# Financial Expertise as an Arms Race

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## 1 CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Introduction</td>
<td>2</td>
</tr>
<tr>
<td>3 Key Notation and Terms</td>
<td>2</td>
</tr>
<tr>
<td>4 Financial Expertise as a Deterrent</td>
<td>3</td>
</tr>
<tr>
<td>5 Investing in Expertise</td>
<td>6</td>
</tr>
<tr>
<td>6 Destabilizing Effects of Expertise</td>
<td>7</td>
</tr>
<tr>
<td>7 Parameterization</td>
<td>9</td>
</tr>
<tr>
<td>8 Other Benefits from Financial Expertise</td>
<td>11</td>
</tr>
<tr>
<td>9 Signaling Game with Two-Sided Asymmetric Information</td>
<td>11</td>
</tr>
<tr>
<td>10 Conclusion</td>
<td>14</td>
</tr>
<tr>
<td>10.1 Summary</td>
<td>14</td>
</tr>
<tr>
<td>10.2 Critiques</td>
<td>14</td>
</tr>
<tr>
<td>10.3 Extensions</td>
<td>15</td>
</tr>
<tr>
<td>11 References</td>
<td>16</td>
</tr>
<tr>
<td>12 Appendix</td>
<td>16</td>
</tr>
</tbody>
</table>
2 Introduction

This paper investigates the role that expertise plays in over-the-counter (OTC) financial transactions. The authors argue that financial firms are incentivized to overinvest in financial expertise by hiring highly knowledgeable employees. By gaining expertise, the financial intermediary is able to more accurately process information about the values of assets traded, giving the firm an advantage in bargaining with competitors. However, this advantage can be offset in equilibrium by similar investments in expertise made by the competing trader. This investment in expertise can be destabilizing, however, as it creates a risk of destroying the gains to trade when there is a shock in market volatility. The model in this paper illustrates the incentives for financial market participants to overinvest in financial expertise.

We will see that firms acquire expertise up to a threshold level, after which point additional expertise would result in breakdowns in trade. It is well documented that financial expertise can potentially create adverse selection problems by disrupting trade (Samuelson) and, though adverse selection may be avoidable to some degree when trading, it can be unavoidable in many settings, such as in the classic used cars example (Akerlof). Firms then face a tradeoff between too little expertise, which hurts profits when trading with experts, and too much expertise, which requires price concessions to overcome adverse selection that can swamp gains to trade and disrupt trade altogether. This results in expertise choices being such that tiny increases in volatility can cause trade breakdowns, implying that adverse selection is an equilibrium choice.

In today’s world of finance, financial intermediaries compete to hire top talent from the nation’s best schools. Prior to the financial crisis, these firms had immense human capital, which worked to transform simple securities into complex financial instruments, making it difficult to value the securities. Thus, the firms had an advantage in valuing the products based on their own expertise. However, when volatility increased due to decreasing housing prices and increasing default rates, estimates of the fundamental value of the complex securities became highly uncertain. Though the experts knew less than before with regards to the underlying values of the securities, they still knew more than others, and this asymmetric information increased in importance, as adverse selection disrupted trade.

In sum, expertise helps firms in times of low volatility. Each firm, in anticipation of the other firm’s actions, will invest in expertise up to a threshold level. This will protect the firm against opportunistic trading, and maintain its gains to trade. This is the “arms race”. However, during periods of high volatility, asymmetric information becomes more important, and the information advantage of the seller becomes very valuable. The price increases to a point at which the buyer is not willing to pay, and trade breaks down due to adverse selection. We will see that firms will combat these breakdowns in trade by decreasing their level of expertise.

3 Key Notation and Terms

<table>
<thead>
<tr>
<th>$i, j$</th>
<th>Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>$v$</td>
<td>Seller’s common valuation</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>Private value component; source of gains to trade</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>$s$</td>
<td>Signal of high or low value</td>
</tr>
<tr>
<td>$H, L$</td>
<td>Denotes high or low value of the asset</td>
</tr>
<tr>
<td>$\mu$</td>
<td>Probability that the signal is correct; $\mu_i = \frac{1}{2} + e_i$</td>
</tr>
<tr>
<td>$e_i$</td>
<td>Expertise of agent $i$; $e_i \in \left[0, \frac{1}{2}\right]$</td>
</tr>
<tr>
<td>$p$</td>
<td>Price</td>
</tr>
<tr>
<td>$\bar{e}$</td>
<td>Bound of expertise</td>
</tr>
<tr>
<td>$c(e)$</td>
<td>Cost of obtaining expertise $e$</td>
</tr>
<tr>
<td>$I$</td>
<td>Indicator function</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Difference in high and low volatility values in a low-volatility regime; $\sigma = (v_h - v_l)$</td>
</tr>
<tr>
<td>$\pi$</td>
<td>Probability of a high-volatility regime; conversely $(1-\pi)$ is low volatility</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Multiplier for the difference in high and low volatility values in a high-volatility regime; $\theta \sigma = (v_h - v_l)$</td>
</tr>
<tr>
<td>$\pi^\sigma$</td>
<td>Upper bound on $\pi$; threshold level</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>Multiplier parameter in cost of expertise</td>
</tr>
<tr>
<td>$r(e)$</td>
<td>Revenue from expertise, unrelated to trading games</td>
</tr>
<tr>
<td>$\psi^L_i$</td>
<td>Prob. that the seller has a low signal given that the buyer’s signal is low</td>
</tr>
<tr>
<td>$\Phi^L_{LL}$</td>
<td>Prob. that the value is low given that both parties have a low signal</td>
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</tbody>
</table>

### 4 Financial Expertise as a Deterrent

In the model, financial expertise, including both human capital as well as technological infrastructure, is the ability to value a financial asset accurately under time pressure in response to a trade offer. This is the role of financial expertise that this model will focus on; however, it is clear that there are benefits to financial expertise in other contexts. The reason for this focus is to highlight the destabilizing effects of incentivizing over-investment in financial expertise.

The paper begins with a simple bargaining model in order to illustrate intuition. This simple model demonstrates a trader’s financial expertise as a threat or deterrent against opportunistic bargaining by counterparties, resulting in more favorable terms of trade for the trader. This result holds even though the information gained from expertise is not used in equilibrium. Here, the levels of expertise of the traders are taken as given; later in the paper, this simple model will become a subgame in a more complex model that endogenizes the choice of expertise.

There are two agents in this model, $i$ and $j$, that come together to trade a financial asset. Both agents are assumed risk neutral, and one agent is assigned to be the buyer. Here, the buyer is assumed to be agent $j$. The asset has a common value component, $v$, as well as a private value component, $\Delta$.

Therefore, the buyer’s valuation of the asset is $v + 2\Delta$, while the seller’s valuation is the common value $v$. The source of the gains to trade is given by the private value component, $\Delta$, without which trade would break down. The possible sources of the private value include: a hedging need, unique access to a customer who is willing to overpay, or any other source of value that is not shared by all parties. While all parties know the gains to trade, there is uncertainty in the common value. It is either high, $v_h$, and
or low, \(v\), with equal probability. The difference in possible common values, \((v_h - v_l)\), is a measure for the uncertainty, or volatility in this setting.

The buyer gets all the bargaining power in the ultimatum game, making a take-it-or-leave-it offer to buy the asset at price \(p\). At this point, there is no information about \(v\), and the buyer expects high and low with equal probability. The seller, on the other hand, uses his expertise to obtain information about the asset before responding to the offer. The seller receives a signal, \(s_i \in \{H, L\}\) that the value is high or low, with the accuracy of the signal relying on expertise. The probability of a correct signal is \(\mu_i = \frac{1}{2} + e_i\), where \(e_i \in [0, \frac{1}{2}]\). Therefore, an agent with excellent expertise would know almost the exact common value, while an agent with poor expertise would not be too far off from the uninformed agent expecting either possibility with equal probability. Expertise is the product of prior investment that will be investigated in a later section.

There are two possible cases for this game, first is the case in which the seller’s signal is uninformative \((e_i, \mu_i = \frac{1}{2})\). The buyer offers \(p = E(v)\), the lowest price the seller will accept. Trade always takes place in equilibrium, and the buyer gets the entire surplus \((2\Delta)\), while the seller gets no surplus.

The case in which the seller’s signal is informative \((e_i > 0)\) is more complicated. In this case, if the buyer offers \(p = E(v)\), the seller only accepts when his signal is high, thus eliminating half the gains to trade. The buyer anticipates that he will overpay whenever trade does occur and has two possible responses. First, the buyer could offer the lowest possible price, given that the seller will walk away unless he has a low signal, shown here:

\[
p^* = E(v | s_i = L) = (1 - \mu_i)v_h + \mu_i v_l
\]

When the seller gets a high signal at this price, trade breaks down, and the buyer’s expected payoff is:

\[
\frac{1}{2} (2\Delta + E(v | s_i = L) - p^*) = \Delta
\]

and the expected surplus for the seller is zero.

Alternatively, the buyer can offer a price higher than \(p = E(v)\), hoping that the seller will accept regardless of his signal. The lowest price at which the seller will always accept is:

\[
p^{**} = E(v | s_i = H) = \mu_i v_h + (1 - \mu_i)v_l
\]

Trade always occurs when this higher price is offered, and the loss of gains to trade is avoided. Surplus is then shared with the seller, giving the buyer expected surplus of:

\[
E(v) + 2\Delta - p^{**} = 2\Delta - (v_h - v_l) \left(\mu_i - \frac{1}{2}\right)
\]

\[
= 2\Delta - (v_h - v_l)e_i
\]

The seller’s expected surplus at this price (for both signals):

\[
E[p^{**} - E(v | s_i)] = p^{**} - E(v)
\]
\[
\begin{align*}
&= (v_h - v_l) \left( \mu_i - \frac{1}{2} \right) \\
&= (v_h - v_l)e_i
\end{align*}
\]

(5)

Here, without acting on his expertise after the offer is made, the seller is able to extract a higher price.

The only candidate equilibrium offers are then \( p^* \) and \( p^{**} \) since the buyer strictly prefers a lower price, given the probability the seller accepts. The buyer then chooses whichever equilibrium offers the higher expected payoff to him. He offers the higher price \( p^{**} \) if:

\[
2\Delta - (v_h - v_l)e_i \geq \Delta
\]

(6)

or, equivalently:

\[
e_i \leq \bar{e} \equiv \frac{\Delta}{v_h - v_l}
\]

(7)

An analogous case, in which the seller is the proposer, is outlined in the appendix.

The tradeoffs for the buyer are that paying a higher price preserves gains to trade, but some of those gains must be shared with the seller. In order to keep the seller from responding to his information, the buyer must pay more when that information is more accurate, or when financial expertise is greater. This trade-off is the driver of the arms race in the model, however this model is limited by the bound in condition (7). If the seller’s financial expertise is too high, the buyer switches to a lower offer in which the seller earns no surplus and trade breaks down due to adverse selection half of the time. Because the bound on expertise tightens if volatility \((v_h - v_l)\) rises relative to gains to trade \((\Delta)\), abnormally high volatility might inhibit trade for investments in expertise that allow for efficient trade normally.

As can be seen from (3), the higher the seller’s expertise, the higher the price to keep him from using the information in responding to an offer. However, once an offer is made, his information is not used. Therefore, the only use of the information in equilibrium is as a deterrent, given that the higher price is offered.

It can be shown, and is in the appendix of the paper, that the same exercise shown here can be carried out when the seller is the first mover and the buyer receives a signal before responding. The only difference is that the price offered that ensures efficient trade is the buyer’s valuation given a low signal. The bound on expertise given by (7) still holds. The important point is that when the agents invest in expertise, they do not know whether they will be making or responding to an offer. This is analogous to financial intermediaries sometimes in need of liquidity and sometimes needing to supply liquidity on short notice.

Another assumption of the paper is that financial expertise has no social value. This assumption allows for the highlighting of incentives to overinvest in financial expertise by showing that they do so when it has no social value. However, some situations in which financial expertise could have social value include: greater expertise in search could help match higher value buyers with lower value sellers, greater expertise could assist in identifying opportunities to better share risk and avoid taxes, and greater expertise could improve price efficiency and lead to better coordinated investment and
operating decisions by firms. Regardless of these benefits, if the incentives presented still exist, then overinvestment in expertise should be expected.

In this model, both traders have expertise. However, in the actual economy, it is obvious that there are market players with no expertise. Such uniformed traders are often referred to as “noise traders.” However, as long as there are times in which financial intermediaries have to trade with each other, instead of noise traders, the deterrent role of expertise modeled in this paper is relevant.

5 INVESTING IN EXPERTISE

This section considers the equilibrium choices of expertise, and provides conditions under which the unique equilibrium involves all traders investing up to this boundary. We consider a two-stage game, treating the above trading game as the second stage. During the first stage, traders acquire expertise at a cost of $c(e_i)$, for level of expertise $e_i$, with $c'(e) > 0$ and $c''(e) > 0$.

In stage 1, traders do not know whether they will be buyers or sellers in stage 2. The authors impose this restriction in order to express the idea that sometimes firms seek liquidity, and sometimes they supply it. From the previous section, we know that if agent j’s expertise is $e_j \leq \bar{e} = \frac{\Delta}{(v_h - v_l)}$, then agent i’s expected payoff in any subgame where he is the buyer is $2\Delta - (v_h - v_l)e_j$, and his payoff when he selling is $(v_h - v_l)e_j$, as long as $e_i \leq \bar{e}$. Since he has equal probability of being a buyer or seller, his expected payoff in each subgame is equal to

$$\Delta + \frac{1}{2}(v_h - v_l)(e_i - e_j). \quad (10)$$

In a Nash equilibrium, trader i takes his counterparties’ actions as given, and the effect of a trader’s choice of expertise is independent of that of his opponent. Expertise payoff increases up to the threshold level, and both agents will invest up to that point, when expertise is neutralized. The expected surplus is shared equally between the traders, with each receiving $\Delta$. We can generalize the above equation by find the expected payoff for agent i in any given trade by

$$\frac{1}{2} e_i(v_h - v_l) I \left( e_i \leq \frac{\Delta}{v_h - v_l} \right) + \frac{1}{2} \left[ \Delta + (\Delta - e_j(v_h - v_l)) I \left( e_j \leq \frac{\Delta}{v_h - v_l} \right) \right] \quad (11)$$

where I is an indicator function to ensure that the level of expertise is below threshold level. The first term represents responder payoff, and the second term represents the proposer payoff. Since each agent’s choice of expertise is independent of the other agent’s choice, agent i will invest in expertise by maximizing the function.
\[
\frac{1}{2} e_i (v_h - v_l) I \left( e_i \leq \frac{\Delta}{v_h - v_l} \right) - c(e_i). \tag{12}
\]

That is, since agent \(i\)'s level of expertise only affects his payoff when he is the responder, he will maximize that term, minus the cost of obtaining the expertise. The first-order condition imposes that all agents acquire \(\bar{e}\) level of expertise if \(c'(\bar{e}) \leq \frac{1}{2} (v_h - v_l)\), meaning that firms will acquire expertise as long as the marginal cost of expertise is less than the marginal gain from trade. If this inequality does not hold, then agents acquire \(\hat{e}\), which satisfies \(c'(\hat{e}) = \frac{1}{2} (v_h - v_l)\). Strict convexity of the cost curve means that no other expertise level will provide the same payoff, so the equilibrium will be unique.

6 Destabilizing Effects of Expertise

In the first two sections, investments in expertise were simply wasteful; in this section the overinvestment in expertise causes problems. This happens when a jump in volatility leads to breakdowns in trade (or illiquidity) due to adverse selection because firms can neither costlessly nor immediately adjust their expertise.

Common values are now drawn from two possible regimes: low volatility, with probability \(1 - \pi\), where \((v_h - v_l) = \sigma\); and high volatility, with probability \(\pi\), where \((v_h - v_l) = \theta \sigma\) with \(\theta > 1\). In the high probability case, the two possible common values are farther apart. Considering the same steps as the last section with stochastic volatility, the expected payoff for agent \(i\) in the trading subgame is given by (14):

\[
\frac{1}{2} \left[ (1 - \pi) e_i \sigma I \left( e_i \leq \frac{\Delta}{\sigma} \right) + \pi e_i \theta \sigma I \left( e_i \leq \frac{\Delta}{\theta \sigma} \right) \right]
+ \frac{1}{2} \left[ \Delta + (1 - \pi)(\Delta - e_j \sigma) I \left( e_j \leq \frac{\Delta}{\sigma} \right) + \pi (\Delta - e_j \theta \sigma) I \left( e_j \leq \frac{\Delta}{\theta \sigma} \right) \right]
\]

The first term in the brackets still represents the expected payoff for agent \(i\) when he is a seller and the second term in the brackets represents his expected payoff when he is buyer. The optimal strategies are again independent, so agent \(i\)'s optimal investment in expertise will maximize (15):

\[
\frac{1}{2} \left[ (1 - \pi) e_i \sigma I \left( e_i \leq \frac{\Delta}{\sigma} \right) + \pi e_i \theta \sigma I \left( e_i \leq \frac{\Delta}{\theta \sigma} \right) \right] - c(e_i)
\]

We now have four candidates for the equilibrium level of expertise:

i. the highest level of expertise that allows for efficient trade with low volatility: \(\tilde{e}_l \equiv \frac{\Delta}{\sigma}\)

ii. the highest level of expertise that allows efficient trade with high volatility: \(\tilde{e}_h \equiv \frac{\Delta}{\theta \sigma}\)

iii. the level of expertise that satisfies the first order condition with low volatility: \(\hat{e}_l\) such that:

\[
\frac{1}{2} (1 - \pi) \sigma = c'(\hat{e}_l) \tag{16}
\]

iv. the level of expertise that satisfies the first order condition with high volatility: \(\hat{e}_h\) such that:

\[
\frac{1}{2} [(1 - \pi) \sigma + \pi \theta \sigma] = c'(\hat{e}_h) \tag{17}
\]
Proposition 1: Suppose that
\[ c'(\frac{\Delta}{\sigma}) < \frac{\sigma}{2} \]  
(18)
so that \( \bar{e}_i = \frac{\Delta}{\sigma} \) is the unique equilibrium with a single, low volatility regime (i.e., when \( \pi = 0 \)). Then, then for any \( \theta > 1 \), there exists a \( \pi^\theta > 0 \) such that, for any \( \pi < \pi^\theta \), \( \bar{e}_i \) remains the unique equilibrium in the choice of expertise. The upper bound on \( \pi \) is given by (19):
\[
\pi^\theta = \min \left\{ 1 - \frac{2}{\sigma} c' \left( \frac{\Delta}{\sigma} \right), \frac{\left( 1 - \frac{1}{\theta} \right) \Delta - 2[c \left( \frac{\Delta}{\sigma} \right) - c \left( \frac{\Delta}{\theta \sigma} \right)]}{\left( 2 - \frac{1}{\theta} \right) \Delta} \right\}
\]

The complete proof of this proposition is in the appendix of the paper; here the intuition behind the proof is presented. When low volatility has a lower probability than one and \( \pi \) is less than the first argument in the min operator in (19), then the marginal gains from expertise still exceed the marginal cost of expertise. The two candidate equilibriums given by the first order conditions can then be ruled out due to the convexity of the cost function. The second argument of the min operator ensures that the probability of high volatility is low enough that the benefits of gaining a better price when responding to offers under low volatility are not overwhelmed by the expected loss in gains to trade when volatility is high (plus the cost of investing in the higher level of expertise, \( c(\bar{e}_i) - c(\bar{e}_h) \)).

This proposition highlights the potential problem with overinvestment in expertise. Higher expertise means an improved ability to accurately assess an asset’s value, therefore increasing the adverse selection problem. This means the threat of facing a better informed counterparty forces an intermediary to make a higher offer to ensure trade takes place. Trade then becomes fragile because when volatility increases, the value of information increases and the viable offer from the buyer that is simultaneously always accepted by the seller cannot be made. With a small enough probability of high volatility, however, the increase in profits from improving bargaining position by adding expertise outweigh the gains to trade lost when volatility is high. The optimal path for the intermediary then becomes maximizing his profits in the more probable low volatility environment, even though such a strategy leads to lower profits in the improbable high volatility environment. Because each financial firm acts in its own best interest, in equilibrium, trade breaks down with an unconditional probability of \( \pi \), and \( \pi \Delta \) of expected gains to trade are lost.

While adverse selection and the fact that decisions that are good for one state might be bad for another are well understood, the new aspect of this model is that the degree of adverse selection is chosen. Both the acquisition of expertise and its limits are endogenous responses. The tradeoff, as has been shown throughout the paper, is that the liquidity supplier’s share of the surplus is increasing in his expertise, but the increase in expertise increases the risk of worsening the asymmetric information leading to trade breaking down and resulting in zero surplus. Large liquidity suppliers, then, face the struggle of both wanting to appear sufficiently informed so as to improve their bargaining position, while not appearing overly informed, or else traders will avoid them. Hence, expertise is constrained, as is seen in the model, and intermediaries acquire expertise, even though it puts their business at risk.
There are two forces that are necessary to incite an arms race in expertise to lead to break downs in liquidity. First, valuation must be sufficiently complex and uncertain to warrant investment in expertise to the point that liquidity is at risk. Second, volatility or uncertainty must jump in response to an exogenous shock.

In this model, the choice of expertise is made before the volatility is known; however, in the actual economy, financial firms adjust their level of expertise in reaction to changing levels of volatility. The model, then, highlights the case of expertise becoming costly for firms when volatility increases. These results would hold as long as the adjustment cost for firms does not allow for an instantaneous and complete response. In this way, this model stands in contrast to the usual explanation of the value of financial expertise. Usually, it is thought that more uncertainty would increase the value of expertise. However, following financial crises, times of high volatility and destruction of liquidity, contractions in hiring and employment of professional employees in the financial industry, or decreases in “expertise.” This model explains this apparent contradiction. Because the one theoretically coherent explanation for a breakdown in trade in high volatility environments is adverse selection, and expertise having been shown to worsen this problem in the model, the addition of expertise during normal volatility and contractions of expertise during high volatility is expected. It is also important to note that, while it seems implausible that the cause of illiquidity during financial crises arise from financial intermediaries knowing too much when they appear baffled by what is happening, the intermediaries are in fact simply less baffled than their counterparties.

7 Parameterization

Previous sections presented a two-stage game with two trading parties. This section introduces a model in which a trader\(i\) invests in expertise anticipating many trading games and meets a random counterparty drawn from a set of potential traders during each game. We continue to use the volatility probabilities of \(\pi\) and \(1-\pi\) for high and low volatilities, respectively, and treat each trading subgame as a random draw for buyer or seller status. Level of expertise is acquired at a cost of \(c(e)\) before the first trading encounter, and this expertise remains constant through time. Future expected payoffs are discounted at rate \(\delta\).

We take the cost of acquiring education, \(c(e)\), to be given by \(c(e) = \frac{\kappa e^2}{\sigma}\). Hence, \(c'(e) = \frac{2ke}{\sigma}\), with \(e = \frac{\Delta}{\sigma}\).

We can use this new definition of cost, as well as the discount rate, to expand the threshold level of high volatility probability given in the previous section by

\[
\pi^\theta = \min \left\{ 1 - 2(1 - \delta) \frac{\kappa \sigma^2}{\sigma^2}, \frac{(1-\frac{1}{\sigma}) - (1-\delta)(1-\frac{1}{\sigma^2}) \frac{\kappa \sigma^4}{\sigma^2}}{(2-\frac{1}{\sigma})} \right\}
\]  

(20)

Both terms are decreasing in \(\frac{\kappa \sigma^4}{\sigma^2}\), meaning that the threshold level of high volatility probability decreases as expertise, \(\frac{\Delta}{\sigma}\), increases. Essentially, if high volatility is very likely, firms will invest less in expertise. Perhaps more intuitively, we can take \(\pi\) as given and instead look at the restraints on the level of expertise, \(e_i\). Simply set both terms less than \(\pi\) and solve for expertise in expanded form, such that
\[
\frac{\kappa \Delta}{\sigma^2} < \min \left\{ \frac{1-\pi}{2(1-\delta)}, \frac{1-2\pi(1-\delta)}{(1-\delta)(1-\theta^2)} \right\} \tag{21}
\]

We can see that when gains to trade (\(\Delta\)) are low compared to the volatility (\(\sigma\)), expertise will be comparatively less costly, which will exacerbate the arms race. A low cost parameter (\(\kappa\)) will also increase the arms race.

The authors use two figures to illustrate the relationships among the parameters. In Figure 1, we see the relationship between the probability threshold (\(\pi^0\)) and the volatility multiplier (\(\theta\)), given example parameter values for \(\Delta\), \(\delta\), and \(\sigma\). The key takeaway is that the probability of a jump to the high volatility regime can be substantial. For example, when the jump in volatility is 50% (\(\theta = 1.5\)), the probability of jumping to a high volatility environment is 15%.

![Figure 1](image)

Figure 2 shows the relationship between equilibrium expertise (\(e^*\)) and gains to trade (\(\Delta\)), given predetermined levels of \(\theta\) and \(\pi\). When the gains to trade are small enough so that the \(\frac{\kappa \Delta}{\sigma^2}\) inequality holds, \(e^* = \bar{e}_l\) (the low volatility expertise). However, when \(\Delta\) is large and violates the inequality, there is a drop in expertise from \(\bar{e}_l = \frac{\Delta}{\sigma}\) to \(\bar{e}_h = \frac{\Delta}{\theta \sigma}\), which still increases, but at a lower rate. In essence, when gains to trade are small relative to volatility, firms want high expertise, since the occasional breakdown in trade will only make them lose a small \(\Delta\). However, when gains to trade get larger, breakdowns in trade become more costly, as firms lose a larger \(\Delta\) value. They will then lower expertise to ensure that trading still occurs.
8 Other Benefits from Financial Expertise

In the models previously presented in this paper, it is assumed that financial firms derive no benefit from financial expertise other than trading. In reality, this is not the case, as there are other ways in which expertise can produce revenue and other benefits for the firm. This additional revenue is denoted $r(e)$, examples of which include compensation for investment banking activities or for improving a client’s risk management processes. In the two-stage model with one trading encounter (see Financial Expertise as a Deterrent), we simply add $r(e)$ to the payoff. This additional revenue of course makes financial firms more likely to acquire expertise. Since the revenue is unrelated to trading payoffs, adding $r(e)$ is equivalent to decreasing the cost of expertise $c(e)$ by the same amount, making it easier to satisfy the conditions on $\bar{e}$.

If $r(e)$ increases quickly around the threshold, this will create a new equilibrium level of expertise, $\tilde{e} > \bar{e}$, such that $r'(\tilde{e}) = c'(\tilde{e})$. Despite the expected increase in trade breakdowns due to the extra expertise, firms will still invest in expertise since the marginal benefits are so high. The revenue gain from the higher expertise is greater than the expected loss in gains to trade plus the cost savings.

This simply increases incentives for firms to acquire expertise, making breakdowns in trade at least as frequent as in the models without the additional revenue. For simplicity, the authors continue to ignore these extra revenues, noting that their addition would not change the core results of their models.

9 Signaling Game with Two-Sided Asymmetric Information

In this section, the model is extended to include the situation in which both buyer and seller can acquire expertise. Until this section, the information was asymmetric for only one side, only the seller had access to expertise. Now both sides have access to expertise and the asymmetric information is two
sided. The analysis will show that the tradeoffs seen in the earlier sections will still hold up in this expanded game. There are many equilibria that arise in this setting, and the analysis proceeds as follows: first, it is shown that only pooling equilibria, in which the buyers with high and low signals offer the same price, support efficient trade; second, in order for this pooling equilibria to exist, there is a restriction on the level of expertise acquired leading to ex-ante payoffs that are the same as the payoffs in the subgame with one sided asymmetric information; third, because beliefs are credibly updated and efficient trade happens whenever possible, traders will increase their expertise to the point that volatility jumps lead to breakdowns in trade as seen in earlier sections. Here will be presented an intuitive explanation of the logic supporting these outcomes, a formal proof can be found in the appendix of the paper.

A. Trading Subgame

Again using the case where the first mover is the buyer, and given $s_b \in \{H,L\}$ and $s_s \in \{H,L\}$ as the buyer’s and seller’s signals respectively, and $\mu_b = \frac{1}{2} + e_b$ and $\mu_s = \frac{1}{2} + e_s$ as the probabilities, which increase with expertise, that the respective signals are correct, it can be shown that

**Lemma 1:** The only equilibria in which efficient trade always occurs are pooling equilibria in which the high-signal and low-signal proposers offer the same price, which is accepted by the seller.

This is because, if there were an equilibrium in which different types of buyers offer different prices, the seller would need to accept all of the buyer’s offers. If the buyer then anticipates this response, he should offer the price that is favorable to himself, regardless of his signal, which is contradictory.

In order to show that pooling equilibria supporting efficient trade exist, perfect sequential equilibria must exist in the trading game, which then require a bound on expertise. A perfect sequential equilibrium (as defined by Grossman and Perry (1986)) is “supported by beliefs $p$ which prevent a player from deviating to an unreached node, when there is no belief $q$ which, when assigned to the node, makes it optimal for a deviation to occur with probability $q$.” This result helps to restrict the behavior of the traders the buyer updates any off-equilibrium beliefs associated with a deviation via Bayes’ rule given the best response of the seller. There is then, at most, one type of pooling equilibrium that is perfect sequential. The price at this equilibrium will be the same as the price offered with one sided asymmetric information, and equilibrium play will proceed in the same way as shown in previous sections, where $p^*$ is the price the buyer offers and the seller receives the unconditional expected payoff of $(v_h - v_l)(\mu_s - \frac{1}{2})$.

To verify that $p^*$ is in fact a pooling equilibrium, the participation constraint and incentive compatibility constraint of the low signal buyer must be checked. Because both types of buyer pay the same price, and the expected value of the asset is weakly higher after receiving a high signal, satisfying the low signal buyer’s participation constraint guarantees the satisfaction of the high buyer’s participation constraint. Also, the buyer will never offer a price higher than $p^*$ because the seller would accept, which he will also do at $p^*$, and the buyer would pay more. The payoff to a low signal buyer from offering $p^*$ is (24):
This payoff must be at least zero for a pooling equilibrium at $p^{**}$. As long as there is positive expertise, the buyer must give some of the surplus to the seller in order to make him accept the offer. Compared to the one sided asymmetric information case (in which $\mu_b = \frac{1}{2}$ and $e_b = 0$) the buyer has a lower expected payoff because his signal is low, and he knows he is overpaying by more relative to the common value.

Now, the buyer deviating to a lower price needs to be checked. If the buyer instead chooses to offer a lower price, $p < p^{**}$, the seller would only accept after a low signal. In this case, the buyer will offer the lowest price possible, which is $p^* = E(v|s_s = L)$. Now, the acceptance by the seller confirms his signal, and he extracts less surplus compared to the one sided asymmetric information case whenever both signals are more informative than that of the seller alone. The buyer is therefore overpaying ex-post and will not deviate to a lower price.

**Proposition 2:** The only equilibria that involve efficient trade in the trading subgame and that are perfect sequential as defined in Grossman and Perry (1986) are pooling equilibria at $p^{**}$. Such efficient perfect sequential equilibria exist if and only if:

$$\frac{2\Delta}{(v_h - v_l)} \geq \frac{(e_s + e_b)}{\frac{1}{2} - 2e_se_b}$$  \hspace{1cm} (25)

The buyer then receives an ex-ante expected payoff of

$$2\Delta + (v_h - v_l) \left( \frac{1 - \mu_s - \mu_b}{2} + \frac{\mu_b - \mu_s}{2} \right) = 2\Delta - (v_h - v_l)e_s$$  \hspace{1cm} (26)

Since trade always takes place, the seller receives the remaining surplus of:

$$(v_h - v_l)e_s$$  \hspace{1cm} (27)

Since trade always occurs at the same price as one sided asymmetric information, the ex-ante payoffs are the same as in the one sided asymmetric information case. Agent $i$, before knows whether he, or agent $j$, is the buyer or the seller earns an expected payoff of:

$$\Delta + \frac{1}{2}(v_h - v_l)(e_i - e_j)$$  \hspace{1cm} (28)

Given his opponents level of expertise, trader $i$ increases his expected payoff by increasing his expertise, with similar incentives to invest as in the one sided asymmetric information case. So, in an equilibrium preserving efficient trade, expertise plays the same role with two sided symmetric information as in one sided asymmetric information.

There are two results that then follow from the condition for the existence of a perfect sequential efficient equilibrium and Proposition 2. First, there is a unique symmetric expertise pair $e^* = \frac{v_h - v_l}{4\Delta} \left[ 1 + \frac{4\Delta^2}{(v_h - v_l)^2} - 1 \right]$ that satisfies (25) from Proposition 2 with equality, and is greater than zero whenever $\frac{v_h - v_l}{\Delta}$ is greater than zero. Second, crossing this boundary or an increase in volatility, because
the left hand side of (25) is decreasing in \((v_h - v_l)\), causes the efficient, perfect sequential equilibria to cease to exist.

B. Choice of Expertise

The choice of expertise in two sided symmetric information plays out in a similar fashion to one sided symmetric information. Assuming low cost of expertise and low probability of high volatility state, all agents will anticipate a low volatility state and reach the pooling equilibrium at \(p^{**}\). Their expected payoffs will then be linear in expertise, and the agents will invest in expertise up to a boundary where an increase in expertise will lead to a prevention of efficient trade and a destruction of some of the gains to trade. Again, as in the one sided asymmetric information case, this boundary will have efficient trade with low volatility and breakdowns to trade with high volatility, regardless of the size of the spike in volatility.

The main difference in the choice of expertise in the two sided symmetric information case is that there will be other types of equilibria. For this reason, the paper imposes the perfect sequential equilibrium refinement from (Grossman and Perry). This assumption; the assumption that traders will prefer efficient perfect sequential equilibria over inefficient perfect sequential equilibria when both exist; and the fact that when both traders invest up to the symmetric threshold \(e^*\), no trader has an incentive to deviate to a higher level of expertise where trade breaks down with positive probability allows for a unique prediction for investment in expertise. At this level of expertise, small infrequent volatility spikes lead to breakdowns in trade.

10 Conclusion

10.1 Summary

In a sentence, this paper models the incentives for financial intermediaries to overinvest in financial expertise. Expertise allows firms to increase speed and accuracy when pricing securities in low-volatility regimes. However, when there is a spike in volatility, adverse selection problems arise, and trade breaks down. If the volatility spikes are relatively infrequent, then the gains to trade lost during trade breakdowns are not as important as the increase in profits that expertise brings in the low-volatility regime. Despite the threat of trade breakdowns, firms will invest in expertise to the maximum level allowed in the low-volatility regime. The arms race occurs when this expertise is neutralized by the other agent’s similar investment. Therefore, adverse selection and breakdowns in trade can be present in equilibrium.

10.2 Critiques

As Turley (2012) notes, “If traders are foolish now, they were foolish before. Shrewd traders will always prefer to be better informed than their counterparty. We are forced to ask: what changed?” Turley’s problem with this paper is the fact that spending on financial expertise has increased sharply, but only in the last few decades. If financial markets as modeled in this paper lead to arms races, then why have the arms races only started recently? Turley argues that the increasing efficiency of financial
transactions has led to the increase in spending on expertise, due to the fact that increasing efficiency has allowed for ever more complex financial instruments.

The authors remark in the Parameterization section that trading history is anonymous, so that there is no opportunity for traders to build a reputation. This is a clear downside of the model, as participants in over-the-counter markets often rely on their reputations in addition to expertise in order to engage in trade. This can make more of an impact when trading in multi-stage games. If the trader will be in the market in subsequent periods, he is more inclined to build a good reputation.

10.3 Extensions

Glode and Lowery extend their study of expertise in the financial markets with a paper exploring how financial experts are compensated and whether their generally high salaries are justified. They model a scenario in which financial experts are compensated not only for the value that they produce for the firm, but also for the harm they are not causing the firm by working for a different company. Called the “defense premium”, this salary hike guards against the negative externalities that could occur if the employee is hired by a different company. (Glode and Lowery, Compensating Financial Experts)

This paper hints at the idea of expert immorality, a topic that can be extended in later papers. A recent paper on the “star culture” within investment banking briefly discusses how experts may rationally “supply excessively complex products in order to signal their abilities” (Chen, Morrison and Wilhelm Jr). Expanding upon the incentives that exist among financial experts could be a good extension of this class of paper.

There is emerging thought in the finance research regarding the counterintuitive nature of the value of expertise and human capital in general. This paper showed that more expertise is not always better, and Chen, et al. discuss the adverse incentives that experts may have. A 2013 paper by Andrea Eisfeldt and Dimitris Papanikolaou discusses a premium that investors put on firms with larger amounts of organization capital – that is, companies that depend on key talent and firm-specific efficiency (Eisfeldt and Papanikolaou). The argument is that since these firms do not own the human capital like they would a physical asset, there is a risk that key talent leaves the company. We can think of companies, such as Apple, Google, or consulting firms, which rely heavily on their talent and are at a higher risk of diminished profits if these experts leave. This results in investors placing a higher risk premium on firms with greater organization capital, or loosely, higher expertise. There are many different ways in which this paper can be extended to discuss many facets of expertise.

On another note, professional sports offer an interesting application of this model. In professional sports, athletes are of varying ability and signed to contracts of varying lengths and costs. Because professional sports franchises are constrained by either operating budgets or salary caps, they are constrained in the number and overall value of contracts they can have. In this way, it is easy to analogize player contracts as assets to their teams. Also, through a draft mechanism, future players enter the league under the control of the team that picks them. Because valuing players’ skills and the fact that draft picks represent unknown future players, there is uncertainty in the actual value of players and picks. Because teams have different short term and long term goals, different players have different value to different teams. This analogizes to the liquidity needs in the model. For example, a good team
with a chance to win a championship may trade assets with higher long term values, such as young players or draft picks, to a bad team for assets with higher short term values, such as an accomplished veteran on contract to the end of the season. In this way, general managers of professional sports franchises can be seen as the agents in the model. While this is an interesting way to think about professional sports, it is much more difficult to image an exogenous shock to uncertainty that would lead to destruction of trade as is seen in the model. A large scale change in the rules of the sport could be such an exogenous shock.

11 References


12 Appendix

Symmetry of Trading Game

In Section 4 of the Notes (Financial Expertise as a Deterrent), a model in presented in which the proposer of the trade is the buyer. Here, be briefly outline the analogous case in which the seller proposes the trade. In this case, the highest price he can propose while ensuring that the trade goes through is

\[ p^{**} = E(v|s_i = L) \]  
(A1)

The payoff is

\[ p^{**} - [E(v) - 2\Delta] = 2\Delta - (v_h - v_l) \left( \mu_i - \frac{1}{2} \right) \]

\[ = 2\Delta - (v_h - v_l)e_i. \]  
(A2)
The above price and payoff pair to equations (3) and (4). The price approaches the price from the upper bound (i.e. what is the maximum the seller can charge) rather than the lower bound (i.e. what is the minimum that the buyer can offer). Note that these will be the same price. Similarly, the payoff is now from the seller’s point of view, equally the revenue from the trade (its price) minus the loss of the asset plus the gains from trade. Equation (4) shows the opposite point of view, with the buyer’s payoff being the asset value and gains from trade minus the price paid.

Consider the following: 

\[ p^* = E(v|s_i = H). \]  

(A3)

This is when the seller proposer offers the asset at a high price, and the trade will go through at least half the time. In equation (1), we see the opposite situation in which the buyer proposes a low price, which will be accepted at least half the time.

Finally, we look at the seller’s payoff using the strategy of offering the high price.

\[ \frac{1}{2}(p^* - E[(v|s_i = H) - 2\Delta]) = \Delta \]  

(A4)

This is analogous to equation (2) which expresses the buyer’s expected payoff under this strategy. Both have the same conclusion, that the payoff is \( \Delta \). As we have shown, a comparison of the payoffs at prices \( p^* \) and \( p^{**} \) yields the same inequality for levels of expertise. Therefore, the cases of assigning the buyer or the seller to be the trade proposer are analogous.

**Proof of Proposition 1**

An intuitive outline of the proof can be found in the notes or in the first paragraph under equation (19) in the paper. This is meant to supplement the intuition with a mathematical outline of the proposition.

From equation (16), we have the first order condition for the low-volatility regime and note

\[ \frac{1}{2}(1 - \pi)\sigma \geq c'(\tilde{e}_l) \quad \implies \quad \pi \leq 1 - \frac{2}{\sigma}c'(\tilde{e}_l) \]  

(A5, A6)

Recall that \( \tilde{e}_l = \frac{A}{\sigma} \) and we have the first term in the \( \min\{\cdot,\cdot\} \) function (19). From this result and the fact that \( \tilde{e}_l > \tilde{e}_h \), we get the three following conditions:

\[ \frac{1}{2}[(1 - \pi)\sigma + \pi \theta \sigma] > c'(\tilde{e}_l), \quad \frac{1}{2}(1 - \pi)\sigma > c'(\tilde{e}_h), \quad \frac{1}{2}[(1 - \pi)\sigma + \pi \theta \sigma] > c'(\tilde{e}_h) \]  

(A7,8,9)

We can now rule out equilibria levels of expertise where the first-order conditions hold with equality \( \tilde{e}_h \) and \( \tilde{e}_l \) (see equation (13)) and focus on \( \tilde{e}_l \) and \( \tilde{e}_h \), levels of expertise which rely on the inequality of the first order conditions. Given the payoff function, \( \tilde{e}_l \) will be preferred if the following holds

\[ \frac{1}{2}(1 - \pi)\tilde{e}_l \sigma - c(\tilde{e}_l) \geq \frac{1}{2}[(1 - \pi)\tilde{e}_h \sigma + \pi \tilde{e}_h \theta \sigma - c(\tilde{e}_h)] \]  

(A10)

When \( \pi = 0 \) (i.e. 0 probability of high volatility regime), we can take the derivative of \( c(\tilde{e}_l) \) to get

\[ c'(\tilde{e}_l) < \frac{\sigma}{2}, \]  

equivalent to the Proposition 1 condition in (18). Thus, even for small probabilities \( \pi \), the term \( \pi \tilde{e}_h \theta \sigma = \pi \Delta \) in (A10) will be small and won’t violate the inequality. Multiplying (A10) by 2 and performing algebra, we are left with
\[
\frac{[\bar{e}_l - \bar{e}_h]\sigma - 2[c(\bar{e}_l - c(\bar{e}_h))]}{[\bar{e}_l + (\theta - 1)\bar{e}_h]\sigma} \geq \pi \tag{A12}
\]

Since this condition as well as the (A6) condition must hold, and we know that they are not binding when \( \pi = 0 \), we may combine them when \( \pi < \pi^\theta \) such that

\[
\pi^\theta = \min\left\{1 - \frac{2}{\sigma}c'(\bar{e}_l), \frac{[\bar{e}_l - \bar{e}_h]\sigma - 2[c(\bar{e}_l - c(\bar{e}_h))]}{[\bar{e}_l + (\theta - 1)\bar{e}_h]\sigma}\right\} \tag{A15}
\]

We leave it to you to show that this is equivalent to (19) in the proposition when substituting for the values of \( \bar{e}_l \) and \( \bar{e}_h \). \( \square \)