The Epistemology of Speculation

What’s past is prologue

Shakespeare, The Tempest, 2.1.238

Pieter Jonker

Master Thesis 30 EC
EIPE
Erasmus School of Philosophy
Erasmus University, Rotterdam
Supervisor: prof. dr. J. Vromen
Advisor: dr. C. Heilmann

January 2019

Net word count: 23,726
## Content

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Speculation under Common Knowledge</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>2.1 Introduction</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>2.2 Keynes’ and Hicks’ Theory of Normal Backwardation</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>2.3 The Theory of Storage</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>2.4 The Rational Expectations Hypothesis</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>2.5 The Efficient Market Hypothesis</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>2.6 Common Knowledge</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2.7 Conclusion</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>Ecological Rationality and Speculation</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3.1 Introduction</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3.2 <em>Homo Heuristicus</em></td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>3.3 The Adaptive Market Theory</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>3.4 Conclusion</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Private Information</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>4.1 Introduction</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>4.2 Information Cascades</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>4.3 Private Information</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>4.4 Conclusion</td>
<td>28</td>
</tr>
<tr>
<td>5</td>
<td>Social Epistemology and Speculation</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>5.1 Introduction</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>5.2 Knowledge and Unknowledge</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>5.3 Trust and Distrust</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>5.4 Rumours</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>5.5 Expertise</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>5.6 Epistemic Authority</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>5.7 Conclusion</td>
<td>37</td>
</tr>
<tr>
<td>6</td>
<td>The Demography of Speculation</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>6.1 Introduction</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>6.2 Regular market participants</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>6.3 Noise traders</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>6.4 Financialization</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>6.5 Conclusion</td>
<td>41</td>
</tr>
<tr>
<td>7</td>
<td>Conclusion</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>References</td>
<td>43</td>
</tr>
</tbody>
</table>
List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIPE</td>
<td>Erasmus Institute of Philosophy and Economics</td>
</tr>
<tr>
<td>LME</td>
<td>London Metal Exchange</td>
</tr>
</tbody>
</table>
1. Introduction

Speculation is the purchase (or temporary sale) of goods for later resale (repurchase), rather than use, in the hope of profiting from the intervening price changes (Newbery, 2008). Speculation is a ubiquitous phenomenon on financial and commodity markets. Many people think they will succeed in making money by entering into speculative transactions.

Speculation has always had a somewhat negative image. Aristotle, for instance, already said that speculation is justly censurable, for it has not its origin in nature and compared it with usury (Aristotle, Politics, 1258b). The examples that he gave as proof to his opinion, however, are related to price gouging, cornering the market, which is from an ethical point of view more blameworthy than simple speculating\(^1\). The negative image of speculation, however, has continued until today. Pope Benedict XVI (2008) criticized the ill effects of speculation when he discussed the needs of the weakest and poorest people whose vulnerability today has increased because of financial speculation and instability and their pernicious effect on the price of foodstuffs and energy. Criticism of speculators comes from all sides of the political spectrum. Both Vladimir Lenin and Abraham Lincoln stated bluntly that speculators should be shot (Jacks, 2007).

Mainstream economics, however, has a less negative opinion about speculation. Friedman (1953) thought that speculation helps to stabilize prices. Speculators who buy when prices are too low or sell when prices are too high, and so help to stabilize prices, will make a profit, while those who do the opposite will suffer losses. The Efficient Market Theory, which became dominant in mainstream economics since the 1970s, holds that in well-established markets, such as the financial and commodity markets, actual market prices will already reflect all information that is presently available. The remaining short-term price fluctuations are the result of pure chance effects. In those conditions, speculation is the potential force which stabilizes prices. Actual speculative transactions, however, make no sense, as profits and losses will cancel out, and the transactions costs will result in a net loss (Fama, 1988). The assumption of purely random price movements, also called the random walk hypothesis, is the foundation for many instruments in financial risk management, such as the Black-Scholes model of option pricing and the Value-at-Risk statistic that summarizes total risk in a portfolio (Hull, 2015).

Many people, however, remain unconvinced, and do believe that speculation can bring profits. And they have reason to do so. Trend following, i.e., buying when prices have consistently risen for some time and selling when prices have been going downwards, is a strategy that has shown to be profitable for the past two hundred years (Lempérière et al, 2014). This finding clearly contradicts the efficient market hypothesis.

The enduring profitability of trend following is intriguing. What can explain such a universal, persistent behaviour of prices? There are two possible explanations. The first is that agents under-react to news and only progressively include the available information into prices. Hong and Stein (1999) have proposed a model along this line. The under-reaction to news might be the result of a conservatism bias in the interpretation of market news, and this inertia will lead to trends. The other explanation is that investors are not completely rational and have only limited computational power and, for either reason, cannot digest all available information immediately and correctly. In a complex world, where

\(^{1}\) One example of Aristotle was the case of Thales the Milesian. He was reviled for being a poor philosopher. To prove that philosophers also could make money, he cornered the market for olive presses in anticipation of a large olive harvest and so became rich. This answers the question: If you are so smart, why aren’t you rich?
The Epistemology of Speculation

information is difficult to decipher, it is tempting to use a heuristic, a decision rule that ignores some of the available information to be able to decide rapidly. Trend following could be such a heuristic. Herding, just following the example of others based on the human instinct to gregariousness and conformity, could be another one.

In this thesis I will discuss the epistemology of speculation. Epistemology is the study of knowledge. In contemporary epistemology, knowledge is defined as a justified true belief. It is not enough that a belief is accidently true, one should have a justification to believe that it is true in order to qualify as knowledge. Speculators will enter a transaction if they have arguments to attach a high probability for a price movement in a certain direction. This probability is not an objective probability, like the propensity for radioactive decay that certain atoms possess, but an epistemological probability, derived from the weight of the arguments that justify the belief that the price will move in that direction (Gillespie, 2000). A speculator will assess the actual market conditions based on the information that is available to him and translate this assessment into a probability using his knowledge of the price mechanism at work in this market. Receiving new information, both private and generally available information, will lead to a revision of the probability he will attach to a price movement in a certain direction. When the efficient market hypothesis is correct and all available information is already priced in, then there can be no justification for believing that the future price will be different from the present one. In that case, entering into a speculative transaction is comparable to gambling, just taking a chance. If the efficient market hypothesis is not correct, then not all available information is already priced in and speculation can have the positive effect of bringing additional information to the market through the witness of the speculative transactions taking place and will so help to speed up the adaptation to new circumstances (Angel et al., 2009).

I will start in chapter 2 with the role of speculation as discussed in mainstream economics. In those discussions it is assumed, mostly tacitly, that there is common knowledge among all relevant market participants: not only do they all know all relevant facts underlying the present market price, but they also know that all others know them too and will treat them as persons having that knowledge. The Efficient Market Theory is the conclusion of this assumption in combination with the more familiar assumption made in mainstream economics that all market participants act according to the prescriptions of rational choice theory (in the version without risk). As already mentioned, under these conditions there is hardly any possibility to speculate profitably on the price movement. If one accepts, however, different degrees of risk aversion among the market participants, then speculators can have a role to play as liquidity providers. In many situations, a transaction to buy or to sell means assuming a price risk for a certain period. A producer who agrees to an order for his finished product, knows that its production will take some time. In the meantime, the market conditions for his raw materials can change. Distributors often make marketing arrangements that can only be changed periodically. Forward selling or forward buying can help to alleviate these risks. But different degrees of risk aversion can lead to situations in which forward transactions between buyers and sellers do not fully match, and more risk averse market participants will be willing to pay an insurance fee for transferring risk onto speculators. Liquidity provision can be seen as an extension of the role attributed by Friedman to speculation as a potential force to price stabilization.

In the next chapters I will discuss the various consequences when these two assumptions of common knowledge and rational choice do not hold. In those cases, speculators will have a more active role, bringing their own information, right or wrong, to the market. I start with loosening the assumption of rational choice in chapter 3. Many market participants will follow heuristics, routine rules for deciding what to do in a certain market condition, instead of considering all possible alternatives and choosing the one with the highest expected utility. These decision rules were optimal in the previous market
conditions, obtained by trial and error, and allow for reducing the costs of decision making and grabbing market opportunities without much delay. However, when market conditions change, these decision rules might no longer be optimal, and it will take some time before these decisions rules will be adapted in a new trial and error procedure. This reasoning lead towards the Adaptive Market Theory (Lo, 2017). In this theory, there is room for profitable speculation during the transition period. Speculators who know the heuristics of particular categories of market participants can make a profitable use of this knowledge. Exemplary are the activities of so-called smart money taking advantage of the trend following dumb money.

In the chapter 4 I will discuss the role of private information which, by definition, is not, or not yet, part of the common knowledge. Having or acquiring private information offers the possibility of using it for speculative purposes. In many jurisdictions, insider trading is considered to be a criminal activity, and institutional arrangements are made to prevent insider trading as much as possible, for instance by requiring that all market relevant information must be published as soon as possible. But how effective are these arrangements? Assuming that others will have acquired private information can cause so-called information cascades. It will be shown that sophisticated traders can use an information cascade for profitable speculation.

In chapter 5 I will discuss the role of information as such. Subjects like misinformation, disinformation, trust and rumours will be discussed. Falling victim to cheating and fraud are real dangers for any speculator.

Chapter 6 is dedicated to the demography of speculation: who are the speculators and is their profile changing. Financialization is a catch word for the changes taking place, leading toward speculative transactions that are not exclusively motivated by the events taken place in a specific market, but also by movements of financial capital between different markets.

At several places throughout this thesis examples will be taken from the copper market, a commodity market where speculation has a long tradition. In an annexe a more systematic overview of the copper market will be given.

The conclusion of the thesis is that speculation can have a positive role. It is more than just gambling, while regulators should take care to prevent that speculation turns into market manipulation. But between those two extremes, speculation can provide liquidity, facilitating transactions between more and less risk-averse market participants, and can have an epistemic role: bringing information to the market that is not yet common knowledge. For this reason the epistemology of speculation is an interesting subject: what can speculators know about the future price?
2. Speculation under Common Knowledge

2.1 Introduction

The price of a commodity and its future development offers guidance to production and consumption decisions. Take the price of copper. A copper mining company will want to know what the future price of copper will be when deciding on a major investment decision, for instance to develop a new pit in an existing mine complex. A secondary producer will want to know whether scrap collection can be organized profitably at the future market price. An automotive firm will want to know what this important raw material, a vehicle contains on average about 1.5 kilometre of copper wire, will cost when deciding on his production and marketing plan for the next car sales season. The same applies for a building company or a cable producer. These are all professional parties, with access to relevant information about market conditions, and the ability to translate this information into reliable assessment of market conditions. Of course, there will be some uncertainty about future events. Natural disasters, wars and civil unrest, accidents and diseases, changes in technology, all could cause realisations to deviate from predictions, bringing windfall profits to some, and windfall losses to others. When positive and negative deviations will cancel each other out in the long run, one is justified to decide on the predictions based on market knowledge.

If all market participants know the relevant facts about the market conditions, they have mutual knowledge. But market participants also know that the other participants will have the same knowledge. This means that there is common knowledge: two market participants no only both know that event $E$ will happen, but party 1 also knows that party 2 knows that $E$ will happen, and party 2 knows that party 1 knows that party 2 knows that $E$ will happen, and so on. This infinite definition of common knowledge is minted by Lewis (1969). It has been formalized by Aumann (1979) in the following way:

- Define the operator $K_i(E)$ as “player i knows that $E$”
- The statement that “everyone in group $I$ knows that $E$” can then formally defined as follows:
  $$K_I(E) := \cap_{i \in I} K_i(E)$$
  where $I$ is a non-empty set of players
- If $E$ is common knowledge for group $I$, then not only everyone in group $I$ knows that $E$ is true, but this fact is completely transparent to all members of the group. We first define $K^n_I(E)$ by induction for $n \geq 0$:
  $$K^0_I(E) = E \quad \text{and for } n \geq 1, \quad K^n_I(E) = K_i(K^{n-1}_I(E))$$
- Now common knowledge can be defined as the following infinite conjunction:
  $$C_I(E) = \cap_{n \geq 0} K^n_I(E)$$
- Unpacking the definitions gives:
  $$C_I(E) = E \cap K(E) \cap K(K(E)) \cap K(K(K(E))) \cap ...$$

In economics, mutual knowledge of the relevant market conditions is assumed. Market participants acting in error or ignorance of the market conditions, will be soon driven out by competition. But often the stronger assumption of common knowledge is also made. An example is the efficient market theory, which states that all relevant market information is already included in the actual market price. All new relevant information is quickly digested by all market participants, and all know that the others will also have done so, so all will have already adapted their behaviour to the new conditions. In that case, there will be no disagreement between the market participants about what the correct price is. A producer will trade with a consumer, both accepting the present market price as the correct one.

Is speculation possible under the assumption of common knowledge? Adherents of the efficient market theory say no. There is no justification to be found in the available information to assume that
The Epistemology of Speculation

the future price will be different from the present one. Anticipated changes in market conditions will be properly discounted and included in the actual price. There are of course from time to time market anomalies, price movements that cannot be explained by changes in the relevant market conditions, but they are to be attributed to pure chance. In that case, speculation can sometimes bring profits, but these profits will be offset by losses at other occasions. The transaction costs involved will make sure that in the long turn speculation will be loss-making. Speculation in those conditions is just gambling, in the same way as buying a lottery ticket in every subsequent drawing or playing roulette repetitively can bring occasional profits but will be loss-making for certain in the long run.

In this chapter I will discuss the development of economic thinking about the role of speculation from the theory of normal backwardation of Keynes and Hicks in the 1930s until the efficient market theory of the 1970s and show the role of the assumption of common knowledge in this development. The chapter will end with a discussion whether there are indeed no possibilities for speculation under common knowledge.

2.2 Keynes’ and Hicks’ Theory of Normal Backwardation

Keynes (1930, II 142-4) was dealing with the situation of a producer who must take a decision whether to start a production process that will take some time before the product can be sold at the market. He will only start production if he expects it will be profitable. As there is always the possibility that market conditions will deteriorate in the meantime, he runs the risk that the finished product can only be sold at a loss. If he could sell his product forward, then he will be freed from this risk and can be certain of the profitability of this operation.

The price risk will then be transferred to a counterpart who buys the product forward. Such a forward contract is called a future. The seller of a future is called a short hedger, the buyer a long hedger. The counterpart might be a consumer or a speculator. A speculator does not want to use the product himself, so he will have to sell the contracted quantity at the spot market just before the expiration day of the contract to avoid actual delivery. So, the speculator will only buy the future if he expects that the spot price at the expiration day will be higher than the actual price of the future. But because the speculator will bear the risk that the actual spot price could be lower than he now expects, the speculator will only buy the future if the expected profit margin is high enough. The speculator wants to be rewarded for his assumption of risk by means of a risk premium. The producer, on the other hand, will see this risk premium as insurance costs, providing cover for the commercial risk involved with his production decision.

This is idea behind the theory of normal backwardation as developed by Keynes (1930). The long hedge of the speculator makes it possible for the producer to transfer the commercial risk of production towards the speculator. As both parties will know what they are doing and what the motives of the other party are, this will mean, according to Keynes, that in “normal” conditions, when supply and demand conditions are expected to remain unchanged, and therefore the spot price is expected to be the same in the coming months as it is to-day, the actual price of a future should be lower than the actual spot price. The difference will be the risk premium for the speculator. He calls this normal backwardation. Backwardation is the market terminology for a situation in which the price of a future is below the actual spot price. The opposite situation is called contango. Keynes estimated that the risk premium would normally be in the order of magnitude of ten per cent on an annual basis.

Keynes also considered what would happen when the situation is not “normal”. What will happen when there are surplus stocks in the market? In that case, the futures price must be higher than the actual spot price, because otherwise it would always pay to sell the surplus stock at the present spot price and buy it back forward, rather than incur the warehouse and interest charges of carrying the
stock. So, the existence of surplus stocks must cause the futures price to rise above the actual spot price, i.e., cause a contango. This contango must be equal to the warehouse, depreciation and interest charges of carrying the stocks. But a contango does not mean that the producer can now hedge himself without paying the usual insurance against price changes. This means that the present futures price must be below the expected spot price at the expiration date by at least the amount of the normal backwardation. The risk premium might then be even higher than normal because of the additional uncertainty introduced by the surplus stocks.

When there is a present shortage of supply, the backwardation can be larger than normal, only limited by the unwillingness of the buyers to pay the higher spot price rather than postpone the date of his purchase.

So, according to the theory of normal backwardation, the producer can always transfer the risk of a future price change to a speculator who will take up this risk when he will be sufficiently rewarded by the positive margin between the present price of the future and the expected spot price at maturity.

Hicks (1938, 137-9) elaborated on this point by arguing why the counterpart to a future will most often be a speculator, and not a market participant on the demand side, who knows he will need the product in the future as an input. On the demand side, however, there is less need to insure against price changes, because the buyer will have a much freer hand in altering his plan when the prices of his inputs soar than a supplier who has already started the production process and is confronted with plummeting prices. So, there will be more producers wanting to sell a future than consumers wanting to buy one. Speculators will have to fill the gap.

The theory of normal backwardation holds that there is strong correlation between futures prices and the expected spot price at the date of expiration. All market participants know that this correlation exists and can make use of this correlation for insurance. And the role of speculation is to bring liquidity to the market by providing the long hedging needed by producers that consumers are unwilling to provide.

2.3. The Theory of Storage

Holbrook Working heavily criticized the theory of normal backwardation for both empirical and theoretical reasons. He started by investigating the differences between the futures prices at different maturity dates at the Chicago wheat market. Wheat is harvested in the USA from June till August, with the peak in July. It takes some time before the harvest is transported to the market. This means that the inventories left over from previous harvest still present in June are sometimes insufficient to meet demand over the June-July period. Working found that the difference between the September and July futures, i.e., the post-harvest and the pre-harvest maturity dates, was roughly equal to the storage costs for those two months when the level of the June inventories were well above the normal level. When inventories were lower, the difference (“spread”) between the September and July future became smaller, and at normal June inventory levels, the future prices were equal. When inventories were below normal, the spread became negative, i.e. the market came into backwardation.

These findings shed considerable doubt on the theory of normal backwardation. Working found that backwardation is not the result of shifting risk upon a speculator, but the result of scarcity during the harvest period. The curve representing the relation between the September-July spread and the June inventory level became known as the Working curve.
Relationship between Chicago July-September Spread in June and United States Wheat Stocks on July 1 (from Working (1933))

But what could explain that some market participants still hold inventory when the June future is higher than the September future? Instead of bearing the storage costs, the owner of the stock could make a profit by selling a June future and buying a September future. The advantage that compensates foregoing these advantages is called the *convenience yield* of storage, a concept introduced by Kaldor (1939). Having physical inventory rather than a paper futures contract means for a merchant, or a processing industry, that he can quickly react to demand without first having to procure the commodity. Having physical inventory saves him transaction costs and will avoid disrupting his business process. This convenience yield can explain why, when inventory levels in June are normal, the spread between the post-harvest and pre-harvest futures can be zero: the convenience yield will compensate for the storage costs.

This reasoning was leading to the *theory of storage*: the relation between the price of a future and the spot price will be determined by the storage costs and the convenience yield. Both will be a function of the actual level of inventory. As there are fixed costs involved in warehousing, marginal storage cost will rise considerably when the demand for storage exceeds the capacity of the existing warehouses and the excess inventory will have to be stored elsewhere. The marginal convenience yield will increase when the inventory level is low but can be negligible when inventory levels are high.

This lead to the following relation between the futures price and the spot price

\[
F(t,T) = S(t) - C_s(t,T) + C_c(t,T)
\]

in which

- \(F(t,T)\): the futures price at date \(t\) with expiration date \(T\)
- \(S(t)\): the spot market price at \(t\)
- \(C_s(t,T)\): the storage costs over the period from \(t\) until \(T\)
- \(C_c(t,T)\): the convenience yield over the period from \(t\) until \(T\)

As soon as the spread between the futures price and the spot price deviates from the relation given above, arbitrage will take place ensuring that the spread will return to the equilibrium level.

Brennan (1958) has formalized the theory of storage by specifying both a demand and a supply curve for storage. The derivation of the demand function starts with assuming that, *ceteris paribus*, the
quantity of consumption in period $t$, $C_t$, will depend on the actual spot price $P_t$. The inverse means that the actual spot price is a function of the quantity consumed, $f(C_t)$. There is the accounting relation that the stocks carried out of the period $S_t$ will be equal to the stocks carried in $S_{t-1}$ plus the production quantity in that period $X_t$ minus the quantity consumed. Rewriting this relation by equating the consumption to $(S_{t-1} + X_t - S_t)$, and taking the difference between the spot price in the next period and the spot price in this period as dependent variable, gives the demand function of storage:

$$P_{t+1} - P_t = f_{t+1}(S_t + X_{t+1} - S_{t+1}) - f_{t}(S_{t-1} + X_t - S_t)$$

The function $f_t$ is time-dependent as the conditions that determine the consumption quantity can change, for instance a changing demand in the end-product for which this commodity is an input. $S_{t-1}$ is an observed quantity. Brennan assumes, “for convenience”, that both $X_t$, $X_{t+1}$ and $S_{t+2}$ are exogenously determined. This assumption is not so obvious for $S_{t+1}$, but it allows him to claim that, because $dP/dC < 0$, the partial derivative of $(P_{t+1} - P_t)$ with respect to $S_t$ will also be negative.

The supply function of storage is derived by assuming that the owner of stock will maximize his profit, revenue minus costs. The revenue of holding stock $S_t$ will be the difference between the expect price in the next period minus the actual price in this period: $EP_{t+1} - P_t$, multiplied by $S_t$. The (net) costs will be the sum of the outlays of the physical storage plus a compensation for risk minus the convenience yield. All three components will be a function of $S_t$. The marginal outlays for physical storage will be a constant up to the capacity level of the warehouse. When $S_t$ is larger than this capacity, marginal outlays for physical storage will rise. The more money is invested in stored commodity, the greater will be the financial risk of the firm owning the stock. This will lead to a higher interest rate charged by lenders, and the owners of equity will require a higher return. Brennan assumes that the marginal compensation required to offset this financial risk is a function of $S_t$, growing slowly from zero until the risk reaches a threshold, after which the compensation will rise rapidly. The convenience yield is a declining function of $S_t$, marginal cost declining to zero and remain at zero when stocks are above a certain level. The profit function is maximized when the marginal revenue is equal to the marginal costs. This gives the supply function, i.e., $(EP_{t+1} - P_t)$ as an increasing function of $S_t$.

Brennan does not discuss how the equilibrium between the demand and supply of storage can be obtained and maintained. He assumes that the demand function will often shift because of changing production and consumption conditions, while the supply function will be stable. This comes down to the assumption that the level of storage in any period is exogenously determined, leaving the discussion about the price elasticity of consumption out of the discussion. This has the advantage that a simply plot between the difference between the expected price in the next period and the observed actual price in this period, $(E(P_{t+1}) - P_t)$, on the y-axis and the level of storage carried out of this period $S_t$ will show the supply curve.

The expected price, however, cannot be observed. Brennan thinks that the price of the future for the next period will be a good predictor for the actual price in that period and can be used instead. When there does not exist such a future, the expectation could be derived from a distributed lag over past prediction errors, what comes down to calculating a moving average over past observed prices after correcting them for a seasonal pattern. Brennan uses the price differential calculated in this way to plot the supply curve.

Of the cost components, only the marginal outlays for physical storage can be observed. Subtracting these from the price difference gives a residual that is assumed to consist of the marginal convenience yield plus the marginal compensation for risk. When the level of storage is low, the convenience yield will be the dominant component, while when the level of storage is high, the compensation for risk...
will be the dominant factor. Brennan compares the curves so obtained for different commodity markets and find significant differences in the compensation of risk between commodity markets of semi perishable commodities and more durable commodities. In the markets of semi perishable commodities, the required compensation for risk is higher, probably due to the risk of quality deterioration.

The theory of storage attributes a different role for speculation than the theory of normal backwardation does. In the latter, speculation is setting the price of the future by requiring a premium to be deducted from the expected price at the expiration date, while in normal conditions this expected price will be equal to the present price. In the theory of storage, speculators are one of the providers of storage, besides producers, merchants and consumers. As all these market participants will engage in hedging for at least a part of their activities, either for reducing their risk or for obtaining an additional premium, both the price of the future and the actual price will be determined in combination. In practice, most market participants will act on “the basis”, i.e., the spread between the actual price and the price of the future for an expiration date not too far in the future. When the level of stocks diminishes, there is less need for speculators providing storage above the storage provided by the normal market participants. As the speculators will demand the highest compensation for risk and will not profit from a convenience yield, they will be the first reducing their supply of storage when the basis will decline because of the lower demand for storage. In the theory of storage, the implicit assumption is that the price of the future for an expiration date not too far in the future, equals the expected price at that date.

2.4. The Rational Expectations Hypothesis

Both theories discussed above are difficult to verify empirically because of the critical role of the price expectations, which are difficult, if not impossible, to observe. Muth (1961) proposed to use rational expectations: expectations that are essentially the same as the predictions of the relevant economic theory. This means that the expectations of the relevant market participants tend to be distributed about the prediction of the economic theory. Muth does not assume that all market participants are having the same expectation, it is enough that the average of their expectations is equal to the prediction of economic theory.

Muth starts with discussion price expectations in an isolated market, i.e., without inventories. He gives the following simplified model, in which all variables are deviations from their equilibrium values. $C_t$ is consumption in period $t$, $P_t$ production in period $t$, $p_t$ the market price in period $t$ and $p_t^e$ the market price expected to prevail in period $t$ based on the information available at $(t-1)$. There is a production lag, and the length of the period considered is equal to the length of this lag. There is an error term $u_t$ with mean zero, representing variations in production conditions, for instance weather conditions influencing yields. The model is then:

\[ C_t = -\beta_p p_t \]
\[ P_t = \gamma p_t^e + u_t \]
\[ P_t = C_t \]

Eliminating the quantity variables give

\[ p_t = \left(-\gamma/\beta\right) p_t^e - (1/\beta).u_t \]

Taking the expectation of $p_t$ then gives as $E(u_t)=0$

\[ E(p_t) = \left(-\gamma/\beta\right) p_t^e \]
Remember that $p_t^e$ is the price expected by the producing firms based on the information available at $(t-1)$. If the prediction from theory $E(p_t)$ would be higher than $p_t^e$, the average of the predictions made by the actual producers, there would be considerable possibilities to profit from this difference by “insiders”, people who know how the market mechanism works, by becoming a producer themselves or by selling a price forecasting service to the producers. This opportunity would not exist if the prediction of the theory and the forecast of the producers are the same. This requires that $p_t^e = 0$, that is, the expected price is equal to the equilibrium value.

The next step is to assume that part of the error $u_t$ may be predicted from prior information, so $E(u_t)$ will not be equal to zero. When requiring that the prediction from theory must be the same as the expected price, we have

$$\frac{-1}{\beta + \gamma} \cdot E(u_t)$$

If the shock is observable, its effect can be incorporated in this way in the expected price. When there is a lasting effect, this will result in serially correlated error terms. Muth shows that this will result in an expected price that will be equal to a geometrically weighted moving average of past prices. When there are deviations from rationality, for example when “insiders” are better than the others in estimating the effect of the exogeneous information, then the results are not fundamentally different. The “insiders” will then have an advantage of one period, the others will use an expected price that will be a geometrically weighted moving average of past prices.

The next step is to introduce inventories. Speculators will try to profit from a price difference between the expected in the next period and actual price:

$$I_t = \alpha(p_{t+1}^e - p_t)$$

Replacing the equilibrium equation given above by:

$$C_t + I_t = P_t + I_{t-1}$$

and eliminating the quantities gives

$$-(\alpha + \beta)p_t + \alpha p_{t+1}^e = (\alpha + \gamma)p_t^e - \alpha p_{t-1} + u_t$$

This is a difference equation in the expected price. Prices and quantities will respond dynamically to the disturbances represented by the error term. Muth shows that there will be a stable solution when the following inequalities are satisfied

$$\alpha > 0$$
$$\beta + \gamma > 0$$

The first condition requires that speculators will act in the expectation of gain (rather than loss), and the second is the condition for Walrasian stability, i.e., that the deviations from the equilibrium between demand and supply will diminish in each next round of transactions, so ultimately equilibrium will be restored.

If the assumption is made that the subsequent error terms are independent, then the expected price will only be correlated to the previous price, the rest of the price history will not convey any additional information:

$$p_t^e = \lambda_{1t}p_{t-1}$$
where the factor $\lambda_1$ will be close to 1 if the influence of inventories is important in this market, and close to 0 if negligible.

This brings Muth to the following conclusions about the economic effects of speculation when expectations are rational. Speculation will reduce the variance of prices by spreading the effect of a disturbance over several time periods. This effect is negligible if $\alpha$ is much smaller than the sum of $\beta$ and $\gamma$. The standard deviation of expected prices first increases when $\alpha$ rises, because speculation makes the time series more predictable and then decreases when $\alpha$ rises further, because actual prices will then have a smaller variability. The variability of production roughly follows the same pattern.

In summary, the conclusion of the rational expectations hypothesis is that expected prices will be equal to the equilibrium price that can be predicted from economic theory given the information set available at (t-1). One-time exogeneous shocks will be quickly incorporated in the expected price, while permanent exogeneous shocks will gradually be incorporated and their effect will dampen quickly. If expected price would deviate from the price predicted by economic theory, then “insiders” could profit. But the activities of these insiders will ensure that the equality between the expected price and the price predicted by economic theory will be quickly restored. When there is speculation then the standard deviation of the expected prices will be smaller than without speculation when the exogeneous shocks are independent as their effect will be spread out over several time periods. The presence of speculation has therefore a stabilizing effect.

2.5. The Efficient Market Hypothesis

The idea that market prices follow a martingale dates to the PhD-thesis of Bachelier in 1900. A martingale is a sequence of random variables for which, at a particular time in the realized sequence, the expected next value is equal to the present value. The name martingale was taken from an 18th-century French betting game. When prices follow a martingale, this means that the expected price in the next period is equal to the present price and can move upward or downward with equal probability.

In the language of betting this is called a “fair game”, as a fair coin gives equal opportunity to arrive at heads or at a tail. In the language of the market this is called a “random walk”: the next step can be in either direction. If prices are following a random walk, it makes little sense to speculate: the chances of making a profit are equal to the chances of losing, so why bother?

Samuelson (1965) generalized the idea of a random walk at the capital market. All available information is already present in the actual price, there is nothing to gain from considering information about previous circumstances. Future developments are uncertain and could work either way. So, an investor could gain from investing in a particular stock if he is lucky that there are more positive than negative future developments, but he could equally make a loss when the opposite happens. The investor cannot know how this will turn out, so investing is a “fair game” and the price will follow a random walk.

Of course, there can be also knowledge about developments to come. If properly anticipated they will already be included in the present price. In a later article Samuelson (1973) made the precision that the properly anticipation of future developments means properly discounting: the price of a stock will be equal to the present value of the anticipated future dividends. This means that the fundamentalist model of investing is correct and compatible with stock prices following a random walk. If there would be a class of investors who have private information about future developments, they could profit by using this information. But when the group of investors having this private information grows larger, their influence on the present price will become larger, and will drive the present price to the level that corresponds with the level that would prevail if all investors would have this information.
Fama (1970) elaborated on the idea that the present value of a financial instrument incorporates all available information. An ideal market would be a market in which prices provide accurate signals for resource allocation, and securities prices fully reflect all available information. He calls a market that meets this condition efficient. This became known as the efficient market hypothesis.

Sufficient conditions for a market to be efficient are (i) a market in which there are no transactions costs in trading securities, (ii) all available information is costless available to all market participants, and (iii) all agree on the implications of current information for the current price and distributions of future prices of each security. Fortunately, these conditions are not necessary for the market to be efficient. Fama thinks that the empirical evidence shows that the deviations from these conditions found in actual markets have only a limited impact and markets are still efficient in the sense given above.

Fama classified several empirical studies of market prices according to the test they applied to the information set that should be fully reflected in the price:

- Weak form test: is the history of the price fully reflected? This has mainly been done by testing whether prices indeed follow a random walk.
- Semi-strong form test: is the speed of price adjustment to other obviously public information high enough?
- Strong form test: have there appeared investors that have monopolistic access to any information relevant for the prices?

Fama thinks that the weak-form tests reported have shown that historical information has been reflected in prices. In some studies, serial correlation between subsequent changes have been found, but this correlation is not big enough to justify a trading rule that will bring a profit, certainly not when some transactions costs will be made. An example of such a trading rule would be a filter that defines a threshold for price changes: ignore small price changes below the threshold, when a price change is above the threshold, buy and hold, until the prices decreases with the threshold percentage, then sell and go short, until the price has increased again with the threshold percentage, then covers the short position and buy. Simulations have shown that such a trading rule will only be profitable when a small filter is used on short-term price movements, but that these profits will be wiped out if transaction costs must be paid. For large filters, the serial correlation is simply too small to be profitably used.

As a side-note, Fama discusses the possibility that the distribution of price changes is not normal. This has later become known as the possibility of the distributions having “fat tails”, i.e., large price changes having a greater probability than predicted by the normal distribution. He thinks, however, that this possibility is not important enough to dismiss the efficient market hypothesis.

The semi-strong tests have been done on the announcement of a split, on announcement of a rate change by the Federal Reserve System, and on second offerings and new issues of shares. In all cases, publicly available relevant information was fully reflected in the price at the time when the information became relevant.

The strong tests referred to by Fama concentrate on the question whether a mutual fund can perform better than a market portfolio selected by an index. One may assume that the management of a mutual fund can have access to relevant information that is not widely known. The results are nowadays well known: the performance of mutual fund is not higher than a market portfolio because the advantage of having some private information is neutralized by the higher transaction and management costs, which include the costs of searching for private information.
So, Fama concluded that the efficient market hypothesis has passed all three tests: market prices fully reflect all available information.

Fama reached his efficient market hypothesis from empirical studies that tried to find deviations from prices following a martingale, and he could not find such deviations. Because prices follow a martingale, he concluded that all available information is fully reflected in the price. For that reason, there seems to no possibility to speculate profitably.

Such a conclusion, however, is an example of **affirming the consequent**: if P then Q, Q, thus P. The hypothesis was that prices are following a martingale because there is common knowledge what the correct price is given the new information. The evidence considered gave Fama no reason to conclude that this hypothesis must be rejected. In statistical hypothesis testing a distinction is made between a type I and a type II error. A type I error is the rejection of a true hypothesis, a *false negative*, while a type II error is failing to reject a false hypothesis, a *false positive*. Concluding that the hypothesis of common knowledge on what the price should be is true because prices are following a martingale, could be a type II error. Take the strong tests of Fama. These tests showed that *private* information can be profitably used. Fama only showed that, in the case of mutual funds, the higher transaction and management costs outweigh the advantage of having private information. But although this is good to know for investors and mutual fund managers, the logical conclusion should nevertheless be that the hypothesis that all available information is already included in the price should be rejected.

### 2.6. Common Knowledge

The third condition set by Fama for markets to be efficient was that “all agree on the implications of current information for the current price and distributions of future prices of each security”. How could this agreement be obtained?

Remember that the efficient market hypothesis was developed from combining the rational expectation hypothesis with the random walk hypothesis. The rational expectation hypothesis says that the expectations of market participants will be equal to the predictions of economic theory. So, when there is a temporary difference between supply and demand, economic theory will predict that producers and/or consumers will adapt their behaviour and equilibrium will be restored. The random walk hypothesis states that, when future developments are properly anticipated, then prices will fluctuate randomly. So, both hypotheses look at how new information is being handled by market participants: interpreting it in the light of the relevant economic theory.

Under the assumption that all market participants are optimizers, i.e., they will try to maximize their expected utility, their actions will depend on the probabilities they attach to the possible future states of the world. New information will be translated into a new subjective probability distribution over possible future states of the world.

When we assume that all market participants have the *same* subjective probability distribution over possible future states of the world, and have chosen their optimizing actions, then there is no reason to expect any further changes in behaviour that would influence prices. This could be a good explanation for the markets to be efficient, i.e., that the actual market price contains all available information. If the market rules also include prices of futures, those prices will then incorporate all presently available information of what could happen until the maturity date of the future.

This does not exclude the existence of price movements because of pure aleatory events if they can move either way and their expected mean value is zero. The possibility of these chance effect makes many actions risky: being long or short always bring risks. A producer that starts production that will be ready after some time, but also the owner of stock, runs the risk of a price decrease, and a consumer
planning to use the commodity as input runs the risk of a price increase. Buying or selling a future is one way to shift this risk to another market participant. When all market participants have the same subjective probability distribution over future states of the world, then the only reason for buying or selling a future is a different appreciation of risk as expressed in their utility function: the more risk averse market participants shifts the risk to a less risk averse one.

This means that when market participants all have the same subjective probability distribution over possible states of the world, the Keynes-Hicks theory of normal backwardation would apply. Producers will be more risk averse than consumers, so speculators will have to be active to equal demand and supply of long futures. And those speculators, who will be the least risk averse, will be willing to enter these transactions if a risk premium can be earned, i.e., the price contained in the future must be lower than the expected future price.

In conclusion, when all market participants have the same subjective probability distribution over possible future states of the world, there still exist opportunities to be rewarded for being a speculator. But how could all market participants arrive at the same subjective probability distribution over possible future states of the world? This could be arrived at in the following way:

- Suppose the market has arrived at an equilibrium, and all market participants consider the present situation as Pareto-optimal: nobody can gain from changing his behaviour. When this situation continues for some time, this will cause all market participants to have the same subjective probability distribution over possible price movements. Call this the common prior assumption.
- Then new information arrives. As all market participants are assumed to be optimizers, they will have to incorporate this new information in their subjective probability distribution of possible price movements. As they all have rational expectations, they will update their probability distribution in a Bayesian way using the predictions of the relevant economic theory. Of course, they might first attach a different likelihood to possible explanations. This will result in different posterior probability distributions.
- This means that there will be some disagreement about the consequences of the new information. This will initiate market transactions between participants having different expectations on the direction or magnitude of the price change due to the new information.
- These market transactions will be observed by all other market participants and will lead to the reactions in supply and demand as described in the relevant economic theory. Under the assumption that the stability conditions are met, this will eventually lead to a new equilibrium. And if the market then remains in equilibrium for some time, the disagreement will disappear in the light of the observed facts, and all subjective probability distributions will converge again into the same distribution for all market participants.

For a market to be efficient, this means that the process of eliminating the disagreement between the market participants on the consequences of the new information must be rapid.

This reasoning leads to the conclusion that it is not enough that there is common knowledge of all market transactions; market should also be from time to time long enough in equilibrium to end disagreement between the market participants.

Speculation of course thrives when market participants disagree on what to expect. The rational expectations assumption drastically reduces the possibilities of disagreement: all will expect what the relevant economic theory predicts, that is that market equilibrium will be restored. But there still can be disagreement at the start of the trajectory from the old equilibrium to the new one. But when the
trajectory followed is being observed, this disagreement will fade out. If the disagreement is ended rapidly, then the new information will be completely incorporated in the market price. Then, speculators will again be reduced to the limited role of providers of insurance against the pure chance effects that remain.

2.7 Conclusion
The discussion in this chapter of what mainstream economics has to say about speculation can be summarized as follows:

- Producers will have a stronger urge for hedging their position than consumers. So, speculators can be useful to fill the gap and make it possible for producers to get insurance against deteriorating market conditions during the production period. Speculators will have to be rewarded to fulfil this role by a kind of insurance premium: the price of the future should be lower than the expected spot price when the product is finished.
- When there are surplus stocks, i.e., when the stocks are larger than the normal working stocks of producers and consumers, then somebody must be found willing to hold these stocks. Speculators are willing to provide storage when the difference between the actual spot price and the expected future spot price is large enough to cover the storage, depreciation and capital costs of holding the product. The capital costs will include a risk premium. When stocks decline, speculators will be the first to leave the market because regular market participants will be more eager to hold the stocks for the convenience yield it offers to their operations.
- Common knowledge is assumed, i.e., when new information arrives, market participants can rapidly reach agreement on its implications for the market price. Trading on dissident opinions will be loss-making.

These results are derived from assuming that all market participants, including the speculators, have rational expectations and are optimizers as prescribed in rational choice theory.

In the next chapters, we will discuss situations in which these assumptions are not met:

- Market participants could not be optimizers but following heuristics, decision rules that use only a part of the available information, either for allowing swift decision making or to reduce the costs of deliberation. This will be discussed in chapter 3: The ecological rationality of speculation.
- Besides public information there can also be private information that is only accessible to some market participants. There is no guarantee that this private information will be incorporated in the market price, at least not for some time. This will be discussed in chapter 4: Private information and information cascades.
- The information that becomes available will not always be correct and complete. There can be misinformation and disinformation. This will be discussed in chapter 5: The social epistemology of speculation.
- And, finally, is it plausible that market participants always establish agreement about the development of the price in the future? Is it possible for speculators who do not agree with the others to survive? This will be discussed in chapter 6: The demography of speculation.

As we will see, in all these cases there are more possibilities for profitable speculation than under the efficient market hypothesis, while the epistemological requirements for being a successful speculator are correspondingly higher.
3. Ecological Rationality and Speculation

3.1. Introduction

The basic assumption underlying mainstream economics is *homo economicus*, all economic agents operate rationally, taking decisions that result in outcomes that satisfy their preferences in an optimal way within the constraints set by the resources and technology that are available to them.

Many decisions of economic agents critically depend on their expectations about future events. However, there are serious problems in observing the expectations of economic agents. Surveys suffer from the phenomenon that people can change their mind when having to be explicit about their thoughts.

In the dynamic economic modelling that was developed after World War II *adaptive expectations* were mostly used. Often a weighted average of past realisations was used as a substitute for the expected value, and in each round a fraction of the last observed forecast error was added. The problem with this method is that the so derived forecasts suffer from systematic errors.

As we have seen in paragraph 2.4, Muth (1961) proposed to replace adaptive expectations with *rational expectations*. Agents will use the relevant economic theory, i.e. their understanding of the economic mechanisms at work, to make a prediction of the equilibrium value that will finally result from the interactions between the agents and use this value as their expectation.

Gueresnie (2005) has investigated how rational economic agents can learn what to expect, arriving at common knowledge what the equilibrium will be. He calls that situation *eductive rationality*. However, it was found that in many economic models, multiple equilibria are possible. It depends on the first actions taken by the economic agents which of these equilibria will materialize. Expectations then become self-fulfilling prophecies. Kirman (2014) shows that this reverses the causation: instead of the equilibrium causing the expectations, the expectations cause the equilibrium.

As we have seen in chapter 2, combining the rational expectations hypothesis with the assumption that common knowledge is obtained, results in the *efficient market theory*: the actual prices will reflect all information available about the fundamental value of the product traded on that market. Why would a *homo economicus* consumer be willing to pay more than the fundamental value? Or a producer to receive less? As a result, short-term price movements, short term defined as a period in which the fundamental value remains unchanged, will be the result of chance, aleatory disturbances of the market, like errors, accidents, weather conditions, etcetera. Often the assumption is made that the combined effect of the chance effects is *white noise*:

\[ P_{t+1} - P_t = \varepsilon_t \]

in which \( \varepsilon \sim N(0, \sigma) \), i.e. a stochastic variable that is normally distributed with mean 0 and standard deviation \( \sigma \). In mathematical terms this means that the price is a *martingale*. In the investment literature it is called a *random walk*, in a price diagram with price on the y scale and time at the x scale, the prices step left (up) or right (down) randomly.

Note that the assumption of a time-independent distribution of \( \varepsilon \) means that *ergodicity* is assumed, i.e. that the combined effect of all factors causing together the aleatory price movements will remain the same in the future as they have been in the past. This means that the value of \( \sigma \) can be known from historical data. Many products of financial engineering, like options, and more sophisticated derivatives such as collateralized debt obligations, are priced on this assumption.
In the efficient market theory, there will be arbitrageurs, people who buy when the price is lower than the fundamental value and sell when higher. As the price returns to the fundamental value, they can reap their reward by selling (or buying) the product against the fundamental value. This is called *buy low, sell high*. This arbitrage is a countervailing power to disturbances on the market as it works in the opposite direction of deviations of the price from the fundamental value. Because this arbitrage has been around already for a long time, its effect is incorporated in the historical value of the standard deviation of the white noise.

In this chapter I will discuss whether it is warranted to use the assumption of homo economicus. Is it plausible to describe the behaviour of economic agents in this way? And do actual market prices indeed always reflect all available information about the fundamental value? In the introduction to this thesis we have mentioned research that shows that over a very long period trend following would have been a successful strategy for speculators. Trend following means *buy when the price has gone up, sell when the price has gone down*, i.e., just the opposite of *buy low, sell high*.

Professional traders make a living out of buying and selling on the market, often on behalf of clients but also for their own account. These professional traders know the phenomenon of trend following and try to profit from it: buying now to sell later at a higher price, or vice versa. Of course, they know that at some moment in time a correction will take place when prices have deviated too much from the fundamental value. They will therefore be wary to be out of the market when the trend will reverse. For that reason, they make use of what is called *technical analysis*, looking for turning points in price trends. Technical analysts try to identify *resistance levels*, a price level that act as a ceiling or a floor, where the price will bounce back, or, when the resistance is broken, the price trend will accelerate. Although most technical analysts still use graphical analysis of price charts (see for instance Green, 2016), much use is now also made of quantitative time series models, calculating moving averages and autoregressive tendencies in price changes with parameters estimated on historical data, and updating those metrics using the most actual data (see for instance, Box and Jenkins, 1970). The methods used in quantitative analysis are the subject matter of *econophysics*, the application of the statistical methods developed in physics to describe the motions of particles to economic prices (see for instance Sinha et. al. 2011).

What could explain the success of trend following? In the investment literature the blame is often put on *dumb money*, money invested by speculators ignorant of the fundamental value. Those speculators will enter a market when prices on that market are rising and leaving when they fall. When this happens the *smart money*, the professional traders, will profit from it in the ways just described, abandoning their normal arbitrage.

In this chapter we will turn to the behaviour of dumb money. Is *homo economics*, market participants as optimizers, a good representation of that behaviour? Gigerenzer (2011) has proposed to use *homo heurISTICus* instead, agents using heuristics to take decisions. Heuristics are decision rules that try to make an *efficient* use of the available information by concentrating on the part that is considered relevant and omitting all other available information. Gigerenzer thinks that in practice humans cannot do without heuristics, life would be impossible if, for each act, we would first have to make a complete analysis of all available information. Acquiring heuristics is an essential ingredient of the socialisation process of each child, and many of those heuristics have been developed during the biological evolution of *Homo sapiens* as improving the fitness for survival and reproduction. In market conditions, however, the heuristics used can be adapted at a much higher space. Lo (2017) calls this the adaptive market theory, as opposed to the efficient market theory. Under normal conditions, the repeated adaption of heuristics in a trial and error process will approach the optimal decision making as supposed in the efficient market hypothesis. But in a changing environment, the previously developed...
heuristics can become dysfunctional. Analysts of the economic crisis of 2008, such as Bookstaber (2017), think that using dysfunctional heuristics, for instance the stop-loss algorithms imposed on asset managers by institutional investors, was a major reason why the initial price correction spiralled into an intense crisis.

The proof of the pudding will be in the eating: what is ecological rational, i.e., what offers the best chance for survival in competitive conditions: (1) trying to discern the fundamental value and use this as the foundation for decision making, or (2) using heuristics and adapting them when the context changes.

3.2. Homo Heuristicus

In many cases it is not very likely that investors are deciding in conformity with the prescriptions of rational choice theory: considering all possible courses of action and choosing the one which has the highest expected utility. An employee that must indicate how to invest his 401k-pension account, will be presented by the HR department of his company or his financial adviser a short list of options, and will in most cases choose the default one. When this option means investing in shares, this employee could contribute to the persistence of a speculative bubble. A speculator who thinks insiders have got information and trade upon it, will follow them, although there is no way to decide on its probability. An asset manager, whose mandate from a pension fund or wealthy individuals includes a stop-loss provision, will start selling a part of the portfolio when the price falls with more than a predetermined threshold percentage, and so contribute to a further price decline, even when he thinks it would be in the interest of his client to hold them in portfolio. So, what these market participants do is to follow a heuristic: decide on perceived cues that suggest a course of action.

Kahneman and Tversky, the founders of behavioural economics, speak about heuristics and biases as deficiencies in decision making compared to rationality and optimizing. Gigerenzer (2011) however, thinks more positively about such heuristics. In the first place, there is often an accuracy-effort trade-off. When putting in more effort and more computation will lead to a higher accuracy of decisions but entail costs, there is, however, a cut-off point, where the costs of acquiring more accuracy outweighs the benefits of taking a decision based on more accurate assessment of the options available and their likely consequences. At this cut-off point, it is rational to stop looking for more precise arguments to take a decision. But in the second place, putting in more effort and computation is sometimes counterproductive. If approached by a person looking like a mug with a knife in his hand, the best strategy is not to find out what his motives are but start running away immediately. Maybe he was just showing off with his knife, or trying to sell it, but better safe than sorry. In fact, in many situations, refraining from gathering more information or doing more computations but following a heuristic, might even produce more accurate decisions. Gigerenzer calls this less-is-more and justifies this principle with a reference to the bias-variance trade-off in statistical inference. This trade-off indicates

---

2 When making predictions using an imperfect model, there will be prediction errors. The variance of these prediction errors will be the sum of the squared bias of the model, the variance of the model and the variance of the noise involved. The bias of a model is the consequence of using a model that does not correctly represents the causal mechanism at work. The variance of the model is the error resulting from the incomplete fit of the model with the past observations. Often, we have the situation of having to choose between imperfect models based on a limited set of past observations. In such a situation, using the most complicated model specification, for instance by taking also non-linearity into account, will lead to a lower variance compared to the variance of the other model, but can increase its bias. This means that a better fit on past observations can lead to worse predictions. This bias-variance trade-off is conditional on the assumption that not only the simple but also the more complicated model is imperfect, so trying to accommodate as much as possible the limited number of observations of past experience will necessarily increase its bias. Of course, when the simple model is less imperfect, the trade-off will not occur.
that a better fit with past experience can lead to making less accurate predictions. The question is, of course, when one is justified in ignoring possible relevant information and to concentrate on the few cues in the environment that are deemed relevant. Gigerenzer calls this *ecological rationality*, it depends on the environment in which a decision must be taken whether one should continue searching or take a decision right away on limited information.

In many situations in daily life, one follows such heuristics, reacting to a cue in the environment without further deliberation. Many of these heuristics are learned, as part of one’s socialisation as a child, in education, or in professional training. Heuristics become part of experience. A professional baseball player has not the time, and probably also not the skills, to solve the differential equations describing the path of a ball hit to know where to go to catch the ball. He follows the ball with his eyes and starts running, adapting his position in such a way that the ball keeps a constant position in his sight. In many cases, reacting to cues has become a routine. Think of an air force pilot. His training starts with getting acquainted with many rules what to do in which situation. But if he is still referring to these rules, he is still a novice, not a professional. A professional will start a routine automatically out of his memory when confronted with a certain situation (Dreyfus and Dreyfus, 1992). When asked afterwards why he has acted in the way he did, he will have difficulty in reproducing the rule he has followed, he simply knew what to do in that situation. He has become ecological rational.

### 3.3. The Adaptive Market Theory

The adaptive market theory of Lo (2017) goes one step further. Lo introduces the element of learning by trial and error. Individuals never know if their current heuristics are good enough, but they can learn by receiving positive or negative reinforcements from the outcomes. When the environment is stable, the progression by trial and error will lead to the optimal, ecological rational heuristic. But when the environment changes, the heuristics of the old environment might not be suited to the new one. Using the old one then becomes ecological irrational behaviour. Lo calls this process of adapting heuristics to changing environments *evolution at the speed of thought* (Lo 2017, 188), and, like in biological evolution, survival is the ultimate driving force. Speculative behaviour that leads to strong losses will stop because the speculator (or his patron) cannot afford going on in this way.

Lo illustrates what is happening in evolution at the speed of thought with the history of the hedge funds since 1949. Hedge funds are private partnerships of wealthy people willing to take great risks. Unlike a normal mutual fund, they not only invest their own money but also borrowed money to increase the stakes and combine investing with going short. For instance, when they think that one company will soon gain a considerable competitive advantage over its main competitor, for instance by making a breakthrough innovation, they will not only invest heavily in the first company but also short sell in the competitor. When the innovation materializes, the stock price of the first company will go up and the stock price of the competitor will go down. In that case, they can make a profit both ways, and that profit can be considerable because of the leverage. If nothing happens, and the stock prices remain the same, then they can liquidate their positions at low costs. But if the inverse happens, then they will incur heavy losses and may lose all their money. This so-called *pairs strategy* proved to be quite successful for some time and got many followers. But when many speculators follow the same strategy, the possibilities from profiting from this strategy start to decline: when many speculators want to go long in a specific stock, the price will go up, and vice versa for the specific stock they want to go short. Consequently, the possible gains were reduced, and it became difficult to maintain the same returns on capital employed, as the costs involved – trading costs, interest paid on borrowed money, costs of borrowing shares to go short – remained the same. In the terminology of the adaptive
market theory, the environment changed, and the heuristic became less suited for this new environment. The pressure of survival asked for a mutation, funds using a strategy better suited to this new environment.

The hedge funds found that mutation in quantitative trading strategies by expanding the pairs strategy to many stocks and using a contrarian trading strategy – buy long shares that have had a lower than average return recently, sell short shares with a higher than average return, and giving them a weight in the portfolio according to the deviation from the average. Normally the period over which the return is calculated is quite short, varying from one week to a month. The idea behind this strategy is reversal to the mean: what goes up, will go down – prices will adjust so the return on investment will be brought back to average. Because a large quantity of data must be handled on a continuous basis, this strategy asked for efficient search algorithms. For that reasons the hedge funds now employ many mathematically educated employees who can program and update those algorithms.

This new variety of hedge funds again attracted many followers. But they critically depend on the availability of lenders willing to borrow them money to leverage their investments. When in the prologue to the credit crisis of 2008 several investment banks needed liquidity to solve their problems in the mortgage markets, mainly because of margin calls on derivatives, they withdrew money from some of the hedge funds, forcing them to liquidate their positions. As most hedge funds had taken positions in the same shares, that meant that for all hedge funds their portfolios went in the wrong direction: they were long in shares which prices were depressed by the liquidating hedge funds and short in shares which prices were rising for the same reason. They lost a lot of money, and many of them had to liquidate, as both lenders and investors lost confidence. This aggravated the problems for the remaining ones. Many hedge funds had to close. In the terms of the adaptive market theory, the environment became so hostile that this species did not survive.

These examples show two things. In the first place they confirm that it is indeed possible to beat the market, there are anomalies in the price formation that can be profitably used. But in the second place they show that heuristics, not derived from theoretical analysis but as the outcome of a pragmatic process of trial and error, were guiding the behaviour of these professional speculators. And the Adaptive Markets Hypothesis explains why these heuristics became outdated when the environment changed, with the consequence that the speculator either had to innovate (mutate) by using another heuristic, better adapted to the new environment, or would disappear as only the fittest will survive.

3.4 Conclusion

As we have seen in chapter 2, the efficient market theory does not leave much room for speculation. The adaptive market theory offers more room for speculators: when the heuristics used by market participants are not adapted rapidly enough when circumstances have changed, smart money can profit from the trend set by dumb money. But this room for profitable speculation has a time window: sooner or later the market participants experiencing systematic losses will adapt, and the window for profitable speculation will disappear. Some call this casino capitalism, making profits not warranted by improving efficiency or better serving the client’s needs, but by gambling on slow adaptation. The CEO of Goldman Sachs, Feinstein, however, has called this (in 2009, shortly after the crisis) “doing God’s work” by promoting the early adaptors and punishing the laggards. As the adjectives indicate, the distinction between smart and dumb money is an epistemological one: smart money will have more justification for its beliefs about what is happening than dumb money has.
4. Private and Public Information

4.1. Introduction

As we have seen in chapter 2, the combination of common knowledge and rational expectations makes it almost impossible to speculate profitably as prices will follow a random walk. Common knowledge will be established when all market participants will have a common prior subjective probability distribution on possible states of the world and update their subjective probability distributions according to the predictions of the relevant economic theory when new information arrives. When those two conditions are met, then their posterior subjective probability distributions will end up being the same, so the only reason to trade in those conditions are differences in risk aversion.

In this chapter we will discuss how this process on digesting new information can take place. In the first place, the new information can be news, information made public and accessible to all market participants. An example are the monthly bulletins of the International Copper Study Group, an intergovernmental body set up to promote market transparency, containing statistical data on copper mine, smelter and refinery production, copper usage, stocks, prices and trade for copper products. When all market participants have rational expectations, one may assume that the process of digesting this information will soon induce a convergence of the posterior probability distributions.

But often the new information will be first available only to insiders. Examples are a mining company that encounters severe production problems and will have to invoke force majeure on its commercial contracts with customers, who will have to look elsewhere to meet their input demands. Or a cable producer that has received a big order for extending an electric grid and will have to secure the future supply of raw material to produce the cables. This information will become known first to a restricted group of market participants, such as traders and banks that have these companies as their clients. Although regulators will try to promote that these market participants make this information public when definitive, there is always a grey area. Insiders could use this information for making transactions while their counterparts to these transactions are unaware of it.

These transactions will be observed by non-informed market participants. Now three things can happen:

- The non-informed market participants assume that some market participants have private information, and act upon it without knowledge of the private information. This may cause a so-called information cascade, an example of herd behaviour that can cause considerable deviations from the equilibrium price until the private information has become public and common knowledge;
- The insiders announce the private information after they have taken a special hedge position. If they know, for instance, that the consequence of the private information will be that the equilibrium price will rise, and they took for that reason a long hedge position, it will be in their interest to make their private information public, so the market price will move rapidly towards the new equilibrium price, ensuring that they indeed make the gain anticipated. This situation might be called induced public information (Marshall, 1974).
- The insiders keep the private information to themselves or sell them to others who keep them secret. This might happen when there are non-economic, for instance legal, reasons to keep the information private, or the information is impossible to prove in this stage. Then the non-informed market participants will come to know about the changing supply and demand conditions only in due time.
Although the market is the transmitter of information in all these cases, as long as the changed demand and supply situation has not become common knowledge, there are ample chances for profitable speculation.

We will discuss each of these situations, starting with information cascades.

4.2 Information Cascades

Bikhchandani and Sharma (2001) have analysed herd behaviour in financial markets. One of the possible explanations of the feedback loops taking place in financial markets is the result of people having to decide on imperfect information. The basic idea that traders have both private and public information available when taking a trading decision. Suppose all investors receive some private information relevant for an investment decision in a commodity market. This private information can be good or bad. Good information is information that makes it probable that investing in this commodity will be more profitable than investing in the second-best option available, while bad information is the opposite. The investors will take in turn a decision whether to invest or not. They will not share their private information with others. The public information available to them consists only of the trades that others made before them. As more and more investors trade, the public information available will accumulate.

Suppose that the first investor, A, has received good information. This will make him invest. The second investor, B, now has not only his private information available but also the public information that A has already invested. Suppose that B has also received good private information. Based on both his private and public information he will then also invest.

But what will B do if he has received bad private information? In this case investor B has received two opposing signals, a good one, because A has invested, and a bad private one. These signals cancel each other out, so he can decide either way, for instance by throwing up a coin. If he decides to invest, then the third investor, C, observes that both A and B have invested. The most likely explanation is that they both had good private information. So, if the information that C received is also good, he will also invest. If, however, his own private information is bad, C will still invest, because C will assume that the good information that led the first two investors to invest outweighs his own bad information. The same applies for each subsequent investor: the public information that all previous investors have chosen to invest will outweigh his own private information, either good or bad. So, if the first two investors have decided to invest, all following investors will also invest. This is called an invest cascade.

In the same way, if the first investor A decided not to invest, and investor B also decides not to invest, either because he has received bad information or because the throwing a dice after having received good information resulted in the decision not to invest, then all further investors will also not invest, irrespective of their private information. This is called a reject cascade.

In conclusion: an individual will be in an invest cascade (reject cascade) if and only if the number of predecessors who have invested is greater (less) than the number of predecessors who did not invest by two or more.
This condition can easily be met, irrespective of the strength of the good signal received by the early mover. Once a cascade has started, the private information of the subsequent investors will never be included in the public pool of knowledge made up by the observed decisions. This implies that cascades can continue even when the private information that started the cascade consisted of rather noisy information, i.e. when the probability that investing in this commodity is better (worse) than investing in the second-best option is only slightly larger (smaller) than 0.5.

A cascade can end when new public information becomes available, for instance the publication of statistical information about the supply/demand situation, or of a market analysis by an investment bank. This new public information allows for reviewing one’s own private information and will trigger a new round of decision making.

In this way Information cascades can explain how a feedback loop can be triggered and sustained, and why the feedback loop can also suddenly stop and start in the opposite direction.

4.3 Private Information

In the literature on game theory, a distinction is made between perfect information and complete information (Perea, 2012). Perfect information means that all previous actions of the agents and the equilibrium outcomes of the game are known, while complete information means that all agents have knowledge about the environment in which the game is played.

Complete information, in this sense, is a necessary condition for common knowledge, and hence for the market to be efficient. The existence of private information is a violation of this condition: the outsiders are for the time being unaware of the existence of the private information. When the transactions made by the insiders become public, they can adapt their subjective probability distribution of what might be the actual supply and demand situation to the transactions actually made. Take the example of the copper market. The volume of transactions in copper on the London Metal Exchange is about 33 times annual copper consumption (Crowson, 2008). Futures are often resold and rebought before maturity. Part of this intensive trading is for technical reasons: adjusting positions to unforeseen developments in production or consumption. But most of this trading is induced by hedging: market participants adapting their long and short positions in response to changed expectations. Traders have a close look at the daily data on the long and short positions taken. They will use this information either for trading on their own account or to convince their clients to trade (and earn a fee executing those orders). So, although the private information has not yet become public, the transactions of the informed insiders are a signal for the non-informed that the environment has somehow changed (Arrow, 1996). Non-informed insiders will be the first to receive these signals, but outsiders can also become aware, for instance by buying a subscription to trading recommendations from trading firms or banks. The signals will have a correlation with the actual change in the environment, and so may compensate part of the incompleteness of the information. Noise is anything that interferes with the transmission of a signal. An information cascade might be such an interfering phenomenon, making a difficult to decipher the actual signal. But there will also be white noise, as previously defined. For that reason, many trading firms nowadays use elaborate algorithms, designed to filter out as much white noise as possible to make a better estimate of the real change in the environment indicated by the signal. Unfortunately, as these algorithms make use of as much information as possible about changes in the environment, there are often cases found of spurious correlations, introducing systematic noise while eliminating white noise.

In dynamic games, having perfect or non-perfect information makes a difference. When assuming the rationality of the opponent, one can use backward induction: reasoning backwards from the end of a situation to find a sequence of optimal policies. What has happened in the past are then facts that
need no inference and might even be considered irrelevant. Using backward induction means that perfect information is not needed. But when one wants to assume that the opponent will not only be rational in the future, but has been rational also in the past, then the past strategy of the opponent must be also considered. In that case perfect information is required (Perea, 2016).

This distinction between perfect and non-perfect information is also relevant in the case of insider trading. When outsiders are part of an information cascade, a professional trade will try to discern the pattern followed and concentrate on the transactions that triggered the cascade as they will be the real signal. This requires the equivalent of perfect information. Of course, the professional trade can also profit from the cascade itself, as explained above, but that is additional, separated from finding out what has happened in the supply and demand situation.

4.4 Conclusion
The efficient market hypothesis requires common knowledge so that prices can reflect all available relevant information. Common knowledge requires that all information is public information. As we have seen, private information will induce insider transactions, both transaction that are motivated by rational choice decisions relating to their own business, but also speculative transactions. These transactions are a signal for the other market participants that something has changed in their market environment. This might lead to an information cascade, the fashion of the day, but also to a new situation of common knowledge as the other market participants are adapting their subjective probability distributions on these signals. In any case, private information allows for more profitable speculation than the efficient market theory predicts.

Insider trading is generally reviled. Many market regulations are aiming at preventing insider trading by requiring relevant information to be released as quick as possible. Penal law is also used to deter insider trading. But at the same time, observing speculative transactions by others motivated by private information can help to become aware of this new information. In this sense, speculation has the positive epistemological role of bringing information to the market rapidly.
5. Social Epistemology and Speculation

5.1. Introduction

As we have seen in Chapter 2, the possibilities for speculation are very limited when there is common knowledge of future price developments among the market participants. Common knowledge means not only that all market participants know what to expect, but also that all market participants know that all other market participants also know what to expect and that all other market participants know that all market participants know that they know, and so on. Common knowledge is assured when (1) all market participants have the same prior beliefs about what will happen, for instance because the market has been for some time in equilibrium, and (2) adjust their beliefs in a Bayesian way when new information comes in and market participants are adjusting their actions in reaction to this new information. This will soon end disagreement between market participants on how the market price will settle on this new information.

In this chapter we will discuss how a market participant will react when new information comes in. How does he change his beliefs about the future price developments under the influence of the new information? How can he know what is happening?

Belief is a mental state, like emotions, desires, and decisions. These mental states can conflict, causing dissonance (Zagzebski, 2012). Many times, when there is dissonance, the self automatically adjust by giving up one of the states that conflict. This often happens when there is a conflict between a belief and a perception. The conflict is short-lived and psychic harmony is restored without conscious attention. Zagzebski thinks that the awareness of dissonance resolved without effort gives us our initial model of rationality. To limit the subject, I will assume in the following that market participants are rational in this sense and will bring their decisions in harmony with their beliefs without friction.

Knowledge is a subject dealt with in epistemology. In epistemology, the standard account of what it means to have knowledge is the so-called tripartite definition of justified true belief. This can be formally written as (Dancy, 1985):

1. \( p \)
2. \( A \) believes that \( p \)
3. \( A \)'s belief that \( p \) is justified

This definition is about propositional knowledge of subject \( A \), i.e. knowledge that \( p \), \( p \) being a proposition like “The price will go upwards”. It does not define knowledge by acquaintance as in “A knows broker X” nor knowledge-how, e.g. the knowledge how to place a trade. The first clause says that \( A \) only knows that \( p \) when \( p \) is true. The second clause states that if \( A \) knows that \( p \), then \( A \) believes that \( p \). The third clause is added to prevent that any lucky guess counts as knowledge, \( A \) should have reasons to believe that \( p \). The truth of \( p \) is not enough to count as knowledge.

An important topic in epistemology, the philosophy of knowledge, is how to justify a belief to withstand scepticism: are claims to knowledge indeed indubitable or necessarily true? Main issues in epistemology are the relations between perceptions and belief and between cause and effect. Traditionally, epistemology concentrates on individual knowledge. Social epistemology, however, concentrates on the knowledge obtained from other people. Here the main enemy to fight is not scepticism, but credulity. Main themes in social epistemology are testimony, expertise and authority.

In this chapter I will discuss speculation from a social epistemology point of view. I will start with the so-called DIKW-hierarchy that is used in information science to describe the transformation of the
available data through information into knowledge and wisdom. This hierarchy can help to outline what can go wrong in using the opinions of others. To avoid falling victim to deceit, the speculator should establish which sources of information are trustworthy. For that reason, trust and distrust will be discussed. This will help in deciding what is fake news and which rumours should be taken seriously. I will conclude by discussing how to choose between competing experts and when it is warranted to hand over decision making to an (epistemic) authority.

5.2. Knowledge and Unknowledge

Information science deals with the collection, classification, storage, retrieval, and dissemination of recorded knowledge. The DIKW-hierarchy of data, information, knowledge, and wisdom is generally used to characterize the transformation processes taking place. This terminology was coined by Ackoff (1989) who defined these terms and their associated transformation processes in the following way:

- **Data** are defined as symbols that represent properties of objects, events, and their environment. They are the products of observation. But are of no use until they are in a useable (i.e. relevant) form. The difference between data and information is functional, not structural.
- **Information** is contained in descriptions, answers to questions that begin with such words as who, what, when and how many. Information systems generate, store, retrieve and process data. Information is inferred from data.
- **Knowledge** is know-how and is what makes possible the transformation of information into instructions. Knowledge can be obtained either by transmission from another who has it, by instruction, or by extracting it from experience.
- **Wisdom** is the ability to increase effectiveness. Wisdom adds value, which requires the mental function that we call judgement. The ethical and aesthetic values that this implies are inherent to the actor and are unique and personal.

Note that these terms are defined from a managerial and organizational point of view. It is a hierarchy, as each step builds on the previous step. The knowledge so defined, is knowledge how and is embodied in routines. Wisdom is compounded knowledge, knowing how to adapt the routines used when conditions change.

The opposite of knowledge (in this sense) is ignorance. Bernstein (2009) has proposed a similar sequence of levels around ignorance in which associated phenomena as credulity and misinformation fit. He proposed to use the antonyms of the DKIW steps to define unknowledge:

<table>
<thead>
<tr>
<th>DIKW-hierarchy</th>
<th>Unknowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Absence or Want of Data, Missing Data</td>
</tr>
<tr>
<td>Information</td>
<td>Misinformation, Disinformation, Error</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Ignorance</td>
</tr>
<tr>
<td>Wisdom</td>
<td>Folly, Stupidity</td>
</tr>
</tbody>
</table>

When data are incorrect or incomplete, errors can result, or, depending on the intention of the person who transforms the data, misinformation, i.e. incorrect or misleading information. But even when the data are accurate, there is the possibility of disinformation. Merriam-Webster’s dictionary describes disinformation as *false information deliberately and often covertly spread (as by the planting of rumours) in order to influence public opinion or obscure the truth*. But even when the information is correct, there can be insufficient knowledge for translating the information into instructions. Uncertainty about future developments can be a major cause of ignorance. Finally, when the decision maker is unable to adapt to changing circumstances, there will be folly or stupidity instead of wisdom.
Folly, acting in a foolish way, can be the result of compounding errors. Stupidity, on the other hand, is defined in terms of maladaptive responses to change. In stupidity, the response to changing conditions is either insufficient, due most likely to self-deception and the tendency to stick to known ways of thought behaviour, or an overly drastic and radical response that is not informed by data. The failure to recognize change that requires response arises from the tendency to insulate oneself from information about change, which could help one to devise an appropriate adaptive response (Welles, 1997).

In the next paragraph we will concentrate on misinformation and disinformation. This critically depends on the trustworthiness of the source of the information. A discussion on how to use expertise and authority as ways to overcome ignorance, folly and stupidity will be discussed afterwards.

5.3. Trust and Distrust

Cheating (deceit, fraud, swindle) is deeply embedded in everyday life. Psychological research shows that totally honest, incorruptible people constitute about 10 per cent of the adult population. Totally dishonest people who will cheat in a variety of situations account for about 5 per cent. The other 85 per cent appear basically honest but will succumb to temptation depending on the situation (Gabor, 1994). Rhode (2018) estimates that costs attributable to the most common forms of cheating total close to a trillion dollars annually in the United States alone.

Market participants in general, and speculators in particular, will receive information relevant for forming their beliefs on the profitability of possible transactions from different sources, like statistics, press releases or periodic reports of organizations involved, news items in (specialized) media, or information from their brokers. How reliable is this information? Are errors excluded? Or is it misinformation, caused by careless propating of erroneous information? Or is it disinformation, nowadays often called fake news? Answering these questions will depend on trusting or distrusting the source of the information.

Trust is a three-place relation: A trust B with respect to domain D. Hardin (2002) has proposed encapsulated interests as the criterion for trust. On this account, A trusts B because A thinks that it is B’s interest to take his or her own interest in the relevant matter seriously. It means that B values continuing the relationship with A and thus takes A’s interest into account as part of his or her own interest. That is, B encapsulates A’s interest in his or her own interest.

There are two important elements in the notion of encapsulated interest: commonality of interest and (the potential for) a continuing relationship. Hausman (2004) concludes that this view means that A trusts B to do X if and only if A believes four things:

1. That B will do X (unless there is some interfering factor),
2. That it is in B’s interest to do X,
3. That (2) is true because B believes that it is in A’s interest that B will do X, and
4. B’s belief that it is in A’s interest that B does X motivates B to do X, because B has an interest in a continuing relationship with A.

The negative of trust is distrust. There is, however, an epistemological asymmetry between trust and distrust (Hardín, 2001). Distrust comes easily because it can be built on a limited behaviour by the distrusted. Trust, however, requires a rich understanding of the other’s incentives.

This means that the first aim of controlling the risk of using unreliable information will be to check for the absence of reasons to distrust. Once this hurdle is taken, the next question is whether the potential news source is trustworthy. Trust is a cognitive act. Trustworthiness, in turn, is a moral quality, the
likelihood that \( B \) will be motivated to follow \( A \)'s interest. Having no reason to distrust is only a necessary, but not a sufficient reason for trustworthiness.

The belief that a source of information is trustworthy can be justified in different ways. One way is to look at its record of accomplishment of past behaviour, its reputation, its strategy, and the promises it makes. Another way is to look for adherence to mandatory or voluntary professional codes of conduct. Yet another way is looking for evidence of professional competence. In these ways the moral quality of agent \( B \) can be established, and, if \( B \) is considered trustworthy, \( A \) can willingly rely on \( B \). When the institutional arrangements are such that one can could get compensation when the source has issued misleading information, then absence of distrust would be sufficient for being justified to rely on agent \( B \) to do \( X \). Then there is hardly any need to investigate the motives of \( B \), and to trust \( B \) in the sense given above. This, however, will in practice require cumbersome legal procedures.

There are many examples in the financial world where trust is not justified. Major banks often have both an equity research department, issuing buy and sell recommendations for individual stocks to their retail clients to attract trading orders, and an investment banking department that raises money for corporate clients by means of initial public offerings (IPO's) of shares in their companies. It is tempting for banks to make the IPO a success by giving positive recommendations to retail investors for those shares. When the bank really believes in the quality of the proposal after a thorough investigation whether this company is fit for an IPO, there is no conflict between the interests of the retail and corporate clients. But in the famous Elliot Spitzer investigation into Wall Street in 2003 it was found that frequently shares in an IPO underwritten by their investment banking department got positive recommendations from the research department, even when the analysts of the research department classified them privately as POS (= piece of shit) (Cassidy, 2003). The reason for this cheating of retail clients was that those analysts participated in the bonuses handed out after a successful IPO. Spinning was also frequently encountered: the analysts could buy some shares in an IPO at a low price, which they could sell with a considerable profit when the IPO was successful. Regulators try to reign in those practices by requiring that analysts disclose their personal interests in stocks they recommend and forcing banks to maintain Chinese Walls between the departments dealing with retail and corporate clients.

Looking for reasons for distrust is called in the financial world called due diligence. And, as the conventional wisdom says, fool me once, shame on you, fool me twice, shame on me. The second step is to look for reasons to trust. Has the source really encapsulated my interests in his strategy? Paying for advice is a way to encapsulate the interests of the client into the interests of the broker. Both activities, establishing trustworthiness by investigating motives and excluding malperformance, are compatible with rational choice theory. In both cases the likelihood of future harm is diminished in comparison with the likelihood of the future benefits of relying on this information.

### 5.4. Rumours

Rumours are unverified propositions of belief. They differ from news because they are unauthenticated bits of information. Rumours might be true and should possibly be acted upon. This differentiates rumour from other forms of informal communication, such as gossip, which is primarily meant to entertain or convey mores, or folklore and legends that do no claim to be true but intend to convey important truths. Rumours, in contrast, insist upon being taken literary. Rumours are an effort after meaning, arising to fill knowledge gaps or discrepancies. Rumours serve an explanatory function, and some rumours are work-in-progress causal attributions.

According to DiFonzo et al. (1994) rumours go through three stages:
The Epistemology of Speculation

1. **Generation**
   In social psychology it is found that rumours arise when events are cognitively unclear (ambiguous) or unstructured, i.e., when they cannot be understood readily because they lack a suitable context. Rumours are explanations that give **structuring or frame** to the ambiguous events within a context.

2. **Evaluation**
   Research suggest that people are more inclined to spread a rumour they believe is true than one they believe is false. Rumours, like prejudices, appear to be evaluated in the light of salient cognitions about the truth. The more a story agrees with conventional wisdom or readily available thoughts and presuppositions, the more likely it will be viewed as probably true. Aspects of this process are:
   a. The available cognitions tend to **modulate** rumour propositions to better fit them with the cognitions;
   b. Rumours also tend to make relevant cognitions available. They incite observers to attend to those events that seem to verify the rumour;
   c. Rumours are assessed along a probability continuum that ranges from very likely to very unlikely to be true. Thus, rumours need not be 100 per cent believed for transmission or reaction.

Often, we are unable to evaluate the information with which we are supplied, so we rely upon our social capital. In other words, we depend on the judgment of those who belong to our networks; beliefs are filtered through social relations. The two core concepts for evaluating rumour are belief and trust; both depend on verification through local relations. The process by which we judge constitutes the politics of plausibility and the politics of credibility. Plausibility is not only personal but is tied to the common experiences of the local network within one is situated. Credibility is not only cognitive but also depends on our social capital. They reflect a shared commitment to sense-making. By relying on others with similar perspectives, we reduce uncertainty. As we search for meaning and cope with threat we must rely upon unsecured information. Facts matter, but they are never orphans. Often, uncertain information, even wrong information, serves as powerfully as if it was valid. If we believe a claim to be true, we act upon it, and it becomes true in its consequences. Some rumours are simply too good to be false.

3. **Dissemination**
   Under uncertain and anxiety-provoking circumstances, a plausible rumour spreads like wildfire. There are two aspects tot his dissemination worth mentioning:
   a. Repetition fosters belief. Merely hearing a tale several times increases the confidence in its veracity.
   b. There is evidence that people tended to hear a rumour about a hit-and-run accident two or three times before they passed it along.

Rumours play an important role in speculation. If rumours were always wrong, they would cause little trouble. The problem is that we cannot tell. For instance, in one study, 43 per cent of the merger rumours published in the column *Heard on the Street* in the Wall Street Journal turned out to be accurate (Fine et al, 2011).

When would it be profitable for somebody who has private information to spread a rumour? Van Bommel (2003) distinguishes three information scenarios. In the first scenario the rumour contains accurate information; in the second, the source has no information, so he bluffs; and in the third, the
source spreads a false rumour. Spreading a false rumour intentionally is known as scalping: taking a long (short) position in a financial product, starting a rumour that the price is going upwards (downwards), and selling (buying) when other investors trade upon the rumour. Scalping is illegal. And both bluffing and cheating erode the reputation of the person spreading the rumour. So, in future cases, his rumours will have lost credibility. Remains the case of the honest rumour. Van Bommel shows that an investor with limited wealth can profit by first investing as much as he can, using his private information. This will have only a limited effect on the price because of his limited wealth. He then spreads the honest rumour. When other investors react to the rumour and start investing also in the same direction, this will have an impact on the price. It often happens that the price then overreacts. Because the source of the rumour anticipates this overreaction, he can profitably trade again in the opposite direction until the price settles at the (new) equilibrium value. In the model presented by Van Bommel, the rumourmonger increases his expected profit from being informed by 50 per cent. So, there can be a rational reason for spreading honest rumours to followers, and other investors can rationally expect that rumours might contain credible information.

5.5. Expertise

As both knowledge and wisdom, as defined in the DIKW-hierarchy, is required to be a successful speculator, it is tempting to make use of experts, people more competent than the speculator himself to give meaning to the available information.

Goldman (2001) has given a veritistic (i.e., truth-related) account of expertise. In this account, an expert is somebody who possesses more beliefs in true propositions and fewer beliefs in false propositions than normal people have in the target domain. This makes expertise a comparative matter, being veritistic superior to the community. But Goldman adds that having fewer false beliefs than normal people is not enough to be called an expert. Some non-comparative threshold of veritistic attainment should be reached and the expert should also have a set of skills and techniques to form true beliefs on new questions arising in the target domain.

The difficulty with this veritistic account of expertise is that laypeople are not in the position to judge whether a person who claims to be an expert has indeed reached this threshold of knowledge and wisdom by comparing the opinions of the putative expert with their own. Being laypeople, they don’t have opinions on the target domain or have not enough confidence in their opinions to use them in the evaluation of a putative expert. Goldman therefore turns to the problem of a layperson who wants to have a true answer to a target question and can choose between two rivalling experts: which one has superior knowledge?

Goldman proposes to use four criteria to justify the choice of the superior expert:

- The arguments being used by the rivalling experts. In most cases, the arguments will be esoteric and cannot be evaluated directly by a layperson. And they often cannot be evaluated directly, i.e. by evaluating the premises of the argument being made. An indirect evaluation will normally consist of deciding which argument sounds the most convincing. Which expert has the best dialectical skills, the quickest and smoothest answers to questions posed? This will result in using the method of inference to the best explanation: from the performance of the rivalling experts the layperson makes an inference as to which expert has superior knowledge in the target domain.

3 Philip Kitcher (1993) calls the process of deciding on the expertise of a scientist by another scientist by comparing opinions on an issue for which the juror is also an expert calibration.
The Epistemology of Speculation

- The opinion of other experts. Which one of the rivalling experts has the most support of other experts? And which one has the most credentials or ratings, which are both forms of agreement by other experts. It is not enough to look only at the number of experts supporting each rival. It is also important to look at their reliability and at their mutual conditional independence. Adding more experts belonging to the same doctrinal community should not make a difference.

- The interests involved. Is the research leading to answering the target question sponsored by a person or organisation who has an economic or political interest in the answer? Or has the expert researched the issue independently?

- The past track records. Although it will be difficult or impossible for the layperson to evaluate the knowledge of the expert with respect to the present target question, he can look at the answers given to previous related questions measured by the results of applying those answers. The expert who can show the best results can convince the layperson that he possesses a superior capacity to give the right answers.

Although Goldman does not provide a precise algorithm for deciding on expertise, his criteria can be used to evaluate the expertise of the analysts working for banks and other financial intermediaries. These so-called sell-side analysts follow the news about several financial products daily. The purpose of this activity is to advise the clients of their firm how to trade in this product, resulting in their firm getting trading order and receiving trading fees. As these sell-side analysts can be important for the image of the firms concerned, many firms organise at regular intervals analyst’s meetings, in which leading executives present the results obtained in the recent past, elaborate on trends and their future strategy, and answer questions from the analysts. The opinions of these analysts are frequently formulated in updates of target values, their estimates of the future fundamental value, and are translated into trading recommendations, such as buy or sell, or more subtle variants, like underweight or neutral.

It is well-known that these analysts are systematically over-optimistic, resulting in more buying than selling recommendations. An often-heard explanation is that these analysts have been exposed already for some time to the biased information provided by market participants who want to influence public opinion in their favour and these analysts have started to believe this propaganda. It becomes a love relation: being seduced to see only the bright side of your partner.

Some specialized media offer the service of providing a continuous overview of the recommendations of all analysts covering a specific financial product. This makes it possible for the investor to look at the support the analyst of his broker has from other analysts and comparing their track records.

Of course, sell-side analysts have an interest in convincing their firms’ clients to trade frequently. Combined with the over-optimism this has been a driving force for the arrival of an alternative, the passive funds, also called trackers. These funds simply follow some index, like the FTSE 100, by investing in all financial products included in the index with the same weights as in the index. These

---

4 A new branch in the history and philosophy of science is agnotology: the study of culturally induced ignorance or doubt, particularly through the publication of inaccurate or misleading scientific data. Examples are the commissioning of scientific studies by the tobacco industry to contest the scientific studies showing that smoking is harmful. See for instance Michaels (2008).

5 The MiFID 2 regulation (MiFID = Markets in Financial Instruments Directive) of the European Union requires that starting in 2018 banks can no longer include the costs of providing advice to investors in the execution fees for actual trading and must charge a separate advice fee. It is estimated (Bloomberg) that this will result in a twenty percent decline in the budgets for investment research as many clients will prefer to trade without this advice.
passive funds can charge low operating costs, because they have no need for analyst research. Epistemically, this means investors, as they turn to passive funds, deny the sell-side analysts their expert status.

5.6. Epistemic Authority

Using expertise is a first step in relying on other person’s knowledge and wisdom, handing over decision making completely is one step further. In that case, the speculator renounces forming his own beliefs about the profitability of possible transaction and accepts the outcome of the belief-formation of another person, an authority.

Authority is the exercise of legitimate influence by one social actor over another. Like trust, authority is a three-place relation between a person X who has authority (the bearer of authority), another person Y for whom X is an authority (the recognizing subject), and a domain of authority (the field). Zagzebski (2012) has used the conditions of political authority as formulated by Raz to discuss epistemic authority, the case in which the belief of an authoritative person gives the subject a reason to hold the same belief. Epistemic authority has a long tradition, especially in religion.

Raz (1988) formulated four conditions of political authority. The first is content-independence. An authoritative utterance gives the subject a reason to follow the directive which is such that there is no direct connection between the reason and the action for which it is a reason. The authority might have directed any number of different actions, and if he had directed a different action, the subject would have had a reason to perform that other action instead. Under the assumption that the subject has reason to accept the authority as legitimate, the subject has reason to do what the authority says that is not dependent upon the content of what the authority says. Correspondingly, the belief of an epistemic authoritative person gives the subject a content-independent reason for belief.

The second condition is the pre-emption thesis. The fact that an authority requires performance of an action is a reason for its performance that replaces other relevant reasons and is not simply added to them. In the case of an epistemic authority this means that the fact that the authority has belief $p$ is a reason for the subject to believe $p$ that replaces his other reasons relevant to believing or not believing $p$ and is not simply added to them.

The third condition is the dependency thesis: all authoritative directives should be based on reasons that already independently apply to the subjects of the directives and are relevant to their action in the circumstances covered by the directive. The epistemic analogue of this thesis is that an epistemic authority’s belief is authoritative for the subject only if the authority’s reasons for believing what he believes reflect the reasons the subject would have if he was forming the belief himself.

The fourth condition is the normal justification thesis: the normal way to establish that a person has authority over another person is to show that the alleged subject is likely better to comply with reasons that apply to him if he accepts the directives of the alleged authority as authoritatively binding and tries to follow them, rather than trying to follow the reasons that apply to him directly. The epistemic analogue is that the authority of another person’s belief is justified by the judgment of the subject that he is more likely to form a belief justified by the available evidence if he believes what the authority believes than if he tries to figure out what to believe on the evidence himself.

---

6 A research done by CEM Benchmarking for the Financial Times found that since 1991 actively managed funds used by pension funds performed on average 60 basis points, i.e. 0.6%, better than the market, but that 44 basis points were taken by the fund management as costs, leaving a net advantage for the investor of only 16 basis points (FTfm, January 29, 2018).

7 An example is the dogma of papal infallibility in the Roman-Catholic Church.
Examples of epistemic authority in speculating are wealth management banking and hedge funds. Wealth management is a service offered by specialized banks towards ultra-high-net-worth individuals and their families. These individuals’ hand over the management of their wealth to the bank, not only investments in stocks and derivatives, but also estate planning and tax planning. These individuals choose a bank from a (often small) list of alternatives, letting each of them highlighting their capabilities and give the chosen one a mandate for a contract period to take decisions on their behalf. Those wealth management relations satisfy all four conditions of an epistemic authority mentioned above. Hedge funds are limited partnerships of qualified investors with a considerable lock-up period. This means that these partnerships only allow entry of investors who are willing to invest a considerable amount of money that cannot be withdrawn for a specified number of years. The managers of these hedge funds then follow a specific investment strategy, sometimes heavily leveraged, sometimes going short, with the intention of obtaining superior returns. Going short means to borrow stocks and sell them, in the expectation that they can be rebought later at a lower price and returned to the lender. The relationship between the qualified investor and the manager of the hedge fund is one of epistemic authority.

An example of an epistemic authority in investing that approaches a religious one, is Warren Buffett, the CEO of the investment company Berkshire Hathaway. This company now manages over $300 billion and has seen its book value growing with 19 per cent annually in the last fifty years. The annual shareholder meeting in Omaha, Nebraska, attracts some 20,000 people, eagerly listening to what Buffett, a great story-teller, has to say. The meeting is referred to as Woodstock for Capitalists, while Buffett is called the Sage of Omaha.

5.7. Conclusion
Cheating is deeply embedded in everyday life. Financial and commodity markets offer many opportunities for fraud and deceit, and speculators when gathering and digesting available information should beware not only of errors, but also of misleading information or disinformation. Social epistemology, a branch of theoretical philosophy, offers some advice how to defend oneself against cheating. Are my interests encapsulated in the interests of the information provider? This criterion is especially relevant in dealing with rumours. Successful speculation requires knowledge and wisdom in making good use of the available reliable information. This knowledge and wisdom are obtained by instruction or abstracted from experience. Expert opinion can be useful in improving the quality of the knowledge and wisdom available. Social epistemology offers a checklist for selecting the superior expert. In some cases, it might be advisable to entrust your wealth, and by consequence possible profits from speculation, to an epistemic authority. What remains, of course, is the necessity to choose that authority.

More cultural and regulatory reinforcement of ethical conduct is clearly necessary on financial markets. Stiffer sanction can also help in promoting integrity. Successful speculation requires a critical attitude towards the information that becomes available. Fraud and deceit will prohibit the convergence towards the common knowledge that is assumed in most economic analyses of speculation. Even when there are common prior beliefs, it will be then be difficult to arrive at an agreement on the future price development. This widens the possibility of both profitable speculation, but also of deception because of unfounded optimism or pessimism. In both cases, the role of the market price in guiding resource allocation can be corroded.
6. The Demography of Speculation

6.1 Introduction

So far, we have discussed the theoretical possibilities of speculation. But who are the speculators, the ones who speculate? We will discuss three categories of speculators.

In the first place, the regular market participants, producers and consumers, frequently perform speculative transactions as part of their risk management. Although the extent of their speculative transactions will vary, their presence as speculators will be permanent. The professional brokers, traders and storage providers also belong to this category.

Then there are the so-called noise traders: speculators who trade on pseudo-signals: the belief that they have special information about the future price, for instance because they did technical analysis, or got advice from a broker or consultant. These speculators can enter the market any time. According to the efficient market theory, they will be traded against by rational arbitrageurs who do know what the fundamental value will be in the time to come. The rational arbitrageurs will profit, and the noise traders will lose money and therefore cannot survive. The result will be that the price will be soon driven back to the fundamental value. In practice, however, it is very well possible for noise traders to make profitable transactions and to survive.

The third category are the speculators who are hedging their investment portfolios. They enter into speculative transactions to diversify their portfolio. Their appearance is a quite recent phenomenon. This is the so-called financialization of commodity markets: speculative transactions that are triggered not so much by developments in the supply and demand conditions of the specific commodity, but by developments in the capital market at large.

6.2 Regular speculators

As has been mentioned already in paragraph 4.3, the annual volume of transactions in copper at the London Metal Exchange is 33 times global production or consumption. Part of this is caused by the risk management of regular market participants. Let me explain by means of an example.

A copper producer will normally have made an annual sales contract with a consumer, for instance a company in the automotive industry, for a regular delivery of his product to this customer. The contract normally specifies the minimal and maximal quantities, but also the quality specification and the points of delivery. These conditions translate into a premium or discount applied to the spot market price. It is customary that the actually shipped quantity is priced at the average spot price at the LME in the last month before delivery plus or minus the agreed premium or discount. The producer can insure himself for the price risk between the moment that the contract has been signed and the delivery dates by selling a future maturing just before the agreed delivery month. Because the producer will have to fulfil his sales contract, he must buy back the future before maturity to avoid being obliged to deliver the product to the buyer of the future. When the spot market price has risen, he will have to pay more for buying back the future than he has received when he sold the future. That is a loss. But this will be compensated for by the higher price his customer will pay him for the actual delivery. Conversely, when the spot price has gone down, he will make a profit on his future that will compensate him for the smaller revenue from his customer. Although the sales contract itself does not count as turnover at the LME, the futures sold and bought do. So, this production quantity will be twice traded at the LME. The customer could do the opposite: buying a future and selling it just before maturity. As these future contracts are made by brokers (“Ring Members”), this means that, when both producer and consumer seek full cover for the price risk, the quantity actually delivered to the customer will be traded four times at the LME.
Making these transactions costs money. Brokers will demand a fee, and the LME requires deposits of part of the amount contracted as a guarantee against possible default of the contract party. The working capital needed for these deposits will incur interest costs. Risk management means that the management will balance these costs against the benefit of avoiding the price risk. This balancing does not stop at the start of the annual sales contract but will continue during the whole duration of the contract. When a producer thinks it is quite certain that the price will rise in the future, he might not wait until the last moment to buy back his future but will do it earlier. When after some time he becomes afraid of a price decline again, he can sell a new future. Another reason to buy or sell futures during the year might be developments in the actual quantities to be sold under this contract within the agreed margins. So, the same sales volume can be traded several times at the LME because of the risk management of the regular market participants.

Risk management is a subjective activity, it is all about expectations, the belief that a market participant holds about the direction in which the future price will move. In behavioural finance, the branch of financial economics that tries to incorporate psychological considerations into the explanation of events, attention is given to the biases involved in decision making with respect to the use of derivatives like futures and options in risk management. Overconfidence is such a bias: overestimating the probability of a good outcome of the risk management decision. Representativeness is another: forming expectations on a small number of observations or using extrapolative expectations. Narrow framing is yet another bias: pay attention only to narrowly defined gains and losses, overlooking the big picture. Beber and Fabbri (2012) investigated corporate speculation for these biases. They found that the personal characteristics of the CEO of a corporation that correlate with overconfidence, such as being younger, holding an MBA and having less previous work experience, explained an increased use of derivatives in risk management in a significant way.

Crowson (2008) found that mining companies frequently speculated with the by-product of their mining operations. For instance, copper mines often produce cobalt as a by-product. The mine companies normally hedge their copper production, but not the cobalt: this is hold in stock for some time, waiting to be marketed when prices are high. This seems to be an example of narrow framing: applying risk management to the main operation for which the mine was set up and considering the proceeds of the by-product as windfall profits.\(^8\)

These examples show that regular market participants will often act as speculators as a corollary of the normal operations.

### 6.3 Noise Traders

Often a distinction is made between noise traders and sophisticated traders. The regular market participants qualify as sophisticated traders, they know how the market works from their own experience. But professional brokers, traders and warehouse operators sometimes must take positions in the market for their own account when the orders of their clients do not completely match. These market participants also count as sophisticated traders.

Noise traders are speculators that do not have access to inside information. They trade on noise, pseudo-signals, such as technical analysis or recommendations in specialized media or from consultants. In the efficient market theory noise traders are seen as a marginal phenomenon. Rational

---

\(^8\) Nowadays cobalt has become an important raw material as a main ingredient of the lithium-ion batteries used in both smartphones and electric cars, mainly as lithium-cobalt oxide. Lithium itself is widely available, not only by mining but also from salt lakes. Cobalt, however, is mainly produced in the Democratic Republic of Congo as a by-product of copper mining.
arbitrageurs will trade against them, and by doing so, will drive the price back to the fundamental value. The rational arbitrageurs will profit, while the noise traders will lose money and will disappear from the market. So, although from time to time some new noise traders will enter the market, these activities will be short-lived.

De Long et al. (1990, 1991) disagree with this negligence of the noise traders in the efficient market theory. They believe that noise traders can have a considerable impact on prices and can make profits for quite some time. De Long et al. distinguish between the fundamental risk and the price risk. An arbitrageur who trades against a noise trader will know the actual fundamental value, but also knows that this fundamental value can change during the term of the contract he will make with a noise trader. Because of this fundamental risk, arbitrageurs are not willing to take an unlimited position. This means that, when there are many noise traders acting on the same pseudo-signals, the arbitrage may fall short of what is needed to bring the price back to the fundamental value. At the same time, the actions of the noise traders increase the price risk: they might even become more optimistic or pessimistic during the term of the contract than they are now. So, it can take quite some time before the price will return to the fundamental value. If the arbitrageur must liquidate his position in the meantime, he will then have made a loss instead of a profit. Because of these risks, arbitrageurs will in general be more risk-averse than the noise traders. The consequence is that noise traders, because they are often willing to assume more risk than the arbitrageurs, can be even more profitable than the arbitrageurs themselves. Given these possibilities for noise traders to make profits, there is no reason to assume that noise traders will always be short-lived. As new noise traders will become active, and the old ones remain active, there is no reason to neglect their existence.

The consequence is that sophisticated traders are often putting more effort in searching for pseudo-signals that noise traders might act upon, than in assessing changes in the fundamental market positions. There is often more to gain by anticipating what the noise traders are going to do and take positions to profit from the price changes caused by noise trading, than by arbitrage against the noise traders. This means that the sophisticated traders may contribute to the actual price driving further away of the fundamental value.

6.4 Financialization
Speculators buying a futures contract must make a considerable investment. For example, the standard size of a futures contract in copper traded at the London Metal Exchange is 25 tonnes. At a price of over $6,000 per tonne, this means that buying a contract means an investment of more than $150,000. As has been discussed in chapter two, speculators will make such an investment only when they expect to get a return on that investment that is higher than the normal interest rate.

In the last decade, several exchange traded funds have been set up that invest in futures contracts. An example is ETFS Copper COPA, traded at both the London Stock Exchange, Euronext and Deutsche Börse. These funds have made speculation in commodities attainable for a much wider group of investors than before. The reason is the desire of financial investors to diversify their portfolios. Since the start of the modern portfolio theory in 1952 by Markovitz, the advice to investors is to reduce the overall risk of their portfolios by diversification, i.e., holding several assets of which the returns are not perfectly positively correlated. Investing in commodities for this reason got a boost in 2000, when, after the collapse of the equity market, institutional investors became aware that the returns on investments in commodities had only a negligible correlation with the S&P index.

This phenomenon is called the financialization of commodities markets, as the motives of these speculators are not solely determined by expectations on the future price developments of that particular commodity, but also by developments in the capital markets, such as movements in equities,
bonds or foreign exchange. When investors are rebalancing their portfolios in reaction to these developments, this will have a spill over effect on the availability of long hedging in the futures markets. An extreme example happened after the financial crisis of 2008, when financial investors had to withdraw money at a large scale from the commodities markets because they needed the money to meet the margin calls on their distressed financial derivatives in the mortgage market. Consequently, the futures prices of many commodities declined considerably. As can be seen in the appendix, the copper price fell from 400 US cents per tonne in the beginning of 2008 to less than 150 US cents per tonne at the end of the year. A more permanent effect of the financialization has been that the futures prices of many commodities now comove, and with oil prices in particular. The effect has been that the volatility of the prices of most commodities has increased (Tang and Xio, 2012).

The significant presence of the financial speculators will have two effects. In the first place their willingness to buy futures will mean that the risk premium that producers must pay to hedge their production will be lower due to the increased competition among long hedgers. But at the same time, the increased volatility will mean that the price risk of producers will have increased, making it more pressing to hedge their production.

There are signals that the increased volatility of commodity prices caused by the financialization has also meant that the correlation between the returns on investment in commodities and equities has increased. This makes the case for diversification from equities to commodities less urgent. So, it might be the case that the recent arrival of the financial speculators might be a passing phenomenon (Adams and Glück, 2015).

6.5 Conclusion

The efficient market theory neglects speculators: arbitrageurs will drive prices back to the fundamental value of the product and by doing so will drive out the noise traders. Their activities will be just white noise, pure chance effects, that inevitable occur when many market participants interact. As the regular market participants will have common knowledge about what is happening in the market, all information will already be incorporated in the actual market price. The movements of both the spot prices and the futures prices can be explained by different risk-aversions among the regular market participants.

The facts are, however, rather different. There are many noise traders active in both financial and commodity markets, and arbitrageurs can find it profitable not to move against them but in parallel to them. This can be an explanation for the success of momentum trading. At the same time, the regular market participants are also doing speculative transactions as part of their risk management. As these transactions are motivated by expectations, they might contribute to additional volatility. A more recent phenomenon are the financial speculators, investing in futures to diversify their portfolios. As this will also increase volatility, this is an additional argument for not following the efficient market theory in its negligence of speculators but rather to give them a prominent role in explaining what happens in the actual markets.
7. Conclusion

Speculation has had a negative image throughout the centuries. Speculation should, however, not be confused with price gouging, market manipulation on the one hand, and gambling, taking risk for the thrill of it, on the other. As our discussion has shown, there is a legitimate role for speculation in well-organised financial and commodity markets. Speculators can provide the liquidity needed for producers and consumers to hedge their positions, helping them to reduce the uncertainty under which they make their production and consumption decisions. Reducing uncertainty will improve the efficiency of resource allocation, and for that reason speculation can play a positive role. Speculation can also bring information to the market, either directly by providing an incentive to owners of private information to stimulate speculators to follow-up, or by speeding up the adaptation of the market price to new information.

But speculation can also have a negative influence. Information cascades and noise traders can cause unwarranted price movements. And financialization can cause prices to move for reasons completely different from resource allocation.

Speculation is motivated by greed. That makes speculation suspect. But since Adam Smith we know that individuals chasing profits can also bring benefits to society by improving efficiency and coordination. Prohibiting speculation is therefore not the right answer to the negative aspects of speculation. Regulating speculation in order to counter fraud and deceit and to promote transparency are better remedies.

In any case, our discussion has shown that speculation cannot be assumed away, as in the efficient market hypothesis. An open eye for the advantages and disadvantages of speculation is needed, both in market regulation and in economic research into the working of markets. Momentum trading has proven to be profitable, so it cannot be taken for granted that speculation always stabilizes prices.

I have used a quotation from Shakespeare’s *The Tempest* as device for this thesis. *What’s past is prologue* means that what has happened in the past sets the stage for what is going to happen. In Shakespeare’s play this statement was used as rationalizing to the audience why Antonio was brought in the position that he had to decide whether to commit murder or not. This also applies to momentum trading: are we going along with what has been developing until now, or do we take another direction? It would be erroneous to think that only the present matters.

When trying to make sense of what is happening in the market, one should take an epistemological stance: what is the weight of the arguments justifying my belief about the direction in which the market will move? Do I have the required information to make inferences? Can I trust this information? Can I separate the signals from the noise? Do I understand what the others are doing? Speculators will never be certain about the future course of a price, but in order to survive as a speculator, they will have to weigh their arguments very carefully, and over and over again. The epistemology of speculation is a verb: it expresses an act, occurrence, or mode of being (Merriam-Webster).
The Epistemology of Speculation

References


Crowson, P. C. F. (2008), Mining Unearthed: The Definite Book On How Political And Economic Influences Shape The Global Mining Industry, Aspermont UK

Dancy, J. (1985), Introduction to Contemporary Epistemology, Blackwell Publishing


DiFonzo, N. and Bordia, P. (2002), Rumors and stable-cause attribution in prediction and behaviour, in: Organizational Behavior and Human Decision Processes 88: 785-800


The Epistemology of Speculation


The Epistemology of Speculation


Annex – The Copper Market

Copper is an extremely ductile metal that is an unusually good conductor of electricity and heat. Copper is found in the free metallic state in nature. This native copper was first used as a substitute for stone by Neolithic humans. Metallurgy dawned in Mesopotamia as copper was cast to shape in molds, was reduced to metal from ores by fire and charcoal and was intentionally alloyed with tin to bronze. Long after the Bronze Age passed into the Iron Age, copper remained the metal second in use and importance to iron. By the 1960s, however, cheaper and much more plentiful aluminium had moved into second place in world production.

Although commercial deposits of copper ores occur in almost every continent, 70 percent of the world’s known reserves are found in seven countries: Chile, the United States, Russia, Congo (Kinshasa), Peru, Zambia, and Mexico. The extraction of copper from ore is normally carried out in three major steps. The first step, mineral processing, is to liberate the copper minerals and remove waste constituents—such as alumina, limestone, pyrite, and silica—so that the copper minerals and other nonferrous minerals of value are concentrated into a product containing between 20 and 30 percent copper. The second step, involving either smelting or leaching, removes a large proportion of impurity elements—in particular iron and, in the case of sulfide ores, sulfur. The final step, refining, removes the last traces of the impurity elements and produces a copper product of 99.99 percent purity. Smelters are often not located in the mine areas but in the countries of consumption.

Copper is used in building construction, power generation and transmission, electronic product manufacturing, and the production of industrial machinery and transportation vehicles. Copper wiring and plumbing are integral to the appliances, heating and cooling systems, and telecommunications links used every day in homes and businesses. Copper is an essential component in the motors, wiring, radiators, connectors, brakes, and bearings used in cars and trucks. The average car contains 1.5 kilometre of copper wire, and the total amount of copper ranges from 20 kilograms in small cars to 45 kilograms in luxury and hybrid vehicles. At a price of $ 6,000 per tonne, this means a cost of $120 to $270 per car. The breakdown of copper use in the USA was in 2017:
Copper is one of the most widely recycled of all metals; approximately one-third of all copper consumed worldwide is recycled. Recycled copper and its alloys can be remelted and used directly or further reprocessed to refined copper without losing any of the metal's chemical or physical properties.

Global Flows of Copper (2015)

The main exchanges at which copper is traded are the London Metal Exchange, the New York
Mercantile Exchange and the Shanghai Metals Market. The LME is by far the most important. There are some 500 warehouses approved by the LME in 35 locations across the USA, Europe and Asia where the metal can be delivered or released against an LME warrant.

The next figure shows the development of global copper stocks, prices and usage. As can be seen, the stocks of copper have been most of the time well below 3 months of consumption. Producers, i.e., mine companies and smelters, hold stocks corresponding with about 1.5 months of consumption, while the stocks hold by consumers correspond with only one week of consumption. Copper consumption is rather stable and shows an upward trend. The price of copper, however, fluctuates widely.

Extension in mine supply arrives in waves. These waves are clearly a lagged response to pricing signals, with the response lag typically being 8-10 years. Consequently, the supply growth typically arrives in periods of weaker pricing.

In 2017, the stocks in LME warehouses were some 600,000 metric tonnes. At a price of 250 US cents per pound, i.e., about $5,500 per metric tonne, the value of these stocks was about $3.3 billion. In 2002, when the stocks arrived at 1,500,000 metric tonnes and the price was only 60 US cents per pound, i.e., about $1,300 per metric tonne, the value of the LME stocks were only $2 billion. In 2011, however, when the price reached 450 US cents per pound, the total value of the LME stocks reached $6 billion. This gives an impression about the size of the investments being made by speculators.