Relationships in OTC Markets*

Tamás Bátyi† Christine A. Parlour‡ Uday Rajan§

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Abstract

We model the relationship between a client and a broker-dealer who provides two services. First, it provides financial advice by constructing a bespoke strategy for coping with future financial contingencies the client may face. The adviser may be a good match or a bad match for the client. Second, the broker-dealer implements the strategy by selling a security to the client over-the-counter. The markup charged to the client on the security includes the adviser's fee. As a result, the markup in the OTC market depends on the length of time a client has been with an adviser, the severity of her needs, and the business volume of the client. The model has implications for the markups on simple versus complex products, and on one-shot versus repeated transactions.

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†Department of Economics, University of California at Berkeley; tbatyi@econ.berkeley.edu

‡Haas School of Business, University of California at Berkeley; parlour@haas.berkeley.edu

§Stephen M. Ross School of Business, University of Michigan; urajan@umich.edu

The securities exchange Act of 1934 defines a broker as "any person engaged in the business of effecting transactions in securities for the account of others." This somewhat broad definition encompasses those who solicit, negotiate or facilitate transactions. Further, their fees or compensation is typically related to the outcome or size of the transaction or deal.[1] By contrast, a dealer is "any person engaged in the business of buying and selling securities for his own account, through a broker or otherwise." Finally, Investment Advisors are defined as a person or firm that is engaged in the business of providing investment advice to others or issuing reports or analyses regarding securities, for compensation." We note that investment advice ranges from asset allocation to providing clients with a selective list of securities.[2] Brokers and Broker-Dealers are required to register with the SEC or FINRA, while investment advisors must register with the SEC, if they operate on the national level or state authorities if their footprint is local. Prominent examples of firms that operate as both broker-dealers and investment advisors are Goldman Sachs and Morgan Stanley.

In many OTC markets, the boundaries between these three functions are somewhat porous. In as much as many OTC securities are smaller issues or bespoke, broker-dealers can only be effective if they also make suggestions. Whereas in other markets, broker dealers provide little advice but essentially focus on transaction services. In order to understand these different roles, we construct a theoretical model in which a broker-dealer provides two distinct services for client. First, it provides financial advice. Specifically, a client needs a strategy to cope with future financial contingencies or hedging needs. The broker-dealer devises a bespoke strategy for the client. Second, the broker-dealer sells a security to the client over-the-counter. The broker-dealer's fee for the advice is bundled into the markup of the security, potentially inflating the observed price of the security on the OTC market.

Our contracting model features moral hazard. Devising a strategy for a client is costly in terms of effort, as the broker-dealer has to first learn the preferences or the exact needs of the client. Greater effort implies that it is more likely to identify the right strategy, but effort is privately costly to the broker-dealer. A broker-dealer may find it easier or more difficult to exert effort for a client; in other words it may be a good or a bad match for the task required by the client.

After a client has signed on with a broker-dealer, she may be faced with another contingency that requires another financial strategy to be developed. The first need may or may not have fully materialized, so that the outcome of the first strategy may be unknown to the client. The client has to decide whether to re-hire the same broker-dealer she had before (i.e., to develop a long-term relationship) or to switch to a new broker-dealer.

When faced with a new client, a broker-dealer has two motivations to invest high effort. First, knowledge about the client's preferences is long-lived, so high effort with a new client reduces the cost of effort in future interactions with the client. Second, high effort increases the likelihood of a successful strategy being devised, and in turn increases the likelihood that the client signs on to a repeated relationship.

[1] https://www.sec.gov/divisions/marketreg/bdguide.htm

[2] https://www.sec.gov/answers/invadv.htm

As the contract between the broker-dealer and the client is potentially long-term, the fee charged by the broker-dealer depends on the length of the relationship with the client. In addition, it depends on the severity of the client's needs, and finally on the size of the client relative to the broker-dealer's overall client portfolio. As the fee is directly built into the markup of the security the client purchases, a direct implication is that the price paid by a final customer in the OTC market is customized to the client, and depends on the relationship between the client and the broker-dealer.

Therefore, an excessive markup observed on the price may merely reflect the quality of advice provided to the client. This contrasts with the usual explanation of high markups reflecting inefficiency in this market as a result of search costs or bounded rationality on the part of clients. As an example, complex contingencies require complex financial products, so our model also delivers the implication that complex securities have high markups relative to simple securities. The implication again is that the broker-dealer has incurred high costs in determining the right strategy for a client with a complex need.

Our view of the relationship between the broker dealer and client is based on notion of relational contracts explored in Baker, Gibbons and Murphy (2002). A large literature analyses equilibrium in OTC markets as the outcome of random search beginning with Duffie, Gârleanu and Pedersen (2005). In this vein, Atkeson, Eisfeldt and Weill (2015) considers equilibrium entry and exit when banks provide risk sharing services. Various sophisticated extensions of search models such as Nekyludov (2014), Nekyludov and Sambalaibat (2015), Huggonier, Lester and Weill (2015), Chang and Zhang (2015) extend the random search paradigm to be more consistent with the stylized facts.

The role of the intermediary has received renewed attention recently. For example, Babus and Hu (2016) considers how they may facilitate trade between agents who can strategically default and have partial information. In this world, intermediaries through their informational advantage can effect welfare improving trade; indeed, one in the center of a star informational network can be most welfare enhancing. Chang and Szydlowski (2016) consider a competitive market for advice.

Earlier work such as Bernhardt, Dvoracek, Hughson, and Werner, (2005), indicate that large brokers receive better terms of trade. Edwards, Harris, and Piwowar (2005) document the effect of transparency on corporate bond spreads. Green, Hollifield and Schurhoff (2007) similarly find very high spreads in opaque markets. O'Hara, Wang, and Zhou (2015) document very high spreads in corporate bond markets. Recently, a series of papers has considered the characteristics of the OTC market. Typically, these focus on bond markets as these data are (more) readily available. For example, Hendershott, Li, Livdan and Schurhoff (2016) show that trading relations are the most important determinant of good execution terms in OTC markets. They find that execution costs are higher for those that are smaller and are also relationship specific: connections matter more than trader identities. They also find that long term relationship emerge between dealers and their clients — half of the insurers in their sample who trade bonds do so with the same dealer. Di Maggio, Kermani and Song (2016) document that during the financial crisis, that stronger relationships correspond to better terms of trade.

1 Model

Consider a three-date contracting problem with one principal and one agent. At date 0, the principal contracts with the agent to perform a customized financial task. The outcome of the task is revealed with probability p at date 1, and with probability $1-p$ only at date 2. In addition, at date 1, with some probability ϕ, the principal needs to hire an agent to perform a second task. The outcome for the principal can either be good or bad (y_g or y_b). The outcome may be thought of broadly as whether the principal is satisfied with how well the task has been conducted. Although this outcome is not be measured in terms of money, we will refer to it as the "output." Both principal and agent are risk-neutral toward wealth, and we normalize the discount rate to zero.

The agent has a type that is unknown to both parties when the initial contract is signed at date 0. After signing the contract, the agent finds out the precise nature of the task. At that point, the agent privately understands whether they are well- or ill-equipped to perform the task. That is, they learn whether they have a high or a low disutility per unit of effort (c_h or c_ℓ) for this particular task. The type therefore captures the quality of the match between the principal and agent. In other words, the type is not inherent to the agent, and may be different if the agent is chosen to perform a task for some other principal.

For an agent of type θ, the cost of providing effort e at date 0 is $c_\theta e^2$. Here, $c_h > c_\ell > 0$. The ex ante probability of the agent being the low-cost type is q. Let $\bar{c} = qc_\ell + (1-q)c_h$ be the expectation of c. There is a minimum effort level $\underline{e} > 0$, so that $e \in [\underline{e}, 1]$. If the agent puts in higher effort, he is more likely to generate a higher output for the principal at date 1. In other words, $\Pr(y = y_g \mid e_1) = e_1$. The utility of outcome $j \in \{b, g\}$ to the principal is $u(y_j)$, which we frequently denote by u_j, and let $\Delta_u = u(y_g) - u(y_b)$. Finally, we assume that the agent has a reservation utility $\bar{w}$ at date 0.

At date 1, the agent may also perform a second task for the principal. If the agent works for the principal at date 0, they learn something about the principal that improves their performance on the second task. Specifically, $\Pr(y = y_g \mid e_2) = e_1 + e_2$. The type of the agent remains the same across the two tasks. The cost of the additional effort at time 2 is $c_\theta e_2^2$. The agent's reservation utility at date 1 remains $\bar{w}$.

Because the task satisfies a particular financial need and the outcome is not measured in terms of money, we assume that the output is not contractible. Therefore, the agent has to be compensated with a fixed fee for the task at each date. In a standard contracting model, the output serves as a noisy signal about the effort of the agent. Here we assume that the principal observes the output at the interim date with probability p. While the principal cannot contract on it, they can decide whether to re-hire the agent based on whether output is good or bad. We present the timeline in Figure 1.

We consider a perfect Bayesian equilibrium of this game. We consider two variants of the model. First, as a benchmark we assume the principal cannot commit to the contract that will be offered at date 1 if the second task arises. Second, we consider the situation in which the principal can commit at date 0 to the future contract that will be offered at date 1.

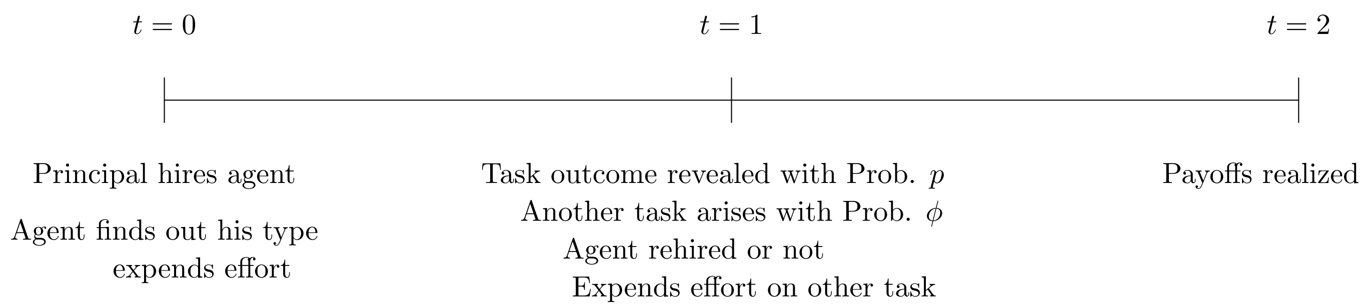

Figure 1: **Timeline of relationship**

2 Optimal Contract

We now turn to the outcome of the contracting game between the principal and the agent. Consider an agent with type $\theta \in \{c_\ell, c_h\}$. When he is hired by the principal, neither he nor the principal knows whether he will be a good match (i.e., have low cost). The agent learns their realized cost before taking an action at date 0.

The only information that the principal receives is whether the task the agent undertakes results in a good or bad outcome. His private outcome is therefore a signal on the quality of the match (i.e., the type of the agent). At date 1, this signal can take one of three values: Either he receives no information, or the task yields a good outcome or a bad outcome. Thus, at date 1, $s \in \{\emptyset, g, b\}$. Let ψ_s be the principal's posterior belief that the agent has low effort costs, conditional on the output realization. The principal's beliefs about the agent's type will inform his decision to hire the agent or go to the marketplace and approach them to undertake his second task (if it arrives). Let ρ_s be the probability the agent is re-hired if the second task arrives, based on the signal $s \in \{\emptyset, g, b\}$.

We assume that if the principal does not hire *some* agent to perform their task, their payoff is extremely low. That is, given the parameters $\underline{e}, q, c_h, c_\ell$ and Δ_u, the principal is better off hiring an agent from the pool of the agents rather than leaving the task undone.

Further, recall that the outcome of a given task is not contractible. Therefore, on a given task, the wage offered to the agent is just a fixed amount, regardless of the task outcome. Then, if the relationship is terminated at date 1, the outcomes for the agent and principal are as follows.

Lemma 1 *Suppose that either the principal or the agent terminate the relationship at date 1. Then,*

i) The agent is hired by another principal and receives an expected payoff of $\bar{w}$.

ii) The principal hires another agent and receives an expected payoff equal to $\underline{e}u_g+(1-\underline{e})u_b-\bar{w}-\bar{c}\underline{e}^2$

Notice that the type of the agent is match-specific. Thus, both the high and low cost agent anticipate the same payoffs if they quit the relationship and return to the pool to find another principal.

Of particular interest are the cases in which the principal and agent interact for more than one period, i.e., form a relationship. If the relationship continues after one period (i.e., the agent is re-hired) the principal offers a contract $(w_{\theta 2}, e_{\theta 2})$ for the second task. There are two possibilities for this contract. The principal may be able to commit to the long-term contract at date 0. In this case, the contract offered to type θ is $(w_{\theta 1}, e_{\theta 1}, \rho_s, w_s, e_s)$, where each of ρ_s, e_s, and w_s can take on 3 values, depending no the realization of the date 1 signal. Alternatively, the principal cannot commit to the long-term contract at date 0. Then, the date 0 contract is $(w_{\theta 1}, e_{\theta 1})$. The contract at date 1, (ρ_s, w_s, e_s) must be a best response to observed events.

Recall that before performing the first task, the agent finds out if he is a good match for the principal, or in other words if the agent is the low cost type (c_ℓ). He cannot credibly communicate this to the principal and so the principal updates his beliefs based on any information he obtains about how successful the agent was in performing the task. He thus updates on one of three possible signals, $s \in \{\emptyset, g, b\}$. Let ψ_s denote the posterior probability that the agent is the low-cost type. The posterior belief is determined as follows. Denote the effort provided by type θ at date 0 as $e_{\theta 1}$. Then, the probability of seeing y_g given type θ is $e_{\theta 1}$. Therefore,

$$\psi_g \quad = \quad \Pr(\theta = \ell \mid y_g) = \frac{q e_{\ell 1}}{q e_{\ell 1} + (1-q) e_{h1}} \tag{1}$$

$$\psi_b \quad = \quad \Pr(\theta = \ell \mid y_b) = \frac{q(1 - e_{\ell 1})}{1 - q e_{\ell 1} - (1-q) e_{h1}}. \tag{2}$$

Here, $e_{\ell 1}$ and e_{h1} are endogenous variables, and depend both on the wage offered by the principal in the first period, and whether or not the principal can commit to a wage conditional on rehiring.

It is worth noting that the last period is somewhat special, in that both the principal and the agent know that the relationship will terminate. Therefore, as there is no room to provide incentives as a function of his effort, the agent will always put in the lowest possible effort, $\underline{e}$. Irrespective of this, not all agents are similar in that one who worked for the principal in the previous period is more efficient at providing good outcomes. Implicitly, the agent, whatever his inherent match with the principal, is more effective because of his first-period experience (recall that the probability of the good outcome if the first-period agent is rehired is $e_1 + \underline{e} \geq 2\underline{e}$). This effect encourages the principal to use an agent again.

The countervailing force is that after working for a principal, the agent has a sense of how easy it is for him to perform the required tasks — in other words, he knows his type. The agent who finds it costly to exert effort requires appropriate compensation for doing so.

Because $c_\ell < \bar{c}$, these two effects both work in the same direction if the principal can succeed in rehiring only the low-cost agent. As mentioned above, at date 1 all agents provide the minimal level of effort, $\underline{e}$. Essentially, after learning that he is well-matched to the task at hand, the low-cost agent is willing to take on the task at a lower wage than the high-cost agent, and therefore at a lower wage than a newly-hired agent as well. We characterize the optimal contract under two possible cases — either the principal can commit to a contract, or cannot do so. The crucial trade-off is whether the principal can use the promise of a high date 1 wage to provide incentives to the agent at date 0. There are two benefits to the principal of inducing more than the minimum effort at date 0. First the outcome is more likely to be good at date 1 or date 2. Second, if another task arrives at date 1, the agent has a significant effort advantage over any new agent in providing the services. As we show in Section 3 below, these two possibilities have different implications for securities markets.

2.1 Optimal Contract with no Commitment

As a benchmark, the first type of relationship we consider is one that resembles centralized markets. Specifically, even though a principal and an agent have interacted in the past, they do not enter into multi-period agreements about what will happen conditional on being rehired. In other words, relationships are unimportant and broker-dealer services are a commodity, traded in the spot market. In such markets, the inability of the principal to commit to pay a specific wage conditional on rehiring the agent, effectively prevents the principal from providing incentives to the agent and thus better outcomes for himself.

Specifically, regardless of the principal's preferences over rehiring one or both agents, if there is no commitment, each type of agent provides minimal effort at both dates.

Proposition 1 *Suppose that the principal cannot commit to a wage if he rehires the agent. Then the only equilibrium is one in which both types of agents provide minimal effort $\underline{e}$ at both dates.*

Suppose the principal offers a contract at date 1 that provides a wage $w_2 = \bar{w} + c_\ell \underline{e}^2$. Then, the low-cost agent will accept, but the high-cost agent will reject the contract. To induce the high-cost agent to accept the contract at date 1, the wage must be raised to $\bar{w} + c_h \underline{e}^2$. Notice that because both types provide the same effort, and output is not contractible, the types cannot be separated out by the contract. That is, in this scenario, the low-cost type must also be paid the higher wage. The extra cost incurred as a result of overpaying the low-cost type, in turn, depends on the principal's posterior beliefs given the signal, ψ_s.

The principal's decision on which type of agent to retain is summarized in Lemma 2.

Lemma 2 *Suppose that the the principal has belief ψ_s that an agent is the low cost type. Then, the principal retains both the low- and high-cost agents if*

$$\Delta_u \quad \geq \quad \left(q + \frac{\psi_s}{1 - \psi_s}\right)(c_h - c_\ell)\underline{e}. \tag{3}$$

Conversely, if (3) is violated, the principal retains only the low-cost agent.

Proposition 2 provides the equilibrium outcome in the no-commitment case.

Proposition 2 *If the principal cannot commit to a wage if he rehires the agent, then,*

(i) The wage in the first period is $\bar{w} + \bar{c}\underline{e}^2$.

(ii) In the second period, if

(a) $\Delta_u \geq \left(q + \frac{\psi_s}{1-\psi_s}\right)(c_h - c_\ell)\underline{e}$ *the agent performs the second task if it arrives (probability* ϕ*), and the wage is* $\bar{w} + c_h\underline{e}^2$.

(b) $\Delta_u < \left(q + \frac{\psi_s}{1-\psi_s}\right)(c_h - c_\ell)\underline{e}$*, then with probability* ϕq*, the agent performs a second task and the wage is* $\bar{w} + c_\ell\underline{e}^2$*, while with probability* $\phi(1-q)$*, a different agent performs the task and receives* $\bar{w} + \bar{c}\underline{e}^2$.

Part (ii) (a) provides the condition under which the principal is better off rehiring both types of agent at date 1, rather than screening out the high-cost type. Suppose the principal can screen out the high-cost agent at date 1. They know that, if re-hired, the low-cost agent will provide minimal effort ($\underline{e}$) at date 1. The lack of commitment implies that, in this case, the principal will try to hold the low-cost agent down to the smallest wage at which the agent participates. This wage is $\bar{w} + c_\ell\underline{e}^2$. Now, a contract with wage equal to $\bar{w} + c_\ell\underline{e}^2$, in turn, successfully screens out the high-cost agent at date 1. Any new agent hired at that date faces a one-period problem, and provides minimal effort.

2.2 Optimal Contract with Commitment

We now turn to the case in which the ability to forge a relationship helps the principal. In particular, we characterize a contract that has the following features:

(a) If there is no signal, the agent is rehired at a wage equal to that implied by the IR constraint of the low-cost type. In this case, high-cost agent will definitely move to another job.

(b) If the signal is good, the agent is rehired at some wage strictly greater than that implied by the IR constraint of the low-cost type. Such a wage may be too low for the high cost agent. In this case, the agent will move to another job.

(c) If the signal is bad, the agent is rehired at a wage equal to that implied by the IR constraint of the low-cost type. In this case, high-cost agent will definitely move to another job.

The key feature of such a contract is that an agent has an incentive to work hard (i.e., provide more than the minimal level of effort) at date 0. As a result, the principal rewards them with a higher wage in the contract at date 1.

With this contract in mind, we can determine the optimal effort exerted by both types of agent.

Lemma 3 *Suppose that the principal offers a wage* w_2*. Then, for type* θ*, the optimal first period effort is*

$$e_\theta^* = \max\left\{\frac{\phi p(w_2 - \bar{w} - c_\theta\underline{e}^2)}{2c_\theta}, \underline{e}\right\}. \tag{4}$$

Notice, as one might expect, the agent who determines that he is the high cost type will always exert weakly lower effort in the first period. The actual effort level depends on the wage, w_2, which will be determined by the preferences of the principal and how important it is for him to avoid the bad outcome. Notice, also, that it is the wage in the second period that determines the effort in the first period. This is because the principal cannot contract on the output, because it involves his personal assessment of how well the financial advice suited his needs. However, he can use his ability to commit to a wage conditional on retaining the agent that induces the agent to invest in the relationship in the first period.

This intuition is similar to that in Holmstrom (1999). In his career concerns model, the agent has a productivity type that is not known to either principal or agent. Beliefs about the type vary with output, so a high output implies a high posterior expectation of productivity. All firms see this, and so the agent's wage in the labor market depends on firms' posterior expectation of productivity. So if the agent works hard today, output is likely to be higher, leading to higher wages tomorrow. The difference with our model, is that in our environment, productivity depends on the quality of the match between principal and agent. Thus, knowing their productivity in the match with the current principal does not let the market infer anything about their productivity in the match with another principal. If, in addition, we assume that output is non-contractible (because it is an amorphous "satisfaction" on the part of the principal), the only way to induce effort at date 0 is to promise the agent a high wage in the second task. That promise, in turn, requires commitment by the principal at date 0 to future wages.

Proposition 3 *Suppose the principal can commit to a wage decision for the second task. Specifically, the principal credibly indicates that if he rehires the agent, he will pay him a specified wage. The following is the optimal contract for c_h sufficiently large:*

(a) If there is no signal, the second period wage is $w_2^* = \bar{w} + c_\ell \underline{e}^2$. The agent accepts it if he is the low cost type, else he quits and the principal hires another agent at $\bar{w} + \bar{c}\underline{e}^2$.

(b) If the signal is good, the wage is $w_2^* = \bar{w} + c_\ell \underline{e}^2 + \frac{\{q+\phi(p+q(1-p)\}\Delta_u}{2\phi pq}$. With probability $1-q$, the agent rejects it, and a new one is hired.

(c) If the signal is bad, the principal offers the wage $w_2^* = \bar{w} + c_\ell \underline{e}^2$. The agent accepts it if he is the low cost type, else he quits and the principal hires another agent at $\bar{w} + \bar{c}\underline{e}^2$.

3 Results and Interpretation

Our contracting framework is stylized, however we can use it to shed some light on the outcomes and financial arrangements in long term relationships. This is because over-the-counter financial markets in the US encompass relatively standardized products such as corporate bonds, in which transaction quality is relatively easy to track, and there is third party verification of the investment characteristics (such as analysts) to truly bespoke securities such as equity swaps or securitized instruments. With appropriate parameterizations, our model can shed light on some of these cases.

First, consider transactions in financial securities that are relatively standardized such as corporate bonds. In this case, the broker-dealer provides little or no investment advice, but might provide information on available liquidity. For the principal, the difference between a good and bad outcome will be the advantage in execution quality he receives from using the specific broker. In this case, Δ_u, the difference between high and low quality executions will be small. Further, given the reporting requirements on corporate bonds, the probability that he receives a signal about the performance of the agent will be high, as will the probability that he receives another task. By contrast, consider a bespoke security such as the infamous ABACUS structure. The likelihood of receiving a signal on the success of the security is low (before another task arrives), and the difference in payoff between a good and a bad outcome for the principal is likely to be high.

We first start by observing that relationships are valuable for the principal

Corollary 3.1 *The payoff to the principal is weakly higher in any market if he can form a relationship.*

We do not model relationship formation, but the outcomes conditional on a relationship being in place. Given the somewhat complex business models of most broker-dealers, various other characteristics besides performance in over the counter markets could determine whether or not a relationship is feasible.

The fees and compensation to the agent and how they vary based on the characteristics of the relationship. Notice, that in this simple contracting framework, the "wage" offered to the agent includes all possible markups over the value of the asset, including direct compensation and securities markups. If an intermediary is acting as a broker-dealer, then compensation will be determined by spreads. Conversely, for more complex transactions or products, the spreads could be lower, but the direct or fixed fees could be higher. We therefore stress that our prediction is on the total compensation paid to the agent and this is weakly higher if the principal and agent have a relationship. Notice, that the principal in this case is getting what he paid for. As we have pointed out above, he is weakly better off for having committed to a relationship and the higher fees do not imply that he is worse off.

Corollary 3.2 *Fees for the principal are always weakly higher if he has a relationship with the agent. Thus, observed markups are weakly higher if the principal and the agent have a relationship.*

The empirical implication of Corollary 3.2 is that the average fees remitted when principal agent pairs form relationships are higher than if they randomly change. In particular, markets that are characterized by stable relationships and low switching should have higher fees. At first glance, this corollary appears counter-intutive, and seems to contradict the stylized results reported in the empirical literature. We note however, that this corollary is true, holding everything fixed. In particular, conditional on being in a relationship, the larger the volume of services required by the principal, the lower the fees.

Corollary 3.3 *The higher the business volume, the lower the markup.*

Thus, our framework implies that it is important to distinguish between the existence of a relationship and the size of that relationship. Our proxy is ϕ, which is the probability that another task arrives.

There is a trend to make more information available about trades and prices in over the counter markets. The following corollary provides a direct link between the principal's ability to verify the agent's performance (for example through ex post trade transparency) and the markups that are paid.

Corollary 3.4 *The more likely the principal is to receive a signal about the agent's effort, p, the lower is the observed markup.*

The intuition for this result is as follows. The principal designs his contract to provide incentives to the agent to put in high effort in the first period. If there is little or no chance of the principal being able to observe the outcome of the task and therefore to realize that the agent put in high effort, the principal has to offer the agent a massively high wage to induce the effort that he wants in the first period. In other words, w_2 is the wage conditional on seeing the realization of the task. Thus, transparency makes it cheaper for the principal to induce high effort from the agent.

Another benefit of transparency is that it leads to fewer "bad" outcomes. Specifically, in as much as transparency leads to higher effort, it also means that the probability the principal receives a higher output is higher. If we associate bad outcomes as hedging fails or inappropriate investments, a side benefit of transparency is that it may result in a more stable economic environment.

Corollary 3.5 *Markets that are more transparent lead to more stable economic environments.*

4 Conclusion

There has been an increased regulatory and academic interest in over-the-counter markets, both because so many types of assets are traded on such markets and are central to the viability of many systemically important financial institutions. In this paper, we have take a somewhat different view of markets and allow for the possibility that relationships can be tailored to the match between the client (principal) and the agent (a broker-dealer/investment advisor).

We take the position, that while most models assume that the principal knows what asset he wants to buy and verifies that the agent did so efficiently; in many over the counter markets (in particular bespoke securities) or securities with unusual cash flow profiles, the principal acquires a position to serve a financial need, and not necessarily because he wanted that specific security. An immediate implication of this assumption is that the service itself is not contractible or even verifiable.

A contracting approach is fundamentally different to a random or assortative matching model. Besides being a natural way to examine long term relationship, it provides a way to analyze transactions in which a broker dealer or similar institutions can materially affect the financial position of an agent.

5 Appendix

Proof of Lemma 1

(i) The agent returns to the pool and receives his reservation utility.

(ii) The principal hires someone from the pool and has a relationship with them for one period. The agent knows their own type at the time effort is chosen, but not when they sign the contract. In other words, the IC constraint depends on type, but the IR constraint does not. We still have the case that $w_h = w_\ell = w$. Therefore, the agent's IC constraint is

$$e \in \arg\max_{\tilde{e}} \tilde{e}w + (1 - \tilde{e})w - c_\theta \tilde{e}^2, \tag{5}$$

whereas the IR constraint is

$$w - \bar{c}e^2 \geq \bar{w}. \tag{6}$$

It is immediate that each type provides effort $e = \underline{e}$. The wage is therefore $w^* = \bar{w} + \bar{c}\underline{e}^2$. Ex post, the low type earns more than their reservation utility and the high type earns less than their reservation utility. The principal's expected utility follows.

■

Proof of Lemma 2

The principal has some posterior belief (based on the signal) on whether the agent is the high-cost or low-cost type. Recall, the posterior probability of the agent being the high-cost type as ψ_s. (When there is no signal, $\psi_\emptyset = q$.) From the principal's point of view, there are two possible wages in the second period:

1. The principal offers a wage that retains both agents in the second period. Then, the wage must satisfy the IR constraint of the high-cost type.

$$\begin{aligned} w_h - c_h\underline{e}^2 &= \bar{w} \\ w_h^* &= \bar{w} + c_h\underline{e}^2. \end{aligned} \tag{7}$$

The principal's utility in this case is

$$(\underline{e} + \psi_s e_\ell^* + (1 - \psi_s)e_h^*)u_g + (1 - \underline{e} - \psi_s e_\ell^* - (1 - \psi_s)e_h^*)u_b - \left(\bar{w} + c_h\underline{e}^2\right). \tag{8}$$

2. The principal offers a wage which only the low-cost type accepts. In this case, the wage satisfies the IR constraint of the low-cost type. Therefore,

$$w_\ell^* = \bar{w} + c_\ell\underline{e}^2. \tag{9}$$

Further, with probability $1-\psi_s$ the agent is the high cost type and thus quits and so the principal has to hire a new agent. The overall expected utility from this case is therefore

$$\psi_s[(\underline{e}+e_\ell^*)u_g+(1-\underline{e}-e_\ell^*)u_b-\bar{w}-c_\ell\underline{e}^2]+ \\ (1-\psi_s)[\underline{e}u_g+(1-\underline{e})u_b-\bar{w}-\bar{c}\underline{e}^2]. \tag{10}$$

Comparing the two expected utilities of the principal, Case 1 (the principal retains both agents) is preferred if and only if

$$[\psi_s(\underline{e}+e_\ell^*)+(1-\psi_s)(\underline{e}+e_h^*)]u_g+[1-\psi_s(\underline{e}+e_\ell^*)-(1-\psi_s)(\underline{e}+e_h^*)]u_b-\left(\bar{w}+c_h\underline{e}^2\right)\geq \\ \psi_s[(\underline{e}+e_\ell^*)u_g+(1-\underline{e}-e_\ell^*)u_b-\bar{w}-c_\ell\underline{e}^2]+(1-\psi_s)[\underline{e}u_g+(1-\underline{e})u_b-\bar{w}-\bar{c}\underline{e}^2]. \tag{11}$$

Recall that $\bar{c}=qc_\ell+(1-q)c_h$. Then, the condition reduces to:

$$(1-\psi_s)e_h^*\Delta_u \geq (\psi_s+q(1-\psi_s))(c_h-c_\ell)\underline{e}^2 \tag{12}$$

$$e_h^*\Delta_u \geq \left(q+\frac{\psi_s}{1-\psi_s}\right)(c_h-c_\ell)\underline{e}^2. \tag{13}$$

Substituting $e_h^*=\underline{e}$ on the left-hand side of the last equation yields condition (3) in the statement of the Lemma. ■

Proof of Proposition 1

Consider date 1. Either a task arrives or does not. If no task arrives, the principal has no action at date 1. Therefore (given the assumption of equal discount rates), it is weakly optimal to wait until date 2 and pay the agent at date 2. In this case, the agent receives $w_{\theta 1}$ at date 2.

Suppose that a task arrives, then the principal knows that the output was g or b, or there is no signal. If the principal fires the agent, he receives a payout given by Lemma 1 (ii). However, if the principal retains the agent then the date 1 task is the last task the agent will perform, so they provide effort $\underline{e}$. Even though there is no signal, note that by date 1, the agent knows their type, and for the same level of effort, the current agent generates a higher likelihood of obtaining the good output y_g.

At time 1, the problem solved by the agent of type θ may be represented as follows. Suppose the agent provides effort e. Then:

(i) With probability e, the output on task 1 is y_g, and with probability $1-e$, it is y_b. This output is observed with probability p at date 1.

(ii) If the output is not observed (with probability $1-p$), and the second task arrives (with probability ϕ), the agent is always re-hired if they are the low-cost type. If they are the high-cost type, they are re-hired with probability ρ_h. (In equilibrium, ρ_h must be consistent with inequality (3), substituting in q for ψ_s.)

(iii) Suppose the output is observed and the second task arrives. After seeing the output, the principal offers either (a) a contract that satisfies the indifference condition of the low-cost agent, or (b) a contract that satisfies the indifference condition of the high-cost agent. In particular, the principal prefers (b) when inequality (3) is satisfied.

Note that the principal always wants to re-hire the low-cost agent, regardless of the level of output. Therefore, $\rho_{\ell i} = 1$ for all $i = g, b$.

Observe that the RHS of (3) includes a term $\frac{\psi_s}{1-\psi_s}$. This is clearly greater in the high-output state than in the low-output state (as $\psi_g > \psi_b$). Therefore, we are left with three possibilities:

(a) (3) is satisfied when $s = g$; i.e., good output is observed. There are two sub-cases: (i) (3) is satisfied with equality at $s = g$, in which case $\rho_{hg} \in [0, 1]$, or (ii) (3) is strictly satisfied with $s = g$, in which case $\rho_{hg} = 1$.

(b) (3) is violated when $s = b$; i.e., bad output is observed. Again, there are two sub-cases: (i) (3) is satisfied with equality at $s = b$, in which case $\rho_{\ell g} \in [0, 1]$, or (ii) (3) is strictly violated with $s = b$, in which case $\rho_{\ell g} = 0$. .

(c) (3) is weakly satisfied when $s = b$ but weakly violated when $s = g$. If both inequalities are strict, then $\rho_{hb} = 1$ and $\rho_{hg} = 0$; otherwise, it is possible that either ρ_{hb} or ρ_{hg} is strictly between 0 and 1.

Consider the equilibrium in case (c) when output is observed, that involves rehiring both types of agent if output is not observed. Of course, the conditions for this depend on the endogenous values of $e_{1\ell}$ and e_{1h}. Consider the problem faced by an agent of type θ at date 0. Suppose they provide effort e. With probability p, output is observed. With probability e, output is good. In this case, the principal sets the wage based on the IR condition of the low-cost type. Therefore, the low-cost type earns their reservation utility $\bar{w}$. The high-cost type leaves, and also earns their reservation utility $\bar{w}$. With probability $1 - e$, output is low. In this case, the contract satisfies the IR condition of the high-cost type. The high-cost type earns the reservation utility $\bar{w}$, and the low-cost type earns $\bar{w} + (c_h - c_\ell)\underline{e}^2$. The same payoffs are earned if output is not observed (with probability $1 - p$).

The utility of the low type is therefore:

$$\begin{aligned} U_\ell &= w_1 - c_\ell e^2 + p(e\bar{w} + (1-e)(\bar{w} + (c_h - c_\ell)\underline{e}^2)) + (1-p)(\bar{w} + (c_h - c_\ell)\underline{e}^2) - c_\ell \underline{e}^2 \\ &= w_1 - c_\ell e^2 + p\bar{w} + (1-p)(\bar{w} + (c_h - c_\ell)\underline{e}^2) + p(1-e)(\bar{w} + (c_h - c_\ell)\underline{e}^2) - c_\ell \underline{e}^2. \end{aligned} \quad (14)$$

The derivative with respect to e is:

$$\frac{\partial U_\ell}{\partial e} = -2c_\ell e - p(\bar{w} + (c_h - c_\ell)\underline{e}^2) < 0. \quad (15)$$

Therefore, the optimal level of effort is the minimal effort $\underline{e}$.

The utility of the high type may similarly be expressed as:

$$\begin{aligned} U_h &= w_1 - c_h e^2 + p(e\bar{w} + (1-e)\bar{w}) + (1-p)\bar{w} - c_h \underline{e}^2 \\ &= w_1 - c_h e^2 + \bar{w} - c_h \underline{e}^2. \end{aligned} \tag{16}$$

It is immediate that the optimal level of effort is $e = \underline{e}$.

In cases (a) and (b) both the probability of being re-hired and the wage set for second need is the same after all cases if outcome is observed. So any effort $e > \underline{e}$ does not increase expected income of agent, but is costly.

■

Proof of Proposition 2

First notice that if both agents put in low effort in the first period, then irrespective of the signal, the posterior belief that the agent is of the low cost type is the same as the prior: q. The condition in Lemma 2 then becomes:

$$\Delta_u \geq \left(q + \frac{\psi_s}{1-\psi_s}\right)(c_h - c_\ell)\underline{e}. \tag{17}$$

If this is satisfied, the principal chooses to hire both types of agents, and the lowest fee at which he can do so is $\bar{w} + c_h \underline{e}^2$. If this is violated, he prefers to offer the wage $\bar{w} + c_\ell \underline{e}^2$ which the low cost agent is willing to accept. This occurs with probability q. The high cost agent rejects the wage, which occurs with probability $(1-q)$ and the principal has to attract an agent of unknown type from the pool, as indicated in Lemma 1. The cost for doing so is $\bar{w} + \bar{c}\underline{e}^2$. Finally, note that this occurs if the principal receives a second need, which occurs with probability ϕ.

■

Proof of Lemma 3

Consider the utilities of the two agents. Here, we have

$$\begin{aligned} U_\ell &= w_1 - c_\ell e^2 + \phi[p\{e(w_2 - c_\ell \underline{e}^2) + (1-e)\bar{w}\} + (1-p)(\bar{w} + (c_h - c_\ell)\underline{e}^2)] \\ &= w_1 - c_\ell e^2 + \phi p(w_2 - \bar{w} - c_\ell \underline{e}^2)e + \phi(\bar{w} + (1-p)(c_h - c_\ell)\underline{e}^2). \end{aligned} \tag{18}$$

The first-order condition now implies that

$$e_\ell^* = \frac{\phi p(w_2 - \bar{w} - c_\ell \underline{e}^2)}{2c_\ell}. \tag{19}$$

If $\underline{e}(\underline{e} + 2) < \frac{\phi p(w_2 - \bar{w})}{c_\ell}$, then $e_\ell > \underline{e}$.

For the high-cost type, if $w_2 \geq \bar{w} + c_h \underline{e}^2$, the utility on the second task after high output is $w_2 - c_h \underline{e}^2$. Otherwise, the utility is $\bar{w}$. The utility after low output is $\bar{w}$ (because the high-cost agent leaves). The utility if output is not observed is also $\bar{w}$. Therefore,

$$U_h = w_1 - c_h e^2 + \phi[p(e \max\{\bar{w}, w_2 - c_h \underline{e}^2\} + (1-e)\bar{w}) + (1-p)\bar{w}]. \tag{20}$$

The optimal effort is

$$e_h^* = \begin{cases} \max\{\underline{e}, \frac{\phi p(w_2 - \bar{w} - c_h \underline{e}^2)}{2c_h}\} & \text{if } w_2 > \bar{w} + c_h \underline{e}^2 \\ \underline{e} & \text{otherwise.} \end{cases} \tag{21}$$

■

Proof of Proposition 3

Denote $u_j = u(y_j)$ for $j = g, b$ and $\Delta_u = u_g - u_b$. The principal's utility is determined as follows. On task 1, the low-cost type provides effort e_ℓ^* and the high-cost type effort e_h^*. Suppose c_h is high enough that $e_h^* = \underline{e}$. Then, the utility from task 1 is $(qe_\ell^* + (1-q)\underline{e})u_g + (1 - qe_\ell^* - (1-q)\underline{e})u_b - w_1 = (u_b + (1-q)\underline{e}\Delta_u - w_1) + qe_\ell^*\Delta_u$.

Consider task 2. We assume that c_h is high, so that the high-cost agent is not rehired under any circumstances. In what follows, we use the fact that c_h is high thus not re-hired if there is no signal. Then, the possibilities at date 1 are:

(a) With probability $p\phi(qe_\ell^* + (1-q)e_h^*)$, a good signal and a second task arrive. In this case, (signal g is seen), the wage is w_2. If $w_2 \geq \bar{w} + c_h \underline{e}^2$, both agents stay on and thus, the probability of good output on the second task is

$$\psi_g(e_\ell^* + \underline{e}) + (1-\psi_g)(e_h^* + \underline{e}) = \underline{e} + \psi_g e_\ell^* + (1-\psi_g)e_h^*. \tag{22}$$

If $w_2 < \bar{w} + c_h \underline{e}^2$, (i.e., if condition (3) is violated, and the principal only wishes to retain the low-cost agent) then the high cost agent leaves, and the principal draws another agent from the pool. The probability of good output on task 2 is then

$$\psi_g(e_\ell^* + \underline{e}) + (1-\psi_g)\underline{e} = \underline{e} + \psi_g e_\ell^*. \tag{23}$$

Now, when c_h is large, we have $e_h^* = \underline{e}$. Denote $z = qe_\ell^* + (1-q)\underline{e}$.

Then, multiplying the probability of the outcome times the principal's utility from task 2 in this outcome, we obtain the expected utility of the principal from task 2 as:

$$\begin{aligned} \gamma_g &= z\Big((\underline{e} + \psi_g e_\ell^*)u_g + (1 - \underline{e} - \psi_g e_\ell^*)u_b - \psi_g w_2 - (1-\psi_g)(\bar{w} + \bar{c}\underline{e}^2)\Big) \\ &= z(u_b + \underline{e}\Delta_u - \bar{w} - \bar{c}\underline{e}^2) + z\psi_g(e_\ell^*\Delta_u - (w_2 - \bar{w} - \bar{c}\underline{e}^2)). \end{aligned} \tag{24}$$

Observe that $\psi_g = \frac{qe^*_\ell}{qe^*_\ell + (1-q)\underline{e}} = \frac{qe^*_\ell}{z}$. Therefore, $z\psi_g = qe^*_\ell$, so that we can write

$$\begin{aligned}
\gamma_g &= (qe^*_\ell + (1-q)\underline{e})(u_b + \underline{e}\Delta_u - \bar{w} - \bar{c}\underline{e}^2) + qe^*_\ell(e^*_\ell\Delta_u - (w_2 - \bar{w} - \bar{c}\underline{e}^2)) && (25)\\
&= (1-q)\underline{e}(u_b + \underline{e}\Delta_u - \bar{w} - \bar{c}\underline{e}^2) + qe^*_\ell(u_b + \underline{e}\Delta_u - \bar{w} - \bar{c}\underline{e}^2)\\
&\quad + qe^{*2}_\ell\Delta_u - qe^*_\ell(w_2 - \bar{w} - \bar{c}\underline{e}^2) && (26)\\
&= (1-q)\underline{e}(u_b + \underline{e}\Delta_u - \bar{w} - \bar{c}\underline{e}^2) + qe^{*2}_\ell\Delta_u + qe^*_\ell(u_b + \underline{e}\Delta_u - w_2). && (27)
\end{aligned}$$

(b) With probability $p\phi(1 - qe^*_l - (1-q)e^*_h)$ a bad signal and a second task arrive. In this case (signal b is seen), the wage is $\bar{w} + c_\ell\underline{e}^2$, and thus only the low cost agent will stay on. Thus, the probability of good output in the second period is

$$\psi_b(e^*_\ell + \underline{e}) + (1-\psi_b)\underline{e} = \underline{e} + \psi_b e^*_\ell \tag{28}$$

In this case, the expected utility of the principal on task 2 may be written as:

$$\begin{aligned}
\gamma_b &= (1-z)\Big((\underline{e} + \psi_b e^*_\ell)u_g + (1 - \underline{e} - \psi_b e^*_\ell)u_b - \bar{w} - (\psi_b c_\ell + (1-\psi_b)\bar{c})\underline{e}^2\Big)\\
&= (1-z)(u_b + \underline{e}\Delta_u - \bar{w} - \bar{c}\underline{e}^2) + (1-z)\psi_b(e^*_\ell\Delta_u + (\bar{c} - c_\ell)\underline{e}^2). && (29)
\end{aligned}$$

Now, observe that $\psi_b = \frac{1-qe^*_\ell}{1-qe^*_\ell-(1-q)\underline{e}} = \frac{1-qe^*_\ell}{1-z}$. Therefore, $(1-z)\psi_b = 1 - qe^*_\ell$. Hence,

$$\begin{aligned}
\gamma_b &= (1 - qe^*_\ell - (1-q)\underline{e})(u_b + \underline{e}\Delta_u - \bar{w} - \bar{c}\underline{e}^2) + (1 - qe^*_\ell)(e^*_\ell\Delta_u + (\bar{c} - c_\ell)\underline{e}^2) && (30)\\
&= (1 - (1-q)\underline{e})(u_b + \underline{e}\Delta_u - \bar{w} - \bar{c}\underline{e}^2) + (\bar{c} - c_\ell)\underline{e}^2\\
&\quad - qe^*_\ell(u_b + \underline{e}\Delta_u - \bar{w} - c_\ell\underline{e}^2) + e^*_\ell\Delta_u - qe^{*2}_\ell\Delta_u. && (31)
\end{aligned}$$

(c) With probability $(1-p)\phi$ no signal is seen but a second task arrives. Because c_h is high, the principal only retains the low-cost agent. Thus, the second period wage is $\bar{w} + c_\ell\underline{e}^2$. The probability of good output on the second task is

$$q(e^*_\ell + \underline{e}) + (1-q)\underline{e} \;=\; \underline{e} + qe^*_\ell \tag{32}$$

Therefore, the expected utility of the principal in this circumstance is

$$\begin{aligned}
\gamma_\emptyset &= (\underline{e} + qe^*_\ell)u_g + (1 - (\underline{e} + qe^*_\ell))u_b - \bar{w} - (qc_\ell + (1-q)\bar{c})\underline{e}^2 && (33)\\
&= (u_b + \underline{e}\Delta_u - \bar{w} - (qc_\ell + (1-q)\bar{c})\underline{e}^2) + qe^*_\ell\Delta_u. && (34)
\end{aligned}$$

Now, the principal's overall utility in the game may be written as

$$V = (u_b + (1-q)\underline{e}\Delta_u - w_1) + qe^*_\ell\Delta_u + \phi p(\gamma_g + \gamma_b) + \phi(1-p)\gamma_\emptyset. \tag{35}$$

Let Γ denote the sum of all terms in V that are invariant to w_2. Note, in particular, that e_ℓ^* depends on w_2. Then, we can write

$$\begin{aligned} V &= \Gamma + qe_\ell^*\Delta_u + \phi p\Big[qe_\ell^{*2}\Delta_u + qe_\ell^*(u_b + \underline{e}\Delta_u - w_2) - qe_\ell^*(u_b + \underline{e}\Delta_u - \bar{w} - c_\ell\underline{e}^2) \\ &\qquad + e_\ell^*\Delta_u - qe_\ell^{*2}\Delta_u\Big] + \phi(1-p)qe_\ell^*\Delta_u \qquad (36) \\ &= \Gamma + qe_\ell^*\Delta_u + \phi pe_\ell^*\Delta_u - \phi pqe_\ell^*(w_2 - \bar{w} - c_\ell\underline{e}^2) + \phi(1-p)qe_\ell^*\Delta_u \qquad (37) \\ &= \Gamma - \phi pqe_\ell^* w_2 + \phi pqe_\ell^*(\bar{w} + c_\ell\underline{e}^2) + (q + \phi(p + q - pq))\Delta_u e_\ell^*. \qquad (38) \end{aligned}$$

Now, from Lemma 3, recall that $e_\ell^* = \frac{\phi p(w_2 - \bar{w} - c_\ell\underline{e}^2)}{2c_\ell}$. Therefore, we can write

$$\phi p w_2 = 2c_\ell e_\ell^* + \phi p(\bar{w} + c_\ell\underline{e}^2). \qquad (39)$$

Substituting into the expression for V in equation (38), we obtain

$$\begin{aligned} V &= \Gamma - 2qc_\ell e_\ell^{*2} - \phi pqe_\ell^*(\bar{w} + c_\ell\underline{e}^2) + \phi pqe_\ell^*(\bar{w} + c_\ell\underline{e}^2) + (q + \phi(p + q - pq))\Delta_u e_\ell^* \qquad (40) \\ &= \Gamma - 2qc_\ell e_\ell^{*2} + [q + \phi(p + q(1-p))]\Delta_u e_\ell^* \qquad (41) \end{aligned}$$

The first-order condition in e_ℓ now directly yields

$$e_\ell^* = \frac{\{q + \phi(p + q(1-p))\}\Delta_u}{4qc_\ell}. \qquad (42)$$

Substituting back into equation (39) and dividing throughout by ϕp, we obtain

$$w_2^* = \bar{w} + c_\ell\underline{e}^2 + \frac{\{q + \phi(p + q(1-p)\}\Delta_u}{2\phi pq} \qquad (43)$$

■

Proof of Corollary 3.1

From Proposition 1, both agent types put in minimal effort. Under the commitment case, the principal could commit to the same wages as in Proposition 1, but chooses not to. Therefore he is always weakly better off when he chooses to induce higher effort.

■

Proof of Corollary 3.2

In the optimal contract, wages are increasing in the effort that the agent exerts. If an agent exerts higher effort, he receives more compensation and therefore the total fees paid are higher. ■

Proof of Corollary 3.3

Note that we can write $w_2^* = \bar{w} + c_\ell\underline{e}^2 + \left\{\frac{1}{2\phi p} + \frac{1}{2q} + \frac{1-p}{2p}\right\}\Delta_u$. The result follows immediately.

■

Proof of Corollary 3.4

Note that we can write $w_2^* = \bar{w} + c_\ell \underline{e}^2 + \left\{ \frac{1}{2\phi p} + \frac{1}{2q} + \frac{1-p}{2p} \right\} \Delta_u$. It is immediate that this is decreasing in p. ■

Proof of Corollary 3.5

The probability of the bad outcome for the principal in each period is $(1 - e)$. Therefore, anything the reduces the effort in either period, will increase the probability of a bad outcome. From Equation 42, the optimal effort is $e_\ell^* = \frac{\{q+\phi(p+q(1-p))\}\Delta_u}{4qc_\ell}$.

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