Blood and Money: Kin altruism, governance, and inheritance in the family firm

Thomas Noe

Balliol College/Saïd Business School, Oxford

European Corporate Governance Institute

thomas.noe@sbs.ox.ac.uk

15 April, 2015

Abstract

Using the inclusive fitness framework (Hamilton, 1964), this paper models family firms. The structure on altruism imposed by the inclusive fitness framework ensures that increasing kinship reduces monitoring efficiency. Nevertheless, when incentive alignment determines management compensation, increasing kinship increases net efficiency. At the same time, increasing kinship promotes nepotistic hiring, and when institutions are weak, may not increase firm value. When labor markets determine compensation, increasing kinship lowers efficiency, but never induces nepotism, and sometimes increases firm value. Family firm founders are always more altruistic toward related managers than their direct descendants, leading to intergenerational conflicts over compensation and hiring policies.

Keywords: Corporate governance, entrepreneurship, kin altruism, contract theory

1 Introduction

Family firms are ubiquitous.[1] Their ubiquity raises the question of whether the defining char-acteristic of family firms—kinship—affects their value and behavior. To address this question, some framework for analyzing kinship's effect is required. By far, the most well developed and empirically validated approach to modeling kinship in the social and natural sciences is founded on Hamilton (1964), which develops an inclusive-fitness based rationale for kin altruism.[2]

The inclusive fitness of a given agent is that agent's own fitness summed with the weighted fitness sum of all other agents, the weights being determined by the other agents' coefficient of relatedness, i.e., their kinship, to the given agent. The logic behind kin altruism is that gene expression affects the number of copies of a gene in the gene pool both through its direct effect on the fitness of the agent expressing the gene and through its effect on the fitness of other agents sharing the gene. Because of relatedness, kin have a far higher than average probability of sharing any gene, including genes for altruistic behavior. Thus, a gene for kin altruism can increase in a population even if it is harmful to the fitness of the agent having the gene, provided that the costs to the agent are low relative to the benefits to kin. Selection of a kin altruistic gene requires that $rB > C$, where r represents the coefficient of relatedness, typically less than 0.50, B the benefit to the relative, and C the cost to the kin altruist.

Kinship altruism imposes strong restrictions on the structure of intra-agent altruism. In general, altruistic preferences are modeled by assuming that one agent internalizes the effects of her actions on the payoffs of another agent, i.e., the utility of the altruistic agent is deter-mined by a convex combination of her own payoffs and the payoffs of the agents for whom

---

[1]As documented by Porta et al. (1999), 45% of publicly listed international firms are family controlled. Even in the U.S., the majority of firms with revenues less than $500 million are family controlled, and many very large firms are tied to families, e.g., Ford, and Walmart. Moreover, a number of very large firms are controlled, managed, and wholly or almost wholly owned, by members of a single family, e.g., Koch Industries and Cargill in the U.S., Esselunga S.p.A and Parmalat Finanziaria S.p.A. in Italy. In fact, even using their most narrow definition of "family firm," Astrachan and Shanker (2003) estimate that more than 30% of US GNP is produced by family firms.

[2]For example, Madsen et al. (2007) provides experimental evidence that agents' willingness to bear costs to benefit other agents is monotonically increasing in kinship. Daly and Wilson (1994) find that step fathers are more than 60 times more likely to kill their preschool children than biological fathers. Field evidence from other researchers shows that kinship relations increase political alliance formation (Dunbar et al., 1995), facilitate the assumption of group leadership (Hughes, 1988), and increase the probability of survival in catastrophic circum-stances (Grayson, 1993).

she as altruistic regard. Kin altruism imposes strong restrictions on the structure of this internalization. Kin altruism must, like relatedness itself, be symmetric, limited, stable over time, and not affected by social interaction. Moreover, as we show, kin altruism, through the genetic calculus, imposes restrictions on the relative strength of altruistic preferences of founders and descendants. In contrast to the predictions of more general "friendship" based frameworks, the relation between kin-altruism model and firm performance is not confounded by causal endogeneity—firm performance might or might not be affected by kin altruism but firm performance cannot affect kinship and thus cannot affect kin altruism.

This paper's agendum is to apply the kin altruism framework to family firms. The focus of our analysis is descendant family firms—firms which are wholly owned and managed by genetically related agents. In the extension sections, we briefly consider the implications of inclusive fitness for the bequest incentives of firm founders. Our analysis shows that the sharp restrictions imposed by kinship altruism deliver quite determinant predictions regarding the effect of kinship on firm performance. These predictions tie the effects of kinship to two of the central concerns of contemporary corporate finance research—the effectiveness of governance and the determinants of managerial compensation.

Specifically, we introduce kin altruism into a fairly standard principal/agent model of effort, monitoring, and diversion. Our analysis shows that kinship's effects on firm behavior are subtle. The first result in the paper is that, consistent with evidence provided by Barr et al. (2008), but not with the perspective of Fukuyama (1995), kinship *per se* does not increase trust. In fact, at fixed compensation and output levels, kinship exacerbates monitoring problems. Thus, the model predicts, consistent with the observations of Bertrand and Schoar (2006) that internal governance conflicts are of first-order importance in family firms. When owners are related to managers, they are soft monitors. Managers know this and take advantage, thereby increasing dissipative monitoring expenses. These predictions are specific to the kin altruism framework in that they depend on both the limited extent of kin altruism and on its symmetry.

Thus, if kinship is to be a source of value in the kin altruism framework, it must create value through some other mechanism. The kin altruism/inclusive fitness framework predicts

that kin agents accept reductions in personal payoffs only if such reductions generate much larger increases in family payoffs. Thus, for kinship to generate value, family agents must operate on a "frontier," an environment where intrafamily payoff distributions significantly affect total family payoffs. The classic principal/agent setting is one such frontier. In the agency setting, both the human capital required to manage the firm and the manager's human capital are family specific. Compensation is determined by incentive considerations, and the tradeoff faced by the owner is that increased compensation increases managerial performance but also increases the manager's agency rents. In this setting, kin altruism increases both managers' willingness to exert effort at any fixed level of compensation and owners' willingness to pay for any fixed level of effort. We show that, despite exacerbating monitoring problems, increasing kinship always increases total family value. Rational kin-altruist owners factor monitoring costs into equilibrium compensation packages. These compensation adjustments both ameliorate the monitoring problem and increase the performance of the kin manager. Even at equilibrium compensation levels, monitoring in the family firm may be less efficient than in non-family firms. However, the net effect of increasing kinship on performance is always positive.

However, increased efficiency need not translate into increased firm value because kinship also affects the distribution of value between family owners and managers. In contrast to the efficiency of family firms, which depends on the agency frontier being open, whether efficiency translates into increased firm value depends inversely on the costs of monitoring inflated by the degree of kinship between the agents. Thus, when the degree of kinship is high, the costs of monitoring must be lower for the efficiency gains from family ownership to translate into firm value gains rather than managerial rents. If we view the costs of monitoring as being inversely related to the quality of institutions, this result predicts complementarity between the quality of institutions and kinship for generating firm value. The only potential source of inefficiency generated by family ownership is nepotistic internal promotion of less competent related managers over more competent internal non-family rivals. However, this problem can be mitigated by attaching the rival candidate to the family through marriage and thereby creating

a common genetic interests through descendants.[3]

Thus, if the incentive boundary always fixed managerial compensation, *ceteris paribus*, our results argue for the organization of production through family controlled firms. However, a number of recent papers question the centrality of incentive considerations, and argue instead that competition in managerial labor markets is the binding constraint fixing managerial compensation.[4] In fact, the question of whether the agency or labor market constraints fix managerial compensation is currently the focus of intense empirical investigation.[5]

Our results suggest that the resolution of this empirical question has significant implications. In our framework, when the incentive constraint is satisfied at labor-market determined managerial compensation levels, the frontier along which family altruism generates value is closed and, thus, kinship lowers efficiency. When a family manager has both general human capital and family-specific human capital, owners use the family specific component of human capital and the manager's family loyalty to reduce compensation. Reduced compensation increases managerial diversion and thus lowers efficiency. However, this inefficient family loyalty "hold up" sometimes increases firm value. In general, firm value is quasiconcave in the degree of kinship between owners and managers: firm value is maximized at intermediate levels of kinship at which the loyalty holdup extracts significant compensation concessions from managers yet kinship is not so high as to significantly erode the monitoring incentives of owners.

When the agency frontier is closed, regardless of whether family owners hire inside or outside the family, owners set compensation to match reservation compensation demands. Thus managers do not earn agency rents. Because managers to not earn agency rents, owner hiring decisions are not nepotistic. Because, family-specific human capital is used by owners simply for rent extraction, family-specific human capital is less efficient than general human capital. Absent any family-specific human capital, e.g., in a pure positive assortative matching environ-

---

[3]See Section 6.1 for more discussion

[4]See for example, Murphy (2002) and Gabaix and Landier (2008)

[5]Philippon and Reshef (2012), Célérier and Vallée (2014), and Lindley and McIntosh (2014) argue that current levels of managerial compensation reflect the value of general cognitive skills in a world where firm value and managerial skill are strategic complements and management skills are general rather than firm specific. However, Böhm et al. (2015) presents conflicting evidence.

ment, firm value and owner welfare is highest when the firm is managed by external managers.

Thus far, we have only discussed the behavior of descendant-owned family firms. As an extension, we consider how founder preferences might affect the structure of descendant firms. We show that, under very weak restrictions on family pedigrees, the genetic calculus of kinship-based altruism implies that founders always exhibit greater "family benevolence" than any of their descendants. Thus, when the descendant managers are related to the founder but not direct descendants, a founder has an incentive to appoint and entrench related managers at the expense of her direct descendants.

The inclusive fitness/kin altruism model of the family firm has a number of implications for performance and behavior. Its most basic insight is that the translation of kin altruism into increased firm efficiency and value is mediated by the institutional/environmental factors discussed above. The exogenous variables that condition these predictions are observable and, in fact, as discussed above, are currently the object of intense empirical investigation. One obvious testable implication is that, holding the quality of institutions fixed, managerial labor market development, proxied perhaps by the likelihood of external hires or the level of managerial compensation, will have negative effect on the proportion of economic activity controlled by family firms. Another prediction, is that, although family managers may underperform relative to optimal external candidate managers, family managers never underperform relative to the performance predicted by their human capital and level of compensation. Third, the model predicts that successor family CEO appointments by founders will lead to higher total compensation, including bequeathed minority ownership stakes, than the total compensation offered when family CEOs are hired by their collateral relatives (e.g., brothers, sisters, cousins). Fourth, it predicts, controlling for managerial labor market conditions, that the compensation of family managers relative to non-family managers will be highest where governance institutions are weakest. As well as providing new testable implications, the kin altruism perspective, which shows that the relative advantage of family firms is mediated by labor-market development and institutional quality, offers a potential explanation for the conflicting empirical results

on the effect of kinship on firm performance.[6]

Related literature

This paper's is an alternative to models of family firms that are grounded in nonessential but stereotypical characteristics of family firms, e.g., operating in environments with weak governance, facing capital constraints, or being small in scale, rather than relatedness per se. (e.g., Burkart et al. (2003) and Almeida and Wolfenzon (2006)). Both the "essentialist" approach taken in this paper, and the "non-essentialist" approach are plausible and grounded by a significant body of theoretical research. Thus, ultimately, the validity of each is an empirical question. However, such empirical research requires a model that clearly specifies the effect of injecting relatedness into standard models of governance and compensation.

This paper can be viewed as part of a growing literature on the economic consequences of altruism. Models of altruism in a finance context are developed in Lee and Persson (2010) and Lee and Persson (2012). These papers consider symmetric altruism. In contrast with our analysis, they do not consider the effect of altruism on governance. Alger and Weibull (2010) do model kinship-based altruism between collateral relations. Their focus is on intrafamily wealth transfers between siblings who work independently. Our focus is on siblings who act as agents for other siblings. Bassi et al. (2014) consider the effect of asymmetric altruism in an abstract principal/setting and show that, holding the altruism of the agent fixed, allocations converge to first best as the principal's altruism converges to one. In contrast, in our paper, we consider instead the sort of limited symmetric altruism implied by kinship relations.

The presence of the sort of generalized altruism modeled in some of these papers does not preclude kin altruism from making determinant testable predictions regarding family-firm behavior. First, as discussed earlier, the distinctiveness of family firm behavior in many cases follows from the restrictions on the structure of altruism implied by the calculus of relatedness

---

[6]Anderson and Reeb (2003) report a positive effect of family ownership on firm performance for U.S. firms and Sraer and Thesmar (2007) report similar results for French firms. However, Miller et al. (2007) and Villalonga and Amit (2006) find, for U.S. firms, that, after controlling for the effect of a founder owner, family firms do not outperform non-family firms. See Miller and Le Breton-Miller (2006) for a comprehensive summary of these results and of the various definitions of "family firm" used in this literature.

rather than from altruism *per se*. Second, kinship altruism is also distinct from altruism in general because it is stable over time and not dependent on reciprocal benefits or continuous social interaction. There is no reason to suppose that altruistic preferences generally share these properties. In fact, it is a matter of dispute whether altruism, even between close friends, has these characteristics (Roberts and Dunbar, 2011). Third, this model considers the effects of increasing the *level* of altruism rather than the effect of the mere presence of altruism. Contrasts between family and non-family firms behavior only require that kin-based relationships exhibit significantly higher overall levels of altruism than non-kin relationships. This assumption reflects the consensus of evolutionary psychology and anthropology research.[7]

2 Model

2.1 Overview

This model aims to capture the behavior of a kin-altruistic family firm operating in a limited enforcement, low verifiability environment. The world lasts for one period, bracketed by dates 0 and 1. All agents are risk neutral and patient. There are two agents in the baseline model: a "family owner" and a "kin manager." Since the owner in our analysis is always a family owner we will refer to the family owner simply as the "owner." Sometimes, when there is no risk of ambiguity, we will refer to the kin manager simply as the "manager." The owner and kin manager are related. The owner has monopoly access to a project which we will call a firm. The owner can only operate the project if he secures the efforts of the kin manager. Collectively, the owner and kin manager are called "family agents" and the total value received by the family owner and kin manager is called "family value." We assume that consanguinity between agents leads them to partially internalize the effects of their actions on the payoffs to other family members. The details of this internalization are provided below.

In the baseline model, the family owner hires the kin manager by making a first-and-final

---

[7]The key role of the agency frontier in our analysis is also analogous to results in evolutionary biology which show that, absent some frontier that permits related agents to increase their total average fitness, the force of selection will not favor kin altruistic allelae(Taylor and Irwin, 2000).

compensation offer that the kin manager can either accept or reject. If the offer is accepted, the manager makes an unobservable effort decision that produces a cash flow also only observed by the manager. In order to induce the manager to exert effort and accept employment, the owner offers the manager a contract that satisfies limited liability. Because effort and realized cash flow are observed only by the manager, neither effort nor the realized cash flow are verifiable or contractible. After observing the cash flow, the manager makes a verifiable report of the cash flow to the owner. The manager and owner then divide reported cash flow based on the employment contract. After receiving the manager's report, the owner has the option of monitoring. Monitoring is not verifiable and imposes a non-pecuniary cost on the owner. Monitoring is perfectly effective in that it always detects and returns to the owner all firm cash flow in excess of reported cash flow.

2.2   Preferences

The kin-altruism preferences of family agents are reflected in their utility function, u:

$$u^{\text{Self}} = v^{\text{Self}} + h\,v^{\text{Relative}}, \tag{1}$$

$$0 \le h \le 1/2. \tag{2}$$

where v^{Self} represents the agent's own value and v^{Relative} represents the relative's value. Value includes both the monetary payoffs and the non-pecuniary cost of effort, in the case of the manager, and monitoring cost, in the case of the owner. Note, that consistent with the inclusive fitness approach, relatives do not internalize the utility or hedonic pleasure of their kin, rather they internalize the payoffs to their kin, which are assumed in our analysis to map into their kin's fitness.[8] The scalar h represents kinship, the strength of the relation, or family tie, between

---

[8]Alternative approaches to modeling altruism are perfectly reasonable but are either much more cumbersome than our approach or less consistent with the kin altruism perspective. One could, for instance, model altruism in a framework in which agents maximized the weighted sum of selfish and related agent utility rather than payoffs. Since the map from payoffs to utility is invertible and monotone, this formulation is equivalent to our approach but is more cumbersome. A very reasonable alternative to our approach would be incorporating a non-linear fitness function in the analysis. This approach would greatly increase the complexity of the analysis and raise questions concerning the dependence of the analysis on the specific fitness function chosen.

the family agents. Condition (2) is motivated by the fact that the ½ is the highest degree of relatedness produced by typical mating patterns.[9] Note that agents are not altruistic in the sense of preferring relatives' gains to their own. If asked how they would split a fixed amount of money with a relative, each relatives' preferred choice is to take everything for herself. However, relatives might abstain from such transfers when the transfers are highly dissipative, i.e., the transfer from one to another significantly reduces family value.

This observation is most apparent if we rewrite the utility function using some equivalent formulations. Let $v^{\text{Family}} = v^{\text{Self}} + v^{\text{Relative}}$ represent family value. Using v^{Family}, we can express the utility function of a family agent in the following forms:

$$u^{\text{Self}} = v^{\text{Family}} - (1-h)\, v^{\text{Relative}}, \tag{3}$$

$$u^{\text{Self}} = (1+h)\, v^{\text{Family}} - u^{\text{Relative}}, \tag{4}$$

$$u^{\text{Self}} = h\, v^{\text{Family}} + (1-h)\, v^{\text{Self}}. \tag{5}$$

These reformulations are trivial from a technical perspective but provide crucial insights for the subsequent analysis. Equation (3) shows that when choosing between two outcomes that produce the same family value, the family agent always prefers the outcome that produces a smaller value for the relative. Equation (4) expresses the principle that when choosing between actions that leave the utility of the relative fixed, family agents always prefer the choice that is family-value efficient. This principle is analogous to the principle in contract theory that, when all possible actions of the principal hold the agent to her reservation payoff, the principal selects the efficient value-maximizing action. We will see that the principle embodied by equation (4) imposes strong limitations on the ability of kinship to affect firm behavior. Equation (5), shows that the utility of family members is a weighted average of selfish and family value, with the

---

[9]The condition that the degree of kinship between the owner and manager, h, does not exceed ½ is motivated by inclusive fitness, which limits for non-inbred, non-monozygotic (i.e., non-identical twins) haploids (e.g., humans) kinship to at most ½. This specific boundary for h is not required to establish our results; however, some boundary is frequently required. As kin altruism becomes unlimited, i.e., $h \to 1$, the monitoring problem generated by relatedness vanishes because either (a) the owner concedes all firm value to the manager or (b) managerial effort converges to the first-best level even in the absence of compensation. Whether (a) or (b) occurs first depends on complex polynomial expressions. Because these cases are not very interesting when altruism is motivated by inclusive fitness, we eschew working them out.

weight on family value given by h and the weight on self value given by $1 - h$.

2.3 Effort

The random cash flow from the project, $\tilde{x}$, has the following distribution

$$\tilde{x} = \text{dist.} \begin{cases} \bar{x}, & \text{w.p. } p \\ 0 & \text{w.p. } 1 - p \end{cases}. \tag{6}$$

The manager selects $p \in [0, \bar{p}]$, $\bar{p} \in (0, 1]$. p represents the probability that the cash flow from the project equals $\bar{x} > 0$. We call p the *uptick probability*. The manager's choice of p imposes a non-pecuniary effort cost of $\mathscr{E}(p)$ on the manager, where $\mathscr{E}(\cdot)$ is a weakly increasing function of p. Effort is not observable by any agent except the manager. If the firm fails to operate, the project produces a payoff of 0, and the manager receives a payoff of v_R, the manager's reservation payoff.

2.4 Kinship and monitoring

After the cash flow is generated, the manager observes the cash flow. The cash flow is the manager's private information. After observing the cash flow, the manager sends a message to the owner. This message is observable and verifiable by third parties. We call this message "reported cash flow." We assume that reported cash flow cannot exceed the cash flow and that the manager reports either 0 or $\bar{x}$.[10] Cash flows in excess of reported cash flows are termed "unreported cash flows." The owner has access to a monitoring technology. If the owner uses the technology and monitors, the owner incurs a non-pecuniary cost of $c > 0$. We call this cost the "cost of monitoring." The monitoring technology is perfectly effective, it completely returns all unreported cash flows to the owner. If the owner does not monitor, the manager receives all unreported cash flows. In this case, we say that the manager "diverts" cash flows.

---

[10]Thus, we can view the report of cash flow as being equivalent to the deposit of the cash flow in an escrow account as in, for example, Harris and Raviv (1995). As in Harris and Raviv, by the revelation principle, we can also assume that the report equals either 0 or $\bar{x}$.

The owner decides whether to monitor after observing the manager's report. Monitoring cannot be verified by third parties but is observed by both the manager and the owner. This assumption is consistent with the sort of informal, "checking up" monitoring by the owner that we aim to model. Because only reported cash flows are verifiable, contracts must be contingent only on reported cash flows. Contracts are assumed to satisfy limited liability. Thus, when the reported cash flow equals 0, the only feasible limited liability contract stipulates a payment of 0 to both the owner and manager. When the reported cash flow equals $\bar{x}$, feasible contracts stipulate that the manager receives w and the owner receives $\bar{x} - w$, where $0 \leq w \leq \bar{x}$. We term w "management compensation" or simply "compensation." If the manager reports $\bar{x}$, reported cash flow equals the highest possible cash flow and the owner knows that the report is truthful. In this case, the owner has no incentive to monitor. If the reported cash flow is 0, then it is either the case that (a) the cash flow is, in fact, 0 and the manager reported truthfully or (b) the manager "underreported," i.e., the cash flow equaled $\bar{x}$ and the manager reported 0.

Our model of reporting and monitoring is quite standard and closely tracks the Townsend (1979) model of costly state verification. The major difference is that, we assume that monitoring is not verifiable, which implies that the owner cannot commit to monitor. In this respect, the paper tracks more recent papers on costly state verification, e.g., Graetz et al. (1986) and Khalil (1997)). For this reason, the Hart (1995) critique, based on renegotiation proofness, of costly state verification models is not relevant in our context.[11]

2.5 Parameter restrictions

Throughout the analysis, we impose the following parameter restrictions:

$$\max_{p \in [0,\bar{p}]} p\bar{x} - (v_R + \mathscr{E}(p) + c) > 0, \tag{7}$$

$$(1-h)\bar{x} - c > 0. \tag{8}$$

---

[11]See the conclusion for a discussion of whether, in a dynamic multiperiod version of this model, kinship would facilitate or impede enforcing monitoring policies that differ from the single-period optimal policy.

(7) implies that the expected cash flow to the project exceeds the cost of effort, monitoring, and the manager's reservation payoff. Thus, absent any kinship between the agents, undertaking the project is optimal even if undertaking the project requires that the owner incur the monitoring expenditure, c. The second restriction, (8), implies that the owner's utility benefit from monitoring when the owner knows that the manager has underreported cash flow, which equals the utility from transferring a concealed cash flow of $\bar{x}$ from the manager to the owner, $(1-h)\bar{x}$, exceeds the cost of monitoring, c. If this assumption were violated, the owner would never monitor and the manager would divert the entire cash flow.

3 Kinship and monitoring when compensation and output are fixed

In this section, we treat compensation, w, and effort, and thus the uptick probability, p, as fixed parameters. Thus, there are only two interesting choices we must analyze: the manager's reporting decision when $x = \bar{x}$, and the owner's monitoring decision when the manager reports 0. In later sections, we will endogenize w using the manager's participation or incentive compatibility conditions. We analyze the monitoring/reporting problem in the case where the game is not trivial, i.e., when the cost of monitoring, c, is positive.

3.1 Incentives to underreport

Let m represent the probability the owner monitors a report of 0. When the cash flow equals $\bar{x}$ and the manager reports $\bar{x}$, he receives w and the owner receives $\bar{x} - w$. If the manager reports 0, and the owner does not monitor, the manager receives $\bar{x}$ and the owner receives 0; if the owner monitors, the manager receives 0 and the owner receives $\bar{x} - c$. Thus, conditioned on underreporting, the manager's utility, which reflects his payoff and the portion of owner's payoff that is internalized as specified in (1), is

$$u_M^{\text{Underreport}} = (1-m)\bar{x} + hm(\bar{x} - c); \tag{9}$$

conditioned on truthfully reporting $\bar{x}$, the manager's utility is

$$u_M^{\text{NotUnderreport}} = w + h(\bar{x} - w). \tag{10}$$

Thus, the manager's best reply is to divert if $m < m^*$, not divert if $m > m^*$, and both diversion and non-diversion are best responses if $m = m^*$, where m^* is determined by equating (9) and (10), which produces

$$m^* = \frac{(1-h)(\bar{x}-w)}{ch + (1-h)\bar{x}}. \tag{11}$$

3.2   Incentives to monitor

Let ρ represent the owner's posterior assessment of the probability that the cash flow is $\bar{x}$ conditioned on the manager reporting 0. Later, we will determine this posterior using Bayes rule. If the owner monitors, the owner will receive $-c$ if the cash flow is 0 and $\bar{x} - c$ if the cash flow is $\bar{x}$. Thus, the owner's payoff from monitoring is

$$\rho \bar{x} - c.$$

If the owner decides not to monitor, his payoff is 0. Now consider the manager's expected payoff conditioned on a report of 0. If the cash flow is actually 0, the manager's payoff is 0 regardless of the owner's monitoring decision; if the cash flow is $\bar{x}$, the manager receives $\bar{x}$ if the owner does not monitor, and 0 if the owner monitors. Thus, the utility to the owner from monitoring is

$$u_O^{\text{Mon.}} = \rho \bar{x} - c.$$

If the owner does not monitor, the owner's utility is

$$u_O^{\text{NotMon.}} = h \rho \bar{x}.$$

Thus, the owner's best reply is to monitor if $\rho > \rho^*$ not monitor if $\rho < \rho^*$; both monitoring and not monitoring are best replies if $\rho = \rho^*$, where

$$\rho^* = \frac{c}{(1-h)\bar{x}}.$$

Let σ represent the probability of the manager reporting 0 conditioned on the cash flow being $\bar{x}$. The cash flow distribution (which is given by (6)) and Bayes rule imply that ρ, the probability that the cash flow equals $\bar{x}$ conditioned on a report of 0, is given by

$$\rho = \frac{\sigma p}{\sigma p + (1-p)}.$$

3.3 Monitoring/reporting equilibrium

In this section, the uptick probability, p is exogenous. For some choices of p, the solution to the monitoring reporting problem is "trivial," i.e., the solution will call for the owner not to monitor and for the manager to divert the entire cash flow. In subsequent sections we show that the owner will never select compensation policies that produce these trivial solutions. Thus, to focus on solutions to the monitoring reporting game which can be supported by optimal compensation policies, we impose the following parametric restriction:

$$(1-h)\bar{x}p > c. \tag{12}$$

To determine the equilibrium level of monitoring and reporting, first note that no equilibrium exists in which monitoring occurs with probability 1: if monitoring were to occur with probability 1, then the manager would never underreport. In that case, monitoring would not be a best response for the owner. Next, note that the highest possible value of ρ, produced by the conjecture that the manager always underreports, is p. Thus, assumption (12) ensures that for a sufficiently high probability of underreporting, the owner would monitor. Thus, there is a unique mixed strategy equilibrium in which (3.2), (11) and (3.2) are satisfied. The equilibrium

probabilities of underreporting, σ^*, and monitoring reports of 0, m^*, are given by

$$\sigma^* = \frac{c(1-p)}{p(\bar{x}(1-h)-c)},$$
$$m^* = \frac{(1-h)(\bar{x}-w)}{ch+(1-h)\bar{x}}. \tag{13}$$

We see from equation (13) that monitoring intensity is decreasing in kinship, h, while managerial underreporting is increasing in h. This implies that diversion is larger when kinship is greater.

The only source of value dissipation in the monitoring/reporting game is *monitoring expense*, the expected cost of monitoring in the reporting/monitoring equilibrium. Monitoring expense is simply the probability of monitoring multiplied by the cost of monitoring, c. Thus, the effect of kinship on family value depends on the probability of monitoring. The effect of kinship on the probability of monitoring is more subtle than the other comparative statics: the owner's monitoring decision is made ex post, after a 0 report is observed.[12] Zero reports occur when the actual cash flow is 0 or the manager underreports. Thus, holding monitoring intensity constant, the probability of monitoring is increasing in the probability of underreporting. Because underreporting triggers monitoring, it increases monitoring costs to the owner. Part of this cost increase is internalized by the related manager. Because kinship increases internalization, the level of monitoring required to deter diversion falls with kinship. At the same time, because the related owner internalizes the manager's gain from diversion in proportion to kinship, the probability of diversion required to trigger monitoring increases with kinship. Thus, kinship both (a) increases underreporting and (b) reduces the probability that zero reports will be monitored. The combined effect of (a) and (b) determines kinship's effect on the probability of monitoring. Monitoring occurs if and only if a report of 0 occurs and that report is monitored. Thus, the probability of monitoring is given by $\text{PM}^* = m^*(1-p(1-\sigma^*))$. The fall in m^* induced by an increase in kinship decreases the probability of monitoring. At the

---

[12]Were the owner to choose the monitoring probability ex ante, before observing the manager's report, the owner's monitoring costs would be sunk and thus would not affect the related manager's diversion incentives. The author is indebted to Simon Gervais for clarifying this point.

same time, the increase in σ^*, also induced by an increase in kinship, increases the probability of monitoring. The effect of kinship on the probability of monitoring is thus not obvious at first glance. However, explicit calculation of the equilibrium probability of monitoring, PM*, shows that

$$\text{PM}^* = m^*(1 - p(1 - \sigma^*)) = \frac{(1-h)^2(1-p)\bar{x}(\bar{x}-w)}{((1-h)\bar{x}-c)(ch+(1-h)\bar{x})}. \tag{14}$$

is an increasing function of h. These observations motivate the following proposition.

Proposition 1. *For fixed compensation, w, and uptick probabilities, p, that satisfy* (12)*, there is a unique equilibrium. In this equilibrium, the probability of monitoring zero reports, m*, and underreporting, σ* are given by equation* (13)*. In the equilibrium,*

(a) The probability of underreporting, σ, is increasing and convex in kinship, h,*

(b) The probability of monitoring of zero reports, m, is decreasing and concave in kinship, h.*

(c) The probability of monitoring and hence monitoring expense are both increasing and log convex (a fortiori convex) in kinship, h.

(d) The probability of diversion is increasing in kinship, h and decreasing in compensation, w.

Proof. These results follow from differentiating the expression for underreporting, zero-report monitoring, diversion, and the total probability of monitoring. □

Thus, at any fixed compensation level, kinship increases both diversion and monitoring expense, which are proportional to the probability of monitoring. This result follows because increasing kinship reduces the welfare loss to the owner from diversion of firm resources by his kin—the manager. This weakens monitoring incentives. Weaker monitoring incentives lead to more underreporting and thus more reports of low cash flows. Since monitoring only occurs after zero reports, this leads to a higher total probability of monitoring even though, conditional on a low report being made, the probability of monitoring is lower. Hence, increasing kinship lowers family value.

This result, although, perhaps, at first sight surprising, is consistent with results in evolutionary biology which rationalize and document that high levels of kinship generate "policing"

problems.[13] Some intuition for this policing problem in the context of this model can be gleaned from inspecting the elasticity of the probability of monitoring with respect to kinship:

$$\frac{\text{PM}'(h)}{\text{PM}} = \underbrace{\frac{c}{(1-h)\left((1-h)\bar{x}-c\right)}}_{\frac{\text{PZeroReport}^{*\prime}(h)}{\text{PZeroReport}^*(h)}} + \underbrace{\left(-\frac{c}{(1-h)\left((1-h)\bar{x}+ch\right)}\right)}_{\frac{m^{*\prime}(h)}{m^*(h)}}. \tag{15}$$

Whether increasing kinship increases the probability of monitoring depends on whether the absolute elasticity of zero reports, $\text{PZeroReport}^{*\prime}/\text{PZeroReport}^*$, exceeds the absolute elasticity of zero-report monitoring, $-m^{*\prime}/m^*$. $\text{PZeroReport}^{*\prime}/\text{PZeroReport}^*$ represents the elasticity of the minimum level of underreporting required to trigger owner monitoring; $-m^{*\prime}/m^*$ represents the elasticity of the minimum level of monitoring required to deter manager diversion. Both elasticities contain the common term, $(1-h)\bar{x}$, but differ with regard to how they factor in the monitoring cost term, c. $\text{PZeroReport}^{*\prime}/\text{PZeroReport}^*$ factors in the entire cost of monitoring, because the owner directly incurs this cost. In contrast, $-m^{*\prime}/m^*$ factors in only that part of the monitoring cost captured by altruistic internalization. For this reason, the level of diversion required to trigger monitoring increases faster than the level of monitoring required to deter diversion and thus the probability of monitoring increases with kinship. This same elasticity effect implies that $\text{PM}'(h)/\text{PM}$ is increasing, i.e., the probability of monitoring, and thus monitoring expense, is log-convex in kinship. Log convexity implies that kinship's marginal effect on the monitoring problem is much greater when the owner and manager are close relatives, e.g., both children of the founder, than when they are distant relations.

4 Kinship when the frontier is open: The agency setting

The agency model is meant to reflect the case where the agency frontier is open; that is, the incentive constraint determines managerial compensation and total family value is always increased by marginal increases in the manager's share of total output. Initially, we assume that the manager's skill as well as the skills required to manage the firm are specific to the fam-

---

[13]See Ratnieks (1988), Gardner and West (2004), El Mouden et al. (2010).

ily firm. We implement this assumption by setting the manager's reservation compensation to zero, i.e., $v_R = 0$, and assuming that the kin manager is the only candidate for managing the firm. The agency problem is introduced by assuming that the uptick probability, p, equals the level of (unobservable) managerial effort. Effort imposes a non-pecuniary additive cost on the manager of $\mathscr{E}$, where

$$\mathscr{E}(p) = \frac{1}{2}kp^2, \quad p \in [0, \bar{p}].$$

We assume that the upper bound on p, $\bar{p}$, and the first-best uptick probability both equal 1. The condition that the first-best uptick probability equals 1 is equivalent to the condition that $k \geq \bar{x}$. To simplify the exposition of the results and reduce the number of free parameters, we further assume that the marginal cost of effort at the first-best uptick probability equals 0, which implies that $k = \bar{x}$. In summary, we impose the following functional form on effort cost:

$$\mathscr{E}(p) = \frac{1}{2}\bar{x}p^2, \quad p \in [0, 1]. \tag{16}$$

Extending the analysis to $k > \bar{x}$ would simply complicate the algebra. The effective upper bound on p in this case would be $x/k < 1$. Since the first-best uptick probability would be less than 1, the monitoring problem would persist even at first-best effort, reducing to some extent the effect of increased p on the value of the firm. Because, as we will see, kinship increases p, this would reduce the positive effect of kinship on value. Permitting $k < \bar{x}$ would change the results in a rather trivial fashion. In this case, the owner could eliminate the agency problem without granting the manager complete ownership of the firm.[14]

For a fixed compensation level, w, and uptick probability, p, monitoring and reporting probabilities will be the same as those derived in Section 3.3, where we analyzed the monitoring and reporting subgame, and are provided by (13). In order to induce the manager to expend

---

[14]More generally, our analysis considers only extreme cases, where the incentive constraint is binding for all solutions or where it is not binding for any solutions to the contracting problem. Intermediate cases are easy to analyze numerically and were included in earlier versions of this paper. However, extending the analysis to such cases does not generate qualitatively different outcomes or analytically tractable comparative statics. Because our framework is designed simply to present the underlying logic of kin altruism's effects on family firms, we have not included these results in the current draft.

sufficient effort to produce uptick probability p, it must be the case that, given compensation w, p is an optimal choice for the manager. Because truthful reporting (like underreporting) is always a best response in the mixed strategy solution of the monitoring/reporting subgame, the manager's utility given truthful reporting, provided by (10), represents the manager's utility when the cash flow equals $\bar{x}$. The cash flow equals $\bar{x}$ with probability p. When the cash flow equals 0, which occurs with probability $1-p$, the manager's utility is simply the internalized cost of owner monitoring, $hcm^*(w)$. Thus, we see that the manager's utility in the agency model conditioned on uptick probability p and compensation w can be expressed as

$$u_M^A(p,w) = p\left(w + h\left(\bar{x} - w\right)\right) - (1-p)\,hcm^*(w) - \frac{\bar{x}\,p^2}{2}.$$

The manager's choice of the uptick probability is defined by

$$p \in \operatorname{Argmax}\{p \in [0,1] : u_M^A(p,w)\}. \tag{17}$$

Solving problem (17) for p yields the equilibrium compensation associated with uptick probability p. Define this level of compensation as $w_M^A(p)$. $w_M^A(p)$ is given by

$$w_M^A(p) = \frac{\bar{x}p - h\left(c + (1-h)\bar{x} + p\left(\bar{x} - c\right)\right)}{(1-h)^2}. \tag{18}$$

$w_M^A(p)$ represents the compensation level that is required to induce the manager to produce uptick probability p given that the manager accepts the owner's employment offer.

The equilibrium monitoring and reporting strategies derived in Section 2.4 require assumption (12). This assumption is equivalent to $p \geq c/((1-h)\bar{x})$. Thus, assumption (12) restricts the domain of $w_M^A(\cdot)$ to $p \geq c/((1-h)\bar{x})$. The range of $w_M^A(\cdot)$ is also restricted by the limited liability constraint. The owner limited liability constraint requires that $w \leq \bar{x}$ and the manager limited liability constraint requires that $w \geq 0$. However because w_M^A is strictly increasing in p we can express these constraints on the range of w_M^A as constraints on the domain of w_M^A. Because w_M^A is strictly increasing and $w_M^A(1) = \bar{x}$, for all $p \in [0,1]$, the owner limited liability

constraint $w \leq \bar{x}$ is satisfied. In contrast, the manager limited liability constraint $w \geq 0$ does restrict the feasible choices of p. Solving equation (18) for $w_M^A(p) = 0$ yields,

$$p^{w=0} = h\left(1 + \frac{(1-h)c}{ch + (1-h)\bar{x}}\right). \tag{19}$$

Thus, the constraint that $w \geq 0$ can be implemented by constraining the owner to choosing $p \geq p^{w=0}$. In summary, condition (12), and the manager limited liability conditions will be satisfied provided that $p_{\min} \leq p \leq 1$, where $p_{\min}$ is defined as

$$p_{\min} = \max\left[p^{w=0}, \frac{c}{(1-h)\bar{x}}\right]. \tag{20}$$

The owner's utility, given uptick probability p, and compensation $w_M^A(p)$ is determined as follows. First, ignore non-pecuniary effort costs and consider cash flows to the owner and manager. Note that randomization in the monitoring/reporting subgame implies that the owner's utility when monitoring equals the owner's utility when not monitoring. Thus, we can represent the owner's utility in the subgame with non-monitoring utility. In this case, the owner's utility is determined as follows: whenever the cash flow is $\bar{x}$ and the manager does not divert, the owner's payoff equals $\bar{x} - w_M^A(p)$ and the manager's payoff equals $w_M^A(p)$. Thus, the owner's utility conditioned on this event is $(\bar{x} - w_M^A(p)) + h w_M^A(p) = \bar{x} - (1-h) w_M^A(p)$. The event occurs with probability $p(1 - \sigma^*(p))$. If the manager diverts, the owner's payoff is 0 and the manager's payoff is $\bar{x}$. Thus, the owner's payoff conditioned on this event is $h\bar{x}$. The probability of this event is $p\sigma^*(p)$. If the cash flow is 0, both the owner and manager earn a payoff of 0. Now consider non-pecuniary effort costs. Regardless of the realized cash flow in the monitoring game, the manager exerts ex ante effort which has a non-pecuniary cost to the manager of $1/2\bar{x}p^2$. This cost is internalized by the owner in proportion to h; thus, it lowers the owner's utility by $h \, 1/2\bar{x}p^2$. Combining these observations yields the expression for owner utility, $u_O^A(p)$.

$$u_O^A(p) = p\left((1 - \sigma^*(p))(\bar{x} - (1-h)w_M^A(p)) + \sigma^*(p)h\bar{x}\right) - h \, 1/2\bar{x}p^2. \tag{21}$$

The only constraint that remains to be considered is the manager's participation constraint. If the manager rejects the owner's offer of employment, the value to both manager and owner will equal 0. This implies that the manager's utility from rejecting the owner's offer is 0. Thus, the manager's participation constraint is

$$u_M^A(p, w_M^A(p)) \geq 0. \tag{22}$$

The owner's problem is to maximize u_O^A over feasible choices of p, subject to the participation constraint, (22), i.e., the owner's problem is given by

$$\max_{p \in [p_{\min}, 1]} u_O^A(p), \tag{23}$$
$$s.t. \ u_M^A(p, w_M^A(p)) \geq 0.$$

We will first solve a relaxed problem which ignores the participation constraint and then show, in Proposition 2, that, in fact, the ignored participation constraint is always satisfied. The relaxed problem is defined as follows:

$$\max_{p \in [p_{\min}, 1]} u_O^A(p). \tag{24}$$

The solution to this problem is characterized by Lemma 1,

Lemma 1. *The solution to the relaxed problem* (24) *has the following characteristics:*

(a) u_O^A *is strictly concave.*

(b) *The value of p that solves* (24) *is always interior.*

(c) *The optimal choice of* p^A *is uniquely defined by the first-order condition:* $u_O^{A\prime}(p^A) = 0$.

Proof: See the Appendix.

The important implication of Lemma 1 is that neither the owner nor manager limited liability constraints ever bind, i.e., the owner will always offer positive compensation to the kin manager but never offer compensation equal to the entire cash flow $\bar{x}$. The owner limited liability constraint not being binding follows from our earlier assumption that $(1-h)\bar{x} > c$. The

manager limited liability constraint not being binding relies to some extent on assumption (2), that $h \leq 1/2$.[15]

4.1   Effect of kinship on output, compensation, and monitoring

Lemma 1 shows that the optimal compensation decision made by the owner is quite well behaved as an optimization problem. However, we will see that the comparative statics of this problem with respect to kinship, h, are quite subtle. Their subtlety results from the symmetric effect of kinship on owner and the manager. When kinship increases, the amount that the owner needs to pay to ensure a given level of effort changes and the owner's willingness to increase compensation also changes. The interaction of these effects make the relation between kinship and variables such as compensation rather complex. To simplify our expressions, we introduce a new variable $\chi = c/\bar{x}$. χ represents the cost of monitoring normalized by the uptick cash flow. Introducing χ simplifies the analysis because the value functions, for the owner and manager, and thus the corresponding utility functions are all homogeneous of degree 1 in $\bar{x}$. Thus, $\bar{x}$ enters the objective function only as a positive multiplier and hence does not affect the optimized value of p. Thus, we can express the optimized value of p purely in terms of h and χ, simplifying our expressions significantly. This raises the question of why we do not simply assume that $\bar{x} = 1$. The reason we eschew this modeling choice is that, when we later extend the analysis to model the owner's choice between hiring a family and non-kin internal rival, we use $\bar{x}$ to model the competence difference between the kin and rival candidate manager.

Our first characterization of the effect of kinship in the agency context, Proposition 2, shows increasing kinship always increases effort and thus the uptick probability, p.

Proposition 2. *The uptick probability, p which solves the relaxed agency problem repre-*

---

[15]There exists a region of the parameter space where h is less than 1 but greater than $1/2$ over which the owner's optimal policy is to set $p = p^{w=0}$, i.e., to pay zero compensation. In essence, in this region, it is optimal for the owner to compensate the kin manager purely through internalized firm value. When this occurs, the limited liability constraint prevents further increases in kinship from changing the terms of compensation.

sented by expression (24), p^A, is

$$p^A(h,\chi) = \frac{1+\chi}{2} + \frac{h}{2}\left(\frac{(1-h)^2+(1-h)h\chi+(1+h)\chi^2}{(1-h)((1-h)(2+h)+h\chi)}\right), \quad \chi = c/\bar{x}. \quad (25)$$

(a) *The uptick probability, p^A, is increasing in kinship h, i.e., $\partial p^A/\partial h > 0$.*

(b) *The marginal effect of increased kinship on the uptick probability is increasing in the normalized cost of monitoring, χ, i.e., $\partial^2 p^A/\partial h \partial \chi > 0$.*

(c) *The utility of the manager given that $p = p^A(h,\chi)$ is always strictly positive. Thus, p^A, the solution to the relaxed agency problem (24) solves the agency problem defined by expression (23).*

Proof: See the Appendix.

The expression for the equilibrium uptick probability provided in Proposition 2 does exhibit a complex dependence on kinship. The complex dependence is expected given the symmetric nature of kinship altruism. However, the relation between kinship and the uptick probability is not as turbid as one might expect simply from inspecting the expression for p^A. First, the character of the equilibrium uptick probability is transparent in some special cases. When the cost of monitoring equals 0 (and thus, $\chi = 0$), $p^A = (1+h)/(2+h)$ and is clearly increasing in kinship, h. When the manager and owner are unrelated, i.e., $h = 0$, the expression for p^A in Proposition 2 reduces to $p^A = (1+\chi)/2$. Thus, increasing the cost of monitoring, increases the equilibrium level of effort when the manager and owner are unrelated. The reason is straightforward. As the cost of monitoring increases, the owner's ability to capture the cash flows of the firm through monitoring falls. Increased capture of firm rents by the manager improves the manager's effort incentives. It is also clear from inspecting the expression for p^A in the Proposition that the uptick probability at positive levels of kinship is always higher than the uptick probability when the manager and owner are unrelated (i.e., $h = 0$).

Second, p^A can be well approximated by

$$p^A(h,\chi) \approx \frac{1+\chi}{2} + \frac{h}{4}\left(1+\left(\frac{\chi}{1-h}\right)^2\right).$$

This approximate expression, over the admissible set of model parameters, approximates p^A with a maximal absolute error of less than 5%.[16] The approximation, which we will not use in our formal derivations, reveals the essential features of the relation between kinship, output, and normalized monitoring costs. It is clearly increasing in h and its rate of increase is increasing in the normalized monitoring costs, χ. The intuition for these results is that kinship increases the owner's willingness to concede rents to increase output. Moreover, the owner prefers firm value reductions resulting from rent concessions to the manager to firm value reductions resulting from dissipative monitoring expenses. The owner's relative preference for rent concessions increases with kinship. Increased compensation lowers monitoring expense at the cost of increased rent concession. Thus, when χ is larger, the concessions to the manager induced by an increase in kinship are larger. These larger concessions lead to greater managerial effort and thus a larger increases in the uptick probability. Proposition 2 shows that the uptick probability itself has the same properties as its approximation. However, some tedious algebra is required for this derivation and it is therefore deferred to the Appendix.

Proposition 2 also shows that the manager's participation constraint is always satisfied by the solution to the relaxed problem. In a model incorporating agent altruism, demonstrating that the manager's participation constraint is satisfied even under the assumption that the manager has no outside options is not entirely trivial. The difficulty is that the manager will internalize part of the owner's value. Because the probability of monitoring and thus the owner incurring monitoring expenses, is higher when output is low, the manager, if he accepts the owner's compensation offer, has an incentive to exert effort simply to lower the owner's monitoring expense. Thus, it is conceivable that the manager might be willing to exert effort at a low compensation level that leaves his utility negative but not as negative as it would have been had the manager accepted employment but exerted no effort. In which case, positive output would be produced were the manager to accept employment but accepting employment would violate the manager's participation constraint. Proposition 2 shows that owners, even if they ignore

---

[16]The approximation was obtained by replacing the denominator of the expression for p^A by the first three terms of its geometric series expansion. The accuracy of the approximation was determined by numerical means and the code is available upon request.

the participation constraint of the manager, will never select such low compensation levels. Compensation violating the participation constraint yet yielding significant output, p, requires a high degree of owner/manager kinship. However, the owner's optimal choice of p, ignoring the participation constraint, increases with kinship. The increase in p is always sufficient to keep the manager's utility positive and thus above the participation constraint.

The question remains as to whether this positive effect of kinship on the uptick probability, p, is countered by the increased monitoring expense induced by increased kinship. The next proposition shows that the probability of underreporting is always increasing in the degree of kinship. Thus, our earlier result—that kinship increases the likelihood of underreporting at a fixed compensation level—also holds when compensation is endogenously determined by the incentive compatibility constraint of the agency model.

Proposition 3. *In the agency setting, the probability that the manager will underreport a high cash flow,* σ^{A*}, *is given by*

$$\sigma^{A*} = \frac{(1 - p^A(h, \chi))\chi}{p^A(h, \chi)(1 - h - \chi)}.$$

σ^{A*} *is increasing the degree of kinship, h, between the manager and owner.*

Proof: See the Appendix.

Proposition 3 shows that increased kinship never induces the owner to adjust compensation upward sufficiently to nullify the underreporting incentives generated by increased kinship. However, underreporting *per se* does not generate monitoring expenses. It only generates costs if zero reports are monitored. The likelihood that zero reports are monitored depends not only on the normalized cost of monitoring, χ, but also the level of compensation, w. Increasing w reduces the probability of monitoring required to deter diversion. Thus, the effect of kinship on monitoring depends on kinship's effect on compensation. The next result characterizes the compensation–kinship relation.

Proposition 4. *Compensation, w, in the agency setting is given by*

$$w^{A*} = w_M^A(p^A(h, \chi)).$$

Increasing kinship, h, can either increase or reduce w^{A*}. The conditions for each of these cases are provided below: Let $\alpha = \chi/(1-h)$. If

(a) If $\alpha < \underline{\alpha}_W \equiv 1/\sqrt{3} \approx 0.58$, increasing kinship reduces compensation, w^{A*}

(b) If $\alpha > \bar{\alpha}_W \equiv \sqrt{13} - 3 \approx 0.61$, increasing kinship increase compensation, w^{A*}

(c) If $\alpha \in [\underline{\alpha}_W, \bar{\alpha}_W]$ increasing kinship reduces (increases) w^{A*} whenever $h < (>)h_W$, where

$$h_W = \frac{(1-\alpha)\sqrt{(1+\alpha)(4-11\alpha^2+\alpha^3)} - (2+\alpha-6\alpha^2-\alpha^3)}{4\alpha(1-\alpha-\alpha^2)}.$$

Proof: See the Appendix.
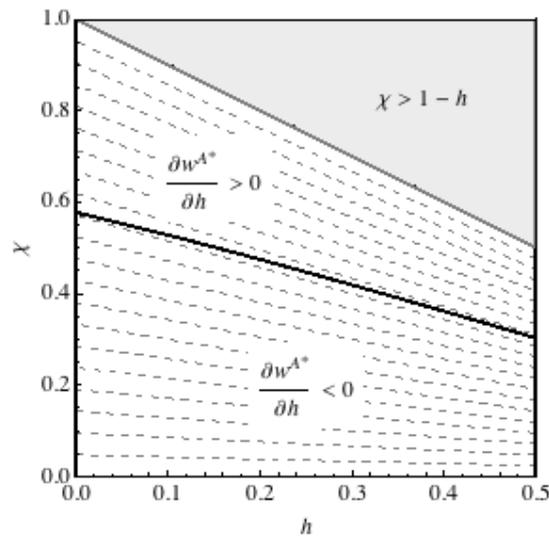
Figure 1: The effect of kinship, h, on compensation, w^{A*}. In the figure, the horizontal axis represents the level of kinship, h. The vertical axis represents the normalized cost of monitoring, $\chi = c/\bar{x}$. The thin dashed lines represent points (h,χ) on the graph which generate the same altruism-inflated cost of monitoring, $\alpha = \chi/(1-h)$.

Note that the our surd parameterization of the boundary between positive and negative kinship effects is expressed in terms of h and $\alpha = \chi/(1-h)$ rather than h and χ. The map $(h,\chi) \hookrightarrow (h,\chi/(1-h)$ is however one-to-one and thus the parametrization provides a complete, albeit not very intuitive, characterization of the (h,χ) regions where increased kinship reduces and increases compensation. Expressed in terms of h and χ these regions are defined by quintic polynomials and thus do not yield tractable parameterizations. In contrast, in the transformed variables h and α, the regions are defined by a jointly quadratic polynomial and

thus permit a surd parameterization. In fact, the proposition shows that the effect of kinship on compensation is almost, but not quite, determined simply by $\alpha = \chi/(1-h)$. Note that α can be expressed as $\alpha = \chi/(1-h) = \chi(1+h+h^2\ldots)$. Thus, α can be thought of as the altruism-inflated cost of monitoring per unit of firm scale. When the altruism-inflated costs of monitoring are high, i.e., $\alpha > \bar{\alpha}_W \approx 0.61$, monitoring costs are salient to owners. The owner sacrifices personal gains to reduce expected monitoring expense and adopts a high compensation policy. Increased compensation lowers monitoring intensity because, at higher levels of compensation, the intensity of monitoring required to deter diversion is lower. When $\alpha < \underline{\alpha}_W \approx 0.58$, the cost of monitoring is not salient to the owner. The owner thus exploits the increased non-pecuniary effort incentives provided by increased kinship to lower managerial compensation. In this case, the uptick probability increases with kinship but not as much as it would have had the owner not reduced compensation. The dependence of kinship's effect on compensation on the altruism-inflated cost of monitoring is illustrated in Figure 1. In the figure, we present the regions of (h,χ)-space were increasing kinship increases and decreases compensation. Dashed curves in the figure represent "iso-α" curves, i.e., points in (h,χ)-space which produce the same altruism-inflated cost of monitoring. The fact that these curves are nearly parallel to the boundary between the regions where increasing kinship increases and reduces compensation indicates the close but not quite perfect dependence of the compensation–kinship relation on α.

As shown in Section 3.3, at fixed compensation levels, kinship reduces the owner's incentive to monitor zero reports, albeit not sufficiently to counter the increased level of underreporting. When compensation is endogenously determined by the incentive problem, Proposition 4 shows that increases in kinship reduces compensation when α, the altruism-inflated cost of monitoring, is sufficiently small. Reduced compensation increases the level of monitoring required to deter diversion and in some cases this increase is sufficient to counter the reduction in monitoring incentives induced by increased kinship. This observation is formalized in the following proposition.

Proposition 5. *The probability that the owner will monitor reports of a low cash flow in the*

agency setting, m^{A*}, is given by

$$m^{A*} = \frac{1 - p^A(h, \chi)}{1 - h}.$$

Increasing kinship, h, can either increase or reduce m^{A*}. The conditions for each of these cases are provided below: Let $\alpha = \chi/(1-h)$; define $\underline{\alpha}_m = \sqrt{2} - 1 \approx 0.41$; define $\bar{\alpha}_m \in (0,1)$ as be the unique positive root of the cubic equation, $\alpha^3 + 9\alpha^2 + 3\alpha - 4$, $\alpha_m \approx 0.51$.[17] Then

(a) if $\alpha < \underline{\alpha}_m \approx 0.41$, increasing h increases monitoring, m.

(b) if $\alpha > \bar{\alpha}_m = 0.51$, increasing h reduces monitoring

(c) If $\alpha \in (\underline{\alpha}_m, \bar{\alpha}_m)$, then increasing h increases (decreases) monitoring whenever

$$h > (<) \frac{\sqrt{1 - 2\alpha + 3\alpha^4 - 2\alpha^5} - (1 - 3\alpha^2)}{2\alpha(1 - \alpha - \alpha^2)}.$$

Proof: See the Appendix.

Proposition 5 shows that, once again, the effect of kinship is fixed to a large extent simply by the altruism-inflated cost of monitoring, α. When this cost is low, $\alpha < \underline{\alpha}_m \approx 0.41$, the cost of monitoring is of second-order importance to the owner and the owner uses increases in the manager's kin altruism to reduce the manager's compensation so much that, even after accounting for the reduced underreporting incentive engendered by kinship, the owner must increase monitoring to deter diversion. Thus, m increases with kinship. When $\alpha > \underline{\alpha}_m \approx 0.51$, the adverse effect on family value of monitoring expenses becomes sufficiently salient to deter the owner from making such substantial reductions in compensation.

In contrast to the owner's compensation and monitoring strategy, expected monitoring expense is not tightly related to the altruism-inflated cost of monitoring. Monitoring expense is directly dependent on another factor—the uptick probability, p. Because a low cash flow must be reported when the cash flow is truly low, and, when the cash flow is high, the probability that it will be reported as low is less than one, increasing p reduces monitoring expense. When

---

[17]In fact, it is possible, using Cardan's formula for cubic, to solve for this cubic equation for $\bar{\alpha}_m$. The exact solution is $\bar{\alpha}_m = -3 + 2\sqrt{6}\sin\left(\frac{1}{3}\tan^{-1}\left(\frac{\sqrt{367}}{41}\right)\right) + 2\sqrt{2}\cos\left(\frac{1}{3}\tan^{-1}\left(\frac{\sqrt{367}}{41}\right)\right).$

this effect is sufficiently strong, monitoring expense can fall as kinship increases even when the altruism-inflated cost of monitoring is low. When this occurs, compensation falls with kinship, and thus underreporting increases, and the probability of monitoring zero reports also increases. However, the positive effect on the uptick probability induced by increasing kinship is sufficient to outweigh both of these effects. This result is formalized in Proposition 6.

Proposition 6. *Expected monitoring expense in the agency setting, ME^{A*}, is given by*

$$ME^{A*} = \bar{x}\chi\frac{(1-p^A(h,\chi))^2}{1-h-\chi}.$$

Increasing kinship, h, can either increase or reduce ME^{A*}. The conditions for each of these cases are provided below. Let $\alpha = \chi/(1-h)$. If

(a) If $\alpha < \alpha_{ME} \equiv \frac{1}{2}\left(\sqrt{145}-11\right) \approx 0.52$ then kinship always increases ME^{A*}.

(b) If $\alpha \geq \alpha_{ME}$, then increasing kinship reduces (increases) ME^{A*} whenever $h < (>)h_{ME}$, where

$$h_{ME} = \frac{-6\alpha^2 - \alpha - \sqrt{(1-\alpha)^2(2\alpha+1)(2\alpha+3)(3-4\alpha)} + 3}{2\alpha(\alpha(2\alpha+3)-3)}.$$

Proof: See the Appendix.

4.2 Kinship's and value

Thus, for a significant range of the parameter space, increasing kinship both increases output by increasing p and reduces monitoring expense. In fact, as the next proposition demonstrates, even over the region where kinship increases monitoring expense, the net effect of increasing kinship on family value under equilibrium compensation policies is always positive.

Proposition 7. *Family value in the agency setting, $v^{A*} = v_M^{A*} + v_O^{A*}$, is given by*

$$v^{A*} = \bar{x}\left(\frac{p^A(h,\chi) + (1-p^A(h,\chi))p^A(h,\chi)}{2} - \frac{\chi(1-p^A(h,\chi))^2}{1-h-\chi}\right).$$

v^{A*} is increasing in kinship, h.

Proof: See the Appendix.

The intuition behind Proposition 7 is that the only region of the parameter space where increased monitoring expense might overwhelm the positive effects of increased kinship on output is a region where the altruism-inflated cost of monitoring is low. However, over this region, although monitoring expense is increasing in kinship, it is small in absolute terms and thus the increased monitoring expense is always more than compensated by the increased output induced by increasing kinship.

The payoffs, i.e., value, received by the owner and manager are given by substituting in the equilibrium reporting and monitoring probabilities, given by equation (13), the equilibrium compensation schedule, given by equation (18), and the equilibrium uptick probability, given by (25), into the manager's value function and then noting that the owner's value is the difference between family value, given in Proposition 7, and the manager's value. This yields, after some algebraic simplification, the following expression:

$$v_M^{A*} = \bar{x}\frac{1}{2}\left(1 + (1 - p^A(h,\chi))\left((1 - p^A(h,\chi))\left(\frac{2(1-\chi)}{1-h-\chi} - 1\right) - \frac{2(1-h(1-\chi))}{(1-h)^2}\right)\right) \quad (26)$$

$$v_O^{A*} = v^{A*} - v_M^{A*}, \quad (27)$$

where v^{A*} is given in Proposition 7 and p^A is defined by equation (25).

Proposition 7 showed that when incentive constraints bind, kinship increases family value. This increase in family value is divided between the manager and the owner. This raises the question of who captures the value gain? Although it is not possible to obtain a complete surd parameterization of the regions where increasing kinship increases firm and manager value, once again the division of the gains from kinship depends largely on the altruism-inflated cost of monitoring, $\alpha = \chi/(1-h)$. This result is recorded below.

Proposition 8. *Let $\alpha = \chi/(1-h)$ represent the altruism-inflated cost of monitoring and let v_O^{A*} represent the owner value in the agency model. Similarly let v_O^{M*} represent the manager value. (a) When the altruism-inflated cost of monitoring, α, is less than the unique root (between 0 and 1) of the polynomial, $-6 - 10\alpha + 19\alpha^2 + 18\alpha^3 + 3\alpha^4$, which is approximately equal to 0.624, owner value increases as kinship increases. When α is greater than*

$1/\sqrt{2} \approx 0.707$ *owner value decreases as kinship increases. For α values between these two roots, the sign of the value/kinship relation is not uniform in α but varies with the other parameters of the model.*

(b) When α is less than the unique root of $-1 - \alpha + 5\alpha^2 + \alpha^3$ between 0 and 1, which is approximately equal to 0.525 manager value decreases as kinship increases. When α is greater than the unique root of $-26 - 31\alpha + 88\alpha^2 + 54\alpha^3 + 5\alpha^4$ (between 0 and 1), which is approximately equal to 0.604, manager value increases as kinship increases. For α values between these two roots, the sign of the value/kinship relation is not uniform in α but varies with the other parameters of the model.

Proof: See the Appendix.

Proposition 8 shows that the division of kinship gains depends primarily on the altruism-inflated cost of monitoring. When this cost is low, the direct effect of kinship in reducing compensation and the indirect effect from reduced compensation increasing monitoring, both reduce manager value and increase owner value. When the altruism-inflated cost of monitoring is high, the owner, anticipating the large increased monitoring expense that kinship generates at a fixed compensation policy is willing to increase compensation significantly. This leads to higher value for the manager and lower value for the owner. In intermediate cases, the owner and manager split the gain from the increase in family value and both owner value and manager value increase.

5   When the frontier is closed: the labor market setting

The labor market model is meant to reflect the case where the agency frontier is closed. That is, the labor market participation constraint determines managerial compensation and the uptick probability selected by the firm does not vary with kinship. In order to maximize the transparency of the logic underlying the results, we choose the simplest possible parameterization of the model that satisfies these conditions: the upper bound on the uptick probability, $\bar{p}$, is less than 1, effort is costless, and the manager's reservation value is positive. The specific

parametric assumptions we impose are as follows:

$$\mathscr{E}(p) = 0 \quad (28) \qquad\qquad v_R > 0, \quad (31)$$
$$\bar{p} < 1 \quad (29) \qquad\qquad (1-h)\bar{x}\bar{p} > c, \quad (32)$$
$$\bar{x}\bar{p} - v_R > c. \quad (30)$$

This rather stark specification of the labor market setting is not the only scenario that will produce our results. For example, it is easy to augment the specification with a fixed cost for effort for all positive levels of the uptick probability. In this scenario, again, the uptick probability selected by the firm will equal $\bar{p}$ regardless of kinship. It is also possible to add a quadratic cost of effort, of the sort used in Section 4, provided that the effort cost parameter k is sufficiently small to ensure that the upper bound, $\bar{p}$, is the optimal uptick probability for the firm regardless of kinship. In both of these cases, effort costs to the manager for producing $p = \bar{p}$ would factor into the manager's participation constraint in the same way as increasing the manager's reservation value by a like amount. However, these elaborations do not add new insight and force us to track two variables—reservation value and fixed effort cost—which end up being perfect substitutes. Thus, our parameterization is simpler and more economical than these alternatives. The key to the results in this section is that the model parameterization satisfies the condition that, in response to an increase in kinship, the owner will not alter the terms of compensation in a way that increases family value.

In the labor market setting, the uptick probability is fixed. Thus, kinship affects value only through its effect on compensation. This makes the analysis considerably more tractable. In the agency setting, we were only able to analytically characterize the directional effect of marginal increases in kinship on the endogenous variables, (e.g., family value, owner value). In the labor market analysis, we will be able to also characterize the overall "shape" of the functional relation between kinship and these variables.

5.1 Markets for human capital when management skills are firm specific

In this section, we assume that the skills of the kin manager have value outside the family firm but that the skills required to manage the family firm are family specific and thus the kin manager is the only viable candidate for managing the firm. In the next section, we consider the effect of making the human capital required to manage the family firm general. The scenario developed in this section corresponds to an economy with well-developed markets for professional labor but not for managerial labor. An economy where professionals, e.g., lawyers, accountants, possess general skills and are hired in competitive labor markets, but managers are promoted and advanced to top positions only by "working their way up" through the firm. Thus, v_R represents the kin manager's value in this market for professional labor.

We initiate the analysis of labor markets in this setting for two reasons. First, this scenario is a reasonable approximation of labor markets for many time periods and many economies. Markets for professional labor developed long before markets for CEOs and, even in the country with arguably the most developed CEO labor market, the U.S., external hiring of CEOs was very rare as recently as forty years ago (Murphy and Zabojnik, 2007). The second reason, is that, as we shall see, the only effect of introducing general management skills on the structure of compensation comes through its effect on reservation utility. When the skills required to manage the firm are firm specific, the manager's rejection of the owner's compensation offer will force the firm to shut, producing a payoff of 0 for the owner. Thus, in this setting the manager's reservation utility depends only on v_R, the manager's labor market value outside the firm. When the skills required to manage the firm are sufficiently general so that operation under an external manager is feasible, kin altruism implies that the manager internalizes part of the owner's payoff under the external rival when considering whether to accept or reject the owner's offer. At the same time, the owner's choice between the external and kin manager depends on the kin manager's reservation compensation level. This simultaneity makes the algebra much more complex. Thus, it seems natural to first develop the intuition in the simpler case of specific management skills and then generalize to the more complex case.

5.1.1 Compensation

No output can be produced without managerial effort. Thus, the owner will always offer sufficient compensation to ensure effort and retain the manager. Since effort is costless in this specification, the manager, if he accepts employment, will always exert sufficient effort to produce $p = \bar{p}$. If the manager accepts employment, the cash flow to the manager equals either $\bar{x}$ or 0. If the cash flow equals $\bar{x}$, the manager's utility is as given in the monitoring/reporting subgame defined in Section 3.3. Since both underreporting and not underreporting are best replies in the subgame, we can use the manager's utility when the manager does not underreport to compute manager utility in this case. If the realized cash flow is 0, the manager's payoff is 0 and the owner's payoff equals the expected loss from monitoring the manager's 0 cash flow report, given by $-m^* c$. Thus, the manager's utility is

$$u_M^L(w) = \bar{p}\,(w + h\,(\bar{x} - w)) - (1 - \bar{p})h\,m^*(w)\,c. \tag{33}$$

The owner's utility is determined in like fashion. If the manager reports $\bar{x}$, which occurs with probability $(1 - \sigma^*)\,\bar{p}$, the owner's utility is $\bar{x} - (1 - h)\,w$. If the manager report's 0, the owner's utility is given by the mixed strategy equilibrium in the monitoring/reporting subgame. Since both monitoring and not monitoring are best replies in the subgame, we can use the owner's utility when the owner does not monitor to compute owner utility in this case. The utility of the owner after a report of 0 given that the owner does not monitor is given by $h\rho^* \bar{x}$. The probability of a zero report is $1 - (1 - \sigma^*)\,\bar{p}$. Thus, the owner's utility is given by

$$(1 - (1 - \sigma^*)\,\bar{p})(h\rho^* \bar{x}) + ((1 - \sigma^*)\,\bar{p})(\bar{x} - (1 - h)\,w).$$

Using equation (3.2) we can simplify this expression to

$$u_O^L(w) = \bar{p}\,((1 - \sigma^*)(\bar{x} - (1 - h)\,w) + \sigma^* h\bar{x}). \tag{34}$$

From (13), (34), and (32) it is clear that, despite kinship, the owner's utility is decreasing in the level of managerial compensation. For this reason the owner will never set compensation higher than the level required to satisfy the problem's constraints. One constraint is the labor market participation constraint: if the manager does not work for the firm, he earns v_R and the owner's payoff is 0. Thus, the minimum managerial compensation that satisfies the participation constraint is determined by the equation

$$u_M^L(w) = v_R.$$

Solving this equation for compensation, w, yields the minimal compensation to the manager required to ensure that the participation constraint is satisfied:

$$\frac{v_R}{\bar{p}} - \frac{h((\bar{p}\bar{x} - v_R)((1-h)(\bar{p}\bar{x} - c) + c\bar{p}))}{(1-h)\bar{p}(ch + (1-h)\bar{p}\bar{x})}. \tag{35}$$

There is one other constraint on compensation, limited liability, which requires a non-negative payment to the manager. Thus, in order to obtain the equilibrium level of compensation we need only impose the limited liability condition. Hence, when the participation constraint can be satisfied at a positive level of compensation, the participation constraint binds; otherwise the manager's compensation is 0. Hence, compensation in the labor market setting is given by

$$w_M^{L*} = \max\left[\frac{v_R}{\bar{p}} - \frac{h((\bar{p}\bar{x} - v_R)((1-h)(\bar{p}\bar{x} - c) + c\bar{p}))}{(1-h)\bar{p}(ch + (1-h)\bar{p}\bar{x})}, 0\right]. \tag{36}$$

Our first result is that, as long as the participation constraint binds, i.e., compensation is positive, increasing kinship reduces equilibrium compensation level, w_M^{L*}. This result is recorded below.

Proposition 9. *In the labor market setting, compensation, w_M^{L*}, is weakly decreasing in kinship, h and, whenever $w_M^{L*} > 0$, w_M^{L*} is a smooth strictly decreasing convex function of h.*
Proof: See the Appendix.

The negative effect of kinship on compensation results from a "loyalty hold-up." Because

the management skills required by the project are family specific, if the manager refuses to work for the family firm, project cash flows are lost, which harms the family as a whole. The manager internalizes the family's losses and thus will be reticent to reject low salary offers from the owner. In the presence of kin altruism, the indispensability of the manager weakens rather than strengthens the manager's ability to extract value from the firm.

5.1.2 Efficiency

In Section 3.3 we showed that the probability of monitoring increases with kinship at fixed compensation. In Section 5.1.1 we showed that increased kinship leads to lower compensation. Reductions in compensation, absent diversion by the manager, increase the size of the owner's residual claim, $\bar{x} - w$. The gain from diversion relative to non-diversion is exactly this residual share. Thus, lowered compensation makes underreporting more attractive at any fixed monitoring policy. Hence, reductions in compensation require increases in monitoring to deter underreporting. Combining these two observations makes the logic behind the following proposition apparent.

Proposition 10. *In the labor market setting,*

(a) if $w_M^{L*} > 0$, the probability that the owner will monitor the manager's report of a zero cash flow, m^*, is strictly increasing in kinship.

(b) The probability of monitoring and monitoring expense are increasing in kinship.

(c) Family value is decreasing in kinship.

Proof: See the Appendix.

Note that both when the payment to the manager is fixed, the case considered in section 3.3, and in this section, where the payment is negotiated, kinship increases the unconditional probability of monitoring. However, in the fixed payment case, the probability of monitoring conditioned on a report of zero falls as kinship increases. However, when compensation is fixed by the labor market participation constraint, the loyalty hold up ensures that even the conditional probability of monitoring increases with kinship. Thus, although kinship increases the probability of monitoring even when compensation is fixed, the probability of monitoring

will be much more responsive to increases in kinship when compensation is negotiated and the participation constraint binds. This implies that, in the labor market setting, the adverse effect of kinship on family value is much more pronounced than in the fixed compensation case.

5.1.3 Value of the owner and manager

The effect of kinship on owner and manager value depends not only on kinship's effect on efficiency but also on its effect on the distribution of value between the manager and the owner. Because of these distributional effects, increasing kinship may increase owner value even when it lowers family value. First consider owner value. Equations (36), (13), and (34), determine the owner's value, v_O^{L*}, which is given by

$$v_O^{L*} = \bar{p}\left(m^* \bar{x} \sigma^* + (1 - \sigma)(\bar{x} - w_M^{L*})\right) - c\, m^* (1 - \bar{p}(1 - \sigma^*)). \tag{37}$$

where σ^* is defined by (13) and w_M^{L*} by (36).

From Propositions 9 and 10, we see that increasing kinship will (i) lower compensation, (ii) increase underreporting, and (iii) increase monitoring expense. Effect (i) increases firm value while effects (ii) and (iii) lower firm value. For this reason, the relation between firm value and kinship is, in general, neither monotone nor concave. However, the relation between kinship and value is strictly quasiconcave. Hence, the relation is always unimodal. Whether the value-maximizing level of kinship is interior depends on the costs of monitoring relative to the total expected operating cash flows. These observations are formalized in Proposition 11.

Proposition 11. *In the labor market setting,*

(a) firm value is a strictly quasiconcave function of kinship, h, and thus is minimized at extreme values of kinship.

(b) If $\bar{p}\bar{x} > (1 + \frac{1}{\sqrt{2}})c \approx 1.71\,c$, then for h sufficiently small, firm value is increasing in kinship.

Proof: See the Appendix.

Proposition 11 shows that, unless the cost of monitoring c is very high relative to the expected cash flow, $\bar{p}\bar{x}$, owner value is increased by some degree of kinship with the manager.

This result is not surprising the light of Proposition 1 which shows that the adverse monitoring effect of kinship is relatively small at low kinship levels.

Now consider the manager's value. Because, in the labor market setting, there are no effort costs, the manager's value is just the expected cash flow received by the manager. It is given by

$$v_M^{L*} = \bar{p}\left((1 - m^*)\sigma^* \bar{x} + (1 - \sigma^*)w_M^{L*}\right). \tag{38}$$

The effect of kinship on the manager's value function is somewhat subtle. Recall, that the labor market participation constraint is always binding at the equilibrium compensation contract if the limited liability constraint is satisfied. However, this condition only ensures that the manager's *utility* from accepting employment is constant not that the *payoff* from accepting employment is constant. Utility incorporates indirect internalized family gains and direct payoff gains. Increasing kinship from a sufficiently high starting point can actually increase the payoff required to meet the manager's participation constraint. This perhaps counterintuitive effect results because an increase in kinship increases monitoring expense and thus lowers family value. Hence, at higher kinship levels, the manager has less family gain to internalize. In order to keep the manager's utility constant, the manager's direct payoff gains must increase.

Proposition 12. *The the labor market setting, the manager's value is strictly quasiconvex in kinship, h and thus manager value is maximized at extreme values of kinship.*
 Proof: See the Appendix.

5.2 Markets for human capital when management skills are general

In this section we introduce general management skills. We assume that there exists a continuum of non-family firms and managers. All non-family firms have production technologies identical to the family firm's, i.e., the technology produces an uptick cash flow with probability $\bar{p}$ and a zero cash flow with probability $1 - \bar{p}$. These firms employ the same monitoring technology as the family firm. If employed by a non-family firm, all managers, including the kin manager, produce an uptick cash flow of $g \in [0,1]$. Non-family, "external," managers also

produce an uptick cash flow of g if employed by the family firm. All managers have the same reservation value, v_R. The only difference between the kin manager and the external managers is that the kin manager produces an uptick cash flow of 1 if employed by the family firm. Thus, g is a measure of the proportional contribution of general human capital to family firm value while $1 - g$ measures the contribution of family-firm specific human capital to family firm value.

Because, outside the family firm, all managers have identical productivity, under the assumption of a competitive labor market, all managers, if hired by non-family firms, will earn their reservation payoff, v_R. We assume that the expected firm cash flow under the external candidate gp exceeds both the cost of monitoring c and the manager's reservation value, v_R, i.e., $gp > \max[c, v_R]$. We also assume that the labor market participation constraint rather than the limited liability constraint is the binding constraint determining the kin manager's compensation.

Compensation and hiring within the family firm are determined as follows: First, the owner decides whether to approach the kin manager or an external candidate. If the owner approaches an external candidate, the owner makes a compensation offer that meets the external candidate's reservation value. Because the uptick probability equals $\bar{p}$, the owner will offer compensation equal to $v_R/\bar{p}$ to the external candidate manager. That manager will accept the owner's offer and manage the firm. If the owner approaches the kin manager, the owner makes a first-and-final compensation offer of w to the kin manager. If the kin manager rejects the owner's offer, the kin manager is matched with an external firm and earns the reservation payoff v_R and the owner hires an external manager at a compensation of $v_R/\bar{p}$. If the kin manager accepts the owner's offer, the kin manager is hired to manage the firm.

Kin altruism implies that the reservation utility of the kin manager depends on the payoff to the owner in the event the owner hires the external candidate. Thus, solving for equilibrium compensation requires that we first solve for the owner's value under the external manager. This value is given by the owner's value expression, equation (37), developed in the previous section, under the assumption that $\bar{x} = g$ and $h = 0$. Because the compensation, monitoring,

and underreporting incentives when the manager hires the external candidate are not affected by kin altruism, computing owner value under the external manager, which we represent by v_O^E, is fairly easy. In fact, plugging into (37) using the values $\bar{x} = g$ and $h = 0$ shows that owner value under the external manager is given by

$$v_O^E(g) = (\bar{p}\,g - v_R)\left(1 - \frac{c\,(1-\bar{p})}{p\,(g-c)}\right). \tag{39}$$

The owner's compensation offer, w, will equate the manager's utility from accepting the owner's offer with the utility from rejecting the offer. In the previous section, the manager's reservation utility equaled v_R. With a viable rival external manager, the firm will not shut if the kin manager rejects the owner's offer, rather the firm will operate and operation will produce a value of $v_O^E(g)$ for the owner. Thus, the minimal compensation offer that the manager will accept will be fixed to generate utility of $v_R + h\,v_O^E(g)$ for the manager. This compensation offer is determined in exactly the same way as compensation was determined in the previous section. Thus, using equation (36), we see that the equilibrium wage for the kin manager given that there is a viable rival external candidate manager is given by

$$w_M^{Lr*} = \frac{v_R + h\,v_O^E(g)}{\bar{p}} - \frac{h\,((\bar{p} - (v_R + h\,v_O^E(g)))((1-h)(\bar{p}-c) + c\,\bar{p}))}{(1-h)\,\bar{p}\,(c\,h + (1-h)\bar{p}\bar{x})}. \tag{40}$$

As can be seen by inspecting equation (39), the owner's value conditioned on hiring an external manager is increasing in g. However, an increase in g also increases the manager's utility from rejecting the owner's compensation offer. As can be seen by inspecting equation (40), this effect increases the equilibrium compensation offered by the owner to the kin manager. Because the owner's payoff is decreasing in compensation w and the kin manager's payoff is increasing in w, conditioned on the owner hiring the kin manager, the owner's payoff is decreasing in human capital generality and the kin manager's value is increasing. Moreover, as shown in Proposition 1, monitoring expense is decreasing in w. Thus, conditioned on the owner hiring the kin manager, an increase in the generality of human capital increases the manager's value, decreases the owner's value, and reduces monitoring expense. This result is recorded

below.

Proposition 13. *Conditioned on the owner hiring the kin manager, an increase in the contribution of general human capital to the value of the family firm, g, will*

(a) increase the manager's value,

(b) lower the owner's value,

(c) reduce monitoring expense and thus increase total family value.

Proposition 13 implies that the professionalization of management has positive spill-over effects on firms that are not professionally managed.

Proposition 13 begs the question of whether the owner will hire the kin manager at all. To answer this question, note that Proposition 1 shows that increasing compensation decreases monitoring expense and that kinship increases monitoring expense. Total family value equals the gross expected cash flow from the project, $g\bar{p}$ under the external candidate manager and $1 \times \bar{p} = \bar{p}$ under the kin manager, less monitoring expense. Thus, if the human capital used by the family firm is completely general, i.e., $g = 1$, total family value will be strictly higher if the kin manager works outside the family firm and the owner hires the external candidate manager.

Under the owner's optimal compensation strategy, which pushes the kin manager to his reservation utility, the kin manager's utility is the same regardless of whether the kin manager works inside or outside the firm. From equation (4), we know that, when choosing between alternative policies that produce the same utility for the kin manager, the owner will choose the policy that maximizes total family value. Thus, when $g = 1$ and, by the continuity of the value and compensation functions, when g is sufficiently close to 1, the owner will always hire the external manager and the kin manager will work for a non-family firm. These observations are recorded in the next proposition and illustrated in Figure 2.

Proposition 14. *In the labor market setting, when a viable candidate external manager exists, the owner of the family firm will always choose the manager, kin or external, that will produce the highest total family payoff. Moreover, there exists a level of human capital generality, $g^* < 1$, such that, whenever g is greater than g^*, the owner hires the external candidate manager*
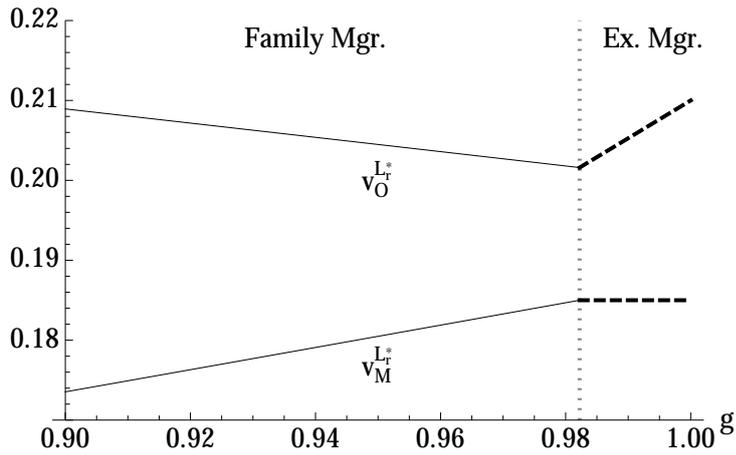
Figure 2: *Effect of rival external candidate managers in the labor market setting.* The figure plots the manager's and owner's value as a function of g, the fraction of output in the family firm attributed to general human capital. The parameters used in this illustration are $\bar{p} = .5$, $c = .25$, $h = .25$, and $v_R = .185$.

rather than the kin manager.

As Figure 2 illustrates, initially, increasing the generality of human capital does not affect the choice of manager but rather serves to increase the kin manager's compensation. However, at sufficiently high levels of human capital generality, the owner prefers to hire the external manager. In which case, the kin manager works outside the family firm. Because the kin manager is working outside the family firm, further increases in human capital generality do not affect the kin manager's payoff. However, further increases in generality, through their output increasing effect, increase owner payoffs.

6 Extensions and applications

6.1 *Nepotism and rival internal managers*

Thus far, we have only considered rival managers when the rivals are external and compensation is determined by competitive labor markets. In this section, we consider rival internal candidate managers in the agency setting. These rivals can be thought of as employees of the firm who have developed the firm specific skills required to manage the firm. In keeping with the specificity of human capital assumption, we assume neither the rival internal manager nor

kin manager have general skills. Thus, both the internal rival candidate and the kin candidate managers will earn a payoff of 0 if not selected to manage the family firm. Under both candidates, the normalized cost of monitoring, χ, is the same. There are only two differences between the kin candidate and the rival internal candidate. The rival internal candidate is not related to the owner and the rival internal candidate generates a payoff of $\bar{x} = e > 1$ conditioned on an uptick while the kin candidate manager generates a payoff of $\bar{x} = 1$. Thus, the internal rival candidate is assumed to be more able than the kin candidate manager in that, for any fixed level of effort, the rival internal candidate produces greater expected output. In the sequel, we will simply refer to the rival internal candidate manager as the "rival manager" and the kin candidate manager as the "kin manager." The hiring game has exactly the same structure as specified in Section 5.2.

A key result which greatly simplifies the analysis in this section is that the kin manager's participation constraint is never binding, i.e., if the owner hires the kin manager, then, evaluated at the owner's agency-optimal choice of p and w (developed in Section 4), the kin manager's participation constraint is satisfied. This is not a trivial result in the presence of a viable internal rival manager. Even though the manager's payoff from rejecting the owner's offer is 0, the kin manager's utility will internalize part of the owner's payoff under the rival and this internalization will generate a positive reservation utility for the kin manager. However, the assumption that the kin manager's human capital is firm specific, in fact, ensures that the kin manager's participation constraint never binds. Roughly, the reason that the participation constraint never binds is that, for the kin manager's participation constraint to bind, it must be the case that the owner's payoff under the rival manager is very high. But, whenever the owner's payoff from hiring the rival is that high, the owner prefers to simply hire the rival manager. Thus, when the kin manager is hired, he is hired at the same terms as developed in Section 4.

Lemma 2. *In the agency setting where the human capital of both the internal rival and the kin manager are firm specific, the kin manager's participation constraint is never a binding constraint on the compensation received by the kin manager.*

Proof: See the Appendix.

Lemma 2 implies, in sharp contrast to the external labor markets' case, that, when the owner hires the kin manager, the presence of internal rivals has no effect on the efficiency, firm value, or compensation in the family firm. Thus, the effect of rival internal candidates on the family firm flows entirely from the owner's hiring decision. Measuring the efficiency of the owner's hiring decision is not a trivial exercise. For any fixed level of effort, the more competent rival manager produces higher expected output. However, this does not imply that the rival manager is more efficient than the kin manager. Kinship can increase managerial effort and sometimes, at endogenous compensation levels, also reduce monitoring expenses. We measure the efficiency effect of the owner's hiring decision using a utilitarian social welfare function which equals the sum of the payoffs to the owner, rival manager, and kin manager. A hiring choice is efficient if it is best under this measure. In contrast, we define a hiring as "nepotistic" if the owner hires the kin manager even though hiring the rival produces a higher owner payoff, i.e., because of kin altruism, the owner hires the kin manager at the cost of lowering firm value.

Using Lemma 2 and these definitions, we formalize our results simply by using the agency model solution of Section 4 to characterize the payoff and utility of the owner under the kin and rival managers (setting $h = 0$ for the rival). First note that, because the payoff to the manager who is not hired equals 0, if the kin manager is hired, the total payoff will equal the sum of the kin manager's value and the owner's value, which we represent by v^K. Similarly, if the rival manager is hired, the total payoff will equal the sum of the owner's value and the rival manager's value, which we represent by v^R. We represent the owner's value if the owner hires the kin manager by v_O^K and, if the owner hires the rival manager, by v_O^R. We represent the value of the kin and rival manager if they are hired by the owner by v_M^K and v_M^R respectively. Because the owner's payoff, which equals firm value, is given by the total value less the value received by the hired manager, the increase in firm value from hiring the rival manager is given by

$$\Delta_{\text{Nep.}}^R = (v^R - v^K) - (v_M^R - v_M^K). \tag{41}$$

Similarly, the efficiency gain from hiring the rival manager under the social welfare objective

function is

$$\Delta_{\text{SW}}^{R} = v^{R} - v^{K} > 0. \tag{42}$$

The owner's actual hiring decision is governed neither by the social welfare function nor firm-value maximization but rather by the kin altruism function as specified in (1). Using the form of the altruism function given in equation (3) we can express the owner's gain from hiring the rival manager as

$$\Delta_{O}^{R} = (v^{R} - v^{K}) - (v_{M}^{R} - (1 - h) v_{M}^{K}). \tag{43}$$

Hiring is *nepotistic* when $\Delta_{\text{Nep.}}^{R} > 0$ and $\Delta_{O}^{R} < 0$. Hiring the kin manager is *inefficient* if $\Delta_{\text{Nep.}}^{R} > 0$ and $\Delta_{O}^{R} < 0$. Our basic result, presented in Proposition 15, is that the owner is indeed biased under both the social welfare and firm value maximization criteria toward hiring the kin manager but that this bias sometimes leads to more efficiency than non-nepotistic manager selection policies based on firm value maximization.

Proposition 15. *When choosing between the rival internal manager and kin manager in the agency setting,*

(a) relative to both the efficiency and firm-value maximization, the owner is biased against hiring the rival manager, i.e., $\Delta_{O}^{R} < \Delta_{\text{SW}}^{R}$ and $\Delta_{O}^{R} < \Delta_{\text{Nep.}}^{R}$.

(b) Parameters of the model exist under which hiring the kin manager is nepotistic but, nevertheless, efficient.

(c) Parameters of the model exist under which hiring the kin manager is not nepotistic but inefficient.

Proof: See the Appendix.

The conclusions of the proposition are illustrated in Figure 3. Part (a) of Proposition 15 shows that the owner's hiring decision is never "anti-nepotistic," the owner never selects the rival manager when selection of the rival manager results in either lower firm value or reduced efficiency. Part (b) is illustrated by Region (b) of Figure 3. In this region, the altruism-inflated cost of monitoring is high. Thus, the owner is very willing to concede rents to the kin manager and thereby reduce monitoring costs and improve effort incentives. This effect more than
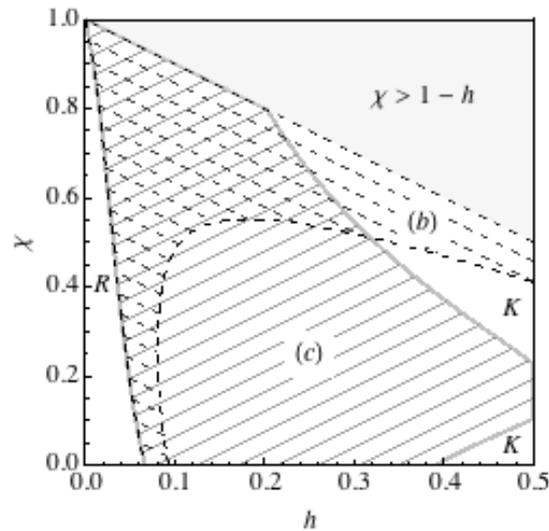
Figure 3: *Nepotism in the agency setting.* In the figure, the degree of kinship, *h*, is plotted on the horizontal axis and the normalized level of kinship, $\chi = c/\bar{x}$ on the vertical axis. In the region of the graph covered with the dashed mesh, the owner hires the kin manager but firm value would have been higher if the rival manager had been hired. In the region of the graph covered with solid mesh, the owner hires the kin manager but efficiency would have been higher if the rival manager had been hired. In the regions labeled (R) K, the firm value, efficiency, and owner utility are all higher if the (rival) kin manager is hired.

offsets the inefficiency caused by the lower ability of the kin manager. Thus, hiring the kin manager is efficient. However, rent concessions to the kin manager lower firm value so much that firm value would have been higher under the rival manager, i.e., hiring is nepotistic. Part (c) is illustrated by Region (c) of Figure 3. In this region, the altruism-inflated costs of monitoring are low. Hence, compensation to the kin manager is also low. Firm value is maximized by hiring the kin manager because the lower managerial rents under the kin manager more than offset the efficiency gain from hiring the more competent rival. Thus, in this case, hiring the kin manager is not nepotistic but is inefficient.

Inefficiency and nepotism are generated in the internal labor market framework because managers earn agency rents and owners prefer to keep rents "in the family." In practice, one potential mechanism for mitigating these costs is to bring the internal rival into the family through marriage. Affine relations have offspring who are genetically related. Thus, if agents' actions primarily affect the fitness of their descendants, the conditions for kin altruism are satisfied by affinity bonds (see Hughes (1988)). For example, under the historic Japanese practice

of adopting candidate CEOs into the family, which is usually accompanied by marriage of the
adopted son to a family member, owners should exhibit kinship altruism toward rival managers
who are affinity relations.[18]

6.2 Founders vs. Descendants

In this section, we show that kin altruism rationalizes conflicts between founders and descendant owners. The ability of founders to shape the policy followed by the firm after ownership as passed to descendants will be constrained by legal environment in which the firm operates and analyzing these constraints is beyond the scope of this paper. However, as we shall see, the restriction imposed by inclusive fitness on the structure of altruism, generate determinant predictions concerning the nature of such conflicts.

Consider the preferences of a firm founder at date -1, the last date before control passes to descendants. Suppose, that founder knows she will die between date -1 and date 0. Thus, the founder derives no direct payoff from the descendant firm. The founder's preferences will be determined by kin altruism. The founder has two descendants: S and N. We represent the kinship between the founder and S with h_S, the kinship between the founder and N by h_N, and the kinship between N and S by h_{NS}. We assume that

$$0 \leq h_N < h_S \leq 1/2 \text{ and } 0 \leq h_{NS} \leq 1/2.$$

Expression (6.2) implies that the kinship between the founder and S is greater than the kinship between the founder and N. We assume that S is incapable of managing the firm but N is capable of managing the firm. Consider the founder's preferences over the value received by N and S subsequent to her demise. The founder's utility is the relationship-weighted sum of N's and S's values, i.e., the utility of the founder is given by $u_F = h_S v_S + h_N v_N$, where v_S, and v_N represent value to N and S. Next, note that the founder's utility function is only unique up to increasing affine transformations. Thus, dividing by h_S, we can and will express the founder's

---

[18]See Mehrotra et al. (2013) for an empirical analysis of Japanese adoption practices and corporate governance. See Mehrotra et al. (2011) for a more general discussion of the role of arranged marriages in family businesses

utility in the following equivalent form:

$$u_F = v_S + h_F \, v_N, \quad h_F = h_N/h_S.$$

As in the baseline model, the descendants' preferences are given by the kin altruism utility function. Thus, S's preferences are given by $u_S = v_S + h_{NS} v_N$, and N's preferences are given by $u_N = v_N + h_{NS} v_S$. For example (assuming no inbreeding) if S is the son of the founder and N is the founder's nephew, then $h_S = 1/2$, $h_N = 1/4$, $h_{NS} = 1/8$, $h_F = 1/2$.

Ax expression (5) shows, family members' decisions trade off family welfare against selfish gain. For the founder, $h_F = h_N/h_S$ represents the degree to which her preferences are aligned with family value as opposed to the value received by S while h_{NS} represents the degree to which N and S weigh family value relative to their selfish value. If $h_F > h_{NS}$, then we will term the founder's preferences *benevolent*.

If founder preferences are benevolent, her preferences tilt more toward family value as opposed to the value received by particular family members. Are founders benevolent? A model of altruism based on social connectedness or friendship would provide little guidance in answering this question. However, the logic of kinship-based altruism provides us with a fairly definitive answer—typical family structures imply founder benevolence.

Proposition 16. *The following conditions are sufficient for founder benevolence:*

i. *The founder is not inbred, S is the son of the founder, N is not a descendant of S, and the coefficient of relation between the founder's spouse and N, represented by h'_N, is less than three times the coefficient of relation between the founder and N, h_N.*

ii. *The founder is not inbred, N is not a direct descendant of either the founder or founder's spouse but is related to the founder, and the family tree is unilateral, i.e., all indirect lines of descent between collateral relatives pass through only one of the relatives' parents. In this case, the founder's family altruism coefficient, h, exceeds S's by a considerable margin, i.e., $h_F \geq 4 h_{NS}$.*

Proof: See the Appendix.

The logic behind Proposition 16 is transparent given the mathematics of kinship relations. If *S* and *N* are collateral relatives, and the family tree is not too bushy, either because of consanguineous or affinity marriages, the primary path connecting collateral relatives runs through the founder. Thus, the primary path connecting the founder to *S* and *N* is shorter than the path connecting *S* and *N* to each other. Because relatedness declines geometrically with the number of arcs connecting relatives, collateral relatives are less closely related to each other than each is related to the founder. Given the weak restrictions on family pedigree required to support founder benevolence, we will focus on this case in the subsequent analysis.

We assume that only *N* is capable of managing he firm. Thus if the founder bequeaths the firm to *N*, *N* will own the firm and either hire an external manager or manage the firm himself. In which case, *N* will not make any transfer payment to *S* as such payments do not raise total firm value and do lower the payoffs to *N*, which implies, given the limited nature of kin altruism that such transfers are not optimal. If the founder bequeaths ownership to *S*, then *S* will either hire *N* or an external manager to manage the firm. The tradeoff faced by the owner is that, on the one hand, bequeathing the firm to *N* can increase efficiency by eliminating the agency conflict within the firm by unifying ownership and management. On the other hand, the founder's utility weighs payoff to *S* more than payoffs to *N* and bequeathing to *N* lowers *S*'s payoff. It is clear that for sufficiently low levels of h_F, the founder will bequeath ownership to *S*. This is the case we focus on, and is in fact this case rationalizes the existence of the sort of descendant family firm modeled in this paper. When control passes to *S*, the question arises of whether the preferences of the descendant owner over the polices of the firm post bequest are the same as the founder's preferences. The basic consequence of Proposition 16 is that for more or less normal pedigrees, their preferences are not aligned and the direction of the misalignment is predicted by the restrictions inclusive fitness places on kin altruism.

Lemma 3. *Let $v(\gamma)$ represent total family value conditioned on any policy variable of the descendant firm, e.g., compensation, w, or choice between internal and external manager. Let Γ represent the set of feasible policies. Let u_F and u_S represent the utility functions of the*

founder and her closest descendant, S, respectively. Then the founder optimal polices generate weakly higher total family value than S-optimal polices, i.e., if $\gamma_F \in \text{argmax}_{\gamma \in \Gamma} u_F(\gamma)$ and $\gamma_S \in \text{argmax}_{\gamma \in \Gamma} u_S(\gamma)$, then $v(\gamma_F) > v(\gamma_S)$.

Proof: See the Appendix.

Thus, when the founder bequeaths ownership to her closest relative, *S*, the founder's preferences over post-bequest policies can differ from *S*'s and, in fact, will generally differ unless, for both policy choices, *N*'s participation constraint binds. In which case, equation (4) implies that both will agree on choosing the family value maximizing policy. When preferences differ, the founder tilts always toward increasing the payoff to *N* when *N* manages the descendant firm as this tilt leads to higher total family value. Thus, in the agency setting and the labor market setting when the limited liability constraint binds, the founder has an incentive to design complex mechanisms aimed at entrenching and increasing the compensation of the managing relative, *N*. A number of mechanisms might be employed to achieve this goal, e.g., bequests of non-controlling stakes, long-term employment contracts, severance payments, and executive pensions.

7 Concluding remarks

In summary, we have developed a model of family firms, based on their defining characteristic—relatedness. Relatedness is modeled using a standard paradigm in the social and biological sciences—inclusive fitness. Based on extant research in the social sciences, we have every reason to believe that inclusive fitness produces substantial differences between the level of altruism in family and non-family firms, and, as our analysis shows, these level differences have determinate effects on the resolution of standard principal/agent governance problems within firms.

Of course, this paper is only a first step in addressing the role of kin altruism in business relations. The analysis was developed within very simple economic frameworks. Extending the analysis beyond these frameworks would no doubt yield greater insights and additional inter-

esting predictions. As well as the obvious technical extensions of the analysis, e.g., enlarging the space of potential cash flow realizations, the most interesting directions for extension are dynamics and scope.

Dynamics are interesting at two time scales: the dynamics within a single generation and the dynamics of inter-generational inheritance. Within a single generation, an interesting issue is how kin altruism affects monitoring and compensation. Monitoring is costly to the family as a whole and, hence, a natural question to ask is how, in a dynamic repeated game version of this model, kinship might affect the ability of the family agents to implement a Pareto superior outcome as a subgame perfect equilibria, e.g., implement an outcome in which the manager does not divert. Typically, such welfare improving equilibria in the repeated games are implemented via "trigger strategies," as soon as one agent deviates from the equilibrium path prescribed by the welfare-improving equilibrium, agents switch to playing their single-shot equilibrium strategies. Kinship would reduce defection incentives because agents would internalize not only their own loss from defection but also losses of kin agents. However, kinship, for exactly the same reason, internalization, would make the renegotiation proofness of these trigger strategies more problematic because internalization would greatly increase the set of alternative allocations that, in utility terms, Pareto dominate the utility from the defection continuation.[19]

Across generations, the question of how founding owners might implement family altruistic policies through bequests is both interesting and rather subtle. Founders aim to transfer firm value to close relations, even if they are not competent to manage the family firm, but, at the same time, limit the ability of such relations to exploit more competent, distantly related kin managers. The founding owner, in essence, would use her bequest as a mechanism design to implement these preferences. Realizing that the parties could renegotiate any division of cash flow and control rights specified in her bequest, the owner would design her bequest to set the status-quo points in descendant-relative negotiations over management and ownership allocations.

In addition, the analysis could be extended outside the pure family firm context to consider

---

[19]See Farrell and Maskin (1989) for a discussion of renegotiation proofness in repeated games and see Kahn and Mookherjee (1992) for a discussion of renegotiation-proofness in games with infinite action spaces.

minority stakes by non-family members. One issue is the effect of kinship on the marginal cost of outside capital. Another is the effect of kinship on the family owner's gain from exploiting outside minority investors. A third issue is how kinship affects the willingness of family owners to cede control rights to outside investors. These issues are very interesting, but their resolution requires an understanding of how kinship affects incentives for opportunism, monitoring, compensation setting, and effort. Exactly the sort of understanding that this paper aims to provide.

References

Alger, Ingela and Jörgen W Weibull, "Kinship, incentives, and evolution," *The American Economic Review*, 2010, pp. 1725–1758.

Almeida, Heitor V. and Daniel Wolfenzon, "A theory of pyramidal ownership and family business groups," *The Journal of Finance*, 2006, *61* (6), 2637–2680.

Anderson, R. and D. Reeb, "Founding-family ownership, corporate diversification, and firm leverage," *Journal of Law and Economics*, 2003, *46*, 653–684.

Astrachan, Joseph H. and Melissa Carey Shanker, "Family Businesses' Contribution to the U.S. Economy: A Closer Look," *Family Business Review*, 2003, *16* (3), 211–219.

Barr, A., M. Dekker, and M. Fafchamps, "Who Shares Risk with Whom under Different Enforcement Mechanisms?," *Economic Development and Cultural Change*, 2008, *60* (4), 677–706.

Bassi, Matteo, Marco Pagnozzi, and Salvatore Piccolo, "Optimal contracting with altruism and reciprocity," *Research in Economics*, 2014, *68* (1), 27–38.

Bertrand, Marianne and Antoinette Schoar, "The role of family in family firms," *The Journal of Economic Perspectives*, 2006, *20* (2), 73–96.

Böhm, Michael, Daniel Metzger, and Per Strömberg, "Since you're so rich, you must be really smart: Talent and the finance wage premium," 2015. Working paper, Swedish House of Finance.

Burkart, Mike, Fausto Panunzi, and Andrei Shleifer, "Family firms," *The Journal of Finance*, 2003, *58* (5), pp. 2167–2201.

Célérier, Claire and Boris Vallée, "Are bankers worth their pay? Evidence from a talent measure," 2014. SSRN working paper.

Daly, Martin and Margo I. Wilson, "Some differential attributes of lethal assaults on small children by stepfathers versus genetic fathers," *Ethology and Sociobiology*, 1994, *15* (4), 207 – 217.

Dunbar, R.I.M., Amanda Clark, and Nicola L. Hurst, "Conflict and cooperation among the Vikings: Contingent behavioral decisions," *Ethology and Sociobiology*, 1995, *16* (3), 233 – 246.

Farrell, Joseph and Eric Maskin, "Renegotiation in repeated games," *Games and Economic Behavior*, 1989, *1* (4), 327 – 360.

Fukuyama, F., "Social capital and the global economy," *Foreign Affairs*, 1995, *74.*

Gabaix, Xavier and Augustin Landier, "Why has CEO pay increased so much?," *The Quarterly Journal of Economics*, 2008, *123* (1), 49–100.

Gardner, Andy and Stuart A. West, "Cooperation and punishment, especially in humans.," *The American Naturalist*, 2004, *164* (6), pp. 753–764.

Graetz, Michael J, Jennifer F Reinganum, and Louis L Wilde, "The tax compliance game: Toward an interactive theory of law enforcement," *Journal of Law, Economics, & Organization*, 1986, pp. 1–32.

Grayson, Donald K., "Differential mortality and the Donner Party disaster," *Evolutionary Anthropology: Issues, News, and Reviews*, 1993, *2* (5), 151–159.

Hamilton, W. D., "The genetical evolution of social behavior: I," *Journal of Theoretical Biology*, 1964, *7*, 17–52.

Harris, M and A Raviv, "The role of games in security design," *Review of Financial Studies*, 1995, *8* (2), 327–367.

Hart, Oliver, *Firms, Contracts and Financial Structure*, Clarendon Press, Oxford (1995), 1995.

Hughes, Austin L., "Kin networks and political leadership in a stateless society, the Toda of South India," *Ethology and Sociobiology*, 1988, *9* (1), 29 – 44.

Kahn, Charles M and Dilip Mookherjee, "The good, the bad, and the ugly: Coalition proof equilibrium in infinite games," *Games and Economic Behavior*, 1992, *4* (1), 101–121.

Khalil, Fahad, "Auditing without Commitment," *The RAND Journal of Economics*, 1997, *28* (4), pp. 629–640.

Lee, Samuel and Petra Persson, "Authority versus loyalty: Social incentives and modes of governance," 2010. Western Finance Association Meetings 2010.

_ **and** _ , "Financing from family and friends.," 2012. NYU Working Paper No. FIN-12-007.

Lindley, Joanne and Steven McIntosh, "Growth in within graduate wage inequality: the role of subjects, cognitive skill dispersion and occupational concentration," 2014. Working paper, Department of Economics, University of Sheffield.

Madsen, Elainie A., Richard J. Tunney, George Fieldman, Henry C. Plotkin, Robin I. M. Dunbar, Jean-Marie Richardson, and David McFarland, "Kinship and altruism: A cross-cultural experimental study," *British Journal of Psychology*, 2007, *98* (2), 339–359.

Mehrotra, Vikas, Randall Morck, Jungwook Shim, and Yupana Wiwattanakantang, "Must Love Kill the Family Firm? Some Exploratory Evidence," *Entrepreneurship Theory and Practice*, 2011, *35* (6), 1121–1148.

_ , _ , _ , **and** _ , "Adoptive expectations: Rising sons in Japanese family firms," *Journal of Financial Economics*, 2013, *108* (3), 840 – 854.

Miller, Danny and Isabelle Le Breton-Miller, "Family governance and firm performance: Agency, stewardship, and capabilities," *Family Business Review*, 2006, *19* (1), 73–87.

_ , **Isabelle Le Breton-Miller, Richard H. Lester, and Albert A. Cannella**, "Are family firms really superior performers?," *Journal of Corporate Finance*, 2007, *13* (5), 829 – 858.

Mouden, Claire El, Stuart A. West, and Andy Gardner, "The enforcement of cooperation by policing," *Evolution*, 2010, *64* (7), 2139–2152.

Murphy, Kevin J., "Explaining Executive Compensation: Managerial Power versus the Perceived Cost of Stock Options," *The University of Chicago Law Review*, 2002, *69* (3), pp. 847–869.

Murphy, Kevin J and Jan Zabojnik, "Managerial capital and the market for CEOs," *Available at SSRN 984376*, 2007.

Philippon, Thomas and A. Reshef, ""Wages and Human Capital in the U.S. Financial Industry: 1909–2006," *Quarterly Journal of Economics*, 2012, *127*, 1551–1609.

Porta, Rafael La, Florencio Lopez de Silanes, and Andrei Shleifer, "Corporate ownership around the world," *The Journal of Finance*, 1999, *54* (2), pp. 471–517.

Ratnieks, Francis L. W., "Reproductive harmony via mutual policing by workers in eusocial hymenoptera," *The American Naturalist*, 1988, *132* (2), pp. 217–236.

Roberts, Sam GB and Robin IM Dunbar, "The costs of family and friends: an 18-month longitudinal study of relationship maintenance and decay," *Evolution and Human Behavior*, 2011, *32* (3), 186–197.

Sraer, David and David Thesmar, "Performance and behavior of family firms: Evidence from the french stock market," *Journal of the European Economic Association*, 2007, *5* (4), 709–751.

Taylor, Peter D. and Andrew J. Irwin, "Overlapping generations can promote altruistic behavior," *Evolution*, 2000, *54* (4), 1135–1141.

Townsend, Robert M., "Optimal contracts and competitive markets with costly state verification," *Journal of Economic Theory*, 1979, *21* (2), 265 – 293.

Villalonga, Belen and Raphael Amit, "How do family ownership, control and management affect firm value?," *Journal of Financial Economics*, 2006, *80* (2), 385 – 417.

Appendix: Online supplement for
Blood and Money: Kin altruism, governance, and inheritance in the family firm

Thomas Noe
Balliol College/Saïd Business School, Oxford
European Corporate Governance Institute
thomas.noe@sbs.ox.ac.uk

Proof of Lemma 1. We start by demonstrating (a). Differentiating u_O^A twice with respect to p yields

$$\frac{\partial^2 u_O^A}{\partial^2 p} = -\frac{\bar{x}\left(ch + \left(2 - h - h^2\right)\bar{x}\right)}{(1-h)\bar{x} - c}.$$

The denominator is positive by assumption (12). Because the numerator is positive for all $h < 1$ and thus *a fortiori* for $h < 1/2$, $ch + \left(2 - h - h^2\right)\bar{x} > 0$. Thus, $\partial^2 u_O^A / \partial^2 p < 0$, showing that u_O^A is strictly concave. Next consider (b). We need to show that neither $p = p_{\min}$ nor $p = 1$ are optimal solutions to problem (24). Note that

$$u_O^A(p) = \bar{x}\hat{u}_O(p),$$

where

$$\hat{u}_O(p) = \frac{2p\left(1 + h + \alpha + h\alpha^2\right) - 2\alpha\left(1 + h\alpha\right) - p^2\left(2 + h + h\alpha\right)}{2(1-\alpha)} \quad \text{and} \quad \alpha = \frac{c}{(1-h)\bar{x}}.$$

$\hat{u}_O$ is simply a scaled version of u_O^A where the cost of monitoring, c, is expressed as a fraction of $(1-h)\bar{x}$. Thus, the sign of derivative $\hat{u}_O$ with respect to p is always the same as the sign of u_O^A. Note also that assumption (12) implies that $\alpha \in [0,1)$. Expressing $p^{w=0}$ in terms of α yields

$$p^{w=0} = \frac{h(1+\alpha)}{1+h\alpha}.$$

We first show that $p^A > p^{w=0}$. We differentiate $\hat{u}_O$ with respect to p and evaluate the derivative

at $p = p^{w=0}$. This yields

$$\frac{\partial \hat{u}_O}{\partial p}\bigg|_{p=p^{w=0}} = \frac{\left(1-h-h^2\right) + \left(1-h-h^2\right)\alpha + \left(2h-h^2\right)\alpha^2 + h^2\,\alpha^3}{(1-\alpha)(1+h\,\alpha)}.$$

Because $h \in [0, 1/2]$ and $\alpha \in [0, 1)$, this expression is always positive. This implies, given result (a) of this lemma, that $p^A > p^{w=0}$. Now consider, $p = \alpha = c/(x(1-h))$. Evaluating the derivative of $\hat{u}_O$ at α yields $\hat{u}_O' = 1 + h > 0$; thus, again, $p^A > \alpha$. Hence, $p^A > \max[p^{w=0}, \alpha] = p_{\min}$. Finally, consider $p = 1$. Following the same approach as followed for $p = p_{\min}$ shows that

$$\frac{\partial \hat{u}_O}{\partial p}\bigg|_{p=1} = -(1+h\,\alpha) < 0.$$

Thus, $p^A < 1$. Hence, result (b) has been established. Finally, result (c) follows from (a) and (b). □

Proof of Proposition 2. The functional form of p^A, given in equation (25) is obtained, after some significant manipulation, from solving the first-order condition of Lemma 1.(c).

To prove (a), we simply compute the derivative of p^A with respect to h. Tedious algebraic manipulations of this expression yield

$$\frac{\partial^2 p^A}{\partial h} = \frac{(1-h) + (2-h)\,h\,\alpha + (1+h)\,(1+2h)\,\alpha^2 + h^2\,\alpha^3}{(1-h)\left((2+h)^2 + 2h\,(2+h)\,\alpha + h^2\,\alpha^2\right)}, \tag{A-1}$$

where $\alpha = \chi/(1-h)$. Assumption (8) ensures that $\alpha \in [0, 1]$. Thus, inspection of the expression (A-1) shows that $\partial p^A/\partial h > 0$.

To prove (b), we compute the cross partial derivative, $\partial^2 p^A/\partial h \partial \chi$. Tedious algebraic manipulations of this expression yield

$$\frac{\partial^2 p^A}{\partial h \partial \chi} =$$
$$\frac{(1-h)^3\,h\,\left(2+2h-h^2\right) + (1-h)^3\,(2+5h)\,\left(2+2h+h^2\right)\,\alpha + 3\,(1-h)^3\,h^2\,(2+h)\,\alpha^2 + (1-h)^3\,h^3\,\alpha^3}{(1-h)^5\,(2+h)^3 + 3\,(1-h)^5\,h\,(2+h)^2\,\alpha + 3\,(1-h)^5\,h^2\,(2+h)\,\alpha^2 + (1-h)^5\,h^3\,\alpha^3},$$
$$\tag{A-2}$$

where $\alpha = \chi/(1-h)$. Assumption (8) ensures that $\alpha \in [0,1]$. Thus, inspection of this expression for the cross partial, (A-2), shows that $\partial^2 p^A/\partial h \partial \chi > 0$.

Next consider (c). Note that the manager's utility along the equilibrium compensation schedule w_M^A is given by

$$u_M^A(p, w_M^A(p)) = \frac{(1-h)p^2 - 2h\chi(1-p)}{2(1-h)}.$$

Thus, the sign of $u_M^A(p, w_M^A(p))$ is determined by

$$SS(p) = \frac{p^2}{1-p} - \frac{2\chi h}{1-h}.$$

$SS(p)$ is increasing in p and from equation (25) we see that $p^A > (1+\delta)/2$. Thus,

$$SS(p^A(h,\chi)) > SS((1+\delta)/2) = \frac{(1+\chi)^2}{2(1-\chi)} - 2\chi\frac{h}{1-h}. \tag{A-3}$$

By assumption (2), $h < 1/2$. Thus, $h/(1-h) < 1$. Thus,

$$SS((1+\delta)/2) > \frac{(1+\chi)^2}{2(1-\chi)} - 2\chi > 0, \quad \chi \in [0,1]. \tag{A-4}$$

Expressions (A-3) and (A-4) yield the result that $SS(p^A(h,\chi)) > 0$. Because, *SS* determines the sign of $u_M^A(p, w_M^A(p))$, $u_M^A(p, w_M^A(p)) > 0$ and (c) is established. □

Proof of Proposition 3. Define σ^A as the probability of underreporting given uptick probability p, kinship h and normalized cost of monitoring χ. Equation (13) provides the probability underreporting, σ^A, given p. Thus, σ^A is given by rewriting equation (13) in terms of χ. This yields,

$$\sigma^A(p, h, \chi) = \frac{(1-p)\chi}{p(1-h-\chi)}. \tag{A-5}$$

If we substitute in the equilibrium probability of monitoring given by equation (25) and differ-

entiate with respect to h, we obtain

$$\frac{\partial}{\partial h}\sigma^A(p^A(h,\chi),h,\chi) = \frac{\chi\left(2h(1-h)^2 + \left(1+h+2h^2\right)\chi(1-h)\right)}{\left(1-h-h^2+h^3+\chi-h\chi+h\chi^2\right)^2}.$$

Inspection shows that this expression is always positive. $\qquad\square$

Proof of Proposition 4. Define

$$\hat{w}^A(p,h,\chi) = \frac{p(1-h(1-\chi))-h(1-h+\chi)}{(1-h)^2} \qquad (A\text{-}6)$$

$$w^A(p,h,\chi,\bar{x}) = \bar{x}\hat{w}^A(p,h,\chi) \qquad (A\text{-}7)$$

$\hat{w}^A$ represents the equilibrium compensation in the agency setting to the manager, w^A_M defined in equation (17) expressed in terms of the normalized cost of monitoring, χ when $\bar{x}=1$. w^A represents the equilibrium compensation expressed in terms of χ for a general choice of $\bar{x}$. Since the sign of the relation between kinship, h, and compensation does not depend on $\bar{x}$ we will analyze the effect of h on $\hat{w}^A$. Substituting p^A into equation (A-6) and differentiating with respect to h yields

$$\frac{\partial}{\partial h}\hat{w}^A(p^A(h,\chi),h,\chi) = \frac{(1-h)(1-h(1-\chi))\frac{\partial}{\partial h}p^A(h,\chi) - (1-h(1-\chi)+\chi)(1-p^A(h,\chi))}{(1-h)^3}.$$

This expression will have the same sign as

$$\frac{\frac{\partial}{\partial h}p^A(h,\chi)}{1-p^A(h,\chi)} - \left(\frac{1-h(1-\chi)+\chi}{(1-h)(1-h(1-\chi))}\right). \qquad (A\text{-}8)$$

For the sake of signing this expression, we compute the negative of the log derivative of $1-p^A$ below:

$$-\frac{\partial}{\partial h}\log\left(1-p^A(h,\chi)\right) = \frac{\partial_h p^A(h,\chi)}{1-p^A(h,\chi)} =$$

$$\frac{\chi}{(1-h)(1-h-\chi)} + \frac{(1-h)^2 - \left(1+h^2\right)\chi}{(1-h(1-\chi))\left((1-h^2+\chi(1+h))+(1-h-\chi)\right)}. \qquad (A\text{-}9)$$

If we apply equation (A-9), simplify, and then apply the variable transformation, $\chi = \alpha(1-h)$, we obtain the following form of expression (A-8).

$$\frac{2\alpha\left(-1+\alpha+\alpha^2\right)h^2 + \left(-2-\alpha+6\alpha^2+\alpha^3\right)h + \left(-1+3\alpha^2\right)}{(1-h)(1-\alpha)(1+h\alpha)(2+h+h\alpha)}.$$

The denominator of this expression is positive so the sign of expression (A-17) is determined by its numerator. We can write the numerator in the following fashion:

$$\text{NUM}(h) = C_2(\alpha)h^2 + C_1(\alpha)h + C_0(\alpha),$$

$$C_2(\alpha) = 2\alpha\left(\alpha^2+\alpha-1\right),$$

$$C_1(\alpha) = \alpha^3 + 6\alpha^2 - \alpha - 2,$$

$$C_0(\alpha) = -3\alpha^2 - 1.$$

If $\alpha \leq 1/\sqrt{3}, C_1, C_2$, and C_3 are all non positive and one of these terms at least is negative. Thus, if $\alpha < 1/\sqrt{3}$, NUM < 0. Now suppose that, $\alpha \geq 1/\sqrt{3}$, then C_0 is nonnegative and thus NUM evaluated at 0 is nonnegative. NUM, evaluated at $h = 1/2$, equals $1/2(2\alpha+1)\left(\alpha^2+6\alpha-4\right)$. The function $\alpha \hookrightarrow 1/2(2\alpha+1)\left(\alpha^2+6\alpha-4\right)$ is a polynomial that has only one root in the unit interval, $\sqrt{13}-3$, and this function is increasing at its root. If $\alpha < \sqrt{13}-3$, then,

$$\text{NUM}(h=0) \geq 0 \text{ and } \text{NUM}(h=1/2) \leq 0.$$

$\alpha < \sqrt{13}-3$ implies that $C_1 < 0$ and $C_2 < 0$, and hence NUM is decreasing. Hence, if $\alpha < \sqrt{13}-3$ and $\alpha \geq 1/\sqrt{3}$, NUM has a unique root on the interval $[0,1/2]$. If $\alpha > \sqrt{13}-3$,

$$\text{NUM}(h=0) > 0 \text{ and } \text{NUM}(h=1/2) > 0. \tag{A-10}$$

In this case, if NUM has any roots in $(0,1/2)$, it would have to have two roots in the interval $(0,1/2)$. For this to be possible, it would have to be the case that NUM is convex, i.e., $C_2 > 0$. We argue that these condition cannot be satisfied. If NUM had two roots in $(0,1/2)$ it would

also have to have minimum in $(0, 1/2)$. The minimum of NUM is achieved at $(-C_1)/(2C_2)$. For this minimum to be less than $1/2$ it would have to be the case that $C_2 > -C_1$. For NUM to have a root, its discriminant must be positive, i.e., $(-C_1)^2 \geq 4C_2 C_0$. $C_2 > -C_1$ implies that $(-C_2)^2 \geq 4C_2 C_0$ or $C_2 > 4C_0$. However,

$$C_2 - 4C_0 = 2\left(\alpha^3 - 5\alpha^2 - \alpha + 2\right). \tag{A-11}$$

This polynomial is concave, negative, and decreasing in α at $\alpha = \sqrt{13} - 3$. Thus, the polynomial is negative, for all $\alpha > \sqrt{13} - 3$. Thus, no root exists for $\alpha > \sqrt{13} - 3$ thus, by expression (A-10), for $\alpha > \sqrt{13} - 3$, and thus NUM is positive. $\square$

Proof of Proposition 5. If we express the equilibrium probability of monitoring zero reports, m^* given by (13) in terms of χ and replace w with its equilibrium value defined by equation (A-7) we obtain m^A which represents the probability of monitoring zero reports given that compensation is determined by (A-7). This yields

$$m^A(p, h, \chi) = \frac{(1-h)(1-\hat{w}^A(p,h,\chi))}{1 - h(1-\chi)} = \frac{1-p}{1-h}. \tag{A-12}$$

The equilibrium level of monitoring is obtained by evaluating this expression at p^A. Thus, the equilibrium probability of monitoring is given by

$$m^{A*} = m^A(p^A(h,\chi), h, \chi) = \frac{1 - p^A(h,\chi)}{1-h}.$$

The derivative of this expression with respect to h will have the same sign as

$$\frac{1}{1-h} - \frac{\frac{\partial}{\partial h} p^A(h,\chi)}{1 - p^A(h,\chi)}. \tag{A-13}$$

If we apply equation (A-9), simplify, and then apply the variable transformation, $\chi = \alpha(1-h)$,

we obtain the following form of expression (A-13).

$$\frac{1 - \alpha(2+\alpha) + h\left(2 - 6\alpha^2\right) - 2h^2\alpha\left(-1+\alpha+\alpha^2\right)}{(1-h)(1-\alpha)(1+h\alpha)(2+h+h\alpha)}. \tag{A-14}$$

The denominator of this expression is positive so the sign of expression (A-14) is determined by its numerator. We can write the numerator in the following fashion:

$$\text{NUM}(h) = C_2(\alpha)h^2 + C_1(\alpha)h + C_0(\alpha),$$

$$C_2(\alpha) = 2\alpha\left(1 - \alpha - \alpha^2\right),$$

$$C_1(\alpha) = 2\left(1 - 3\alpha^2\right),$$

$$C_0(\alpha) = 1 - 2\alpha - \alpha^2.$$

If $\alpha < \underline{\alpha}_m = \sqrt{2} - 1$, then all three coefficients are positive and thus $\text{NUM} > 0$. If $\alpha \geq \underline{\alpha}_m$, then $C_0 \leq 0$. Next note that, when $\alpha \geq \underline{\alpha}_m$, if $C_2 < 0$ then $C_0 < 0$ and $C_1 < 0$. Thus, if $C_2 \leq 0$, then $\text{NUM} < 0$. Thus, NUM can have a real roots only when $\alpha > \underline{\alpha}_m$ and $C_2 > 0$. Over this region NUM is strictly convex and, because $C_0 < 0$, NUM will have one root if $\text{NUM}(h = 1/2) \geq 0$. Otherwise, NUM will have no roots and $\text{NUM} < 0$. Because $\text{NUM}(h = 1/2) \geq 0$ if and only if $4 - \alpha^3 - 9\alpha^2 - 3\alpha \geq 0$, if a root exists, NUM is positive when h is less than the root and negative when h is greater than the root. The root itself is provided by the quadratic formula used to define equation (c). $\qquad\square$

Proof of Proposition 6. First note that monitoring expense is given by $cm(1 - p(1 - \sigma))$. Since monitoring expense is proportional to the total monitoring probability $m(1 - p(1 - \sigma))$ for fixed c, we will determine the effect of kinship on the probability of monitoring rather than the cost of monitoring. Using equations (A-5) and (A-12), we see that the equilibrium probability

of monitoring is given by

$$\text{PM}^{A*} = \text{PM}^A(p^A(h,\chi),h,\chi) = m^A(p^A(h,\chi),h,\chi)(1-p^A(h,\chi),h,\chi)(1-\sigma^A(p^A(h,\chi),h,\chi)))$$

$$= \frac{(1-(p^A(h,\chi),h,\chi))^2}{1-h-\chi}.$$

(A-15)

Differentiation with respect to h yields

$$\frac{\partial}{\partial h}\text{PM}(p^A(h,\chi),h,\chi) = \frac{(1-p^A(h,\chi))\left((1-p^A(h,\chi))-2(1-h-\chi)\frac{\partial}{\partial h}p^A(h,\chi)\right)}{(1-h-\chi)^2}.$$

This expression will have the same sign as

$$\frac{1}{2(1-h-\chi)} - \frac{\frac{\partial}{\partial h}p^A(h,\chi)}{1-p^A(h,\chi)}.$$

(A-16)

If we apply equation (A-9), simplify, and then apply the variable transformation, $\chi = \alpha(1-h)$, we obtain the following form of expression (A-16).

$$\frac{\alpha\left(3-3\alpha-2\alpha^2\right)h^2 + \left(3-\alpha-6\alpha^2\right)h - 2\alpha^2}{(1-h)(4(1-\alpha)+2h^2(1-\alpha)\alpha(1+\alpha)+2h(1-\alpha)(1+3\alpha))}.$$

(A-17)

The denominator of this expression is positive so the sign of expression (A-17) is determined by its numerator. We can write the numerator in the following fashion:

$$\text{NUM}(h) = C_2(\alpha)h^2 + C_1(\alpha)h + C_0(\alpha),$$

$$C_2(\alpha) = \alpha\left(3-3\alpha-2\alpha^2\right),$$

$$C_1(\alpha) = 3-\alpha-6\alpha^2,$$

$$C_0(\alpha) = -2\alpha^2.$$

We consider the sign of NUM. When $\alpha = 0$, $\text{NUM} = 3h \geq 0$. Now suppose that, $\alpha \in (0,1]$. In this case C_0 is negative, C_2 is a quadratic function of α which is positive between $(0,r_2)$, $r_2 = \frac{1}{4}\left(\sqrt{33}-3\right)$ and non positive otherwise. C_1 is a quadratic function of α which is positive

between $(0, r_1)$, $r_1 = \frac{1}{12}\left(\sqrt{73} - 1\right)$ and non positive otherwise. $r_2 > r_1$ thus for $\alpha \geq r_2$ both coefficients, C_1 and C_2 are non positive. Because C_0 is negative, it is thus not possible for NUM to have a root when $\alpha \geq r_2$. When $\alpha < r_2$, C_2 is positive and thus NUM is convex. Thus, because $C_0 < 0$, NUM has a root between 0 and 1/2, if and only if, when evaluated at $h = 1/2$, NUM is non-negative. Otherwise NUM as no root. NUM is non-negative when evaluated at $h = 1$ if and only if $\alpha \leq \frac{1}{2}\left(\sqrt{145} - 11\right)$. This unique root NUM, used in equation (b) is provided by the quadratic formula:

$$\text{NUM}(h) = 0 \Leftrightarrow h = \frac{-6\alpha^2 - \alpha - \sqrt{(1-\alpha)^2(2\alpha+1)(2\alpha+3)(3-4\alpha)} + 3}{2\alpha(\alpha(2\alpha+3)-3)}. \quad \text{(A-18)}$$

If h is greater than the right hand side of (A-18), NUM is positive. Otherwise it is negative. This is the characterization provided in the proposition and thus completes the proof. $\qquad\square$

Proof of Proposition 7. First note that total firm value is given by output, $\bar{x}p$ less expense, $cm(1 - p(1 - \sigma))$, and less the manager's effort cost, $1/2\bar{x}p^2$. As in Section 2.4 , we can express family value as

$$\bar{x}\left(p - \chi m^A(p, h, \chi)\left(1 - p(1 - \sigma^A(p, h, \chi))\right) - 1/2 p^2\right).$$

Using the definition of the equilibrium monitoring and diversion strategies provided in equations (13), and substituting out w using equation (18), we can express family value as a function of p, the uptick probability as

$$v^A(p, h, \chi, \bar{x}) = \bar{x}\,\hat{v}^A(p, h, \chi), \quad \hat{v}^A(p, h, \chi) = \tfrac{1}{2}\left(p + p(1 - p)\right) - \frac{\chi(1-p)^2}{1 - h - \chi}.$$

Evaluating this expression at p^A, given by equation (25), yields

$$\frac{\partial}{\partial h}\hat{v}^A(p^A(h, \chi), h, \chi) = \frac{(1 - p^A(h, \chi))\left(\left((1-h)^2 - \chi^2\right)\frac{\partial}{\partial h}p^A(h, \chi) - \chi(1 - p^A(h, \chi))\right)}{(1 - h - \chi)^2}.$$

This expression will have the same sign as

$$\frac{\frac{\partial}{\partial h}p^A(h,\chi)}{1-p^A(h,\chi)} - \frac{\chi}{(1-h)^2 - \chi^2}. \tag{A-19}$$

If we apply equation (A-9), simplify, and then apply the variable transformation, $\chi = \alpha(1-h)$, we obtain the following form of expression (A-19).

$$\frac{\frac{\partial}{\partial h}p^A(h,\chi)}{1-p^A(h,\chi)} - \frac{\chi}{(1-h)^2 - \chi^2} = \frac{\text{NUM}}{\text{DENOM}}. \tag{A-20}$$

$$\text{NUM} = (1-h) - (1+h^2)\,\alpha + (1+2h)\alpha^2 + (1+h)(1+2h)\alpha^3 + h^2\,\alpha^4,$$

$$\text{DENOM} = (1-h)(1-\alpha)(1+\alpha)(1+h\alpha)(2+h+h\alpha), \tag{A-21}$$

$$\alpha = \frac{\chi}{1-h}.$$

Note that the parameter restriction given by equation (12), implies that $\alpha \in [0,1]$. This implies, combined with our parameter restriction that $h \in [0,\nicefrac{1}{2}]$, that DENOM is always positive. Thus sign the of NUM/DENOM will depend on the sign of NUM. Evaluated at $\alpha = 0$, NUM $= 1-h > 0$; Evaluated at $\alpha = 1$, NUM $= (1+h) + (1+h)(1+2h) > 0$. Thus if NUM were ever negative for $\alpha \in (0,1)$ it would have to have at least two roots in this interval. For a fixed h, NUM is a polynomial in α and, under our assumption that $h \in [0,\nicefrac{1}{2}]$, has only one sign change. Thus, by Descartes rule of signs, NUM has at most one real root. Thus NUM has no roots and hence NUM > 0. Because DENOM > 0, this implies, by equation (A-20), that $\frac{\partial}{\partial h}\hat{v}(p^A(h,\chi),h,\chi) > 0$ and thus family value is increasing in kinship, h. $\qquad\square$

Proof of Proposition 8. We prove part (a) of the proposition. The derivation of part (b) is quite similar and thus is omitted. Owner value is given by

$$\bar{x}p - (p(\sigma(m0 + (1-m)\bar{x}) + (1-\sigma)w) + (1-p)0) - cm(1 - p(1-\sigma)).$$

Owner value consists of the total expected terminal cash flow, $\bar{x}p$, less the manager's payoff (excluding effort costs), and monitoring expense. When the cash flow is $\bar{x}$, the manager's payoff

equals w if the manager does not underreport and the cash flow is $\bar{x}$. If the manager underreports, the manager's payoff is $\bar{x}$ if the owner does not monitor and 0 if the owner monitors. If the cash flow is 0, the manager's payoff is 0. Monitoring expense equals the cost of monitoring multiplied by the probability of monitoring. If the owner monitors a low report, then monitoring will occur unless the cash flow is $\bar{x}$ and the manager does not underreport. Thus, the probability of monitoring is $m(1-p(1-\sigma))$. Using the definitions of σ^A, m^A and w^A provided in (A-12), (A-12), and (A-7), we can express owner value for a given uptick probability p as follows:

$$v_O^A(p,h,\chi,\bar{x}) = \bar{x}\,\hat{v}_O^A(h,\chi)$$

$$\hat{v}_O^A(p,h,\chi) = \frac{(1-p)\left((1-h)^2 p - \chi\left(1-h\left((1-h)+(1-\chi)\right)\right)\right)}{(1-h)^2\,(1-h-\chi)} \tag{A-22}$$

Because owner value, v_O^A is a positive scale multiple of normalized owner value, $\hat{v}_O^A$, we will assume without loss of generality that $\bar{x}=1$ and thus owner value equals normalized value. Substituting the definition of p^* from equation (25) into $\hat{v}_O^A$ defined by equation (A-22), and then differentiating with respect to h yields the marginal affect of kinship on owner value:

$$\frac{\partial \hat{v}_O^{A*}}{\partial h} = \frac{\text{NUM}}{\text{DENOM}},$$

$$\text{NUM} = -h^3\,(2h+1)\chi^5 - h^2(h+2)(4h+3)(1-h)\chi^4 - h\left(10h^2+18h+9\right)(1-h)^2\chi^3 +$$
$$2h\left(2h^2+3h+3\right)(1-h)^4\chi + 2\left(h^2+h+1\right)(1-h)^5 -$$
$$\left(-2h^4-4h^3+2h^2+9h+4\right)(1-h)^3\chi^2,$$

$$\text{DENOM} = (1-h)^4\left(2-h-h^2+h\chi\right)^3.$$

The sign of this expression depends only on the numerator, NUM. If we make the substitution and $\chi = \alpha(1-h)$ in the numerator and then divide out the common positive factor, $(1-h)^5(1+$

αh), we obtain the polynomial $\mathscr{P}$ which has the same sign as $\partial v_O^{A*}/\partial h$.

$$\mathscr{P}(\alpha,h) = C_0(h) + C_1(h)\,\alpha - C_2(h)\,\alpha^2 - C_3(h)\,\alpha^3 - C_4(h)\,\alpha^4,$$

$$C_0(h) = 2\left(1 + h + h^2\right),$$

$$C_1(h) = 2h\left(2 + 2h + h^2\right),$$

$$C_2(h) = 4 + 9h + 6h^2,$$

$$C_3(h) = h\left(1 + h\right)\left(5 + 4h\right),$$

$$C_4(h) = h^2\left(1 + 2h\right).$$

(A-23)

Because, C_2, C_3, and C_4 are positive and $\alpha \geq 0$, $\mathscr{P}$ is strictly concave in α. Evaluated at $\alpha = 0$, $\mathscr{P} > 0$ and evaluated at $\alpha = 1$, $\mathscr{P} < 0$. Thus, there exists a unique $\alpha_0(h)$ such that, $\mathscr{P}(\alpha_0(h), h) = 0$ and, for all for all $\alpha < \alpha_0(h)$, $\mathscr{P}(\alpha, h) > 0$ and for all $\alpha > \alpha_0(h)$, $\mathscr{P}(\alpha, h) < 0$. Next note that the partial derivatives of $\mathscr{P}$ are given by

$$\frac{\partial \mathscr{P}}{\partial h} = 2\left(1 + 2h\right) + 2\left(2 + 4h + 3h^2\right)\alpha - 3\left(3 + 4h\right)\alpha^2 - \left(5 + 18h + 12h^2\right)\alpha^3 - 2h\left(1 + 3h\right)\alpha^4.$$

$$\frac{\partial \mathscr{P}}{\partial \alpha} = 2h\left(2 + 2h + h^2\right) - 2\left(4 + 9h + 6h^2\right)\alpha - 3h\left(1 + h\right)\left(5 + 4h\right)\alpha^2 - 4h^2\left(1 + 2h\right)\alpha^3.$$

Like $\mathscr{P}$, both $\partial \mathscr{P}/\partial h$ and $\partial \mathscr{P}/\partial \alpha$ are concave in α, positive at $\alpha = 0$, and negative at $\alpha = 1$. Because they are concave and cross the x-axis from above, $\partial \mathscr{P}/\partial h$ and $\partial \mathscr{P}/\partial \alpha$ are decreasing whenever they are nonpositive.

Now, let $b = 3/5$. Note that, evaluated at b,

$$\mathscr{P}(\alpha = b, h) = \frac{2}{625}\left(175 + h\left(25 + 4h\left(13 + 6h\right)\right)\right) > 0.$$

Thus, $\alpha_0(h)$, the root of $\mathscr{P}$, is greater than b, i.e.,

$$\alpha_0(h) \in (b, 1).$$

(A-24)

Now consider the partial derivative of $\mathscr{P}$ with respect to α evaluated at b,

$$\left.\frac{\partial\mathscr{P}}{\partial\alpha}\right|_{\alpha=b} = -\frac{1}{125}\left(600 + 1525\,h + 1723\,h^2 + 506\,h^3\right) < 0. \tag{A-25}$$

Because $\partial\mathscr{P}/\partial\alpha$ is decreasing in α whenever it is negative, inequality (A-25) implies that

$$\frac{\partial\mathscr{P}}{\partial\alpha} < 0, \quad \alpha \in [b,1]. \tag{A-26}$$

Expression (A-24) and inequality (A-26) then imply that

$$\frac{\partial\mathscr{P}}{\partial\alpha}(\alpha_0(h),h) < 0. \tag{A-27}$$

Next, we show that it is also the case that

$$\frac{\partial\mathscr{P}}{\partial h}(\alpha_0(h),h) < 0. \tag{A-28}$$

The proof of (A-28) is a bit more involved. To establish (A-28), we will show that

$$\frac{\partial\mathscr{P}}{\partial h} < \mathscr{P}(b,h), \quad \alpha \in [b,1]. \tag{A-29}$$

To establish inequality (A-29), first consider the difference between $\partial\mathscr{P}/\partial h$ and $\mathscr{P}$ evaluated at b. This difference is given by

$$\mathscr{P}(b,h) - \frac{\partial\mathscr{P}}{\partial h}(b,h) = \frac{12}{25} - \frac{158\,h}{625} - \frac{8\,h^2}{125} + \frac{48\,h^3}{625} > \frac{211}{625} > 0, \tag{A-30}$$

where the last inequality is obtained by dropping the positive cubic term from the middle equation and maximizing the negative terms by setting $h = 1/2$.

Now, consider the difference between the derivatives of $\partial\mathscr{P}/\partial h$ and $\mathscr{P}$ with respect to α. We claim that

$$\frac{\partial}{\partial\alpha}\frac{\partial\mathscr{P}}{\partial h} < \frac{\partial}{\partial\alpha}\mathscr{P}, \quad \alpha \in [b,1]. \tag{A-31}$$

To see this, note that

$$\frac{\partial}{\partial \alpha}\left(\frac{\partial \mathscr{P}}{\partial h} - \mathscr{P}\right) = 2\left(2 + 2h + h^2 - h^3\right) - 2\left(5 + 3h - 6h^2\right)\alpha -$$
$$3\left(5 + 13h + 3h^2 - 4h^3\right)\alpha^2 - 4h\left(2 + 5h - 2h^2\right)\alpha^3.$$

$\partial/\partial\alpha\left(\partial\mathscr{P}/\partial h - \mathscr{P}\right)$ is decreasing in α because the coefficients associated with the positive powers of α are all negative for $h \in [0, 1/2]$. Because $\partial/\partial\alpha\left(\partial\mathscr{P}/\partial h - \mathscr{P}\right)$ is decreasing, to show that it is negative for $\alpha \in [b, 1]$ we need only show that it is negative when evaluated at b. Evaluating at b yields,

$$\frac{\partial}{\partial\alpha}\left(\frac{\partial\mathscr{P}}{\partial h} - \mathscr{P}\right)(b, h) = -\frac{37}{5} - \frac{1921\,h}{125} + \frac{41\,h^2}{25} + \frac{506\,h^3}{125} \leq -\frac{37}{5} < 0, \qquad \text{(A-32)}$$

where the last inequality follows because $h \in [0, 1/2]$. Inequality (A-32) establishes inequality (A-31) which, together with inequality (A-30), establishes inequality (A-29). Inequality (A-29) and expression (A-24), together with the fact that, by definition, $\mathscr{P}(\alpha_0(h), h) = 0$, imply that

$$0 = \mathscr{P}(\alpha_0(h), h) > \frac{\partial\mathscr{P}}{\partial h}(\alpha_0(h), h),$$

which establishes inequality (A-28).

Inequalities (A-28) and (A-27) imply, via the implicit function theorem, that,

$$\alpha_0'(h) = -\frac{\frac{\partial\mathscr{P}}{\partial h}(\alpha_0(h), h)}{\frac{\partial\mathscr{P}}{\partial\alpha}(\alpha_0(h), h)} < 0.$$

Therefore, α_0 is decreasing in h. Because $\mathscr{P}$ has the same sign as $\partial v_O^{A*}/\partial h$ and $\mathscr{P} < 0$, when $\alpha > \alpha_0(h)$, $\partial v_O^{A*}/\partial h < 0$ when $\alpha > \alpha_0(h)$. Because α_0 is decreasing, a sufficient condition for $\partial v_O^{A*}/\partial h < 0$ is for $\alpha > \alpha_0(0) = 1/\sqrt{2} \approx 0.707$. Similarly, a sufficient condition for $\partial v_O^{A*}/\partial h > 0$ is $\alpha < \alpha_0(1/2)$. $\alpha_0(1/2)$ is the unique root between 0 and 1 of the polynomial, $-6 - 10\alpha + 19\alpha^2 + 18\alpha^3 + 3\alpha^4$ and is approximately equal to 0.624. $\qquad \square$

Proof of proposition 11. First consider part (a) of the proposition. Let $\bar{h}$ be defined as follows:

$$\bar{h} = \max\{h \in [0, 1 - c/(\bar{p}\bar{x})] : w_M^*(h) \geq 0\}. \tag{A-33}$$

After considerable algebraic simplification, we can express the value of the family firm as a function of h, restricted to the domain $[0, \bar{h}]$ as follows:

$$v_O^{L*}(h) = (\bar{p}\bar{x} - v_R)\frac{\mathbf{N}(h)}{\mathbf{D}(h)},$$

$$\mathbf{N}(h) = \left(\left(c^2 + (1-h)\bar{x}(\bar{p}\bar{x} - c)\right) - \frac{c^2}{1-h}\right),$$

$$\mathbf{D}(h) = ((1-h)\bar{x} - c)(hc + (1-h)\bar{p}\bar{x}).$$

The functions, $h \hookrightarrow \mathbf{N}(h)$ and $h \hookrightarrow \mathbf{D}(h)$ are both positive under the assumptions given in (32) and (30). The term $\bar{p}\bar{x} - v_R$ is a positive and constant in h and thus can be ignored in the subsequent derivation. Because the functions $\mathbf{N}$ and $\mathbf{D}$ are smooth and positive over their domain, and the second derivative of $\mathbf{N}$ is negative while the second derivative of $\mathbf{D}$ is positive, $\mathbf{N}(\cdot)$ is strictly concave and positive and $\mathbf{D}(\cdot)$ is strictly convex and positive. This implies that the ratio $\mathbf{N}(h)/\mathbf{D}(h)$ is strictly quasiconcave over $[0, \bar{h}]$ (Boyd and Vandenberghe, 2004, Example 3.28). The value function is strictly decreasing over $h \in [\bar{h}, 1/2]$, and is continuous at $\bar{h}$. Thus, the value function is strictly quasiconcave over the entire range of h, $[0, \bar{h}]$.

To establish part (b), note that at $h = 0$ the participation constraint is always binding. Differentiating v_O^{L*} and evaluating $h = 0$ yields,

$$v_O^{L*'}(0) = \frac{(\bar{p}\bar{x} - v_R)\left(-c^3(1-\bar{p}) + c^2\bar{x} - 2c\bar{p}\bar{x}^2 + \bar{p}^2\bar{x}^3\right)}{\bar{p}^2(\bar{x} - c)^2\bar{x}}. \tag{A-34}$$

Note that the denominator of the right-hand side of equation (A-34) is always positive so to sign the relation consider the numerator of (A-34). If we expressing the numerator using the

normalized monitoring costs, χ, we obtain

$$\bar{x}^3 \left(\bar{p}\bar{x} - v_R\right) \chi^2 \left(\left(\frac{\bar{p}}{\chi} - 1\right)^2 - (1-\bar{p})\chi \right).$$

This expression has the same sign as

$$\left(\frac{\bar{p}}{\chi} - 1\right)^2 - (1-\bar{p})\chi.$$

Thus, if

$$\frac{\bar{p}}{\chi} > 1 + \frac{1}{2}\sqrt{\chi^4 + 4(1-\chi)\chi} - \frac{\chi^2}{2},$$

then $v_O^{L*'}(0) > 0$. Next note that

$$1 + \frac{1}{2}\sqrt{\chi^4 + 4(1-\chi)\chi} - \frac{\chi^2}{2} \leq 1 + \frac{1}{2}\sqrt{1 + 4(1-\chi)\chi}.$$

The maximizer of $1 + 4(1-\chi)\chi$ is $\chi = 1/2$. Replacing χ with its maximizer shows that

$$1 + \frac{1}{2}\sqrt{1 + 4(1-\chi)\chi} \leq 1 + \frac{1}{\sqrt{2}} \approx 1.71.$$

$\square$

Proof of Proposition 12. The manager's value is the maximum of the manager's value when the limited liability constraint binds, i.e., $w = 0$ and manager's value when the participation constraint binds. The maximum of strictly quasiconvex functions is strictly quasiconvex. The manager's value is clearly increasing in h on the limited liability constraint. Thus, we only need to show that the manager's value is quasiconvex when compensation is determined by the participation constraint. To see this, note that, the manager's value,when the manager's value is determined by the participation constraint, which we represent by v_M^p, can be simplified to

obtain

$$v_M^p(h) = \bar{p}\bar{x} - (\bar{p}\bar{x} - v_R)\mathbf{F}(h), \tag{A-35}$$

$$\mathbf{F}(h) = \frac{\mathbf{N}(h)}{\mathbf{D}(h)}, \tag{A-36}$$

$$\mathbf{N}(h) = \frac{(1-h)^2\,\bar{p}\bar{x}(\bar{x}-c) - c^2 h}{(1-h)\bar{x} - c}, \tag{A-37}$$

$$\mathbf{D}(h) = (1-h)(ch + (1-h)\,\bar{p}\bar{x}). \tag{A-38}$$

Next note that $\mathbf{N}$ is strictly concave and positive and $\mathbf{D}$ is strictly convex and positive. Thus using an argument identical to the one used in the proof of Proposition 11 we can verify that $\mathbf{F}$ is quasiconcave. Because $\mathbf{F}$ is quasiconcave and the term multiplying $\mathbf{F}$ in equation (A-35) is negative and constant in h, we see, from inspecting (A-35) that v_M^p is quasiconvex. $\square$

Proof of Lemma 2. If, in a solution to the owner's problem with a rival internal manager, the kin manager's participation constraint binds then is must be the case that the agency optimal policy developed in Section 4 is not feasible because it violates the kin manager's participation constraint and the owner prefers to hire the kin manager. Since, in this section, we assume that human capital is firm specific, the kin manger's value payoff outside the family firm, $v_R = 0$. Thus, the kin manager's reservation utility equals the internalized payoff to the owner under the rival manager. The payoff to the owner, assuming the owner hires the rival internal manager, is fixed and independent of the compensation policy followed when the owner hires the kin manager. We represent this value with v_O^R. We represent values and utilities resulting from agency optimal solution to the owner's problem developed in Section 4, which is also the solution to the owner's problem in this assuming that the owner hires the kin manager and the kin manager's participation constraint is satisfied, by superscripting with a $*$. We represent the actual solution to the owner's problem which is restricted by the manager's participation constraint by superscripting the same variables with a c.

First note that, For the manager's participation constraint to be violated at the agency optimal policy, it must be the case that the manager's utility from accepting the owner's employ-

ment offer at these terms is less than the manager's utility from rejecting the offer. Thus, it must be the case that

$$v_M^{A*} + h v_O^{A*} < h v_O^R. \tag{A-39}$$

For the owner to prefer to hire the kin manger under the owner's optimal manger-participation constrained policy, it must be the case that

$$h v_M^{Ac} + v_O^{Ac} \geq v_O^R. \tag{A-40}$$

Because imposing the manager participation constraint on the owner's problem cannot increase the owner's utility,

$$v_O^{A*} + h v_M^{A*} \geq v_O^{Ac} + h v_M^{Ac}. \tag{A-41}$$

Conditions (A-39), (A-40), and (A-41), imply that

$$v_O^{A*} + h v_M^{A*} \geq v_O^R \quad \text{and} \quad \frac{1}{h} v_M^{A*} + v_O^{A*} < v_O^R,$$

implying that

$$\frac{1}{h} v_M^{A*} < h v_M^{A*}. \tag{A-42}$$

Proposition 2 showed that $v_M^{A*} > 0$. Thus, because $h \in (0, 1)$, condition (A-42) cannot be satisfied, which shows that conditions () and () cannot be simultaneously satisfied, which, in turn, shows that the participation constraint is not binding. $\square$

Proof of Proposition 15. The manager's value function, v_M^A, in the agency model, expressed in terms of χ, is given by

$$p \left(\sigma^A(p,h,\chi) \left(m^A(p,h,\chi) 0 + (1 - m^A(p,h,\chi)) \bar{x} \right) + (1 - \sigma^A(p,h,\chi)) w^A(p,h,\chi) \right)$$
$$+ (1-p) 0 - \frac{p^2}{2}. \tag{A-43}$$

Using the definitions of σ^A, m^A and w^A provided in (A-12), (A-12), and (A-7) we can express

this the manager's value as for a fixed uptick probability, p, as follows:

$$v_M^A = \bar{x}\hat{v}_M^A(p,h,\chi), \text{where}$$
$$\hat{v}_M^A(p,h,\chi) = \frac{1}{2}\left(1 + (1-p)\left((1-p)\left(\frac{2(1-\chi)}{1-h-\chi} - 1\right) - \frac{2(1-h(1-\chi))}{(1-h)^2}\right)\right). \quad \text{(A-44)}$$

Manager value in the agency setting, v_M^{A*} is then obtained by substituting the equilibrium uptick probability function p^A in equation (A-44), i.e.,

$$v_M^{A*} = \bar{x}\hat{v}_M^A(p^A(h,\chi),h,\chi). \quad \text{(A-45)}$$

First note that an inspection of equations (41) and (43) shows that the firm-value gain from hiring the external manager exceeds the family owner's gain by hv_M^K. Thus, it is clear that the family owner's utility gain from hiring external manager is always less than his payoff gain. To prove that the family owner's gain from hiring the external manager exceeds the social welfare gain, we proceed as follows. First note that,

$$\Delta_O^R - \Delta_{\text{SW}}^R = (1-h)v_M^K - v_M^R. \quad \text{(A-46)}$$

Thus, if we can show that the right-hand side of equation (A-46) is negative the proof of (a) will be complete. We establish this result in two steps. From expression (A-44), the value of the external manager, v_M^R, equals $e\,\hat{v}_M^A(p^A(h=0,\chi),h=0,\chi)$. Because for the family manager, $\bar{x}=1$ by assumption, the value of the family manager, v_M^K, is given by $\hat{v}_M^A(p^A(h,\chi),h,\chi)$, where $h>0$. Thus, we can express equation (A-46) as

$$\Delta_O^R - \Delta_{\text{SW}}^R = (1-h)\hat{v}_M^A(p^A(h,\chi),h,\chi) - e\,\hat{v}_M^A(p^A(h=0,\chi),h=0,\chi). \quad \text{(A-47)}$$

In fact, we will show that

$$(1-h)\hat{v}_M^A(p^A(h,\chi),h,\chi) - \hat{v}_M^A(p^A(h=0,\chi),h=0,\chi) < 0, \quad \text{(A-48)}$$

which, because by assumption $e > 1$, and the fact that the external manager's value is always positive, establishes that the right-hand side of equation (A-47) is negative. To establish (A-48), first note that, using the definition of the manager's value given by equation (A-44) and the definition of p^A given by equation (25), we see that

$$\hat{v}_M^A(p^A(h=0,\chi),h=0,\chi) = \frac{1}{8}(1+\chi)^2. \tag{A-49}$$

The expression for $\hat{v}_M^A(p^A(h,\chi),h,\chi)$ where $h > 0$ is considerably more complex but is obtained in the same fashion. Substituting the definition of p^A into the definition of $\hat{v}_M^A$ given in equation (A-44) yields

$$\hat{v}_M^A(p^A(h,\chi),h,\chi) = \frac{\text{Num}}{\text{Denom}},$$
$$\text{Num} = (1-h)^4\left(1-h-3h^2-h^3\right) + (1-h)^3 2\left(1-h-2h^2-h^3\right)\chi,$$
$$+ (1-h)^2\left(1+5h-2h^2-2h^3\right)\chi^2 + (1-h)\left(2h+4h^2\right)\chi^3 + h^2(1+h)\chi^4$$
$$\text{Denom} = 2(1-h)^3\left(2-h-h^2+h\chi\right)^2. \tag{A-50}$$

Thus expression (A-48) is equivalent to

$$(1-h)\,\text{Num} - \left(\frac{1}{8}(1+\chi)^2\right)\text{Denom} < 0. \tag{A-51}$$

Using equation (A-50), we can express condition (A-51) as a polynomial, $\mathscr{P}$ in χ with coefficients C_i determined by h

$$\mathscr{P}(\chi;C_1(h),\dots C_4(h)) = (1-h)\,\text{Num} - \left(\frac{1}{8}(1+\chi)^2\right)\text{Denom} =$$
$$C_0(h) + C_1(h)\chi^1 = C_2(h)\chi^2 + C_3(h)\chi^3 + C_4(h)\chi^4,$$

where

$$C_0(h) = -\frac{1}{4}(1-h)^4 h \left(8 + 13h + 4h^2\right),$$

$$C_1(h) = -\frac{3}{2}(1-h)^3 h \left(2 + 2h + h^2\right),$$

$$C_2(h) = \frac{1}{4}(1-h)^2 h \left(16 - 2h - 6h^2 - h^3\right),$$ (A-52)

$$C_3(h) = \frac{1}{2}(1-h) h \left(2 + 10h + h^2 - h^3\right),$$

$$C_4(h) = \frac{1}{4}h^2 \left(3 + 6h - h^2\right).$$

Note that for all $h \in [0, 1/2]$, C_2, C_3, and C_4 are positive. Thus, $\mathscr{P}$ is convex and for fixed C thus always attains its maximum at extreme values of χ. Because the range of permissible values of χ is 0 to $1 - h$, we see that

$$\mathscr{P}(\chi; C_1(h), \ldots C_4(h)) \leq \max[\mathscr{P}(0; C_1(h), \ldots C_4(h)), \mathscr{P}(1-h; C_1(h), \ldots C_4(h))] =$$

$$\max\left[-\frac{1}{4}(1-h)^4 h \left(8 + 13h + 4h^2\right), -(1-h)^4 h^2 (1+h)^2\right] < 0, \ \forall h \in (0, 1].$$

Thus, (a) is established.

The proof of (b) and (c) is provided through a numerical example furnished by Figure 3. $\square$

Proof of Proposition 16. First consider condition i. Note that by Malécot's formula (see Malécot (1948) or Chapter 5 of Lange (2002)),

$$h_{NS} = \frac{1}{2}\left(h_N + h'_N\right).$$ (A-53)

Because the founder is not inbred and S is her son, $h_S = 1/2$. Using this fact and equation (A-53) we have that

$$\frac{h_{NS}}{h_N/h_S} = \frac{1}{4}\left(1 + \frac{h'_N}{h_N}\right),$$

and the result follows.

To prove condition ii, first note that by assumption N is not a direct descendant of the founder or the founder's spouse. Thus, all lines of descent connecting N and S are indirect. By the assumption that the family tree is unilateral and that the founder and N are related, all

indirect lines of descent connecting S and N pass through the founder. Thus, each of these lines of descent also connects the founder to N. Thus, for each path from S to N, there exists a path from the founder to N, which is shorter by at least one arc. By Wright's formula for the coefficient of relationship (Wright, 1922), we see that the contribution of a path from S to N to relatedness is at most half of the corresponding path from the founder to N. Therefore, the coefficient of relationship between N and S, h_{NS}, which is the sum of all the path contributions by the Wright formula, is at most one half of the coefficient of relationship between the founder and N, h_N, i.e., $h_{NS} \leq h_N/2$. Because the founder is not inbred, $h_S \leq 1/2$. Thus, $h_N/h_S \geq 4 h_{NS}$. The result follows. $\qquad\square$

Proof of Proposition 3. Consider two polices $\gamma_F \in \mathrm{argmax}_{\gamma \in \Gamma}\, u_F(\gamma)$ and $\gamma_S \in \mathrm{argmax}_{\gamma \in \Gamma}\, u_S(\gamma)$. Let $v_F^* = v(\gamma_F)$ and let $v_S^* = v(\gamma_S)$. The fact that γ_S (γ_F) is an optimal policy for S (F), and the representation of kin altruistic preferences given by equation (5) implies that

$$h_F\, v(\gamma_F) + (1 - h_F)\, v_S(\gamma_F) geq h_F\, v(\gamma_S) + (1 - h_F)\, v_S(\gamma_S), \qquad \text{(A-54)}$$

$$h_{NS}\, v(\gamma_S) + (1 - h_{NS})\, v_S(\gamma_S) \geq h_{NS}\, v(\gamma_F) + (1 - h_{NS})\, v_S(\gamma_F). \qquad \text{(A-55)}$$

Equations (A-54) and (A-55) imply that

$$(h_F - h_{NS})(v(\gamma_F) - v(\gamma_S)) - (h_F - h_{NS})(v_S(\gamma_F) - v_S(\gamma_S)) \geq 0 \qquad \text{(A-56)}$$

Thus,

$$v(\gamma_F) - v(\gamma_S) \geq v_S(\gamma_F) - v_S(\gamma_S). \qquad \text{(A-57)}$$

Because F's utility is nondecreasing in both v_S and v, if γ_F is an optimal policy for F it must be the case that either,

$$v(\gamma_F) - v(\gamma_S) \geq 0 \quad \text{or} \quad v_S(\gamma_F) - v_S(\gamma_S) \geq 0. \qquad \text{(A-58)}$$

Because S's utility is nondecreasing in both v_S and v, if γ_S is an optimal policy for S it must be

the case that either,

$$v(\gamma_F) - v(\gamma_S) \leq 0 \quad \text{or} \quad v_S(\gamma_F) - v_S(\gamma_S) \leq 0. \tag{A-59}$$

Equations (A-57), (A-58), and (A-59) imply the result. $\qquad\square$

References

Boyd, Stephen and Lieven Vandenberghe, *Convex Optimization*, Cambridge University Press, 2004.

Lange, Kenneth, *Mathematical and Statistical Methods in Genetics*, Springer, 2002.

Malécot, G, *Les Mathématiques de l'Hérédité*, Masson et Cie, 1948.

Wright, Sewall, "Coefficients of inbreeding and relationship," *The American Naturalist*, 1922, *56* (645), pp. 330–338.