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Chapter 15.1

Investment in expertise

Outline

- Problem and model assumptions
- Buyer setting low price
- Buyer setting high price
- Optimal expertise
- Summary

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Outline

- For traders to generate profits, they rely on the access to information and their ability to interpret this information. This is referred to here as expertise.
- Expertise is obtained from knowledge of the trader about the asset they seek to purchase or sell, but also inferences about the behaviour of other traders. This knowledge will be based on experience, training, and depend on the information that can be accessed.
- Expertise will be costly to traders as they need to built up the knowledge through training and practice, but also will require access to databases and other information sources.
- We will here look into the optimal level of expertise of traders.

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Outline

- We will first of all look at how expertise manifests itself in our model and then explore the behaviour of the buyers of securities, before combining their behaviour with that of sellers to determine the optimal level of expertise.

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- We will now see how expertise by traders can be modelled.

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Trading expertise

- In order to make profits from trading, investment banks need to invest into the expertise of their traders
- Trading profits of one investment bank are the losses of another investment bank
- Investment banks are competing for profits through expertise

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Trading expertise

→ The success in trading will depend on the level of expertise a trader has.

- Trading requires information and knowledge about the interpretation of this information; this is jointly referred to as 'expertise'. Such expertise would encompass the qualities of the asset traded, but also how other traders behave and the impact both factors have jointly on future prices.
- Trading is a zero sum game. A profit can be made by a trader if he buys an asset below its (future) value. As a trade involves a buyer and a seller, there must be another trader that sells the asset below its (future) value, making a loss. This loss is identical to the profits of the buyer, thus on aggregate there are no profits or losses from trading. The traders might not be aware of the losses they are making as the true (future) values are not known, so both traders might believe to make a profit, based on their expertise.
- A trader having better information is more likely to make a profit than a loss, hence traders will be competing to make profits of other traders by increasing their expertise. We will here look specifically at traders in investment banks, but this would in principle apply to any trader.

→ We can now look at how we model expertise here.

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Signals for traders

- Benefits of trading ΔV can be positive if diversification and hedging are considered, in addition of trading profits
- Value of the security is V_H with probability π, or V_L otherwise
- Traders receive a signal s that is accurate with $Prob\left(V_H|H\right) = Prob\left(V_L|L\right) = \rho_i \geq \pi$
- Expertise is $e_i = \rho_i - \pi$ and costs C_i to obtain
- Expertise is only available to sellers

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Signals for traders

→ Information, and hence expertise, is commonly modelled as a signal about the future value of an asset.

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  - We assume firstly that there are trading benefits as the trade might increase diversification, leading to a higher utility level due to the portfolio of assets held being more aligned with the preferences of the trader; there might also be benefits that arise from the hedging od risks as a result of the trade.
  - This benefits are in addition to the profits from the trading itself.
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  - We assume the asset can have a high value. Without having any information, we know a probability for this high value to be realised.
  - We assume the asset can have a low value. Without having any information, we know a probability for this low value to be realised.
- We now assume that traders receive a signal about the value of the asset, this signal is either high (H) or low (L) and it is correct in that the high (low) value will be realised if the signal is high (low) with some probability. This probability is the precision of the information, the higher the value, the more precise the information is.
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  - We define the expertise of a trader as the precision of the signal they receive and the higher the precision of the signal, the higher the level of expertise. We define the expertise here relative to a benchmark precision, which is the probability that the asset has the high value. If the trader has no information, and thus no expertise, this will be the probability the would assign to the high value; we focus on the high value here in any case.
  - Acquiring the expertise is costly and these costs will be increasing with the level of expertise, with marginal costs increasing as well.
- We assume that only sellers have expertise, buyers have no expertise at all. This assumption can be justified by traders having an exposure to the asset paying more attention to it than those who do not hold it.

→ We will now see how this expertise of sellers affects the prices that a buyer is willing to pay.

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- Problem and model assumptions
- **Buyer setting low price**
- Buyer setting high price
- Optimal expertise
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- We first consider the case where the buyer of the asset is only willing to pay a low price for the security.
- This low price might indicate that the buyer has received a signal indicating a low value, although the precision of this information will be low.

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Trades occurring

- Assume a buyer i is only willing to pay $P^* = E[V|L]$ and has no expertise itself
- A transaction only occurs if the seller j obtains a low signal
- This happens if the value is high, but the signal is wrong or the value low and the signal correct: $\pi (1 - \rho_j) + (1 - \pi) \rho_j$

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Trades occurring

→ Regardless of the willingness of the buyer to purchase the asset, a trade is only completed if a seller agrees to it.

- - We now assume that a buyer is willing to pay what he beliefs to be the price if the low signal were received.
  - The buyer has no expertise and hence will not necessarily base this price on information; instead we assume that this decision is taken for arbitrary reasons.
- A seller will be willing to sell the asset at this price only if he has received the low signal. Having received a high signal would imply that the value of the asset is higher and he would not be willing to sell it below its value and incur a loss.
- The low signal is received if the true value is high, but they receive the wrong signal, or the true value is low and the signal received is correct.

→ We can now determine the profits of the buyer from this transaction.

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Buyer profits

- Trading profits are the value of the security and the trading benefits, less the price paid, if the trade happens
- $\Pi_B^i = \left(\pi \left(1 - \rho_j\right) \left(1 - \pi\right) \rho_j\right) \left(E\left[V|L\right] + \Delta V - P^*\right)$
- Value of the security is low as this is the signal of the informed seller, else no trade would happen at this price

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Buyer profits

→ We can now determine the profits of buyers willing to pay the low price.

- When purchasing the security the buyer obtains the security with its value and the benefits of trading in general, such as diversification or hedging.
- These benefits are reduced by the price at which the asset is purchased.
- These profits are only realised if a trade occurs in the first place.

Formula

- The value of the security the buyer obtain must be the value given a low signal as assigned to it by the informed seller.
- If the value would be higher, the seller would not be willing to trade. Thus acceptance of the trade by the seller reveals the value of the security.

→ Of course, the value equals the price and these two terms will eliminate each other, leaving us only with the trading benefits.

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- We can now explore the case where the buyer is willing to pay a high price for the asset.

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Buyer profits

- If the buyer is willing to pay $P^{**} = E\left[V|H\right]$, trade will always happen as the value of the seller is never above this amount
- $P^{**} = Prob\left(V_H|H\right)V_H + \left(1 - Prob\left(V_H|H\right)\right)V_L = \rho_j V_H + \left(1 - \rho_j\right)V_L$
- Trade does not indicate the value of the security as it happens regardless of the signal the seller obtains, which is then $E\left[V\right] = \pi V_H + \left(1 - \pi\right)V_L$
- Trader profits: $\hat{\Pi}^i_B = E\left[V\right] + \Delta V - P^{**} = \Delta V - \left(V_H - V_L\right)e_j$

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Buyer profits

→ Having determined the profits of a buyer offering the low price, we will now look at a buyer offering a high price.

- - If the buyer offers to pay the high value, that is the value the informed seller assigns if he receives the high signal, a trade will always occur.
  - That is because the value the seller assigns to the asset is either below the price offered (low signal) or equal to it (high signal) and thus the seller will always want to sell the asset.
- The price offered can be rewritten as the high value, provided the high signal is correct, or the low value of the asset if the signal is incorrect. We can insert the signal precision as defined above and obtain the *formula*.
- - The fact that a trade occurs does not reveal any information on the value of the asset to the buyer. This is in contract to the case where the buyer offers a low price only; there the seller accepting the offer indicated that the value of the asset was low.
  - As the trade always occurs, regardless of the information the informed seller holds, it can reveal no information.
  - The expected value of the asset to the buyer is then given by the buyers information only as the high value being realised with probability π and the low value with probability $1-\pi$.
- When purchasing the security the buyer obtains the security with its value and the benefits of trading in general, such as diversification or hedging; these benefits are reduced by the price at which the asset is purchased. We can then insert for the expected value of the security and the price paid from above, using our definition of expertise to obtain the *formula*.

→ We can now determine whether the buyer will offer a high or a low price.

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Maximum signal precision

- Buyers offer the high price if $\hat{\Pi}_B^i > \Pi_B^i$
- Signal precision must not be too high: $\rho_j \leq \rho^* = \frac{\pi+(1-\pi)\frac{\Delta V}{V_H-V_L}}{1+(1-2\pi)\frac{\Delta V}{V_H-V_L}}$
- Low signal precision is required as else adverse selection costs are too high for the buyer to offer the high price

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Maximum signal precision

→ We will now derive the condition under which the buyer is willing to offer a high price for the asset.

- The buyer will offer a high price if the profits of doing so are higher than offering the lower price. Offering the higher price brings certainty in obtaining the asset and the trading benefits, while offering a lower price may not result in a trade and the trading benefits do not materialise; this is traded off against the lower price the buyer pays.
- Inserting for all variables we obtain that the signal precision must not exceed a level as given in the *formula*.
- The seller is better informed and will only trade if it is profitable, implying that the buyer will make a loss. This loss is more likely the more precise the signal is as the seller will trade less and less on a wrong signal. Thus the trading losses of the buyer are increasing and need to be compensated for by the trading benefits (ΔV) and at some point of information precision, their value is not high enough.

→ We can now use these results to determine the optimal level of expertise, and hence signal precision, for sellers.

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- We now derive the optimal level of expertise by traders.

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Seller profits

- Total trading benefits of buyers and sellers are $\hat{\Pi}_S^j + \Pi_B^i = \Delta V$
- This implies for seller profits of $\hat{\Pi}_S^j = (V_H - V_L)\, e_j$
- Being buyer and seller is equally likely
- $\hat{\Pi}^i = \frac{1}{2}\hat{\Pi}_B^i + \frac{1}{2}\hat{\Pi}_S^i - C_i$
- We take into account the costs of expertise

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- → First we determine the profits sellers make from trading.
- ▶ Trading in itself is a zero-sum game as argued above, hence the trading profits of sellers will be equal to the trading looses of buyers. As buyers here are assumed to have additional trading benefits ΔV, the net benefits of both traders combined will be those additional benefits.
- ▶ Inserting from the profits of buyers above, we get that the seller has trading profits as indicated in the *formula*.
- ▶ Let us now assume that over time buying and selling is balanced, thus half the time a trader is a seller and the other half a buyer.
- ▶ The profits of traders will then consist of the profits from buying and selling.
- ▶ We need to take into account the costs of gaining the expertise in the first place.
- → These trader profits can now be maximized.

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Optimal expertise

- First order condition for optima expertise is $\frac{\partial \hat{\Pi}^i}{\partial e_i} = 0$
- This gives $\frac{\partial C_i}{\partial e_i} = \frac{1}{2}\left(V_H - V_L\right) > 0$
- Maximum expertise is such that $\rho_j \leq \rho^*$
- If costs are identical, then expertise is identical, $e_i = e_j$
- Trader profits: $\hat{\Pi}^i = \frac{1}{2}\Delta V - C_i$

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Optimal expertise

- → We will now explore the optimal level of expertise that traders obtain to maximize their profits.
- ▶ The first order condition for the profit maximum of a trader is that the first derivative of their profits with respect to the level of expertise is zero.
- ▶ This condition solves for the *formula*.
- ▶ We assume that this result will allow buyers to offer high prices, thus $\rho_i < \rho^*$.
- ▶
  - If the costs of all traders, buyers and sellers, are identical, then the optimal expertise will be identical as the solution to the first order condition is identical across traders.
  - *Formula*
- ▶ Inserting this result, we obtain the total profits as in the *formula*.
- → We can now compare this optimal result with the Pareto optimum for traders.

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No expertise

- If traders have no expertise, $e_i = e_j = 0$ and $C_i = 0$
- Then $\hat{\Pi}^i = \frac{1}{2}\Delta V$
- Not investing into expertise is more profitable
- If a trader does not invest into expertise, it is profitable for the other trader to do so
- This leads to an arms race in the level of expertise

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No expertise

→ We see that the profits of traders are higher, the lower the costs of investing into expertise are. We will explore the implications of this observation further.

- Let us assume that traders have no expertise at all, which implies that they have no costs of acquiring such expertise.
- Having no costs will increase the profits of traders.
- Thus, not investing into expertise increases profits, but we maximized profits and had positive marginal costs, implying that traders acquire expertise at costs.
- The reason for this result is that if the other traders do not invest into expertise, then as a buyer the trader would make less losses (there is less adverse selection) and as a seller would make high profits as he is informed. This gives an incentive to invest into expertise. The result is that all traders invest into expertise.
- While having no expertise would give higher profits for all traders, they engage in an arms race by acquiring expertise and obtain the ability to generate trading profits at the expense of other traders.

→ We thus see that, compared to the social optimum, traders over0invest into their expertise.

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- We can now summarize the key findings of this model.

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Over-investment into expertise

- With trading a (mostly) zero sum game, traders seek to extract profits from other traders
- To extract more profits, they invest into expertise, but as everyone does, no benefits are gained
- Investing less into expertise would be preferred by all traders

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Over-investment into expertise

→ We have seen that traders invest too much into their expertise, exceeding the Pareto optimal level of expertise.

- The reason for investors to over-invest into their expertise is that they seek to extract profits from other traders, who attempt the same, leading to an arms race.
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  - In order to extract more profits from other traders, they invest into their expertise.
  - However, every trader does the same, leading to a situation where the trading profits remain the same, regardless of the level of expertise. Thus there are no benefits from investing into expertise, the costs even reduce the profits for each trader. However, no trader can afford to invest less into expertise as they would make a loss due to other traders having a higher level of expertise.
- All traders would prefer to invest less into their expertise and reduce costs, but this is not an equilibrium.

→ We can now look briefly at some implications of this key result.

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Individual rationality

- Traders are over-qualified
- The investment bank directs too much resources towards them
- This is individually rational, but socially suboptimal

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Individual rationality

→ We have a disconnect between the rational decisions of individual traders and the social optimum.

- Traders invest too much into their expertise and are thus over-qualified, compared to the social optimum.
- A consequence is also that the investment bank, which bears the cost of acquiring this expertise, invests too much resources into proprietary trading and
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  - The decision to invest into expertise is rational for each individual trader and it maximizes their profits, given the behaviour of all other traders.
  - The outcome is, however, socially suboptimal and could be improved by investing less into their expertise.

→ We have thus seen that investment banks invests too much resources into proprietary trading, but this is driven by the competition between investment banks to extract profits from other investment banks' trading desks.

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