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INDUSTRIAL STRUCTURE, EXECUTIVES' PAY AND MYOPIC RISK TAKING

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Industrial Structure, Executives' Pay And Myopic Risk Taking

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Abstract

This study outlines a new theory linking industrial structure to optimal employment contracts and value reducing risk taking. 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 myopic risk taking problem: an executive would wish to inflate early expected earnings at some risk to future profits. To manage this some bonus pay is deferred. Convergence in size amongst the largest firms makes the cost of managing the myopic risk taking problem grow faster than the cost of managing the moral hazard problem. Eventually the optimal contract jumps from one achieving zero myopic risk taking to one tolerating the possibility of myopic risk taking. Under some conditions the industry partitions: the largest firms hire executives on contracts tolerant of myopic risk taking, smaller firms ensure myopia is ruled out.

Keywords: myopic risk taking; moral hazard; compensation; bonuses; bankers' pay; tail risk; industrial structure.

JEL Classification: G21, G34.

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"*This economic crisis began as a financial crisis, when firms and financial institutions took huge, reckless risks in pursuit of quick profits and massive bonuses.*"
President Obama, January 2010.

"*You [Wall Street] don't have to wait for a law to overhaul your pay system so that folks are rewarded for long-term performance instead of short-term gains.*"
President Obama, September 2009.

1 Introduction

In the financial services industry competition between banks and investment houses for bankers and traders is intense. A compelling narrative of the recent financial crisis is that the labour market for bankers has resulted in bankers receiving pay focused too much on short-term revenues. As a result the most senior policy makers in the US, EU and G20 have, with hindsight, decried the huge risks which built up in the financial system. These observations have been met with pleas for firms to reform their pay practices. Globally, financial regulators are rushing to introduce new rules which explicitly intervene in the allowable structure of bankers' pay.

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 the scandals caused by major accidents in industries such as the oil industry, the compelling narrative was again that pressure for short term results led to executives choosing to take risks with the future by cutting back on due testing and delaying safety driven interruptions to production.[2] Invariable in price fixing cartels companies state that individual executives (in a bid to increase their short run profits) act alone when they take risks with future profits by breaking the law and price fixing.

However, before the conclusion that remuneration contracts are excessively focused on short term results can be accepted, we must understand why firms would choose to offer such contracts which entice myopic behaviour in the first place. The hypothesis that those who run firms do not care about risks and are willing to be reckless is both too glib and poorly supported by the evidence. For example, in the financial services industry all the major banks were regulated prior to the crisis with a view to managing their overall risk. Analysis of banks' returns delivers no evidence that those run by CEOs whose interests were better aligned with shareholders were less reckless or made smaller losses – in fact there is weak evidence to the contrary (Fahlenbrach and Stulz 2010). It therefore remains crucial to understand why firms would, in good faith, enter into the remuneration contracts whose outcomes have been so damaging across so many industries. Failure to do so runs the risk that the regulations on pay now being introduced in financial services will quickly outlive their usefulness and become constricting once regulatory

[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.

monitoring improves.

I offer a model which studies the contracting problem between properly governed firms and their executives. I study this problem embedded in a competitive market for executive talent. Only such a model which combines the economics of incentives with the impact of competition between firms for executives can explore whether a market failure in the labour market for executives exists, could lead to excessive risk building up, and could warrant regulatory intervention.

The model I offer has three key parts. First I consider the labour market for an executive to run any given activity undertaken by firms. Examples could be an executive to manage an investment fund; to manage oil drilling in a given geographic area; to manage cargo transportation between two continents for an airline. Firms active in the given industry differ in the size of resources they have available for the executive to manage. Second the executives are subject to two standard contracting frictions: moral hazard and myopic risk taking. Executives must be motivated to exert effort; they must also be motivated to avoid risky projects and behaviour which grows expected short term profits but at the cost of substantially increasing long term risks. This latter myopic risk taking worry is, for example, at the centre of the financial crisis as witnessed by the first quote from President Obama above. Such myopia can manifest itself as share-price manipulation (Stein 1989); by the use of innovative financial products (Foster and Young 2008); 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 which tally with those available in reality. Next the executive hired to run a firm's fund or operation in a given area makes their effort and risk 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 they 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. A firm which solely rewarded using fixed wages would not provide incentives for the executive to exert effort. It may be optimal in some industries to provide none, or only small incentives, to leading executives. I instead wish to focus on those industries where effort needs to be incentivised. To incentivise effort, and so manage the moral hazard problem, 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 has the benefit that nothing is lost to discounting, and it ensures effort is provided. However such pay introduces the myopic risk taking problem. If pay and bonuses can be increased by short term results then an executive will be incentivised to select myopic actions which increase their expected immediate profits, whilst creating a risk of some larger loss in the future. To mitigate the myopic risk taking 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 for a firm to hire their executive on a contract which does not tolerate any myopic risk taking. 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 must receive. What is new however is that as the surplus which must be supplied to an executive rises, the cost to the firm of managing the myopic risk taking problem rises more rapidly than the cost of managing the moral-hazard problem. The benefit of avoiding myopic risk taking to a firm is independent of the market rate executives command. Therefore if the market rate of executives should grow high enough, then some firms will find it optimal, acting in their own interests, to use contracts which tolerate the possibility of myopic risk talking.

The market rate executives command is endogenous. In particular it depends upon the industrial structure of the competing firms. The analysis demonstrates that convergence and growth in size amongst the largest firms raises the surplus the executives command. Hence the paper identifies and studies a link between industrial structure and myopic risk taking. If convergence in an industry increases then the negative externality inherent in competition will drive up the market rates executives command. To deliver the required surplus and ensure no myopic risk taking 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, properly run and motivated to maximise value, endogenously chooses to jump to a contract form which permits some myopic risk taking.

This paper therefore demonstrates how changes in industry structure can lead to a firm choosing to move from a no myopic risk taking equilibrium to one in which some myopic risk taking is tolerated. Such calculations are conducted from the viewpoint of the firm. However the losses from myopic risk taking can go much wider than the firm. To the extent that myopic risk taking creates negative consequences for parties other than the firm there is a rationale for regulatory intervention. This work therefore provides a rationale for what market failure the intervention in pay in the financial services industry can seek to correct; and how this market failure can be tackled.

Related Literature

To study the link between optimal contracting and industrial structure I offer a model of a competitive labour market between firms for executives. This endeavour builds upon the work of Gabaix and Landier (2008) and Edmans, Gabaix and Landier (2008). In this series of papers the authors offer a model of a competitive labour market for CEOs. My contribution is to reformulate these models to allow for both myopic risk taking and moral hazard in a dynamic setting. This extension is key. Without extending the activities of the agent across multiple periods the incentives for pushing risk into the future and so the rationale for deferred pay cannot be studied. This extension results in multiple equilibria: some without firms allowing myopic risk taking and others where it is tolerated; thus, unlike the Gabaix et al. papers I am able to link the jump from one 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). The manager in Stein's model inflates early earnings in a value reducing way to try to fool the market. However the market correctly infers that this will happen and so assigns the correct value to the firm. The manager is caught in a prisoners' dilemma: they must manipulate to avoid investors thinking their business is worse that it is. 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 myopic risk taking. Further, the literature which has grown from Stein's contribution has in general not considered competition for managers. Thus the link between industrial structure, executive contracts and myopic risk taking 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 risk taking 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 (2011) argues that deferred pay, though required for long term value alignment, should be limited if the executive can lose their job in the light of short-term results. In this latter case the executive who has to wait till the future to receive their 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.[3] He (forthcoming) calculates numerically the optimal contract if an executive can both save and potentially take myopic actions. Edmans et al. (2011) extend He (2011) and 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 myopic risk taking and insufficient vesting and 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 vested pay is pushed down. The jump between equilibria can arise from industrial structure, or indeed from other more prosaic features of the market technology and executive patience.

My work highlights the different costs of managing the moral hazard 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 myopic risk taking. 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

[3]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).

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 (forthcoming) considers the impact of competition between banks for bankers on the level of bankers' remuneration and not its structure. In both Thanassoulis (forthcoming) and in this analysis, an executive labour market is modelled in which firms (the banks) compete to hire executives (the bankers) of differing ability. The resulting equilibrium endogenises the level of utility which the executives receive. Unlike here, Thanassoulis (forthcoming) models the default risk which banks face if the executives they hire should make investments with realised losses larger than the equity cushion on the banks' balance sheet. The possibility of this loss governs the market level of bankers' pay. This analysis complements the analysis in the model presented here as the analysis in this paper concerns the optimal structure of pay and bonuses, rather than the level of these bonuses. Unlike Thanassoulis (forthcoming) here we explicitly model the problem of myopic risk taking and demonstrate that competition between banks can be such that the banks would choose, absent any corporate governance failings, to use contracts which tolerate myopic risk taking.

An implication of the study presented here is that, in contrast to the signal-jamming models of Stein (1989) and Goldman and Slezak (2006), it is impossible for the market to back out the exact amount of myopic risk taking an executive will undertake. In my work this arises as the executive is better informed as to their realised ability than the market. The work shares this insight with Peng and Roell (2011) where uncertainty as to the executive's propensity to manipulate short term results has the implication that the market cannot be certain of the level of manipulation. Thus myopic risk taking can have real effects on firm value and the mispricing of risk. In a similar vein Stein (2005) demonstrates that as most asset management funds are open ended rather than closed, they will be obliged to deliver short term results. This leads to real effects as such funds cannot tackle long term mispricing through arbitrage because of the risk of the market moving against such a position in the short term.[4]

Finally this analysis contributes to the young literature on the externalities which firms exert on each other through the labour market. Acharya and Volpin (2010) allow the level of CEO monitoring to be endogenous and demonstrate that competition for CEOs can lead to less monitoring of the CEO.[5] Their study does not explore myopic risk taking concerns and is silent on the optimal remuneration structure. By explicitly studying the contract form in the context of industrial structure we can make predictions as to when an organizational structure which allows for some myopic risk taking will become optimal.

[4]Edmans (forthcoming) argues that, in the context of firms, short termism can be tackled by improved monitoring, and this can be induced by taking on debt to concentrate the equity stake.

[5]For a discussion of corporate governance failures in banking see Thanassoulis (2009).

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 moral hazard and the possibility of myopic risk taking. Finally the model is designed to allow us to address the effect on risk taking 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 and risks are taken depending on the contracts endogenously selected.

2.1 The Competitive Market For Executives

Consider a functional area within the firms in any given industry. For example, in the financial intermediation industry banks offer foreign exchange, equities investing, securitisation, the provision of loans and so on. In, for example, the oil industry, firms have functional areas for exploration, drilling, processing and production. 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 balance sheet for foreign exchange deals, the exploration budget in oil etc.). 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 their 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, their μ_i value, is publicly known. Each individual executive privately learns their realised ability (high or low) after contracting, but before making their business decisions and effort choices. This models an executive discovering their 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. If the executives were risk averse then the results of this study would be strengthened. The outside option 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 $t = 2$.

Suppose an executive of publicly known ability μ is hired by a firm to manage resources of size S. Before making their investment choice the executive privately learns their realised ability as either high or low. If the executive discovers their realised ability is high then they have a binary choice to make: exert effort or not. If they exert effort, then in each period they 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 from the investment in the case of success. The α term is an increase in the probability of success which arises in the event that the executive is of higher ability.

If the executive discovers their realised ability is low then they have a choice between three possible actions: to exert effort and not take myopic risks; to exert effort and take myopic risks; or not to exert effort at all. If the executive of low realised ability exerts effort and does not take myopic risks then they will only 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.

Instead an executive of lesser realised ability can put in effort and take myopic risks. In this case then at $t = 1$ they will have success and generate a profit of ρS with probability $\chi + \alpha$ rather than just χ. However, at $t = 2$ they will only generate the profit ρS with probability η. With probability $1 - \eta$ the risk-taking fails to pay off and a bad outcome results. For the purposes of the model we suppose that failure once again delivers a profit of 0 to the firm. To ensure that this model captures myopic risk taking I restrict the parameters such that

$$\eta < \chi - \alpha \qquad (1)$$

This ensures that profits are reduced if an executive of lesser ability takes the myopic risky action.

If the executive (of realised lesser or high ability) does not exert effort then the business project fails for sure and generates 0 profit in both periods. For convenience the profits which the executive can generate for the firm are captured in Table 1. I assume that success or failure each period is both publicly observable and verifiable. The specific investment undertaken (effort versus not, myopic risk taking or not) is private information to the executive.

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 who exert effort differ in their ability. An executive of lesser ability can take myopic risks to disguise her true ability. This introduces an enhanced risk of failure in the future for the firm. The firm seeks an optimal contract to manage the twin problems of moral hazard and myopic risk taking.

	Profit at $t = 1$	Profit at $t = 2$
High ability executive	$\begin{cases} \rho S & \text{with prob } \chi + \alpha \\ 0 & \text{with prob } 1 - (\chi + \alpha) \end{cases}$	$\begin{cases} \rho S & \text{with prob } \chi + \alpha \\ 0 & \text{with prob } 1 - (\chi + \alpha) \end{cases}$
Lesser ability executive – no myopic risk taking	$\begin{cases} \rho S & \text{with prob } \chi \\ 0 & \text{with prob } 1 - \chi \end{cases}$	$\begin{cases} \rho S & \text{with prob } \chi \\ 0 & \text{with prob } 1 - \chi \end{cases}$
Lesser ability executive – takes myopic risk	$\begin{cases} \rho S & \text{with prob } \chi + \alpha \\ 0 & \text{with prob } 1 - (\chi + \alpha) \end{cases}$	$\begin{cases} \rho S & \text{with prob } \eta \\ 0 & \text{with prob } 1 - \eta \end{cases}$
Banker, either ability, exerts 0 effort	0	0

To focus most cleanly on the interaction between the moral hazard problem and the myopic risk taking problem, the moral hazard problem is made sufficiently severe that it must always be solved. In general one can imagine a setup in which it is not optimal for a firm to incentivise effort from its executive. Pay would be independent of results in this case and so incentives to myopic risk taking would also be absent. The setup here allows us to focus on the more interesting case in which myopia can be a problem as effort needs to be incentivised.

The production function of the executive is modelled here as multiplicative in firm size. Thus an executive can make larger dollar profits if they manage a larger quantity of resources. This would be true of decisions which scale with firm size such as corporate reorganisations and changes in strategy. In the literature on contracts, Rosen (1992) described this as the setting in which executives have a "chain letter" effect on firm performance. For executives in financial services it is naturally the case that profits available from a trade scale with the size of the position one can take. What is important for the model is that larger firms can unlock more value from better executives. For this not to be true one would need to use the polar extreme of a linear production function in which executives had an 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".

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 captured by the triple $\{f, b, v\}$:

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).

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.

I assume that the agent's utility function has the income effect. I opt for the formulation offered by Edmans, Gabaix and Landier (2008). 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. Such a formulation is standard in general equilibrium models (Sannikov 2008, and Edmans, Gabaix and Landier 2008). 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 under risk neutrality the cost of motivating effort would be independent of the total remuneration and outside option of the executive. As a result the moral hazard and myopic risk taking problem could be separated from the level of remuneration. This knife edge result falls away with any departure from linearity in the cost of effort. 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 industrial 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 their 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 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).[6]

2. **Business Decision 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 their ability and they make their business choices using the available resources S_n. The returns generated are given by Table 1. The executive receives the remuneration mandated by their contract.

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

[6] 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 banks) 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). A similar process of bidding has been used in the labour matching literature and again shown to lead to a competitive equilibrium. (For example Crawford and Knoer 1981).

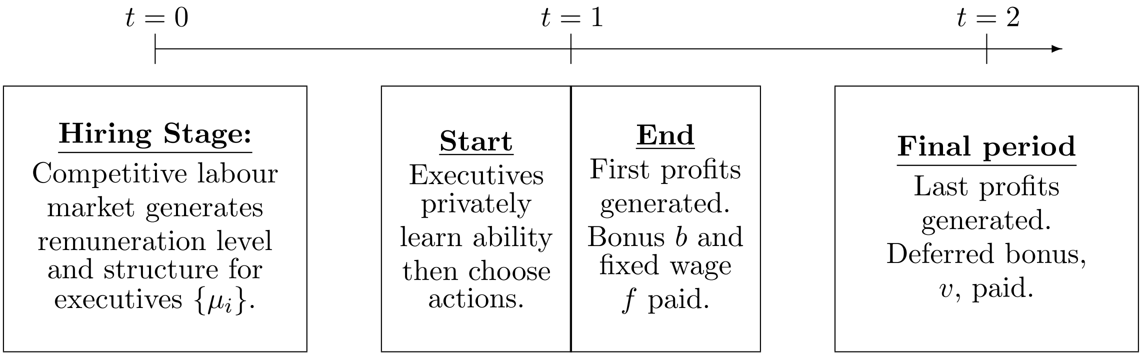

Figure 1: The time line for the model of competition for executives followed by executive business decisions.

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 their 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 if the firm wished to rule out myopic risk taking; and the optimal contract if the firm was willing to tolerate myopic risk taking.

Once these 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) the executive taking myopic risks.

Lemma 1 *Suppose the contract $\{f, b, v\}$ induces effort from the executive. An executive with low realised ability will not take myopic risks 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 realised low level of ability would consider myopic risk taking. Such an action would raise the probability of success in period $t = 1$ and so raise the chance of receiving the bonus, b. The lesser ability executive would only be deterred from increasing their expected pay in this way if the deferred (or vested) pay is large enough. If an executive with low realised ability myopically takes risks then they lower the probability of success in the future, $t = 2$, which lowers their expected future pay. Only when the loss from the deferred component of pay outweighs the immediate gain to myopic risk taking will the executive not take myopic risks.

3.1 Most Profitable Contract Ruling Out Myopic Risk Taking

We are now in a position to determine the optimal contracts if the firm wishes to rule out/rule in myopic risk taking. Let us 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. Let us assume that the firm wishes to incentivise effort whatever the realised ability of their executive. The objective function of the firm is to maximise their 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 take myopic risks if (3) holds. They 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 they will exert effort if

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

If the executive has high realised ability then they 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 their executive exerts effort, and that an executive with low realised ability does not take myopic risks, then the optimal contract satisfies:*

1. *The deferred bonus is lowered to the point that the no-myopic risk taking 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 their 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 they are 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 deferred 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 myopic risk taking problem (Lemma 1). If deferred pay is lowered too much then an executive of lesser ability will find it optimal to take myopic risks 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 myopic risk taking 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 effect of the model structure on 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 their participation constraint. As the executive's utility includes the income effect, the benefits of shirking grow in proportion to the 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 the executive 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 Myopic Risk Taking

We now explore what contracts a firm would use if they were willing to tolerate executives of low realised ability taking myopically risky actions. Let us again assume that the firm wishes to incentivise effort whatever the realised ability of their executive. Once again the objective function of the firm is to maximise their profit net of payments to the executive. This is given by (allowing for the myopic risk taking):

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

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

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

The executive will accept the contract if

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

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

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

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

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

Proposition 2 *If a firm is willing to tolerate an executive of low realised ability taking myopic risks then the optimal employment contract satisfies:*

1. *The deferred (vested) component of pay falls to* $v = 0$.
2. *There is a range of fixed fees and bonuses* $\{f, b\}$ *which deliver the maximum profit to the firm:*
$$f + (\chi + \alpha)\, b = u \text{ and } (\chi + \alpha)\, b \geq f \frac{\Lambda}{1 - \Lambda}$$
3. *Under any of these optimal contracts the payoff to the firm is given by*

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

Using deferred pay is an expensive way for a firm to compensate an executive as the executive discounts it. Deferred pay was needed in Proposition 1 to ensure that the executive was incentivised not to take myopic risky actions. If myopia is tolerated, which is the case considered in Proposition 2, then the firm prepares to use only immediately delivered bonuses (b), along with the fixed fee.

The contract must ensure that the executive exerts effort. Thus not all the utility can be supplied by using the fixed fee, f. The optimal contract is therefore any fixed fee and immediate bonus pair (f, b) which deliver utility u, so satisfying the participation constraint, and which ensure that an executive of low realised ability exerts effort. There is therefore 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 myopic risk taking (Proposition 1). A single contract was selected in that case due to the need to maintain a given ratio of deferred to immediate bonus, and due to the discounting costs of deferred pay.

3.3 High Executive Outside Options And Firm Tolerance Of Myopic Risk Taking

Propositions 1 and 2 took as given the objective of either tolerating myopic risk taking, 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 their targeted executive. Whether it is optimal for the firm to deliver this utility via a contract which rules myopic risk taking 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 myopic risk taking. Hence if executives are to get very high levels of utility, then firms will optimally (considering themselves, not society) deliver this while condoning myopic risk taking.

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 myopic risk taking. 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 myopic risk taking out. It is never optimal to offer contracts which do not incentivise effort.

Let us consider a firm which employs its executive using a contract which delivers no myopic risk taking. From Proposition 1 an executive will only avoid myopic risk taking if the quantity of deferred pay is sufficient to give the executive 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 myopic risk taking (Proposition 1).

Now suppose that the executive's outside option were to rise. In this case the utility which is awarded to the executive 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. As the benefits of shirking are a normal good the benefits of shirking would grow as pay rises. Therefore to continue to induce effort the variable remuneration must also rise.

Given that incentive pay must rise to ensure the executive accepts the contract and exerts effort, the amount of utility delivered via deferred pay must also rise sufficiently to keep the constraint on no myopic risk taking binding: (Lemma 1). Note however that as the executive is impatient, the amount of vested pay must rise faster than u grows by a factor of the executive's discount rate r. Hence the payoff of the firm using contracts which prevent myopic risk taking falls more quickly than u rises (equation 9). Hence as the executives' outside option rises, the cost to the firm increases at a rate in excess of u.

Consider now the possibility of the firm not increasing the deferred pay by enough. This would break the no myopic risk taking constraint and so an executive who discovered they were of lesser ability would take myopic risks. Such myopic risk taking 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 myopic risk taking constraint is broken, pay need not be deferred. Hence the cost to the firm of the remuneration grows by less than in the no myopic risk taking case.

If the outside option the executive enjoys rises sufficiently then the gain from not using deferred pay outweighs the expected reduction in profits which arises from the chance that the executive will be of low realised ability and so take myopic risks. It then becomes optimal for the firm to break the no myopic risk taking constraint and jump to a contract which permits myopic risk taking. The result then follows.

Finally Proposition 3 addresses the possibility of the firm offering a contract which incentivises effort from an executive of high realised ability, and does not incentivise effort from an executive of low realised ability. The benefit of this is that participation of the executive is made cheaper as the executive who discovers they are of low realised ability will draw the fixed wage f, but enhance her utility by the lack of effort. This effect is captured by the cost of effort term Λ. An executive who does not exert effort creates smaller profits for the firm. Proposition 3 demonstrates 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, should the executives' required rents become large enough, then the market, and similarly the firm, will be unable to determine whether myopic risks are being taken. 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 myopic risk taking. This is indeed so and will be formalised in the sections which follow.

4 Competition For Executives And Myopic Risk Taking

We now solve the full model and endogenise the executives' outside options: this will create the link between industrial 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 is not however unique. If the utility that executives had to be provided were high enough then firms would rather use contracts which allow myopic risk taking (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 myopic risk taking, 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 myopic risk taking problems 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 sector, and this can benefit most from an executive of greater 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 myopic risk taking 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 executive. 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 without myopic risk taking 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 Industrial Structure On Myopic Risk Taking

Proposition 4 demonstrates the market rate of surplus which the executives will secure when the firms bid using contracts which prevent myopic risk taking. We have already determined that as the utility which a firm must award its executive rises, so the temptation to move to contacts which allow some myopic risk taking 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 industrial 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 *[**Equilibrium myopia arrives**]A sufficient condition for the no myopic risk taking equilibrium of Proposition 4 to break down, and for contracts tolerating myopic risk taking to enter the market, is if for any firm n :*

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

If industrial structure, the magnitude and distribution of resources $\{S_n\}$ should change so that (18) is triggered then contracts permitting myopic risk taking 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 given by (17); and if the condition (18) of the proposition is satisfied then this utility is high enough to trigger n into offering myopia permitting contracts (condition (16) of Proposition 3).

The last complication in the proof is to manage is the question of what happens if a firm of lower rank should bid using myopia permitting contracts. If they win the services of their targeted executive, so breaking the positive assortative matching, then myopia permitting contracts are in the system. If they do not win then the utility which the employing firm will need to offer rises. This firm will therefore secure lower profits from their secured executive and so bid more aggressively for others. By induction firm n would need to offer even more utility than Proposition 4 and so firm n would again be driven to use contracts which tolerate myopic risk taking.

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. This bidding raises the surplus secured by these executives and, equivalently, increases the market determined level of utility which the firms must make available to the executives they do hire. 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 myopic risk taking. Note further that 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 myopic risk taking is possible:

Corollary 1 *Myopic risk taking is more likely to enter the financial system as:*

1. *Executives are more impatient.*

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

3. *The probability that myopic risk taking will result in failure in the future, $(1-\eta)$, declines.*

If executives are more impatient they discount the deferred pay by a greater amount. As a result to prevent myopic risk taking vested pay must rise. As the costs to the firm of vested pay are higher than immediate bonus pay, the non-myopia equilibrium becomes less stable. Increasing the contribution of ability to the probability of success (α), the amount of deferred pay which needs to be awarded increases if myopic risk taking is to be avoided. This is because an executive who discovers they are not of the highest ability can gain substantially by taking myopic risk and so increasing their $t = 1$ chances of success. To prevent this much pay must be deferred which raises the costs of avoiding myopic risk taking.

Finally in part 3 suppose that the risk of loss in the case of myopic risk taking $(1-\eta)$ declines. The executive now becomes very tempted to take the myopic risk 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 permits some myopic risk taking. One might be tempted to think that myopic risk taking in this scenario matters less as the possibility of loss is reduced. But note that, on account of limited liability, the executive would be indifferent to the size of the loss. In this model the loss is set to zero; however in reality the loss could be much more substantial than this. Hence if failure became more severe in cost, but less likely to occur, the executive would be more tempted to take the myopic risk just when the expected cost from myopic risk taking was rising.

Corollary 1 discusses the link between fundamentals of the technology and executive utility and myopic risk taking. However industrial structure is also clearly relevant to the sufficient condition for myopia to enter the system. In particular we can demonstrate that if there is convergence amongst the largest firms then the risk of myopia entering the market is increased.

For the second part of the following result we require that

$$\mu_{j-1} - \mu_j \geq \mu_j - \mu_{j+1} \text{ for all } j \tag{19}$$

Condition (19) is equivalent to the view that there are more executives of medium skill than there at the highest skill levels. The condition is standard in the economics of skill (see for example, Gabaix and Landier 2008).

Proposition 6 *[**Industrial Structure And Myopia**]*

1. *Suppose that firm m should grow in size without changing its ranking. Then the myopic risk taking condition (18) is more likely to be satisfied for all the top $m-1$ firms, though less likely for firm m.*

2. *Suppose that the condition on skills, (19) applies. Suppose that each of the top m firms grows in size by $\{\sigma_n\}$ whilst preserving the size ranking. Suppose that $\sigma_n > \sigma_{n-1}$ so that the firms become closer in size (convergence). If the change affects enough of the market (m large enough) then the myopic risk taking condition is more likely to be satisfied for all the top $m-1$ firms.*

Proposition 6 can be understood as follows. If firm m grows then it becomes a more aggressive bidder in its bidding for executive $m-1$. To secure their executive the larger firm $m-1$ must supply greater utility; and this increases the chance that $m-1$ will find it preferable to use myopic contracts. The payoff that $m-1$ secures from their executive also falls. This makes firm $m-1$ a more aggressive bidder for the executive one notch up in the league table as they now gain less from their equilibrium match. Thus $m-2$ must also bid more aggressively to match the bidding of $m-1$, and this makes $m-2$ more likely to prefer myopia permitting contracts. This delivers the inductive step by which the risk of myopic contracts increases for all the top $m-1$ firms. The firm of rank m is less likely to resort to myopia permitting contracts as it faces unchanged competition for the executive of rank m, and yet is larger with more to lose from myopic risk taking.

Part 2 explores multiple changes in the distribution of firm resources sizes which characterise a more convergent structure. It is evident from part 1 that growth of a firm creates risks for firms of higher rank, whilst making the growing firm less likely to tolerate myopic risk taking. The result in part 2 allows these two conflicting forces to be weighed against each other. Consider the impact of convergence on some firm $n < m$. The sufficient condition for firm n to prefer myopia tolerating contracts (18), depends upon the weighted sum of the firm sizes for all firms ranked below n. This sum can be split into firms affected by convergence (rank at or above m); and the rest of firms unaffected by the convergence with rank below m. As firm n has grown under convergence, and all firms of rank below m are unaffected, the contribution of the firms of rank below m to this sum is to lower risk. However their contribution to risk is scaled by the skill gap between the executive the firm would hire and the executive one notch up $(\mu_{j-1} - \mu_j)$. This skill gap is small for low ranked firms by (19). Now consider firms of rank m or above. The process of convergence has these firms growing, and growing more quickly than firm n. By assumption $(S_m + \sigma_m) / (S_n + \sigma_n) > S_m/S_n$. Further the contributions of each of these terms is again scaled by the skill gap between the executive the firm would hire and the executive one notch up $(\mu_{j-1} - \mu_j)$. However this skill gap will be much larger than for the firms of very low rank. Therefore if enough firms are affected by the consolidation then all the firms of rank greater than m become more likely to trigger the introduction of myopia condition.

5 Convergence In Industrial Structure

We have a mechanism which links industrial structure to optimal tolerance, or not, of myopic risk taking. If an industry or a sector sees convergence in the firms' sizes then the industry becomes more likely to see the introduction of myopic risk taking permitting contracts. It is natural to study how equilibrium in the market might be characterised if myopic risk taking became present.

We seek to characterise the market equilibrium in which some firms find it optimal to employ their executives using contracts which tolerate myopic risk taking. In this case the positive assortative matching result proved as part of Proposition 4 is no longer complete as some firms will be using myopic contracts. 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 ability α is large enough that*

$$\alpha \left(1 + 2\frac{\mu_{n-1} - \mu_n}{1 - \mu_{n-1}}\right) > \chi - \eta \text{ for all } n \tag{20}$$

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 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 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). But larger firms also stand to lose relatively more from myopic risk taking. The positive match is sustained by ensuring that ability is important enough that the first effect dominates the second. This is delivered by condition (20).

Proposition 7 *[**Convergence And The Myopic Equilibrium**] Suppose (20) holds and that convergence in firm sizes between given firms n and $n-1$ implies that*

$$(1 - \mu_{n-1}) S_{n-1} < (1 - \mu_n) S_n \tag{21}$$

1. *Then if firm n uses a contract which permits myopia to hire its executive, so too does firm $n-1$.*
2. *If condition (21) is satisfied for all n, then in a myopia tolerating equilibrium the industry will partition. All the large firms will use myopia tolerating contracts, all the smaller firms will use contracts which rule myopia out.*

Proposition 7 restricts to the case in which positive assortative matching is guaranteed (Lemma 2 holds as (20) applies). Under (21) we can demonstrate that the following inductive step applies. If, in hiring executive n, firm n uses a myopia permitting contract, then 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 to target executive $n-1$. 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 she used a different contract. Condition (21) 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.

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 (21) would immediately be satisfied. Hence condition (21) is satisfied if the size of S_n is sufficiently close to the larger S_{n-1}. The condition therefore captures industry convergence. If S_n is close in size to $S_{n-1,}$ then firm $n-1$ does not have a big size advantage it can deploy in hiring the better executive. Thus the high bonuses it will have to offer make ruling out myopia very expensive. So firm $n-1$ finds it optimal to also offer myopia-tolerating contracts, yielding the inductive step.

If an industry should see sufficient convergence then it becomes more vulnerable to the equilibrium in contracts which rule out myopic risk taking breaking down (Proposition 6). In this case myopia tolerating contracts will enter the equilibrium. Part 2 of Proposition 7 notes that if the industry is sufficiently converged, (condition 21 holds generally), then in an equilibrium where some firms use myopia tolerating contracts, the market response will differ by size of firm. The industry will partition and the largest firms, those of the highest rank, will all find it preferable to hire their executives using contracts which tolerate myopic risk taking. The smaller firms would all rather use contracts which rule myopia out. Proposition 7 therefore offers a characterisation of the myopic equilibrium linked to industry structure.

6 Empirical Discussion From Banking

This section discusses the available evidence which speaks to the implications of the analysis presented as regards the financial services industry. The recent financial crisis has led to empirical research which seeks to compare the risk profile of banks as against their size. The theory presented here generates the prediction that when the banking sector converges sufficiently, the larger banks will tolerate myopia and so should have higher risk profiles as compared to the smaller banks (Proposition 7). Fahlenbrach, Prilmeier and Stulz (2011) consider whether financial performance in the banking crisis of 1998 (Russian debt default) is predictive of financial performance in the recent financial crisis. The research question they analyse is whether banks are repeat offenders, or can failures be put down to luck in which case previous failures should not have explanatory power for the future. They find that past financial distress in 1998 is predictive of financial distress in the recent financial crisis for the larger half of banks; but not for the smaller banks. Thus larger banks appear to have a business model, or behaviour which makes them more consistently prone to failures. This is supportive of the partition of industry structure predicted by this model.[7] Black and Hazelwood (2011) consider the population of TARP recipients in the US and analyze the banks' commercial and industrial loans directly rather than financial performance. The authors discover that, relative to the control of non-TARP banks, the risk of loan originations after the TARP capital injection increased at large banks and decreased at small banks. This empirical result suggests that executives at the large banks used the TARP funds to maintain a high risk posture which was not the case at smaller banks. This partition of the industry again mirrors that proposed in this model.

Cheng, Hong and Scheinkman (2010) explore the empirical link between executive compensation and risk metrics for banks directly. Cheng et al. explore residual pay which is total staff

[7]See Table 4 and the discussion at the end of section 3.4. Note however that the authors state that in unreported work the effect shrinks in the small sample of the very largest banks.

pay normalised by bank size. Their first finding is that residual pay is positively correlated with numerous measures of bank risk (firm beta, return volatility, the sensitivity of firm stock price to the ABX subprime index). In the notation of this model residual pay is given by u/S which captures the utility provided to the staff member normalised by bank size. The model here predicts that if such residual pay is high enough then the bank would prefer to hire their executive using contracts which tolerate myopic risk taking (Proposition 3). Secondly Cheng et al. find that the risk taking measures they look at are correlated with short-term performance pay, such as bonuses. The model predicts that if residual pay is high enough then a contract which tolerated myopia would have high short term bonus rates and low long term incentives (Proposition 2). Finally Cheng et al. find that the link between residual pay and risk taking is not related to Corporate Governance problems. Thus there is no evidence that the results in Cheng et al. are due to banks behaving against their profit maximising interests. The results of the theory offered here are in accordance with this empirical evidence.

The analysis here argues that industrial structure, convergence amongst the largest banks, can induce the sector to hire bankers with contracts which tolerate myopic risk taking. Further, if convergence is sufficient then the largest banks are the ones which are most likely to use such myopia tolerating contracts. Though not in the model, note that large banks are most likely to be of systemic significance. To assess whether there has been convergence in banking, and so assess whether this problem has been aggravated in recent history, one would ideally like data on the part of the balance sheet of banks and shadow banks devoted to individual business lines. This data is not generally available, but the total balance sheet data is. Boyd and Graham (1991) find that over the decade of the 1980s there was a 15% reduction in the number of US commercial banks, whilst at the same time the set of largest banks grew their share of total assets, and this growth was concentrated not in the very largest, but in banks ranked 11th or more. Thus the US sector experienced convergence of the form described by Proposition 6. In follow up work Boyd and Graham (1998) demonstrate that this convergence phenomenon continued into the next decade of the 1990s. We can conduct a similar exercise for the by comparing the sum of the balance sheets of the five largest financial institutions in the Compustat database against the total balance sheets of the next five financial institutions (ranks 6 to 10), and the five following (ranks 11 to 15).[8] Over the 40 years from 1970 financial institutions ranked 6 to 10 have grown their balance sheets faster than the top 5 to grow from being half the size of the top 5 in 1970 to being nearly 90% of the size of the top 5 in 2007 just before the financial crisis. The same is true of financial institutions ranked 11 to 15. Thus convergence in financial services is a compelling situation to investigate.

7 Conclusion

This paper has modelled executives' incentive contracts in the context of competition between the firms for executives. By doing so cleanly and tractably it has allowed an analysis of the pressures created by industrial structure to tolerate myopic risk taking. This work contributes to the necessary intellectual deliberations which underpin the new regulations on the structure

[8] Compustat, all firms SIC between 6000 and 6300, excluding 6282, years 1970 to 2009 inclusive. 31,333 observations capturing 2,829 separate firms over the 40 years of data.

and level of bankers' pay: regulations which are currently being enacted in the EU and in the US.

Competition between the firms for executives creates a negative externality which acts to make it relatively more expensive for a firm to manage the myopic risk taking problem than the moral-hazard problem. Firms need some bonus pay to manage moral hazard. But if such incentives pay out on short term results then they encourage myopic risk taking. Hence a proportion of bonus pay must be deferred, or vested. Such pay is of reduced value due to the executives' discounting. Convergence in industrial structure has the effect of driving up the remuneration executives' receive due to the negative externality of firm competition. As the surplus which must be delivered to the employees rises, the cost of hiring an executive on a contract which does not tolerate myopic risk taking rises faster still. If convergence is sufficient then a firm can find it optimal to jump to contracts which allow myopic risk taking with some probability. Once this occurs the extent of myopic risk taking, and indeed even if any is, becomes unknown to the firm and the market. Under some stricter conditions the market will partition with the largest firms using contracts which tolerate myopic risk taking, and the smaller firms using contracts which rule out myopic risk taking.

The link I have studied between industrial structure and optimal tolerance of excessive risk taking applies widely. The analysis of the model is made, I believe, more compelling given that it is in agreement with recent empirical evidence from the Financial Sector. The work speaks to the two quotes of President Obama given at the beginning. Excessive risk taking can be ruled out by intervening in the structure of individuals' pay to ensure a sufficient proportion of pay is deferred (vested). This is the structure the Financial Stability Board have been proposing.

A Technical Proofs

Proof of Lemma 1. Consider an agent of low realised ability. If they do not take myopic risks then they would expect remuneration of $f+\chi b+\chi v/(1+r)$. By risk taking the executive would secure $f+(\chi+\alpha)b+\eta v/(1+r)$. Hence the executive will not take myopic risks iff $(\chi-\eta)v/(1+r)\geq \alpha b$. ■

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. But this would contradict (5) being slack. Hence the participation constraint can be written as

$$f+\left(b+\frac{v}{1+r}\right)(\chi+\alpha\mu)=u \tag{22}$$

Equality (22) can be used to rewrite the objective function as

$$\left(2\rho S-\frac{r}{1+r}v\right)(\chi+\alpha\mu)-u \tag{23}$$

This is declining in v. Therefore the no myopic risk taking constraint, (3), must be binding. If it were not then set $v=0$, this would maximise the objective function, (23), if (22) 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

$$(\chi - \eta) v/ (1 + r) = \alpha b \tag{24}$$

By (24), b declines as v declines. By (22), f increases as b and v decline. Therefore lower v, to maximise the objective (23) until (6) is binding. The optimal contract is therefore the solution to (24), (22) and (6) with equality. Algebraic manipulations deliver the optimal contract and firm payoff. ■

Proof of Proposition 2. We will ignore the condition on myopic risk taking, (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. But this would contradict (12) being slack. Hence the participation constraint can be written as

$$f + (\chi + \alpha) b + [\mu (\chi + \alpha) + \eta (1 - \mu)] \frac{v}{1 + r} = u \tag{25}$$

Equality (25) can be used to rewrite the objective function as

$$(\chi + \alpha) \rho S + [\mu (\chi + \alpha) + \eta (1 - \mu)] \left(\rho S - \frac{r}{1 + r} v \right) - u \tag{26}$$

This is declining in v. Therefore we search for parameters which satisfy (25), (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 (26). ■

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 not exert effort whatever their realised ability, then the firm cannot make a positive profit. Therefore suppose that the firm considered hiring an executive and incentivising effort from the executive if they are of high realised ability, and not otherwise. The payoff of the firm in this case would be

$$\mu [(\chi + \alpha) (\rho S - b) + (\chi + \alpha) (\rho S - v)] - f \tag{27}$$

The participation constraint is

$$\mu [(\chi + \alpha) (b + v/ (1 + r)) + f] + (1 - \mu) f/ (1 - \Lambda) \geq u \tag{28}$$

An executive of high realised ability would exert effort if

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

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

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

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

(30) ensures no effort is better than effort and not myopic risk taking, (31) ensures no effort dominates effort with myopic risk taking.

The participation constraint (28) is binding otherwise all payments can be set to 0. Substituting into the objective (27) 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 (28), into (29) 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 (28) and (29) satisfied with equality imply that (30) is strictly satisfied. Substituting (28) and $f = u(1-\Lambda)$ into (31) 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 deferred pay is just marginally 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 myopic risk taking and incentivising effort from the executive, (15), if $\Lambda u < (\eta + \chi + \alpha)\rho S$. This is given by assumption (2). ■

Proof of Proposition 4. Suppose all the firms prefer to use contracts which ensure no myopic risk taking, 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):

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

This can be rewritten as

$$\begin{aligned} & u^{m,n-1}\left\{1 + \frac{r\alpha\Lambda(\chi + \alpha\mu_{n-1})}{(\chi + \alpha - \eta)(\chi + \alpha\Lambda\mu_{n-1})}\right\} \\ = \; & 2\rho S_m\alpha(\mu_{n-1} - \mu_n) + u^n\left\{1 + \frac{r\alpha\Lambda(\chi + \alpha\mu_n)}{(\chi + \alpha - \eta)(\chi + \alpha\Lambda\mu_n)}\right\} \end{aligned} \tag{32}$$

$u^{m,n-1}$ 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 their 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 they are 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 myopic risk taking to arrive (condition 18). Part 1 follows as increasing r lowers the right hand side. For part 2 we rewrite condition (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 note that as η increases both terms on the right hand side of (18) decrease. ■

Proof of Proposition 6. Part 1 is immediate from condition (18). For part 2 consider the left hand side of condition (18) for firm $n < m$. Convergence changes this term by

$$\begin{aligned}&\sum_{j=n+1}^{m} 2\alpha\frac{S_j+\sigma_j}{S_n+\sigma_n}\left[\frac{\mu_{j-1}-\mu_j}{1-\mu_n}\right] + \sum_{j=m+1}^{N} 2\alpha\frac{S_j}{S_n+\sigma_n}\left[\frac{\mu_{j-1}-\mu_j}{1-\mu_n}\right]\\ &-\left\{\sum_{j=n+1}^{m} 2\alpha\frac{S_j}{S_n}\left[\frac{\mu_{j-1}-\mu_j}{1-\mu_n}\right] + \sum_{j=m+1}^{N} 2\alpha\frac{S_j}{S_n}\left[\frac{\mu_{j-1}-\mu_j}{1-\mu_n}\right]\right\}\end{aligned}$$

This is equal in sign to

$$\sum_{j=n+1}^{m}\underbrace{\left[\frac{S_j+\sigma_j}{S_n+\sigma_n}-\frac{S_j}{S_n}\right]}_{+\text{ve}}(\mu_{j-1}-\mu_j) + \sum_{j=m+1}^{N}\underbrace{\left[\frac{S_j}{S_n+\sigma_n}-\frac{S_j}{S_n}\right]}_{\text{-ve}}(\mu_{j-1}-\mu_j)$$

Now use the fact that $\mu_{j-1}-\mu_j \geq \mu_j - \mu_{j+1}$, (condition 19). Then the expression is bounded below by

$$\begin{aligned}&\left[\frac{S_m+\sigma_m}{S_n+\sigma_n}-\frac{S_m}{S_n}\right](\mu_{m-1}-\mu_m) + \left[\frac{\sum_{j=m+1}^{N} S_j}{S_n+\sigma_n}-\frac{\sum_{j=m+1}^{N} S_j}{S_n}\right](\mu_m-\mu_{m+1})\\ > \;\; &(\mu_m-\mu_{m+1})\left[\frac{S_m+\sigma_m+\sum_{j=m+1}^{N} S_j}{S_n+\sigma_n}-\frac{S_m+\sum_{j=m+1}^{N} S_j}{S_n}\right]\end{aligned}$$

This is positive if $\sigma_m > \sigma_n \sum_{j=m}^{N} S_j / S_n$. As $n < m$ we have, by assumption, that $\sigma_m > \sigma_n$.

Therefore the expression is true if m is large enough. In this case risk has increased for all firms with rank higher than m. ■

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 non-myopia inducing contract. In this case firm $n-1$ would also employ executive n with a non-myopia inducing contract by Proposition 3 (as $S_{m-1} > S_m$). If firm m would bid for executive $n-1$ with a non-myopic inducing contract then, by Proposition 4 we have that firm $m-1$ would outbid firm m for executive $n-1$ with such a non-myopia inducing 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

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

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

$$\begin{aligned} (1+\mu_{n-1})(\chi+\alpha)+\eta(1-\mu_{n-1}) &> 2(\chi+\alpha\mu_n) \\ \alpha\left(1+2\frac{\mu_{n-1}-\mu_n}{1-\mu_{n-1}}\right) &> \chi-\eta \end{aligned} \tag{34}$$

   If (34) 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), they 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

$$u^{m,n-1} = u^n + (\mu_{n-1}-\mu_n)(\chi+\alpha-\eta)\rho S_m \tag{35}$$

   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 non-myopia inducing contract. Then firm m would offer utility up to $u^{m,n-1}$ where, from (9):

$$\begin{aligned} & \left(2\rho S_m - \frac{r\alpha\Lambda}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_{n-1})}u^{m,n-1}\right)(\chi+\alpha\mu_{n-1})-u^{m,n-1} \\ = & \left[(1+\mu_n)(\chi+\alpha)+\eta(1-\mu_n)\right]\rho S_m - u^n \end{aligned} \tag{36}$$

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:

$$\frac{r\alpha\Lambda(\chi+\alpha\mu_n)}{(\chi+\alpha-\eta)(\chi+\alpha\Lambda\mu_n)}u^n > (1-\mu_n)(\chi-\alpha-\eta)\rho S_m \tag{37}$$

(a) If firm m were to bid for executive $n-1$ with a non-myopic contract, then they would bid up to utility $u^{m,n-1}$ given by (36), which can be written

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

In response, firm $m-1$, if bidding with a non-myopic contract, would bid for executive $n-1$ a utility of $u^{m-1,n-1}$ derived from (32) 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

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

Using the condition that u^n was high enough that firm m would hire executive n with a myopia inducing contract, (37), the condition for positive assortative matching becomes

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

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 they would bid up to a utility $u^{m,n-1}$ given by (35). In response firm $m-1$, if matching with a myopia inducing contract would bid up to $u^{m-1,n-1}$ derived from (33) 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

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

Using (37), this follows if (34) holds, yielding positive assortative matching.

■

Proof of Proposition 7.

For part 1 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

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

If firm n were to bid for executive $n-1$ with a myopia inducing contract then they would be willing to bid up to a utility of $u^{n,n-1}$ given by (35) of $u^{n,n-1}=u^n+\left(\mu_{n-1}-\mu_n\right)\left(\chi+\alpha-\eta\right)\rho S_n$. Hence we have

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

where the second inequality follows from (38). $u^{n-1}\geq u^{n,n-1}$ as firm n may offer even higher utility to executive $n-1$ if they decide to use a non-myopia inducing 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 (39) 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

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

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 (40) 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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