the expression for the deferred bonus deliver this required weighted average. Finally, if the ability term, μ, increases, then the executive is more likely to have a high realised level of ability after contracting, and so he has a higher probability of delivering a successful project. The remuneration levels can therefore

fall and still satisfy the executive's participation constraint as the bonuses will be received with higher probability.

3.2 Most Profitable Contract Tolerating Myopia

We now explore what contracts a firm would use if it was willing to tolerate executives of low realised ability behaving myopically. Assume again that the firm wishes to incentivise effort whatever the realised ability of its executive. The objective function of the firm is to maximise its profit net of payments to the executive. This is given by (allowing for the myopia):

$$\begin{aligned} & \mu\left[(\chi+\alpha)(\rho S-b)+(\chi+\alpha)(\rho S-v)\right]+(1-\mu)\left[(\chi+\alpha)(\rho S-b)+\eta(\rho S-v)\right]-f \\ = \; & (\chi+\alpha)(\rho S-b)+\left[\mu(\chi+\alpha)+\eta(1-\mu)\right](\rho S-v)-f \end{aligned} \tag{10}$$

The executive will take myopic risks if (3) is violated:

$$(\chi-\eta)\, v/(1+r) < \alpha b \tag{11}$$

The executive will accept the contract if

$$f+\mu(\chi+\alpha)(b+v/(1+r))+(1-\mu)\left[(\chi+\alpha)\, b+\eta v/(1+r)\right] \geq u \tag{12}$$

If the executive is of low realised ability then he will exert effort if

$$f+\left[(\chi+\alpha)\, b+\eta v/(1+r)\right] \geq f/(1-\Lambda) \tag{13}$$

If the executive is of high realised ability then he will exert effort if

$$f+(\chi+\alpha)(b+v/(1+r)) \geq f/(1-\Lambda) \tag{14}$$

Proposition 2 *The optimal contract conditional on the firm tolerating an executive of low realised ability behaving myopically satisfies:*

1. *The deferred (vested) component of pay falls to* $v=0$.
2. *There is a range of fixed wages and bonuses* $\{f,b\}$ *which deliver the maximum profit:*

$$f+(\chi+\alpha)\, b=u \text{ and } (\chi+\alpha)\, b \geq f\Lambda/(1-\Lambda)$$

3. *Under any of these optimal contracts the payoff to the firm is given by*

$$\left[(1+\mu)(\chi+\alpha)+\eta(1-\mu)\right]\rho S-u \tag{15}$$

Using deferred pay is an expensive way for a firm to compensate an executive due to discounting. Deferred pay was needed in Proposition 1 to ensure that the executive was incentivised not to act myopically. If myopia is tolerated, which is the case considered in Proposition 2, then the firm prefers to use only immediately delivered bonuses (b), along with the fixed wage.

The contract must ensure that the executive exerts effort. Thus not all the utility can be supplied by using the fixed wage, f. The optimal contract is any fixed wage and immediate bonus pair (f, b) which delivers utility u, so satisfying the participation constraint, and which ensures that an executive of low realised ability exerts effort. There is a range of possible contracts. All of these contracts have the same cost to the firm and so the firm's payoff is unique.

The multiplicity of contracts arises here as the executive is risk neutral. This contrasts with the case in which the firm wished to avoid myopia (Proposition 1). A single contract was selected in that case due to the need to maintain a given ratio of deferred to immediate bonus, following from the discounting costs of deferred pay.

3.3 High Executive Outside Options And Firm Tolerance Of Myopia

Propositions 1 and 2 take as given the objective of either tolerating myopia, or insisting on its absence. However in a competitive equilibrium of the market for executives the only requirement is that a firm offer a contract which delivers the required level of utility to its targeted executive. Whether it is optimal for the firm to deliver this utility via a contract which rules myopia out, or not, will be endogenously decided. Here we show that if the outside option (u) which must be delivered to the targeted executive grows high enough, then the firm will find it preferable to tolerate the possibility of myopia. Hence if executives are to get very high levels of utility, then firms will optimally deliver this by condoning myopia.

Proposition 3 *If the executive's outside option (u) is sufficiently high then the firm will find it optimal to offer remuneration contracts structured so as to permit myopia. This occurs if the outside option, u, satisfies*

$$\frac{r\alpha\Lambda\left(\chi+\alpha\mu\right)}{\left(\chi+\alpha-\eta\right)\left(\chi+\alpha\Lambda\mu\right)}\cdot u>\left(1-\mu\right)\left(\chi-\alpha-\eta\right)\rho S \tag{16}$$

Otherwise the firm will offer contracts which rule myopia out.

Let us consider a firm which employs its executive using a contract which delivers no myopia. From Lemma 1 an executive will only avoid myopic behaviour if the quantity of deferred pay is sufficient to create a large enough stake in future profits. However executives are impatient, and so the amount of vested, or deferred, pay is kept to the minimum possible level compatible with delivering no myopia (Proposition 1).

Now suppose that the executive's outside option were to rise. In this case the utility which is awarded must rise at the same rate. Part of this extra utility can be delivered via the fixed wage f. However to maintain incentives to exert effort the amount of variable remuneration must also rise. This is an implication of the fact that the executive's utility includes the income effect, which means that the benefits of shirking grow as pay rises.

Given that incentive pay must rise, the amount of utility delivered via deferred pay must also rise sufficiently to keep the constraint on no myopia binding. As deferred pay is discounted, so the amount of deferred pay must rise faster than the rate at which the outside option, u, grows to ensure no myopia. Hence the cost to the firm of using contracts which prevent myopia grows more quickly than the outside option rises (equation 9).

Consider now the possibility of the firm not increasing the deferred pay by enough. This would break the no-myopia constraint and so an executive who discovered he was of lesser ability would behave myopically. Such myopia will lower the value of the firm, gross of salary payments. The amount of such a reduction is unrelated to the executive's outside option. The executive will also have to receive utility equaling the outside option. However as the no-myopia constraint is broken, pay need not be deferred. Hence the cost to the firm of the remuneration grows at the same rate as the outside option, and so grows less quickly than in the no-myopia case.

If the executive's outside option rises sufficiently, then the gain from not using deferred pay outweighs the expected reduction in profits which arises from the possibility of myopia induced profit loss. So it becomes optimal for the firm to break the no-myopia constraint and jump to a contract which tolerates myopia. The result then follows.

The proof of Proposition 3 also addresses the possibility of the firm offering a contract which does not incentivise effort. A contract which targets low effort would generate zero returns for the firm, gross of executive payments, and so is dominated. Consider instead the possibility of the firm incentivising effort from an executive of high realised ability, and not from an executive of low realised ability. The benefit of this is that remuneration is made cheaper as the executive who discovers he is of low realised ability will enhance his utility by the lack of effort. An executive who does not exert effort creates smaller profits for the firm. Proposition 3 confirms that assumption (2) ensures that effort is always worth incentivising as the cost of effort is not too high when set against the possible profit gains from effort.

Proposition 3 has at least two implications. The first is that the firm, and similarly the market, will not always be able to determine whether myopic behaviour has been induced. This will depend on the skill of the executive as regards managing the firm's resources in the current climate with the currently available tools, which is private information to the executive. This contrasts with an influential stream of research (Stein (1989), Goldman and Slezak (2006)), in which executives can take myopic actions, but have no private information as to their ability. As a result the executives' behaviour can be accurately inferred (they are in a prisoners' dilemma) and the market can completely correct for the distortion. Here executives do have private information: hence the level of risk cannot be accurately inferred, and so neither can it be fully corrected for.

The second implication is that one might expect a more concentrated industrial structure, appropriately defined, to drive up executives' outside options and so result in myopia being tolerated. This is indeed so and will be formalised in the sections which follow.

4 Competition For Executives And Myopia

We now solve the full model and endogenise the executives' outside options: this will create the link between industry structure and optimal contract form. We begin by characterising the equilibrium in which all the firms compete using non myopia inducing contracts to bid for and subsequently hire executives. This equilibrium form is not however unique. If the utility that executives had to be provided were high enough then firms would rather use contracts which tolerate myopia (Proposition 3).

Proposition 4 *In the equilibrium in which no firm prefers to offer myopia inducing contracts to the executives, there will be positive assortative matching. The executive of rank n, will be employed at firm n with resources S_n. The executive of rank n will receive utility u^n. Calibrating the worst executive as having outside option $u^N = 0$:*

$$u^n = \sum_{j=n+1}^{N} 2\alpha\rho S_j \left[\mu_{j-1} - \mu_j\right] \cdot \left[1 + \frac{r\alpha\Lambda\left(\chi + \alpha\mu_n\right)}{\left(\chi + \alpha - \eta\right)\left(\chi + \alpha\Lambda\mu_n\right)}\right]^{-1} \tag{17}$$

As, by assumption, all firms use contracts which prevent myopia, the actual contract offered to executive n is given, using (8), by

$$\begin{aligned}
f_n &= \frac{\chi\left(1-\Lambda\right)\left(\chi+\alpha-\eta\right)}{\left(\chi+\alpha-\eta\right)\left(\chi+\alpha\Lambda\mu_n\right)+r\alpha\Lambda\left(\chi+\alpha\mu_n\right)} \cdot \sum_{j=n+1}^{N} 2\alpha\rho S_j\left[\mu_{j-1}-\mu_j\right] \\
b_n &= \frac{\Lambda\left(\chi-\eta\right)}{\left(\chi+\alpha-\eta\right)\left(\chi+\alpha\Lambda\mu_n\right)+r\alpha\Lambda\left(\chi+\alpha\mu_n\right)} \cdot \sum_{j=n+1}^{N} 2\alpha\rho S_j\left[\mu_{j-1}-\mu_j\right] \\
v_n &= \frac{\alpha\Lambda\left(1+r\right)}{\left(\chi+\alpha-\eta\right)\left(\chi+\alpha\Lambda\mu_n\right)+r\alpha\Lambda\left(\chi+\alpha\mu_n\right)} \cdot \sum_{j=n+1}^{N} 2\alpha\rho S_j\left[\mu_{j-1}-\mu_j\right]
\end{aligned}$$

If there were no impatience or myopia problem then positive assortative matching would follow from standard arguments. In particular efficiency is maximised by positive assortative matching as a firm ranked higher has greater resources devoted to the market, and this can benefit most from an executive of greater expected skill. Here however the result is complicated by the fact that transfers from the firm to its executive need to be achieved in such a way that myopia is not induced. This requires some of the transfer to come via deferred pay. However this deferred pay is worth less to the executive than the firm. Hence we are in a setting of non-transferable utility. The proof explicitly calculates how much utility a firm is willing to bid, if necessary, for a given executive. I show that a higher ranked firm would be willing, if forced, to deliver more utility to an executive than a lower ranked firm would. Hence positive assortative matching results.

A firm of rank n will hire the executive of the same rank. However the firm will also be a bidder for the executive one spot up in the league table of quality. The amount firm n is willing to bid for this executive of rank $n-1$ will determine the amount that firm $n-1$ is forced to pay. The amount firm n is willing to bid for executive $n-1$ can be explicitly established using the optimal contract derived in the proof of Proposition 1. Thus, iterating the argument, the utility which has to be offered to the executive of rank $n-1$ depends upon the size of all the firms which rank below S_{n-1} in the size league table. This concretely captures that the utility which must be provided to an executive is decided by a competitive labour market – and the marginal bidder for the executive is the firm with resources one notch down in the distribution of size. Applying this approach inductively the result follows.

An equilibrium of the entire market with myopia ruled out is thus determined explicitly. The utility which needs to be offered to the executives depends upon the size of the rival firms, as well as the executives' skill and features of the investment technology.

4.1 The Effect Of Industry Structure On Myopia

Proposition 4 demonstrates the market rate of surplus which the executives will secure when the firms bid using contracts which prevent myopia. We have already determined that as the utility which a firm must award its executive rises, so the benefit of moving to contacts which tolerate myopia grows. This was the content of Proposition 3. However this earlier result took the executive outside option as exogenous. Proposition 4 has endogenised the executives' outside options and established its level in terms of fundamentals such as industry structure, the investment technology, discount rates and so on. We are therefore in a position to determine when myopia will enter the market equilibrium. A sufficient condition for the market equilibrium in non-myopia inducing contracts to break down and for myopia permitting contracts to enter the equilibrium is as follows.

Proposition 5 *A sufficient condition for the no myopia equilibrium to break down, and for contracts tolerating myopia to enter the market, is if for any firm* n :

$$\sum_{j=n+1}^{N} 2\alpha \frac{S_j}{S_n} \left[\frac{\mu_{j-1} - \mu_j}{1 - \mu_n} \right] > \left(\frac{(\chi + \alpha - \eta)(\chi + \alpha\Lambda\mu_n)}{r\alpha\Lambda(\chi + \alpha\mu_n)} + 1 \right) (\chi - \alpha - \eta) \tag{18}$$

If industry structure, the magnitude and distribution of resources $\{S_n\}$, should change so that (18) is triggered for some firm, n, then contracts permitting myopia will have entered the market equilibrium. Condition (18) is a sufficient condition. If all firms of rank below n bid using non-myopia inducing contracts then the utility which firm n will need to offer the executive of rank n is high enough to trigger firm n into offering a myopia permitting contract. If instead a firm of lower rank should bid using a myopia permitting contract, then either it wins and myopia inducing contracts are in the system; or it loses, preserving the positive assortative matching, but forcing the winning firm to supply even higher utility than calculated in (17). In this latter case, by induction, firm n would need to offer even more utility than Proposition 4 states and so firm n would again be driven to use a contract which tolerates myopia.

This section therefore explicitly demonstrates the negative externality arising from competition between the firms for the executives. Firms bid for executives they will not ultimately win, so raising the surplus they secure. In pushing remuneration up for executives they will not ultimately hire, the firms are not considering the impact on their rival firms. In particular, to deliver ever higher levels of utility the employing firm will ultimately find it preferable to use contracts which permit myopia. Of course, to the extent that firm failure affects others beyond the firm (as is the case in a banking failure, or a failure at an oil well for example), these costs to society are not factored into the firm's decision to jump to myopia permitting contracts.

A more detailed investigation of when market fundamentals will increase the pressures on firms to tolerate myopia is possible:

Corollary 1 *Myopia is more likely to enter the market equilibrium as:*

1. *Executives are more impatient.*

2. *Ability makes a greater contribution to profit generation:* α *increases.*

3. *The probability that short-termist behaviour will result in failure in the future,* $(1-\eta)$, *declines.*

If executives are more impatient they discount the deferred pay by a greater amount. To prevent myopia, deferred pay must rise. As the cost to the firm of deferred pay is higher than immediate bonus pay, the non-myopia equilibrium becomes less stable. If the contribution of ability to the probability of success (α) increases, the amount of deferred pay which needs to be awarded also increases if myopia is to be avoided. This is because an executive who discovers he is not of the highest ability can gain substantially by behaving myopically and so increasing his $t = 1$ chances of success.

Finally in part 3 suppose that the risk of loss in the case of short-termism $(1-\eta)$ declines. The executive now becomes very tempted to take the myopic action as the possibility of reduced period $t = 2$ pay is more remote. If the firm is to counteract this, more deferred pay is required. As this is expensive firms are more likely to find it optimal to jump to a contract which tolerates myopia. One might be tempted to think that myopia in this scenario matters less as the possibility of loss is reduced. However in this model the loss to the firm is set to be a return of zero. In reality the loss could be more substantial than this. Hence if failure became more severe in cost, but less likely to occur, the executive would be more likely to act myopically even though the expected cost from myopia was rising.

Corollary 1 discusses the link between fundamentals of the technology, executive utility, and myopia. However industry structure is also relevant to the sufficient condition for myopia to enter the system (18). In particular we can demonstrate that if there is convergence in size amongst the firms then the risk of myopia entering the market is increased.

Proposition 6 *[**Industry Structure And Myopia**] Suppose that some given firm n should grow in size without changing its ranking. Then the myopia condition (18) is more likely to be satisfied for all the highest ranked $n-1$ firms, though less likely for firm n.*

If the given firm n grows then it becomes a more aggressive bidder in its bidding for executive $n-1$. To secure its executive the larger firm, $n-1$, must match this more aggressive rival bidding and so will supply greater utility. This increases the chance that firm $n-1$ will find it preferable to tolerate myopia (Proposition 3). In addition, as more surplus is supplied to the executive of rank $n-1$, the payoff that the firm secures from its executive declines. This makes firm $n-1$ a more aggressive bidder for the executive one notch up in the ranking, $n-2$. Thus, repeating this argument inductively, all higher ranked firms must increase the surplus they deliver to hire their executives, and so the chance that they will prefer to use myopia tolerating contracts increases. Thus individual firm growth (which contributes to industry convergence) raises the chance of the non-myopia equilibria breaking down.

5 Market Equilibrium With Tolerance Of Myopia

I now offer a more detailed characterisation of the market equilibrium in which some firms find it optimal to employ their executives using contracts which tolerate myopia. If myopia tolerating contracts are used by some, then the positive assortative matching result proved as part of

Proposition 4 no longer applies. The first step is therefore to establish under what conditions we can determine a regular match and so study the resulting equilibrium:

Lemma 2 *Suppose that the contribution of ability to expected returns, α, is large enough that*

$$\alpha\left(1+2\frac{\mu_{n-1}-\mu_n}{1-\mu_{n-1}}\right)>\chi-\eta \text{ for all } n \tag{19}$$

Then in any market equilibrium we have positive assortative matching in which the firm of rank n hires the executive of the same rank n.

Lemma 2 is proved by studying the competition between any two adjacent firms m and $m-1$ for any two executives of rank n and $n-1$. The proof shows that whatever the smaller firm m would be willing to bid to secure executive $n-1$ instead of executive n, the larger firm $m-1$ would be willing to bid more, even if restricted to using the same contract type (myopia permitting or not) as firm m. As the larger firm would outbid the smaller, the positive assortative match is proved. A larger firm stands to gain more from securing executives of higher ability (more likely to have ability realised at the high level). However, acting in the opposite direction, larger firms also stand to lose relatively more from tolerating myopia. The positive match is sustained by ensuring that ability is important enough that the first effect dominates the second. This is delivered by condition (19).

Condition (19) is a sufficient condition delivering positive assortative matching between firms and executives, whatever the contract types (myopia tolerating or not). When combined with the condition for short-termism to be myopic (1), the two conditions trace out a range of permissible parameter values:

$$\alpha<\chi-\eta<\min_n \alpha\left(1+2\frac{\mu_{n-1}-\mu_n}{1-\mu_{n-1}}\right) \tag{20}$$

The more substantial the difference in talent between the executives, the larger this range of permissible parameter values is. If the gap between executives is not too small, larger firms will ensure they outbid smaller rivals and secure the better executive, even if this means using myopia tolerating contracts. A difference in talent between executives is required in all assignment models to generate a reason for firms to compete for the better executives. If all executives had identical talent then the equilibrium of the labour market would be for each firm to pay no more than the outside option of the bottom, N^{th}, ranked executive. This outside option is normalised to zero here. Outside of the parameter range given by (20) positive assortative matching may hold but cannot be guaranteed, and so analytical analysis of this case is prevented.

Using the positive assortative matching one can characterise better how myopic contracts will enter the market equilibrium.

Proposition 7 *Suppose (19) holds, then a sufficient condition for firm n to prefer to use myopia tolerating contracts is if*

$$\left(\sum_{j=n+1}^{N} S_j\right)\Big/ S_n>\frac{\chi+\alpha-\eta}{r\alpha\Lambda}+1 \tag{21}$$

Proposition 7 is an extension of Proposition 5. Proposition 7 delivers a sufficient condition for firm n itself to be using myopia tolerating contracts, rather than solely a condition for myopia

to have entered the industry. It is immediate from Proposition 7 that if the combined size of firms smaller than n grows, then the negative externality acting on firm n becomes more intense. Pay is pushed up and eventually myopia tolerance becomes cost-effective for firm n.

Proposition 7 lays bare the core forces acting on this negative externality and leading to myopia. Convergence in firm size triggers condition (21) and leads to myopia. Executive impatience, a high value for r; and difficulty in motivating effort, a high value of Λ, similarly both trigger condition (21) and also lead to myopia. If effort is costly then the total variable pay must be large, so the amount of deferred pay must also be large making it expensive to ensure no myopia.

The equilibrium when some firms use myopia tolerating contracts can be characterised further, in the case where positive assortative matching is guaranteed (condition (19)):

Proposition 8 *[**Convergence And The Myopic Equilibrium**] Suppose (19) holds and that convergence in firm sizes between given firms n and $n-1$ implies that*

$$(1-\mu_{n-1})\,S_{n-1} < (1-\mu_n)\,S_n \tag{22}$$

1. *Then if firm n uses a contract which permits myopia to hire its executive, so too does firm $n-1$.*

2. *If condition (22) is satisfied for all firms then in a myopia tolerating equilibrium the industry will partition. There will exist a firm of rank $\tilde{n}$ such that all firms of rank equal to or above $\tilde{n}$ (the large firms) will use myopia tolerating contracts, while all firms of rank below $\tilde{n}$ (the small firms) will use contracts which rule myopia out.*

Note that by definition $\mu_{n-1} > \mu_n$. Therefore if there were only a negligible difference in size between firm S_n and the higher ranked S_{n-1} then condition (22) would immediately be satisfied. The condition therefore captures industry convergence in size.

Assume that, in hiring executive n, firm n prefers to use a myopia permitting contract. This arises because of, for example, sufficient firm growth amongst smaller firms (Proposition 7). It follows that executive n's outside option is high enough that firm n finds myopia tolerating contracts cost effective. Hence executive n's outside option can be bounded below using Proposition 3. The amount firm n would then be willing to bid to hire the better executive $n-1$ can in turn be bounded below by calculating what the bid would be if firm n used a myopia permitting contract. This gives a lower bound on firm n's bid for executive $n-1$ as firm n might be able to offer still more utility if it used a different contract. Condition (22) guarantees that this outside option for executive $n-1$ is high enough to trigger firm $n-1$ into hiring executive $n-1$ using a myopia permitting contract, just as firm n did by assumption. The industry partition result is now an immediate corollary.

The larger the firm the greater the possible loss from tolerating myopia in the event of project failure. Therefore, for the larger firm $n-1$ to, notwithstanding, prefer myopia tolerating contracts, it must be that firm n is a very aggressive bidder, which only happens if firm n is close enough in size to firm $n-1$. This is delivered by condition (22). Therefore once executives' utilities have grown high enough amongst smaller firms for myopia permitting contracts to

become optimal, the size convergence amongst the larger firms keeps executive payments high, and so maintains the optimality of myopia permitting contracts. Hence the industry partitions according to rank with all the firms above the partition (the largest firms), finding it preferable to hire their executives using contracts which tolerate myopia. The firms with rank below the partition (the smaller firms) would all rather use contracts which rule myopia out.

Propositions 7 and 8 can be combined to gain insights into the predicted contracting behaviour in a range of industrial settings. As a leading example, suppose that positive assortative matching is guaranteed in an industry (Lemma 2 applies to all firms) and that the top $M < N$ firms in an industry converge sufficiently that these M firms satisfy the convergence condition (22) for each adjacent pair of firms of rank equal to or above M. This example seeks to capture a premier tier of firms in a given industry (such as the top four accountancy firms, the top five oil majors etc.) which are similar in size to each other, and significantly larger than the firms in the second and subsequent tiers. This model predicts that the largest firm in the industry will use myopia tolerating contracts if $\left(\sum_{j=2}^{N} S_j\right) \Big/ S_1 > (\chi + \alpha - \eta)/\, r\alpha\Lambda + 1$ (Proposition 7). In this case, the top M firms will have partitioned at rank $\tilde{n} \in \{1, \dots M\}$ with all firms of rank equal to or higher than $\tilde{n}$ using contracts which tolerate myopia (Proposition 8). A lower bound on the number of firms in the top tier using myopia tolerating contracts is given by the largest value of $n \in \{1, \dots M\}$ such that condition (21) is satisfied for firm n. For firms outside the top tier, that is firms of rank below M, a partition result is not available as condition (22) has not been assumed. Nevertheless, for each such firm a sufficient condition for that firm to be using myopia tolerating contracts is given by Proposition 7. Propositions 7 and 8 therefore offer a characterisation of the myopic equilibrium linked to industry structure.

6 Empirical Implications

This section collects the empirical implications of the analysis, and discusses the available empirical evidence. The wider literature on myopia delivers the implication that executive incentive pay which is focused on short-term results is associated with myopic (short-termist) behaviour. This link between short-term focused pay and induced myopia is an implication of this paper also (Propositions 1 and 2).[9] Specific to the model I have presented are the following implications:

Implication 1: High residual pay (u/S) for executives leads to incentive pay focused on short-term and not long-term outcomes, and so results in short-termist (myopic) behaviour.

Residual pay can be defined as employee remuneration normalised by firm size: u/S. Proposition 3 proves that if residual pay should rise high enough then a firm would prefer to employ its executive using myopia tolerating contracts. That such contracts over-weight bonuses based on short-term results follows from Propositions 1 and 2. Though research has been done on share-price linkages in compensation and short-termism, I am aware of only one study which links bonus structure to residual pay. Cheng, Hong and Scheinkman (2010) study the financial services industry and document a positive correlation between firms using high rates of residual

[9] Evidence for this general link is provided by, for example, Tehranian, Travlos, and Waegelein (1987a, 1987b), Bergstresser and Philippon (2006), Burns and Kedia (2006), and Gopalan, Milbourn, Song, and Thakor (2010).

pay and firms focusing incentive pay on short-term results. Cheng et al. demonstrate that these firms are also the ones taking greater tail-risk. The authors note that though this is suggestive of short-termism, one cannot be certain as a test is not available as to whether the risk-taking was npv reducing.

Implication 2: If the firms in an industry converge in size, then some of the firms are likely to over-weight short-term results in compensation and so display myopic behaviour.

This implication follows from Proposition 6. To my knowledge there is no available empirical study which studies short-termism across industries and relates it to industry structure. This paucity of evidence is due, in part, to the difficulty of distinguishing between short-term and long-term, vested, incentives. Both are performance related elements to pay, but the former encourages short-termism, while the latter deters it. An aggregate measure of incentive pay compounds these two conflicting effects preventing inference. The closest relevant contribution is Gopalan, Milbourn, Song, and Thakor (2010) who develop a measure of CEO pay duration. They document wide variation in CEO pay duration across industries. However they do not study the relationship between the pay duration and individual industry structure.

Implication 3: Under conditions guaranteeing positive assortative matching between firms and executives, an industry which converges in size will partition by size. The large firms (above the partition) will display short-termist, or myopic, behaviour, while the small firms (below the partition) will ensure myopia is ruled out.

This follows directly from Proposition 8. Fahlenbrach, Prilmeier and Stulz (2011) offer evidence in support of this implication from the financial industry. They find that for banks above median size in their sample, past failures are predictive of future failures, so that these banks appear to have a business model, or behaviour, which makes them more consistently prone to failures. This is not true of banks below median size. The result is not driven by banks with assets in excess of $50bn which suggests that 'too big to fail' cannot explain the result. Beyond this study however I am not aware of other rigorous work which seeks to test the partition result. Of relevance, Gala and Julio (2011), show that larger firms invest less than smaller firms in their data set of publicly traded U.S. firms, even after rigorous attempts to control for firm investment opportunities. The authors do not, however, study whether the large firms scaled back their investments out of short-term considerations.

7 Conclusion

Firms need some bonus pay to incentivise effort. If such incentives pay out on short-term results then they encourage myopic behaviour. Hence a proportion of bonus pay must be deferred, or vested. Such pay is of reduced value due to the executives' discounting. Convergence in size in an industry has the effect of driving up the remuneration executives receive as the marginal competitor for an executive is a firm closer in size who would be willing to bid more. As the surplus which must be delivered rises, the cost of hiring an executive on a contract which does not tolerate myopia rises faster still. If convergence is sufficient then a firm can find it optimal

to jump to contracts which tolerate myopia. Under some stricter conditions the market will partition with the largest firms using contracts which tolerate myopia, and the smaller firms using contracts which rule myopia out.

This study therefore generates clear predictions connecting short-term focused compensation, firm short-termism, and industry structure. As yet there is little empirical evidence which studies the link between short-termism and industry structure. Thus the empirical implications of this study remain to be tested.

Firms across many industries seem to tolerate short-termism (or myopia) in their executives. The analysis here contributes to our understanding of why it may be optimal for firms to permit managerial short-termism. Even if the costs of project failure are internalised by the firm, a negative externality exists. Firms bidding for executives they will not ultimately succeed in hiring bid up these executives' remuneration, without considering the costs to other firms of project failure due to myopia when doing so. Where project failures create social costs (oil disasters, financial crises) these costs will also not be internalised. Short-termism can be ruled out by intervening in the structure of individuals' pay to ensure a sufficient proportion of pay is deferred. This is the structure the Financial Stability Board have been proposing for one industry. This structure may be of relevance to other industries also.

A Technical Proofs

Proof of Lemma 1. Consider an executive of low realised ability. If he takes the non-myopic action then he would expect remuneration of $f + \chi b + \chi v/(1+r)$. If he takes the myopic action then he would secure $f + (\chi + \alpha) b + \eta v/(1+r)$. The result follows. ■

Proof of Proposition 1. As (6) implies (7) we can drop the incentive compatibility constraint (7). The participation constraint, (5), must be binding. If it were not then by setting $f = b = v = 0$ all constraints could be satisfied and the objective function maximised; a contradiction to (5) being slack. Hence the participation constraint can be written as

$$f + (b + v/(1+r))(\chi + \alpha\mu) = u \tag{23}$$

Equality (23) can be used to rewrite the objective function as

$$(2\rho S - rv/(1+r))(\chi + \alpha\mu) - u \tag{24}$$

This is declining in v. Therefore the no-myopia constraint, (3), must be binding. If it were not then set $v = 0$, this would maximise the objective function, (24), if (23) and (6) can be satisfied. This is done by setting $f = 0$ and $b(\chi + \alpha\mu) = u$. This is a contradiction to (3).

Hence we can rewrite (3) as

$$(\chi - \eta) v/(1+r) = \alpha b \tag{25}$$

By (25), b declines as v declines. By (23), f increases as b and v decline. Therefore lower v, to maximise the objective (24) until (6) is binding. The optimal contract is therefore the solution to (25), (23) and (6) with equality. Algebraic manipulations deliver the optimal contract and firm payoff. ■

Proof of Proposition 2. We will ignore the condition on no-myopia, (11), and then show that it is satisfied. The participation constraint, (12), must be binding. If it were not then by setting $f = b = v = 0$ all constraints could be satisfied and the objective function maximised; a contradiction to (12) being slack. Hence the participation constraint yields:

$$f + (\chi + \alpha) b + [\mu (\chi + \alpha) + \eta (1 - \mu)] v/(1 + r) = u \tag{26}$$

Equality (26) can be used to rewrite the objective function as

$$(\chi + \alpha) \rho S + [\mu (\chi + \alpha) + \eta (1 - \mu)] (\rho S - rv/(1 + r)) - u \tag{27}$$

This is declining in v. Therefore we search for parameters which satisfy (26), (14) and (13) with $v = 0$. As $b \geq 0$, (11) is trivially satisfied. Hence the optimal contract satisfies $f + (\chi + \alpha) b = u$ and $(\chi + \alpha) b \geq f \frac{\Lambda}{1-\Lambda}$. This is possible and gives a range of (f, b) pairs all of which deliver the maximal payoff to the firm. The payoff to the firm is given by (27). ■

Proof of Proposition 3. Comparing (9) and (15) yields condition (16). We now confirm that securing effort from the executive is worthwhile. If an executive is hired to never exert effort then the firm cannot make a positive profit. Now suppose that the firm considered hiring an executive and incentivising effort only from executives of high realised ability. The payoff of the firm would be

$$\mu [(\chi + \alpha) (\rho S - b) + (\chi + \alpha) (\rho S - v)] - f \tag{28}$$

The participation constraint is

$$\mu [(\chi + \alpha) (b + v/(1 + r)) + f] + (1 - \mu) f/(1 - \Lambda) \geq u \tag{29}$$

An executive of high realised ability would exert effort if

$$(\chi + \alpha) (b + v/(1 + r)) + f \geq f/(1 - \Lambda) \tag{30}$$

while an executive of low realised ability will not exert effort if both the following hold:

$$\chi (b + v/(1 + r)) + f < f/(1 - \Lambda) \tag{31}$$

$$[(\chi + \alpha) b + \eta v/(1 + r)] + f < f/(1 - \Lambda) \tag{32}$$

(31) ensures no effort is better than effort and not myopia, (32) ensures no effort dominates effort with myopia.

The participation constraint (29) is binding otherwise all payments can be set to 0. Substituting into the objective (28) we see that the objective is declining in v as the discounting is costly, but is increasing in f due to the extra utility boost via Λ. Substituting the participation constraint with equality (29), into (30) we can increase the fixed payment f until the constraint binds. This eases the remaining constraints. This yields that $f = u(1 - \Lambda)$. Note that (29) and (30) satisfied with equality imply that (31) is strictly satisfied. Substituting (29)

and $f = u(1-\Lambda)$ into (32) the inequality collapses to $v > 0$. Hence the optimal contract satisfies

$$v = \varepsilon > 0, b = \frac{\Lambda u}{\chi + \alpha} - \frac{\varepsilon}{1+r}, f = u(1-\Lambda)$$

The minimal positive deferred payment (v) ensures that if an executive of high realised ability is just willing to exert effort, an executive of lower ability will not as the expected deferred pay is less. The payoff of the firm is then (almost) equal to $2\mu\rho S(\chi+\alpha) - u + \Lambda u(1-\mu)$. Algebraic manipulation confirms that this contract is dominated by the contract allowing myopia and incentivising effort from the executive, (15), if $\Lambda u < (\eta + \chi + \alpha)\rho S$. This is given by assumption in (2). ■

Proof of Proposition 4. Suppose all the firms prefer to use contracts which ensure no myopia, as stated in the proposition. First we show positive assortative matching. Consider two firms m and $m-1$ and two executives n and $n-1$. Suppose the executive n has an outside option of utility u^n. Firm m, can either hire executive n or try for the better $n-1$. Firm m will be willing to bid a utility of $u^{m,n-1}$ for executive $n-1$ where, using (9):

$$\begin{array}{c} 2\rho S_m(\chi+\alpha\mu_{n-1}) \\ -u^{m,n-1}\left\{1+\frac{r\alpha\Lambda(\chi+\alpha\mu_{n-1})}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_{n-1})}\right\} \end{array} = \begin{array}{c} 2\rho S_m(\chi+\alpha\mu_n) \\ -u^{n}\left\{1+\frac{r\alpha\Lambda(\chi+\alpha\mu_{n})}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_{n})}\right\} \end{array}$$

This can be rewritten as

$$\begin{aligned} & u^{m,n-1}\left\{1+\frac{r\alpha\Lambda(\chi+\alpha\mu_{n-1})}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_{n-1})}\right\} \\ = \; & 2\rho S_m\alpha(\mu_{n-1}-\mu_n) + u^n\left\{1+\frac{r\alpha\Lambda(\chi+\alpha\mu_n)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)}\right\} \end{aligned} \tag{33}$$

$u^{m,n-1}$ is increasing in S_m as $\mu_{n-1} > \mu_n$. Hence firm $m-1$ is willing to offer more utility to the better executive than firm m. Thus we have positive assortative matching.

In equilibrium firm n will need to match the utility which firm $n+1$ is willing to bid for executive n. This utility is $u^{n+1,n}$. Hence $u^n = u^{n+1,n}$. Iterating we have

$$u^n\left\{1+\frac{r\alpha\Lambda(\chi+\alpha\mu_n)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)}\right\} = \sum_{j=n+1}^{N} 2\alpha\rho S_j[\mu_{j-1}-\mu_j] + u^N\left\{1+\frac{r\alpha\Lambda(\chi+\alpha\mu_N)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_N)}\right\}$$

The expression for the equilibrium utility u^n then follow as $u^N = 0$. ■

Proof of Proposition 5. The result is proved by contradiction. Suppose that (18) is satisfied, but that no firm bids for, or employs, an executive using myopically inducing contracts. In this case the utility (u^n) which the executive of rank n commands is given by (17). This level of utility would trigger firm n to use myopic contracts if condition (16) is satisfied. Substituting (17) into (16) yields (18) and so firm n would use myopia inducing contracts, a contradiction.

Now suppose that a firm of rank $m > n$ would bid for the executive one rank higher ($m-1$) using a myopia permitting contract. If such a bid won (and so positive assortative matching was broken) then myopic contracts have entered the equilibrium. Suppose therefore that firm m is still outbid by firm $m-1$. If firm $m-1$ employs its executive using a myopia permitting contract then again myopic contracts have entered the equilibrium. Suppose instead that firm

$m-1$ does not use a myopia inducing contract. As firm m has increased the utility it is offering by moving to a myopia permitting offer, firm $m-1$ will have to match this higher offer and so secure less profit. This will make $m-1$ more aggressive in bidding for the executive of rank $m-2$ as the status quo of keeping executive $m-1$ is less profitable. By induction therefore firm n will have to offer more utility than given in Proposition 4. Hence (16) is again triggered and so firm n will use myopia permitting contracts. ■

Proof of Corollary 1. Consider the sufficient condition for the no-myopia equilibrium to break down (18). Part 1 follows as increasing r lowers the right hand side. For part 2 rewrite (18) as

$$\sum_{j=n+1}^{N} 2\frac{S_j}{S_n}\left[\frac{\mu_{j-1}-\mu_j}{1-\mu_n}\right] > \left(\frac{1}{r\Lambda}\left(\frac{\chi-\eta}{\alpha}+1\right)\left(\frac{\chi+\alpha\Lambda\mu_n}{\chi+\alpha\mu_n}\right)+1\right)\left(\frac{\chi-\eta}{\alpha}-1\right)$$

Now increasing α lowers the right hand side by inspection as $\Lambda < 1$. Finally, for part 3 as η increases both terms on the right hand side of (18) decrease. ■

Proof of Proposition 6. Immediate from condition (18). ■

Proof of Lemma 2. Consider two firms: m and $m-1$. And consider two executives of rank n and $n-1$. Suppose the outside option of executive n is u^n.

1. First we suppose that firm m would employ executive n using a no-myopia contract. In this case firm $n-1$ would also employ executive n with a no-myopia contract by Proposition 3 (as $S_{m-1} > S_m$). If firm m would bid for executive $n-1$ with a no-myopia contract then, by Proposition 4 we have that firm $m-1$ would outbid firm m for executive $n-1$ with such a no-myopia contract. We have positive matching in this case.

   If instead firm m would bid for executive $n-1$ with a myopia inducing contract then, using (9) and (15), firm m would bid a utility of $u^{m,n-1}$ for the executive of rank $n-1$ where

$$\begin{aligned} & \left[(1+\mu_{n-1})(\chi+\alpha)+\eta(1-\mu_{n-1})\right]\rho S_m - u^{m,n-1} \\ = \; & \left(2\rho S_m - \frac{r\alpha\Lambda}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)}u^n\right)(\chi+\alpha\mu_n) - u^n \end{aligned} \tag{34}$$

   The bid for executive $n-1$ is increasing in the fund size, S_m, if

$$\begin{aligned} (1+\mu_{n-1})(\chi+\alpha)+\eta(1-\mu_{n-1}) &> 2(\chi+\alpha\mu_n) \\ \alpha\left(1+2\frac{\mu_{n-1}-\mu_n}{1-\mu_{n-1}}\right) &> \chi-\eta \end{aligned} \tag{35}$$

   If (35) holds then we have positive matching as firm $m-1$ would outbid firm m.

2. Now suppose that both firm m and $m-1$ would employ executive n with a myopia inducing contract. Suppose that firm m would bid for executive $n-1$ with a myopia inducing contract then, using (15), it would be willing to bid up to $u^{m,n-1}$ where

$$\left[(1+\mu_{n-1})(\chi+\alpha)+\eta(1-\mu_{n-1})\right]\rho S_m - u^{m,n-1} = \left[(1+\mu_n)(\chi+\alpha)+\eta(1-\mu_n)\right]\rho S_m - u^n$$

yielding that

$$u^{m,n-1} = u^n + (\mu_{n-1} - \mu_n)(\chi + \alpha - \eta)\rho S_m \tag{36}$$

This is increasing in S_m, so firm $m-1$ would bid more utility in myopia inducing contracts.

Suppose instead that firm m would bid for executive $n-1$ with a no-myopia contract. Then firm m would offer utility up to $u^{m,n-1}$ where, from (9):

$$\begin{aligned} & \left(2\rho S_m - \frac{r\alpha\Lambda}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_{n-1})}u^{m,n-1}\right)(\chi+\alpha\mu_{n-1}) - u^{m,n-1} \\ = \; & [(1+\mu_n)(\chi+\alpha) + \eta(1-\mu_n)]\rho S_m - u^n \end{aligned} \tag{37}$$

The utility offered to executive $n-1$ is increasing in the fund size, S_m, if

$$\begin{aligned} 2(\chi+\alpha\mu_{n-1}) &> (1+\mu_n)(\chi+\alpha) + \eta(1-\mu_n) \\ \chi(1-\mu_n) + \alpha(2\mu_{n-1} - 1 - \mu_n) &> \eta(1-\mu_n) \end{aligned}$$

As $\eta < \chi - \alpha$ and $\mu_{n-1} > \mu_n$ this is true yielding positive assortative matching.

3. Finally suppose that if hiring executive n, firm m would use a myopia inducing contract, whereas firm $m-1$ would not. By Proposition 3, as firm m prefers a myopic contract:

$$\frac{r\alpha\Lambda(\chi+\alpha\mu_n)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)}u^n > (1-\mu_n)(\chi-\alpha-\eta)\rho S_m \tag{38}$$

(a) If firm m were to bid for executive $n-1$ with a non-myopic contract, then it would bid up to utility $u^{m,n-1}$ given by (37), which can be written

$$u^{m,n-1}\left[1 + \frac{r\alpha\Lambda(\chi+\alpha\mu_{n-1})}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_{n-1})}\right] = \rho S_m \begin{bmatrix} (\chi-\eta)(1-\mu_n) \\ -(1+\mu_n-2\mu_{n-1})\alpha \end{bmatrix} + u^n$$

In response, firm $m-1$, if bidding with a no-myopia contract, would bid for executive $n-1$ a utility of up to $u^{m-1,n-1}$ derived from (33) of

$$u^{m-1,n-1}\left\{1 + \frac{r\alpha\Lambda(\chi+\alpha\mu_{n-1})}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_{n-1})}\right\} = \begin{array}{c} 2\rho S_{m-1}\alpha(\mu_{n-1}-\mu_n) \\ +u^n\left\{1 + \frac{r\alpha\Lambda(\chi+\alpha\mu_n)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)}\right\} \end{array}$$

Hence firm $m-1$ is willing to bid more if

$$2\rho S_{m-1}\alpha(\mu_{n-1}-\mu_n) + u^n\frac{r\alpha\Lambda(\chi+\alpha\mu_n)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)} > \rho S_m[(\chi-\eta)(1-\mu_n) - (1+\mu_n-2\mu_{n-1})\alpha]$$

Using the condition that u^n was high enough that firm m would hire executive n with a myopia inducing contract, (38), the condition for positive assortative matching becomes

$$2S_{m-1}\alpha(\mu_{n-1}-\mu_n) + (1-\mu_n)(\chi-\alpha-\eta)S_m > S_m[(\chi-\eta)(1-\mu_n) - (1+\mu_n-2\mu_{n-1})\alpha]$$

As $S_{m-1} > S_m$ and $\mu_{n-1} > \mu_n$ this is satisfied.

(b) If firm m would bid for executive $n-1$ using a myopia inducing contract, then it would bid up to a utility $u^{m,n-1}$ given by (36). In response firm $m-1$, if matching with a myopia inducing contract would bid up to $u^{m-1,n-1}$ derived from (34) as

$$\begin{aligned} u^{m-1,n-1} &= \left[(1+\mu_{n-1})(\chi+\alpha)+\eta(1-\mu_{n-1})-2(\chi+\alpha\mu_n)\right]\rho S_{m-1} \\ &\quad +u^n\left[1+\frac{r\alpha\Lambda(\chi+\alpha\mu_n)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)}\right] \end{aligned}$$

Firm $m-1$ is willing to outbid firm m if

$$\begin{aligned} & \left[(1+\mu_{n-1})(\chi+\alpha)+\eta(1-\mu_{n-1})-2(\chi+\alpha\mu_n)\right]\rho S_{m-1}+u^n\frac{r\alpha\Lambda(\chi+\alpha\mu_n)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)} \\ > \quad & (\mu_{n-1}-\mu_n)(\chi+\alpha-\eta)\rho S_m \end{aligned}$$

Using (38), this follows if (35) holds, yielding positive assortative matching.

■

Proof of Proposition 7. As positive assortative matching is guaranteed (Lemma 2), the utility which firm n must offer to executive n is bounded below by the case in which all lower ranked firms bid using myopia preventing contracts. Hence Proposition 5 delivers a sufficient condition for firm n to use myopia tolerating contracts. Then note that

$$\begin{aligned} \sum_{j=n+1}^{N} 2\alpha\frac{S_j}{S_n}\left[\frac{\mu_{j-1}-\mu_j}{1-\mu_n}\right] &= \sum_{j=n+1}^{N} 2\alpha\frac{S_j}{S_n}\left[\frac{1-\mu_{j-1}}{1-\mu_n}\right]\left[\frac{\mu_{j-1}-\mu_j}{1-\mu_{j-1}}\right] \\ &> \sum_{j=n+1}^{N} 2\alpha\frac{S_j}{S_n}\left[\frac{1-\mu_{j-1}}{1-\mu_n}\right]\frac{1}{2}\left[\frac{\chi-\eta}{\alpha}-1\right] \text{ by (19)} \\ &> \sum_{j=n+1}^{N}\frac{S_j}{S_n}(\chi-\eta-\alpha) \text{ as } \mu_{j-1}<\mu_n \end{aligned}$$

The result follows from (18) as $\Lambda<1$. ■

Proof of Proposition 8. We wish to show the inductive step that if firm n hires executive n with a myopia inducing contract, then firm $n-1$ would likewise use a myopia inducing contract for executive $n-1$.

From Proposition 3 firm n will use a myopia inducing contract to hire executive n if

$$\frac{r\alpha\Lambda(\chi+\alpha\mu_n)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)}u^n>(1-\mu_n)(\chi-\alpha-\eta)\rho S_n \tag{39}$$

If firm n were to bid for executive $n-1$ with a myopia inducing contract then it would be willing to bid up to a utility of $u^{n,n-1}$ given by (36) of $u^{n,n-1}=u^n+(\mu_{n-1}-\mu_n)(\chi+\alpha-\eta)\rho S_n$. Hence we have

$$u^{n-1}\geq u^{n,n-1}>\rho S_n(\chi+\alpha-\eta)\left\{(1-\mu_n)(\chi-\alpha-\eta)\frac{(\chi+\alpha\Lambda\mu_n)}{r\alpha\Lambda(\chi+\alpha\mu_n)}+(\mu_{n-1}-\mu_n)\right\} \tag{40}$$

where the second inequality follows from (39). $u^{n-1}\geq u^{n,n-1}$ as firm n may offer even higher utility to executive $n-1$ if it decides to use a no-myopia contract. From Proposition 3 we can

guarantee that firm $n-1$ will rather use a myopia inducing contract if

$$\frac{r\alpha\Lambda\left(\chi+\alpha\mu_{n-1}\right)}{\left(\chi+\alpha-\eta\right)\left(\chi+\alpha\Lambda\mu_{n-1}\right)}u^{n-1}>\left(1-\mu_{n-1}\right)\left(\chi-\alpha-\eta\right)\rho S_{n-1}$$

Applying (40) this can be guaranteed if

$$S_n\left\{\left(1-\mu_n\right)\left(\chi-\alpha-\eta\right)\frac{\left(\chi+\alpha\Lambda\mu_n\right)}{r\alpha\Lambda\left(\chi+\alpha\mu_n\right)}+\left(\mu_{n-1}-\mu_n\right)\right\}>\frac{\left(\chi+\alpha\Lambda\mu_{n-1}\right)}{r\alpha\Lambda\left(\chi+\alpha\mu_{n-1}\right)}\left(1-\mu_{n-1}\right)\left(\chi-\alpha-\eta\right)S_{n-1}$$

This can be rewritten as

$$S_n\left(\mu_{n-1}-\mu_n\right)>\frac{\left(\chi-\alpha-\eta\right)}{r\alpha\Lambda}\left\{\frac{\left(\chi+\alpha\Lambda\mu_{n-1}\right)}{\left(\chi+\alpha\mu_{n-1}\right)}\left(1-\mu_{n-1}\right)S_{n-1}-\left(1-\mu_n\right)\frac{\left(\chi+\alpha\Lambda\mu_n\right)}{\left(\chi+\alpha\mu_n\right)}S_n\right\} \tag{41}$$

As $\mu_n<\mu_{n-1}$ we have $\frac{(\chi+\alpha\Lambda\mu_{n-1})}{(\chi+\alpha\mu_{n-1})}<\frac{(\chi+\alpha\Lambda\mu_n)}{(\chi+\alpha\mu_n)}$ and so (41) is satisfied if

$$S_n\left(\mu_{n-1}-\mu_n\right)>\frac{\left(\chi-\alpha-\eta\right)}{r\alpha\Lambda}\frac{\left(\chi+\alpha\Lambda\mu_n\right)}{\left(\chi+\alpha\mu_n\right)}\left\{\left(1-\mu_{n-1}\right)S_{n-1}-\left(1-\mu_n\right)S_n\right\}$$

This inequality can be guaranteed if the right hand brace is negative. That is if $\left(1-\mu_{n-1}\right)S_{n-1}<\left(1-\mu_n\right)S_n$. In this case, $n-1$ will also use a myopia inducing contract.

Part 2 is immediate as the inductive condition guarantees that if firm n were to use myopic contracts, so would all firms of higher rank. ■

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