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# Endogenous Governance Transparency and Product Market Competition

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## Abstract

This paper endogenizes both the choice of governance transparency at the firm level and the portfolio decisions of investors. In the model, managers raise money in financial markets that are subject to imperfections arising from the non-observability of output for financiers. Investors, on the other hand, observe a signal correlated with returns. Formal contracting are needed to prevent expropriation of the investor's wealth by the manager. The contract endogenously determines the nature and formation of the cost and benefits of voluntary disclosure. Managers optimally decide on the quality of the signal –used here as the measure of governance transparency– trading off the possibility of expropriating profits against the opportunity to raise more capital. We show that one important driving force behind governance transparency is product market competition: tougher competition translates into lower frictions on the capital market, since investors have better possibilities for portfolio diversification. Managers react to this loss of bargaining power by increasing transparency. Furthermore, firms characterized by low corporate profits or firms where investor protection is strong at the country level will be more likely to avoid voluntary disclosure regimes.

*Keywords:* Corporate Governance; Voluntary Disclosure; Portfolio Choice; Incentives; Product Market Competition

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## 1 Introduction

The common wisdom from the literature dealing with corporate governance is that product market competition can impose discipline on a firm's management.

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Competition between different firms may help to limit losses as well as levels of expropriation. As a result, economies with a high level of competition are characterized by a strong level of corporate governance (see Allen and Gale 2000; Hart 1983; Stigler 1958; Vives, 2000 among others).

However, as Holmström and Tirole (1989: 97) point out "apparently, the simple idea that product market competition reduces slack is not as easy to formalize as one might think." Indeed, Scharfstein (1988) introduces more general preferences to the framework proposed by Hart (1983), and finds that competition actually increases slack.

In this paper, we examine the nature and the process of formation of the cost and benefits of voluntary disclosure choices by the firm, focusing specifically on two factors: (i) the extent to which product market competition affects the quality of information reported and (ii) the extent to which managers privately benefit from operating the firm to the detriment of investors in a setting of publicly reported financial accounting information –that is, the governance role of publicly reported financial accounting information.

We develop a theoretical model of corporate transparency, treating governance disclosure as an endogenous variable and assuming that managers control the precision of the information available to outside investors. Each manager selects the optimal level of transparency, trading off the potential gains of expropriation against the capacity to attract external funding. They do so because new firms lack capital and have to go to capital markets to obtain financial resources.

In practice, managers typically have better information than investors about the value of their businesses. We model this idea, assuming that managers and investors are symmetrically informed when they enter into a contractual agreement. After contracting, however, managers are better informed than outside investors on the realization of returns: the former know the returns realized, whereas outside investors only observe a signal of these returns. The precision of this signal is our measure of governance transparency. Since managers have superior information once the output has been realized, they can extract private benefits at the expense of firm value. Because of this, before knowing the level of output realized, investors offer a contract to managers designed to limit the level of expropriation. The contract, which is contingent on the manager's report –and thus on all observable variables, including the precision of the signal– is defined by the level of capital that investors put into the firm as well as a payment made by investors to managers. Governance transparency affects the equilibrium contract for several reasons: First, a lack of transparency increases the cost of outside finance since it creates uncertainty –the endogenous information risk is higher– which translates into an additional premium paid to the manager. Second, a lack of transparency also impedes the flow of financial capital to firms in need of external resources.

The model is based on the following three key assumptions: First, we assume product market competition of the type the winner takes it all. Second, outside investors are risk averse and rationally formulate their asset allocations and consumption-saving decisions. Third, we assume that information disclosed by

the manager needs to be verifiable. Because managers have incentives to disclose self-serving information, it is unclear whether increased transparency actually reflects credible information. In practice, there are two potential ways to increase the credibility of voluntary disclosures. First, investors can write an ex-ante contract with a third-party who can provide assurance about the quality of management's disclosures. Alternatively, managers can be taken to court ex-post by investors. We concentrate on this second mechanism. Specifically, we introduce an exogenous penalty cost that managers are obligated to pay if taken to court by outside investors and found guilty of fraud, which reflects the strength of the country's legal system. Therefore, the higher this parameter, the more rigorously the country's antifraud law is enforced.

In our second-best economy, the optimal level of disclosure enhances its governance role since managerial private benefits are zero in equilibrium. However, the endogenous level of information risk may be far from zero, since the full disclosure equilibrium may not prevail. That is, transparency becomes the solution to the agency problem and thus, the manager will voluntarily choose a positive level of disclosure even though, ex post, he prefers opacity as it allows him to divert cash flows, because that is the only way that the manager will be able to persuade outside investors. Furthermore, we find a closed-form solution to the optimal level of transparency. Consequently, our theory indicates its driving forces and thus helps us predict which firms are likely to engage in strategies to avoid a proposed regulation. The model delivers the following predictions.

First, we find that a more competitive environment (i.e., more firms) increases the quality of financial accounting information. The mechanism is simple: the higher the numbers of firms in the market, the more firms there are competing for funding. In our theory, this means that a low industry concentration translates into more developed capital markets since it is easier for risk averse shareholders to build a diversified portfolio. As a result, each manager has less market power, (i.e., each firm becomes less important to achieve investors' portfolio diversification) and firms therefore react by offering high governance transparency in order to attract the needed funds.

The empirical work by Giroud and Mueller (2007) shows that competition reduces managerial incentives to slack off. In a subsequent paper, Giroud and Mueller (2008) find that the effect of governance on firms' stock returns, firm value or operating performance is monotonic with the degree of competition. In particular, it is smaller and insignificant in competitive industries, so that governance matters more in non-competitive industries. Likewise, Guadalupe and Pérez-González (2005) show that competition increases the firm's incentives to perform well while also increases the amount of information available to investors. Both forces improve corporate governance. In sum, these recent empirical papers show a positive link between product market competition and governance, but there is no evidence on the mechanism proposed here.

Second, we find that better governance transparency may be driven by higher corporate profits. Under higher profits, agency problems increase because managers have stronger incentives to divert profits, forcing them to impose ex-ante stricter governance disclosure mechanisms as a commitment device to prevent

ex-post expropriation. This result provides a rationale for higher regulation in an economic upturn.

Third, we find that a weak legal system (i.e., lower penalties in the case of being taken to court) implies higher voluntary disclosure. This is because firms try to overcome the negative effects of a weak legal environment, by increasing governance transparency to counterbalance the weaknesses in their country's legislative framework and signal their intention to offer greater investor rights.

In sum, the theory proposed here predicts that firms in a setting of low industry concentration, firms characterized by low corporate profits, or more specifically, firms with a higher proportion of fixed assets (i.e. machinery and equipment) that are easier to monitor and harder to steal, or firms in countries where the country level of investor protection is strong will be more likely to lobby against voluntary disclosure regimes.

The next section places this study in the context of the existing literature. In Section 3, we set up the economy, then in Section 4, we solve for the optimal contract. Section 5 completes the paper with a discussion of the intended contribution, the limitations of this study, and opportunities for future research. The Appendix contains all the omitted proofs.

## 2 Relation to the existing literature

This paper is related to the growing body of literature analyzing governance disclosure at the firm level as well as the literature on corporate governance in competitive settings.

Concerning the first branch of the literature, the papers most closely related to the present one are those of Song and Thakor (2006) and Hermalin and Weisbach (2008). Song and Thakor (2006) recognize, as we do, that the CEO controls the information seen by the board. However, they introduce career concerns on the part of the board and CEO<sup>1</sup> and show that the interaction among these career concerns determines both the board's effectiveness, and the magnitude of inefficiencies that result. In their model, the expected utility of the CEO is the sum of firm value and career concerns, which are functions of how either the board or the shareholders perceive the CEO's ability level. As a result, the CEO might provide less precise information. Hermalin and Weisbach (2008) consider the effect of optimal disclosure rules, which are controlled by the principal, on the contractual and monitoring relationship between principal and CEO. When determining optimal disclosure, the principal tradeoff is that higher disclosure allows for better decisions, but can harm the agent either through career concerns or because the principal can dismiss the agent. Because the CEO has career concerns, she can attempt to interfere with the transmission of information. While the two models and their objectives differ, there is a common finding indicating that, due to career concerns, CEOs try to affect how they are evaluated, either by decreasing disclosure or through other actions.

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<sup>1</sup>By career concerns, they mean the perception of how the agent's human capital is valued by the market, since it determines retention and compensation decisions.

Another important contribution dealing with disclosure is that of Adams and Ferreira (2007), whose model focuses on different issues than the present paper: the implications of the board's dual roles advising and monitoring the firm's management.<sup>2</sup>

We extend and complement the existing literature in several ways. First, the previous work on governance disclosure ignores the issue of contracts between owner and CEO. In a setting of information asymmetries, we introduce managerial private benefits instead, and concentrate on agency problems between managers and investors. In the theory proposed here, parties write contracts, and we analyze the implications of this contracting framework for portfolio choice and firm level transparency. We find that although the managerial private benefits are solved in equilibrium, the market solution is unlikely to produce the socially desirable level of disclosure.

Second, we derive disclosure rules endogenously and based on the profit-maximizing rules. This allows us to understand the factors shaping the quality of information reported by firms. Consequently, this paper also expands the controversial literature on corporate governance and competition by explaining a new channel through which product market competition could affect governance transparency.

In the traditional literature on corporate governance, more competition on the product market implies lower profits and thus fewer possibilities for diverting output. Another channel discussed in the literature is that of competition providing a richer information base on which to write contracts.<sup>3</sup> The conclusion of these studies is that tougher competition enhances corporate governance. We reach the same conclusion here. Our mechanism, however, demonstrates that when investors care about risk-sharing, low competition on the product market may translate into frictions on the capital markets, thus providing bargaining power to the firm since investors cannot fully diversify. As a result, firms do not need to increase disclosure. Or, reversing the argument, with a more competitive environment on the product market, there are more firms in need of finance, and thus investors can diversify more. Firms react by increasing disclosure as a way to signal on capital markets.

Equally importantly, it should be noted that our theory opens the door for a new line of research on empirical issues in governance transparency, in which the new mechanism should be tested and control variables proposed to examine the determinants of firm level governance disclosure. Although, the evidence supports the arguments advances in this study, more research on this is needed to highlight the importance of our theory.

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<sup>2</sup>Similarly, Admati and Pfleiderer (2000) analyze a model of voluntary disclosure by firms in the context of positive externalities in the form of information transfers.

<sup>3</sup>For an empirical analysis on how product market competition affects the type of incentive compensation that goes US executives see Cuñat and Guadalupe (2009).

### 3 The model

The economy is described by a two-period model and is populated by two types of agents: managers and a representative investor. Since managers have no capital endowment, they have to raise money on financial markets to exploit the potential production possibilities. The investor, on the other hand, is endowed with capital. Capital markets are subject to imperfections arising from the non-observability of output for financiers, and formal contracting arrangements are adopted to amend these frictions.

#### 3.1 The set up

##### Managers

The model considers an economy with  $n$  managers who are risk neutral and without initial wealth, but endowed with a risky project.<sup>4</sup> This investment opportunity implies that  $k_t$  units of capital in the first period will return the next period  $\tilde{R}k_t$ , with  $\tilde{R} \in \{R, 0\}$ , and the following probability distribution is commonly known  $pr(\tilde{R} = R) = \frac{1}{n}$ , where  $n$  is a finite number and  $n > 1$ . The parameter  $n$  is the numbers of firms on the market, providing a measure of the degree of competition among firms. In our model, the higher the numbers of firms on the market, the more difficult it is to succeed. This assumption attempts to capture the general belief supported in the theoretical and empirical literature, that competition is a key mechanism threatening the survival of the firm, since with a large number of firms, only the more efficient will survive.<sup>5</sup> Product market competition is of the type winner takes it all.<sup>6</sup>

Managers can undertake their projects only if investors finance them, since managers are endowed with an exogenous stock of capital at birth.

##### Information structure

From the point of view of a single firm, the output realization per unit of capital invested is either high  $R$  or low  $0$ . These realizations are private information to the managers. The representative investor, on the other hand, receives a binary symmetric signal with two possible values: high and low. The correlation between the signal and the realized returns is given by the following

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<sup>4</sup>One justification for the risk neutrality assumption of the manager can be found in the theory formalized by Kihlstrom and Laffont (1979), holding that entrepreneurs should absorb the risk that risk-averse agents do not want to take.

<sup>5</sup>Mata, Portugal, Gimares (1994) empirically examine the factors that influence the probability of a firm's survival on the market and show that market size is an important determinant of firm success. Similarly, Giroud and Mueller (2007) show that an increase in competition reduces a firm's profits. Guadalupe and Pérez-González (2005) find that a higher default probability is associated with tougher competition.

<sup>6</sup>Note that we are assuming a perfect negative correlation among returns on projects in order to keep the analysis straightforward. The results will hold up when assuming a less than perfect correlation as well, as long as the investor has incentives to diversify.

matrix

$$\begin{array}{ccc}
 & \text{signal} = h & \text{signal} = l \\
 \tilde{R} = R & p^i & 1 - p^i \\
 \tilde{R} = 0 & 1 - p^i & p^i
 \end{array}$$

Under perfect information it will be either  $p^i = 1$  or  $p^i = 0$ , while the signal conveys no information about the realization of the project when  $p^i = \frac{1}{2}$ . Since there is a perfect symmetric binary signal we assume without loss of generality that  $p^i \in [\frac{1}{2}, 1]$  so that when the signal is high,  $p(\tilde{R} = R/s = h) = p^i$ , while when the signal is low we have  $p(\tilde{R} = R/s = l) = 1 - p^i$ .

Since output is not observable to the investor, managers have the option of hiding some production. However, the better the quality of the signal received by the investor, the easier it will be for her to protect herself from attempts at expropriation by some of the managers. This is the reason why we take the quality of this signal as an indicator of the quality of governance transparency. In particular, we will show that managers decide about the degree of governance disclosure by trading-off the benefit of attracting more capital against the possibility of extracting higher informational rents from the investor.

### Timing

Contracting takes place in the ex-ante stage, that is, before the realization of the output is known. In the first period, the representative investor has an endowment of capital  $\bar{K}$ , managers, by contrast, are endowed with a project. Once each manager chooses the level of transparency, he proposes his project  $\Pi^i \equiv \{R \text{ w.p. } \frac{1}{n}, 0 \text{ w.p. } 1 - \frac{1}{n}, p^i\}$  on financial markets. Then, the investor announces a contract to each manager. The contract, which is contingent on the manager's report –and thus it depends on all observables and  $p^i$ , consists of the amount of capital that the investor makes in the firm and the contingent transfer paid by the investor to the manager. After that, each manager accepts the contract, borrows  $k_t$ , and invest so that the firm is set up, or the contract is rejected.

At the outset of the second period, a manager produces output equal to either  $Rk_t$  or 0 and this realization is his private information. Then, he makes a claim about the realization of his project  $R^c \in \{R, 0\}$  (where the superscript  $c$  refers to manager's claim), gives the intermediary output consistent with the claim (i.e.,  $Rk_t$ , or 0) and receives a contingent transfer. Therefore, a financial contract consists of capital advance  $k_t$  and a contingent transfer  $w^{i,h}, w^{i,l}$ . The manager has the option of hiding some of the cash flow from the investor.

After that, the representative investor decides based on the private signal and the claim, whether or not to go to court. We assume that as a proof of possibly misleading information, the investor only goes to court when there is a disagreement between the signal and the manager's claim. Courts, which are modeled in a reduced form, have the role of collecting the information that might lead to the detection of fraud, and act upon. If the manager is lying, court finds the manager guilty with certainty, and the manager pays the penalty  $Fk_t$ .

In short, if the project is of low quality, managers end up with income  $y_{i,t+1} = w^{i,l}$ . Without an endowment, the manager is unable to misreport in the low state, since this would entail a level of output  $Rk_t > 0$ . If the returns are high, truthful reporting yields  $y_{i,t+1} = w^{i,h}$ , and concealing yields  $y_{i,t+1} = w^{i,l} + [R - 0]k_t = w^{i,l} + Rk_t$ . That is, by misreporting the manager receives the transfer intended for low return projects plus the hidden output. If the investor decides to go to court and the manager is caught lying, the income becomes  $y_{i,t+1} = w^{i,l} + Rk_t - Fk_t$ . Finally, the investor consumes the proceeds from her investments.

As we will see later on, the equilibrium contract always requires the output surrendered to be consistent with the report. This implies no hiding along the equilibrium path. We will solve the model backwards: after characterizing the optimal transfer, and analyzing the investor's decision, we will study the manager's choice regarding the design of governance transparency.

### The representative investor

The investor is concerned about consumption, saving, and portfolio choice decisions.<sup>7</sup> She derives utility by consuming in the two periods. In particular, we assume the investor is risk averse with a Cobb-Douglas specification of the utility function

$$U_t = c_t^{1-\alpha} c_{t+1}^\alpha,$$

where  $c_t$  is the amount consumed in period one, and  $c_{t+1}$  is consumption in period two. In the first period, each investor is endowed with an amount of physical capital equal to  $\bar{K}$  and faces the following budget constraint

$$c_t + \sum_{i=1}^n k_t^i = \bar{K}, \quad (1)$$

where  $\sum_{i=1}^n k_t^i$  is the amount invested in each firm  $i$  set up by the manager. In the second period investors consume the investment payoff of the diversified portfolio. The investor's income depends on the claim made by the manager

$$y_{t+1} = R^c k_t^i - w^i(R^c).$$

The upper index  $c$  represents the manager's claim,  $k_t^i$  is the amount of capital invested in firm  $i$  by the representative investor, and  $w^i$  represents the equilibrium transfer that the investor pays to manager  $i$ .

In practice, investors have difficulties accessing whether information is credible. Although investors may have strong incentives to detect fraud, they do not always act accordingly because they have inferior access to information. For this reason, we introduce courts with the task of collecting and assessing the information that can lead to the detection of fraud, and consider credibility issues in the simplest way as a small, preliminary step toward a comprehensive

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<sup>7</sup>Note that, in order to make the model tractable, we are not modeling any price setting process. For studies that incorporate the effect of agency cost on equilibrium asset prices see Albuquerque and Wang (2005) and Dow, Gorton and Krishnamurthy (2005).



theory. We assume that as a proof of the possible misleading information, the investor will go to court just when there is a disagreement between the signal and the manager's claim. Therefore, the exogenous parameter  $F$  represents the penalty cost that the manager has to pay if found guilty.<sup>8</sup> We assume that this penalty cost is proportional to the total capital invested in the project, in other words, that the damage done is higher for larger firms.<sup>9</sup> Thus,  $F$  could also be interpreted as the country level of investor protection. Moreover, the following assumption is made

$$R > F \tag{A1}$$

## 4 The equilibrium contracts

The dominant manager strategy, independently of the returns realized, is to claim low returns because in this way the manager can lie and steal a positive amount of the profits. The manager's strategy of claiming high returns, on the other hand, is implicitly self-revealing. To test possibly misleading information, the model assumes that the investor will go to court just when there is a disagreement between the signal and the manager's claim. As a result, the manager is taken to court only when his claim is low and the signal is high. Taking this into account, the incentive compatibility constraint under low returns reads as follows,

$$\begin{aligned} p^i \{w^{i,l} + [0 - 0]k_t^i\} + (1 - p^i) \{w^{i,l} + [0 - 0]k_t^i\} \\ \geq p^i \{w^{i,h} + [0 - R]k_t^i\} + (1 - p^i) \{w^{i,h} + [0 - R]k_t^i\}, \end{aligned} \tag{IC1}$$

where the RHS is the expected utility of the manager if he lies, claiming a high return: given a realization of low returns, the signal would instead be low with probability  $p^i$  and high with probability  $1 - p^i$ . The LHS is the expected utility if he tells the truth, and it shows that with probability  $1 - p^i$ , the return and the claim are both low but the signal is high, so that the investor decides to go to court. Since the manager is not guilty, he does not pay the penalty cost. The inequality above can be rewritten as,

$$w^{i,l} \geq w^{i,h} - Rk_t^i, \quad \forall i = 1, \dots, n.$$

Analogously, when the returns are high the utility of the manager reporting the truth has to be higher than or equal to the utility if he lies,

$$\begin{aligned} p^i \{w^{i,h} + [R - R]k_t^i\} + (1 - p^i) \{w^{i,h} + [R - R]k_t^i\} \\ \geq p^i \{w^{i,l} + [R - 0]k_t^i - Fk_t^i\} + (1 - p^i) \{w^{i,l} + [R - 0]k_t^i\}. \end{aligned} \tag{IC2}$$

Again the RHS now tell us that with probability  $p^i$  the returns as well as the signal are high, but the claim is low. In this situation the investor goes to court,

<sup>8</sup>If  $F$  were part of the optimally chosen contract, the penalty payment would always be strictly positive, since a higher  $F$  implies higher utility for the investor.

<sup>9</sup>The assumption of a proportional penalty cost is useful when solving the portfolio allocation problem of the investor. It allows us to have a closed-form solution of the model.

the manager is caught lying and pays the penalty cost  $Fk_t^i$ . With probability  $1 - p^i$  the claim and the signal are high. The IC2 can be written as,

$$\begin{aligned} w^{i,h} &\geq w^{i,l} + Rk_t^i - p^i Fk_t^i \Leftrightarrow \\ w^{i,h} - w^{i,l} &\geq [R - p^i F]k_t^i, \quad i = 1, \dots, n. \end{aligned}$$

The next lemma shows that in equilibrium the incentive compatibility IC2 is binding, and the IC1 is strict. The intuition is clear: having no endowment, a manager is unable to misreport in the low state (i.e., IC1) since that would entail surrendering a positive amount.

**Lemma 1** *In equilibrium, the incentive compatibility constraint under high returns is binding, while the incentive compatibility when the returns are low is not.*

**Proof.** The two IC conditions are  $(R - p^i F)k_t^i \leq w^{i,h} - w^{i,l} \leq Rk_t^i$ . Since the investor needs to induce truthful reporting, she tries to pay as little as possible under this condition. This is why the left inequality must be binding, which in turn implies that the right inequality is strict. ■

Proposition 1 records the equilibrium transfer. Intuitively, by condition IC1 and IC2, we know that what determines the manager's truthful reporting decision is the gap between wages, that is  $w^{i,h} - w^{i,l}$ , and not their absolute values. This implies that the representative investor wishes to give the lowest possible payoff, which is zero given limited liability upon a low realization, i.e.  $w^{i,l} = 0$  and, the minimum incentive compatible reward upon a high realization to prevent diversion, i.e.  $w^{i,h} = (R - p^i F)k_t^i$ . This proposed contingent contract will guarantee the investor strictly positive income when the project succeeds and it will guarantee no-diversion.

**Proposition 1.** *The optimal contract offered by the investor to a manager with  $p^i$  induces truthful reporting and is given by:*

$$w^{i,l*} = 0, \quad w^{i,h*} = (R - p^i F)k_t^i \quad \text{for every } i = 1, \dots, n \quad (2)$$

**Proof.** See Appendix. ■

The transfer needed to induce truthful behavior in managers can also be interpreted as the price of outside-finance paid by the investors. The optimal transfer per unit of capital invested decreases as  $F$  and  $p^i$  increase, so that higher values of  $F$  and  $p^i$  reduce the cost of outside-finance. Therefore, lack of transparency and/or protection of the investor creates uncertainty –since endogenous information risk increases with a lower  $p^i$ – which in turn translates into an additional premium to the manager.

This result is consistent with empirical evidence provided by Leuz and Verrecchia (2000) documenting that firms' cost of capital decreases when they voluntarily increase transparency. Similarly, Doidge, Karolyi and Stulz (2004) show that foreign firms with cross listings in the U.S., which are subject to higher

accounting disclosure provisions than their foreign counterparts, have higher valuations and a lower cost of capital.<sup>10</sup>

The finding is also consistent with theoretical papers (see, for instance, Castro, Clementi and McDonald, 2004; Himmelberg, Hubbard and Love, 2004; Shleifer and Wolfenzon, 2002) showing that there is a negative correlation between investor protection and the cost of capital. In their models, when investor protection is perfect, managers optimally diversify fully idiosyncratic risk and steal nothing since insiders are risk averse. By contrast, under imperfect investor protection, insiders can credibly commit to lower rates of stealing by retaining a higher fraction of equity. At the same time they are forced to bear higher levels of diversifiable risk, which implies that risk sharing is not complete and thus the cost of capital increases. Their predictions are: first, the weaker the investor protection, the higher the concentration of inside equity ownership, and second, the higher the concentration of inside ownership, the lower the degree of diversification and thus the higher the implied cost of capital. In our model there is a negative correlation between corporate governance –measured either by governance transparency or corporate governance at the country level– and the price of outside investment, although not through ownership concentration, but through an additional premium paid by the investor to induce the manager to make no-diversion. Therefore, the investor pays more when corporate governance is low (i.e.,  $F$  and  $p^i$  are both low) because they recognize that with this extra payment to the manager, more of the firm’s profits will come back to them rather than being expropriated by the manager who controls the firm.

Since higher levels of  $p^i$  and  $F$  imply a higher level of investor protection, the investor always prefers higher governance transparency and penalties to lower ones. If  $F = 0$ , all the power is in the hands of the manager, and the investor would therefore never have access to credible information, the manager is no longer going to choose  $p^i$  as a variable. Indeed, there is no sense in talking about the trade-off of the signal, because there are no longer informational rents. This shows a mutual connection between the elements of a country’s institutional infrastructure and voluntary disclosure by the firm. Moreover, since the investor’s preferences about the penalty  $F$  are not aligned with those of managers, clearly if  $F$  is part of the optimally chosen contract term, the penalty payment will always be strictly positive. See the last subsection for a general discussion about the role of the court in this paper. Further, since  $p^i$  is a decision variable chosen in the interest of the manager and a higher  $p^i$  means a higher quality of information for the investor, and thus more bargaining power to the investor in detriment to the manager, we will show that  $p^{i*} < 1$  holds in equilibrium.

## 4.1 Portfolio choice

In the following, we will first analyze how the investor rationally formulates her asset allocations and consumption-saving decisions. Then look at how gover-

<sup>10</sup>However, as Leuz and Wysocki (2008) point out, this line of research is still in its infancy and certainly needs to be validated through further empirical research.

nance disclosure affects the allocation of resources in the economy. The representative investor solves the following problem

$$\begin{aligned}
& \text{Max}_{\{c_t, (k_t^i)^n, c_{t+1}\}} E(U_t) = E_t(c_t^{1-\alpha} c_{t+1}^\alpha), \\
& \text{st.} \quad c_t + \left(\sum_{i=1}^n k_t^i\right) \leq \bar{K} \\
& \quad c_{t+1} \leq y_{t+1} \\
& \quad y_{t+1} = Rk_t^i - w^{i,h*} \text{ if } s^i \text{ with } i = 1, \dots, n
\end{aligned}$$

where  $s^i$  is when state  $i$  occurs, which is the state where only firm  $i$  succeeds and all others fail. Define  $\tilde{p} = \frac{1}{n-1} \sum_{i \neq j} p_t^i$  as the average level of governance transparency of all other firms. The solution to the maximization problem with respect to the level of capital is given by the next proposition.

**Proposition 2:** *The stock of capital that the representative shareholder invests in firm  $i$  is given by*

$$k_t^{i*} = \frac{\left(\frac{p_t^i}{\tilde{p}}\right)^{\frac{\alpha}{1-\alpha}}}{(n-1) + \left(\frac{p_t^i}{\tilde{p}}\right)^{\frac{\alpha}{1-\alpha}}} \alpha \bar{K} \quad (3)$$

**Proof:** See Appendix.

Other things being equal, the higher the quality of the signal in firm  $i$ , the higher the capital invested in this company will be.<sup>11</sup> The economic behind this result is clear: better transparency cuts down the costs of external finance, which results in a reallocation of resources from firms with a low level of transparency to more attractive firms characterized by more transparent financial accounting information.<sup>12</sup> That is, our theory predicts that better governance transparency enables firms to access capital markets on better terms, which is valuable to firms intending to raise funds. Consistent with this idea, Rajan and Zingales (1998) find that firms in industries with significant needs for external finance, such as the pharmaceutical industry, grew substantially faster during the 1980s in countries with more demanding accounting disclosure standards than firms in the same industries in countries with weak accounting-disclosure standards. Similarly, in a review of the empirical research on disclosure, Healy and Palepu (2001) report voluntary disclosure policies specially when firms issue new capital.

<sup>11</sup> Another channel by which transparency may affect capital markets is through changes in the equilibrium stock return. However, asset pricing statements are beyond the scope of this paper.

<sup>12</sup> If the returns from the investment were heterogeneous across firms, financial accounting information would identify promising investment opportunities, meaning that financial capital would flow toward firms with prospects of high returns and away from sectors with poor prospects. This would lead directly to more accurate allocation of capital to the highest valued use.

## 4.2 Determinants of transparency

Having characterized the optimal transfer and portfolio investment decisions, we are now in a position to take a step back and examine the driving forces behind governance transparency. According to Propositions 1 and 2, the transfer ensuring no hiding along the equilibrium path, and the stock of capital invested by the shareholders  $k_t^{i*}$ , provide the key ingredients to solve the manager problem. That is, managers decide the quality of the signal trading-off between better signals that attract more capital but decrease the informational rents

$$\begin{aligned} \text{Max}_{p^i} \quad & E(U^i) = \frac{1}{n}(R - p^i F)k_t^{i*}, \\ \text{s.t.} \quad & k_t^{i*} = \frac{\left(\frac{p^i}{\bar{p}}\right)^{\frac{\alpha}{1-\alpha}}}{(n-1) + \left(\frac{p^i}{\bar{p}}\right)^{\frac{\alpha}{1-\alpha}}} \alpha \bar{K}. \end{aligned}$$

The FOC of  $p^i$  is given by the following expression,

$$(R - p^i F) \frac{\partial k_t^{i*}}{\partial p^i} = F k_t^{i*}.$$

The return to the manager per dollar invested is  $R - p^i F$  and the term  $\frac{\partial k_t^{i*}}{\partial p^i}$  measures the marginal effect of increasing voluntary transparency on the total amount of capital. The FOC therefore tells us that the optimal level of voluntary disclosure of information is given when the marginal cost of better governance equals the marginal revenues from increasing an additional unit of governance transparency. Let us assume that A2 always holds

$$\frac{1}{2} \leq \frac{R}{F} \left( \frac{(n-1)\alpha}{\alpha(n-1) + (1-\alpha)n} \right). \quad (\text{A2})$$

Note that  $p^{i*} < 1$  always holds, because of A1.

The next proposition shows that even though the manager would like to divert cash flows ex post, and transparency limits his ability to do so, he voluntarily chooses a positive level of transparency ex ante in order to be able to raise capital. Furthermore, the proposition highlights the importance of not just a single variable, but a range of variables related to the degree of market structure of an industry, the quality of enforcement of the rule at the country level as well as the level of the firm's corporate profits of the firm when explaining its disclosure practices.

**Proposition 3:** *Under A2, the level of voluntary governance transparency by the firm is given by*

$$p^* = \frac{R}{F} \left( \frac{(n-1)\alpha}{\alpha(n-1) + (1-\alpha)n} \right), \quad (4)$$

*Moreover, the following comparative statics hold:  $p^*$  is i) strictly increasing with the level of competition, n ii) strictly increasing with the level of corporate*

profits for the firm,  $R$  and  $iii$ ) strictly decreasing with the country dimension of corporate governance,  $F$ .

**Proof:** See Appendix.

First, the model demonstrates that, *ceteris paribus*, more product market competition leads to substantial improvements in the quality of financial accounting information. The specific channel by which product market competition operates is that of portfolio diversification in the capital market. As the number of firms operating in the product market increases, capital markets become more developed since competition in capital markets increases as well: in our model, more product market competition first implies that the potential number of securities in an investor's portfolio increases. Second, tougher product market competition implies a higher investment risk in each firm or project. Both effects together signify that there are more firms to invest in, but each one becomes less important on the market overall. In this contest, it becomes easier for the investor to diversify her portfolio, which in turn entails that the manager has less monopoly power (i.e., each firm becomes less important to achieve portfolio diversification). Then, the only possibility firms have to attract more capital is to provide more information, that is, to increase governance transparency.

Another possible interpretation from the point of view of the investor is that when investment risk increases (i.e., lower  $1/n$ ) the investor demands more information, which in turn, decreases the information risk (i.e.,  $1 - p^*$ ).

Little empirical evidence has been found concerning the relationship between product market competition and corporate governance. Nickell (1996) were the first to analyze this question. They estimate the effects of competition, shareholder control and debt levels on firm-level productivity growth in the UK, including interaction terms. Their results show a positive influence of product market competition, ownership control and financial pressure on productivity growth. Moreover, they find that competition and control can be considered as weak substitutes in a panel of British firms. In a recent paper, Giroud and Mueller (2007) show that firms in non-competitive industries experience a significant drop in operating performance after the passage of an anti-takeover law. By contrast, firms in highly competitive industries experience no significant effect, so that managerial slack appears to increase only in non-competitive industries. Subsequently, Giroud and Mueller (2008), using the democracy-dictatorship hedge portfolio in Gompers et al. (2003), find that the effect of governance on firms' operating performance, long-horizon stock returns or firm value is relatively small in competitive industries compared to non-competitive industries, where governance matters more. Likewise, Guadalupe and Pérez-González (2005) find that product market competition is strongly negative correlated with private benefits of control. They also find that the channels through which competition affects corporate governance are by increasing the quality of the available information for investors and by increasing the default probability.

Although these empirical papers conclude a positive link between product

market competition and corporate governance, this is not a direct test of the model proposed here, because first, they do not concentrate on firms's disclosure and financial reporting standards, and second, they do not assess the disciplining force that competition imposes on firms decisions regarding governance disclosure.<sup>13</sup>

Second, this theory also shows that the degree corporate profits may shape the degree of voluntary transparency. When corporate profits are high, agency problems become significant because the manager has more incentives to lie. As a result, the firm would find it optimal to impose ex-ante stricter governance regulation mechanisms as a commitment device to prevent ex-post expropriation. Hermalin (2008) also concludes that there is a positive correlation between quality of governance and corporate performance. In his theoretical model, like us, firm value determines the level of corporate governance. Unlike us, there is firm heterogeneity in marginal returns to resources. Firms with greater marginal returns raise higher external finance and thus have stronger corporate governance, which in turn increases profits.

Our second result is in line with the work of Himmelberg, Hubbard, Palia (1999), who argue that some firms find it easier to expropriate from minority shareholders due to the nature of their operations. For example, the composition of a firm's assets will affect its contracting environment because it is easier to monitor and harder to steal fixed assets (i.e., machinery and equipment) than "soft" capital (i.e., intangibles, R&D capital, and short-term assets, such as inventories). Therefore, firms operating with higher proportions of intangible assets may find it optimal to adopt higher governance transparency to signal to investors that they intend to prevent the future misuse of these assets.

The empirical work of Gompers, Ishii and Metrick (2003) and Klapper and Love (2003) show a positive and strong correlation between corporate governance at the firm level and firms' operating performance. Because of data limitations, however, they do not analyze the causality issues in depth. Gompers et al. (2003) construct a governance index to proxy for shareholders rights whereas the governance score of Klapper and Love (2003) reports data over seven broad categories measuring management discipline, transparency, independence, accountability, responsibility and fairness. The present paper demonstrates that if we focus only on governance disclosure, the association between transparency and firm performance could go the other way around instead.

Note that if profits fluctuate with the business cycle (so that profits increase during an upswing but decrease during a recession), then we would find that the quality of governance improves in a boom. That is, our analysis would suggest that it is during economic upturns that we need greater governance vigilance.<sup>14</sup>

Third, the stronger the legal system (i.e., the higher the penalty cost when

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<sup>13</sup>Rajan and Zingales (1998) show a positive correlation between competition and higher disclosure. They find that there is more competition in external finance-dependent industries in countries with high-quality disclosure regimes. However, we analyze the causality in the other direction, that is stronger competition implies better governance transparency.

<sup>14</sup>For papers that study business cycle variation in the degree of corporate control friction, see Philippon (2006) and Dow et al. (2005).

a manager is taken to court and found guilty), the lower the level of governance transparency. The exogenous penalty cost  $F$  reflects the effectiveness of a country's legal system. Therefore, a higher penalty cost means better institutions and thus, better investor protection. In general, it is not clear whether the relationship between the country level legal infrastructure and voluntary governance transparency will act as substitutes or complements. One supposition is that firms in countries with weak laws would want to adopt better governance transparency to counterbalance the weaknesses in their country's legal system and signal their intention to offer greater investor rights. This would suggest a negative correlation between governance transparency and country-level laws. By contrast, a second possibility is that in countries with weak laws, the governance transparency is likely to be lower.

It is worth noting that our theory does not attempt to claim that quality accounting is a replacement for country-level judicial reform. Rather, the model, by contrast, suggests that firms in countries with poor investor protection can improve it by adopting better accounting standards. On the empirical side, this result is consistent with the evidence provided by Klapper and Love (2002), Durnev and Kim (2005), and Bruno and Claessens (2006). These papers show that firm-level corporate governance provisions matter more in countries with weak legal environments. These results suggest that well governed firms benefit more in bad corporate governance environments, and that firms can partially compensate for ineffective laws and enforcement by establishing good corporate governance and providing credible investor protection. Similarly, Doidge et al. (2004), using a modification of Sheifer and Wolfenzon's (2002) model, show that although country governance is an important determinant of firm-level corporate governance, when firms have access to global capital markets, country characteristics matter less to explain the quality of governance practices at the firm level. Bhat, Hope and Kang (2006) and Bushman, Piotroski and Smith (2004) show the same results, but using governance transparency measures. Leuz, Nanda and Wysocki (2003) and Ball, Kothari and Robin (2000) suggest that the quality of financial accounting information is limited instead by institutional factors. As far as we know, there is little empirical work on this issue. Further research would help us to understand the interactions between the institutional laws at the country level and voluntary governance transparency by the firm.

Overall, the results are consistent with the view that reporting quality is shaped by numerous factors related to the market structure of the firm, variables related to the firm as well as the country's institutional environment. The roles of these factors show us a bottom line history: managers for whom access to capital markets is important have incentives to signal their intentions to offer better quality of information. Transparency then acts as a disciplining device, and markets are likely to reward those firms that opt for this type of commitment device. These findings are consistent with the hypothesis that one of the main roles of publicly reported financial accounting information in corporate governance is to protect external financiers.



### 4.3 Discussion of modeling assumptions

The results of this study are based on a reduced form model involving a number of strong assumptions. As noted above, many of these results are quite robust to the model specifications. However, this study is subject to several shortcomings. One clear example is the assumption about the reduced form in which courts are introduced.

In the current version of the model, if managers found guilty, they pay the penalty  $F$  but can keep the returns on the project that they hid from outside investors. This implies that the representative investor derives no effective benefits from taking the manager to court (ex post they are in fact indifferent between denouncing or not) but, in equilibrium, it is optimal for her to take the managers to court whenever the claim is low while the signal is high because in this way, she induces the managers to reveal the truth about the returns. In fact, as is explained in the main body of the paper, if investors dismiss courts then it will become optimal for the managers to always claim low returns, implying an investor's expected payoff of zero or even negative independent of the state of nature. In this sense, taking the managers to court play a merely instrumental role.

Interestingly, the main results of the model are robust to modeling changes in the function of the courts. Suppose that if managers are found guilty by the courts, they are also forced to pay to the representative investor her due returns. In this case, the investor is no longer ex post indifferent between taking the manager to court or not and, if going to courts is costless, she will always take the manager to court whenever the claim is low and independently of the signal (indeed, in this case whenever the probability of high realization is different from zero, going to court assures to the investor a higher expected payoff than not going to court). As a result, in equilibrium, managers will always tell the truth independently of the quality of the signal or the level of governance transparency which, consequently, loses importance.

However, if going to court is costly, the investor will always face a trade-off between paying the costs, hoping to recover part of the returns, and not doing so; clearly, the signal becomes crucial in this context since if the signal is high, the expected returns of recurring to the courts will be higher because the probability of recovering returns is higher. In particular, the results of the model are unchanged if the courts' costs are high enough to discourage a legal action whenever the signal is low, but are low enough to incentivize a legal action when the signal is high.

Note also that in this context, the better the quality of the signal, the higher the expected returns of going to court will be. This implies that the conditions determining court' costs will also represent a constraint in the manager's decision problem regarding the quality of signal.

## 5 Conclusions

This paper develops a theoretical model of corporate transparency of firms, treating governance disclosure as endogenous. Capital markets are subject to imperfections arising from the non-observability of output for financiers, and formal contracting arrangements are needed to reduce expropriation of the investor's wealth by the manager. The contract endogenously determines how the cost and benefits of voluntary disclosure are defined. Under the assumption that managers control the precision of the information available to outside investors, we analyze both the extent to which firms voluntarily disclose information in a setting with product market competition and the extent to which publicly reported financial accounting information helps to mitigate the agency problem of cash flow diversion. The contract endogenously determines the central trade-off for the manager when deciding the "quality of governance transparency" because higher quality of information increases the possibility to expropriate a bigger share of the profits against the opportunity to raise more capital in financial markets.

The analysis shows that although managerial private benefits are zero in equilibrium, the optimal level of disclosure is far from perfect. Further, governance transparency matters for several reasons: an absence of transparency increases the cost of investing in a firm and it affects the reallocation of resources, since financiers prefer to invest in more transparent firms. The results are consistent with the view that reporting quality is shaped by numerous factors related to market structure, firm characteristics and country level dimension of the legal system.

The market structure is represented by the level of competition among firms. Our theory predicts that more competition increases governance transparency. Since more competition in the product market entails more possibilities to diversify the portfolio and thus more developed capital markets, the only way firms differentiate among competitors and attract capital is by increasing the quality of their reporting activities. Better financial accounting may also be driven by higher corporate profits, because the higher corporate profits, the greater the possibilities of committing fraud. Thus, the firm would find it optimal to impose stricter governance transparency mechanisms ex-ante to prevent ex-post expropriation. Finally, firms in countries with weak laws will adopt better governance transparency to counterbalance weaknesses in their country's legal and enforcement system and to signal their intention to offer greater investor rights. In short, the model tells us that firms improve governance transparency as a commitment device specially when they need to raise new funds.

It would be interesting to study the issues addressed in this paper in a rich framework. For example, our model is one shot game, involving one period of disclosure followed by one transaction. However, it will be interesting to study the process of governance transparency in a dynamic setting, where the role of reputation credibility issues as mechanisms for solving information problems would provide further insights. Equally importantly, the proposed theory opens the door to new research on empirical issues of voluntary governance trans-

parency, by testing the new mechanisms suggested in the paper, and proposing new control variables to examine determinants of firm level disclosure in large cross sectional data sets. Although the evidence provided here supports the arguments, more research on this subject would be useful to highlight the importance of our theory.

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## 7 Appendix

### Proof of Proposition 1.

First, to induce the incentive for truthful reporting, the investor only needs to ensure that the wage difference  $w^{i,h*} - w^{i,l*}$  satisfies  $(R - p^i F)k_t^i \leq w^{i,h} - w^{i,l} \leq Rk_t^i$ . Hence, utility maximization implies  $w^{i,l*} = 0$ .

Second, if the investor will pay  $w^{i,h*} > Rk_t^i$ , the manager will lie when output is low. If so, the investor's expected income in the second period is

$$\begin{aligned} & \frac{1}{n}[p^i(Rk_t^i - w^{i,h*}) + (1 - p^i)(Rk_t^i - w^{i,h*})] + \\ & (1 - \frac{1}{n})[p^i(Rk_t^i - w^{i,h*}) + (1 - p^i)(Rk_t^i - w^{i,h*})] \\ & = Rk_t^i - w^{i,h*} < 0. \end{aligned}$$

Hence, the investor will not pay  $w^{i,h*} > Rk$ .

Finally, the only possibility is that the investor may choose to pay  $w^{i,h*} < (R - p^i F)k_t^i$ . If so, the manager will lie when output is high. And thus, the investor's expected income in the second period is

$$\begin{aligned} & \frac{1}{n}[p^i(0 - w^{i,l*}) + (1 - p^i)(0 - w^{i,l*})] + \\ & (1 - \frac{1}{n})[p^i(0 - w^{i,l*}) + (1 - p^i)(0 - w^{i,l*})] \\ & = -w^{i,l*} = 0, \end{aligned}$$

Hence, the investor has no incentive to pay  $w^{i,h*} < (R - p^i F)k_t^i$ . Notice that even when  $w^{i,h*} = 0$  the incentive compatible contract is not in place and, the manager will always optimally claim low returns realization. This implies that, whatever the outcome of the shock, the investor's expected income in the second period will be always equal to zero.

Instead, if the investor chooses to pay  $w^{i,h*} = (R - p^i F)k_t^i$ , her expected income is

$$\begin{aligned} & \frac{1}{n}[p^i(Rk_t^i - w^{i,h*}) + (1 - p^i)(Rk_t^i - w^{i,h*})] \\ & + (1 - \frac{1}{n})[p^i(-w^{i,l*}) + (1 - p^i)(-w^{i,l*})] \\ & = \frac{1}{n}(Rk_t^i - w^{i,h*}) = \frac{1}{n}p^i F k_t^i > 0. \end{aligned}$$

Observe that investor's expected income is increasing with the level of corporate governance, at the firm and at the country level (i.e.,  $p^i$  and  $F$ ), providing thus, more bargaining power.

Q.E.D.

### Proof of Proposition 2.

Plugging in the utility function the budget constraint, the utility function may be re-arrange as  $U_t = c_t^{1-\alpha} [V(k_t^1, \dots, k_t^i, \dots, k_t^n)]^\alpha$  with  $V$  being a sub-utility function which is defined over a potentially large amount of capital invested in each of the  $n$  firms,  $k_t^i$ . The expected utility of the representative risk averse investor becomes

$$E(U_t) = [\bar{K} - \sum_{i=1}^n k_t^i]^{1-\alpha} \left[ \sum_{i=1}^n \frac{1}{n} ((R - x^i) k_t^i)^\alpha \right],$$

with  $x^i = R - p^i F$  being the transfer per unit of capital paid by the representative investor to the manager to induce him not to lie. The investor has to choose: i) how to divide the total stock of capital between consumption for the first period and savings and ii) how to divide the amount of capital invested  $\bar{K}_t$  among the  $n$  different projects available on the financial market (i.e., choosing  $k_t^i \forall i = 1, \dots, n$ ).

*Step 1:* Choose between consumption and savings.

Remark 1: Since all firms are symmetric,  $w^i = w \forall i = 1, \dots, n$ . Then, the expected utility may be rewrite as

$$E(U) = [\bar{K} - \sum_{i=1}^n k_t^i]^{1-\alpha} (R - x)^\alpha \frac{1}{n} \left[ \sum_{i=1}^n (k_t^i)^\alpha \right].$$

Remark 2: Moreover, since we have a ex ante homogenous firms, we know that in equilibrium  $k_t^i = k_t \forall i = 1, \dots, n$ . Therefore,  $\sum_{i=1}^n k_t^i = n k_t = K_t$ , which implies that  $k_t = \frac{K_t}{n}$ . Then,  $\sum_{i=1}^n \frac{1}{n} (k_t^i)^\alpha = \frac{n}{n} k_t^\alpha = (\frac{K_t}{n})^\alpha$ .

The investor problem can be rewrite as

$$\text{Max}_{K_t} E(U) = [\bar{K} - K_t]^{1-\alpha} (R - x)^\alpha n^{-\alpha} K_t^\alpha.$$

$$\text{FOC} : \frac{\partial U}{\partial K_t} = 0 \iff (1 - \alpha) K_t - \alpha [\bar{K} - K_t] = 0 \iff K_t^* = \alpha \bar{K}.$$

Notice that  $K_t^*$  is a proportion of the total amount of capital, and  $c_t^* = (1 - \alpha) \bar{K} > 0$ .

*Step 2:* Portfolio allocation: choose  $k_t^i$ .

The investor' problem is given by

$$\begin{aligned} \text{Max}_{k_t^i} E(U) &= [(1 - \alpha) \bar{K}]^{1-\alpha} \frac{1}{n} [(k_t^i)^\alpha (R - x^i)^\alpha + \sum_{i=1}^{n-1} (k_t^i)^\alpha (R - x^i)^\alpha] \\ \text{s.t.} \quad &\sum_{i=1}^n k_t^i = \alpha \bar{K}. \end{aligned}$$

Remark 1. In equilibrium all firms are symmetric and then  $x^i = x \forall i = 1, \dots, n$ . Define  $\tilde{x} = \frac{1}{n-1} \sum_{i \neq j} x^i$ .

Remark 2. In equilibrium  $k_t^i = k_t \forall i = 1, \dots, n$ . Therefore,  $\sum_{i=1}^{n-1} k_t^i = (n-1)k_t^i = \alpha \bar{K} - k_t^i$ , and thus  $k_t^i = \frac{\alpha \bar{K} - k_t^i}{n-1}$ . Or similarly,  $\sum_{i=1}^{n-1} (k_t^i)^\alpha = (n-1) \left( \frac{\alpha \bar{K} - k_t^i}{n-1} \right)^\alpha = (n-1)^{1-\alpha} (\alpha \bar{K} - k_t^i)^\alpha$ .

The maximization problem could be rewrite as

$$\text{Max}_{k_t^i} E(U) = [(1-\alpha)\bar{K}]^{1-\alpha} \frac{1}{n} [(k_t^i)^\alpha (R-x^i)^\alpha + (R-\tilde{x})^\alpha (\alpha \bar{K} - k_t^i)^\alpha (n-1)^{1-\alpha}].$$

$$\text{FOC} : \frac{\partial U}{\partial k_t^i} = 0 \iff (k_t^i)^{\alpha-1} (R-x^i)^\alpha = (R-\tilde{x})^\alpha (\alpha \bar{K} - k_t^i)^{\alpha-1} (n-1)^{1-\alpha},$$

$$k_t^{i*} = \frac{\left( \frac{R-x^i}{R-\tilde{x}} \right)^{\frac{\alpha}{1-\alpha}}}{(n-1) + \left( \frac{R-x^i}{R-\tilde{x}} \right)^{\frac{\alpha}{1-\alpha}}} \alpha \bar{K} = \frac{\left( \frac{p^i}{\tilde{p}} \right)^{\frac{\alpha}{1-\alpha}}}{(n-1) + \left( \frac{p^i}{\tilde{p}} \right)^{\frac{\alpha}{1-\alpha}}} \alpha \bar{K},$$

where the last equality obtain taking into account  $x^i = R - p^i F$  and  $\tilde{x} = R - \tilde{p} F$ , and  $\tilde{p} = \frac{1}{n-1} \sum_{i \neq j} p^i$ .

*Q.E.D.*

### Proof of Proposition 3.

From the manager's problem, we have the following FOC,

$$\frac{\partial E(U^i)}{\partial p^i} = 0 \iff F k_t^{i*} = (R - p^i F) \frac{\alpha K}{1-\alpha} \frac{\frac{\alpha}{1-\alpha} \left( \frac{\tilde{p}}{p^i} \right)^{\frac{\alpha}{1-\alpha} - 1} \left( \frac{1}{\tilde{p}} \right) (n-1)}{\left[ n-1 + \left( \frac{p^i}{\tilde{p}} \right)^{\frac{\alpha}{1-\alpha}} \right]^2}$$

$$F = (R - p^i F) \frac{\alpha}{1-\alpha} \frac{(n-1) \left( \frac{\tilde{p}}{p^i} \right) \left( \frac{1}{\tilde{p}} \right)}{n-1 + \left( \frac{p^i}{\tilde{p}} \right)^{\frac{\alpha}{1-\alpha}}}$$

Since  $p^i = p \forall i = 1, \dots, n$ , the equality above becomes  $(R - p^i F) \frac{\alpha}{1-\alpha} \frac{n-1}{p^i} = F n$ , and thus the optimal value of  $p^*$  is

$$p^* = \frac{R}{F} \left( \frac{(n-1)\alpha}{(n-1)\alpha + (1-\alpha)n} \right) = \frac{R}{F} \frac{(n-1)\alpha}{(n-\alpha)}$$

Notice that by A1 and A2,  $\frac{1}{2} \leq p^* < 1$  holds. Clearly, once we substitute the optimal  $p^{i*}$  into the optimal transfer,  $w^{i,h*} > 0$  always hold.

*Q.E.D.*