Flossbach von Storch
RESEARCH INSTITUTE

SOCIETY & FINANCE 05/03/2019

Discovering Markets

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Abstract

The Discovering Market Hypothesis (DMH) is a better way to explain price movements in financial markets than conventional theory. Market participants communicate with each other in the form of narratives to improve their understanding of their factual information before acting. Thus, market prices are shaped by the subjective interpretation of emerging facts and shared narratives. To understand how new narratives replace existing ones we recur to the theory of scientific revolutions. Winning narratives shape market prices, until their victory is confirmed by the facts, or they are knocked out by facts and replaced by new narratives.

Zusammenfassung

Die Discovering Market Hypothesis (DMH) ist besser geeignet als herkömmliche Theorie, Preisbewegungen auf den Finanzmärkten zu erklären. Marktteilnehmer agieren im Markt und kommunizieren mit anderen Teilnehmern in Form von Narrativen. Dadurch verbessert sich ihr Verständnis der handlungsrelevanten Informationen. Marktpreise sind von der subjektiven Interpretation neuer Fakten und gemeinsamer Narrative geprägt. Um zu verstehen, wie neue Narrative die bestehenden ersetzen, greifen wir auf die Theorie der wissenschaftlichen Revolutionen zurück. Dominante Narrative prägen die Marktpreise, bis ihr Sieg durch die Fakten bestätigt wird, oder sie durch Fakten widerlegt und durch neue Narrative ersetzt werden.

Prices fluctuate, and especially in financial markets, where they are heavily influenced by expectations of the future. Some economists have explained price fluctuations with the myopia of market participants. For instance, bid and ask prices are based on prices observed in the past, and when supply and demand do not match, prices are adjusted. Other economists have replaced myopia with perfect foresight in their models. According to them, all market participants always have all the necessary information to agree on a market clearing price so that prices change only when they receive new information. However, actual price behavior is neither consistent with complete myopia nor perfect foresight of market participants. Sometimes, prices move as if market participants were myopic, sometimes as if they were forward looking. This has prompted another theory, according to which price fluctuations reflect market participants collective oscillation between rational and irrational behavior.

In this paper we argue that there is a better way to explain price fluctuations in financial markets. Market participants form their price expectations on the basis of information they collect and process with their individual skills and knowledge of economic relations. They act in the market, or communicate with others in the form of narratives to improve their understanding of their factual information before acting. Thus, market prices are shaped by the subjective interpretation of emerging facts and shared narratives. The resulting price movements in return influence narratives and the subjective interpretation of facts.

In the remainder of our paper we first discuss the theories of adaptive and rational expectations and the concept of adaptive markets. We then discuss our answer to these approaches, which we dub "Discovering Markets Hypothesis". After presenting empirical evidence supporting our approach we discuss its ability for making predictions.

John Maynard Keynes and the Adaptive Expectations Hypothesis

Keynes saw market participants as driven by "animal spirits". It was often necessary to forecast "what average opinion expects average opinion to be".

The admirable investor John Maynard Keynes, who achieved amazing returns for the Chest Fund at King's College in 1928-1945 (but of whom F. A. Hayek said that he "was not a highly trained or a very sophisticated economic theorist"), thought of two ways how people formed expectations about the future. Where they could, people would rationally calculate subjective probabilities for different outcomes and choose the most likely. But they would also often fall back on whim or sentiment or chance. The latter was especially the case in capital markets, where participants were driven

by “animal spirits”. There, it was often necessary to forecast “what average opinion expects average opinion to be”.[1]

Keynes left the formalization of his macroeconomic and his expectations theory to his disciples, which often led to a mechanistic reduction of his arguments. An example of this is the theory of adaptive expectations. In the adaptive expectations model an expected market price depends on the expected price from the previous period and an “error correction” term, given as a fraction of the difference between the expected and the actual price in the previous period. Thus,

$$p_t^e = p_{t-1}^e + \lambda\,(p_{t-1} - p_{t-1)}^e$$

where λ takes a value between 0 and 1.

This model is not only intuitively appealing but benefits also from the advantage that expected prices can be expressed as a weighted average of past prices. After some algebra we obtain from the above equation:

$$p_t^e = \lambda \sum_{k=1}^{\infty} (1-\lambda)^k \; p_{t-k}$$

where t-*k* denotes time lags (t-1), (t-2), …, etc.
Given its user friendliness the adaptive expectations theory has been built into many macroeconomic models and has been used by many econometricians. However, even its most enthusiastic users have had to admit that it describes the formation of expectations in a very mechanic way, which falls far short of Keynes’ more sophisticated view.

John Muth and the Efficient Markets Hypothesis

The Efficient Markets Hypothesis is the dominant concept for explainig price formation in the academic literature. However, it suffers from pretence of knowledge.

In the early 1960s, the US economist John Muth contradicted the theory of adaptive expectations. He argued that the expectations of economic agents were nothing else than predictions, which could be made with the appropriate economic theory.[2] For the formation of rational expectations only the future counted, which would be fathomed with the help of economic theory.

Muth’s theory, which originally was intended to explain price formation in specific markets, was incorporated into an economy-wide, dynamic general equilibrium model by Robert Lucas. According to Lucas, economic agents form their expectations of the future with full knowledge of all economic

[1] John Maynard Keynes, The General Theory of Employment, Interest, and Money. Cambridge 1936.
[2] John F. Muth, “Rational Expectations and the Theory of Price Movements”. Econometrica, Vol. 29 (1961), pp. 315-335.

relations and on the basis of all available information. On the basis of these expectations they maximize their utility over their lifetime. With his work, which was crowned by the Nobel Memorial Prize in economics in 1995, Lucas challenged established Keynesian macroeconomics. He argued that robust economic predictions could be made only with models founded in microeconomic theory, because macroeconomic relations observed in the past were unstable over time.[3] Economic agents would change their behavior in response to economic policy. For instance, the famous relationship between unemployment and inflation proposed by the Phillips Curve would go up in smoke, when people realized that gains in purchasing power afforded by higher nominal wages were subsequently eroded by higher inflation.

If all economic agents form their expectations for the future with full knowledge of all economic relations and use of all available information, deviations of future events from the expected outcomes must be purely random.

If all economic agents form their expectations for the future with full knowledge of all economic relations and use of all available information, deviations of future events from the expected outcomes must be purely random. We can express the formation of price expectations mathematically in the following way:

$$E_t(P_{t+1}) = P^*_{t+1}$$

$$P^*_{t+1} = P_{t+1} + \varepsilon_{t+1}$$

$$E_t(\varepsilon_{t+1}) = 0$$

The expectation at time t for a price in the subsequent period t+1 is given by price P^*_{t+1}, which is determined by price P_{t+1}, predicted with the appropriate theory and on the basis of all available information, and a random error term, the expected value of which is zero. If all current prices contain all available information and the economy is in equilibrium, future prices deviate from current prices only by chance, and the best predictors for future prices are present prices. The implication for financial markets is that forecasts of future price developments are impossible.

Eugene Fama applied the concept of rational expectations to financial markets and hypothesized that financial prices contained all available information. At a minimum, it should not be possible to use past prices to predict future prices, and at best there would be no difference between market prices and fair prices of financial assets.[4] Thus, if markets are "weakly efficient" future prices cannot be predicted on the basis of past prices. Al-

[3] Lucas' challenge to Keynesian macroeconomics entered the history of economics under the name of „Lucas Critique".

[4] Eugene Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work". Journal of Finance, Vol. 25 No. 2 (1970), pp. 383-417.

ready this rather restrained statement contradicts the theory of adaptive expectations, which assumes that past prices contain valuable information for future prices. If Fama were right, so-called "technical analysis" of markets, which aims to identify past price patterns with a view to predicting future price movements, would be utter nonsense. Many economists and quite a few practitioners share this view. It is of course hotly contradicted by "technical analysts", who make a living by using past prices to predict the future, and so-called "black box" hedge funds, which claim to make money using quantitative analysis of past prices to evaluate future short-term price movements.

According to Fama, markets are "semi-stronlgy efficient", when prices reflect all publicly available information. In this case, forecasts are impossible not only on the basis of past price movements but also by considering new publicly available information relevant for the investment decision. Many empirical studies give evidence in support of this statement. But this is what one would expect as forecasting techniques would be used for making investment decisions instead of publication if they really gave accurate forecasts. Finally, Fama classifies markets as "strongly efficient" when prices not only reflect all relevant public information but also proprietary insider knowledge. In this case, market prices and fair values of assets would be identical. However, in most countries the use of insider knowledge for the purchase or sale of securities is illegal. Hence, a "strongly efficient" market would be one populated by criminals. Moreover, the concept of strong efficiency suffers from a logical inconsistency: If prices always reflected all information immediately, there would be no point in searching for information. But if no efforts were made for acquiring information, prices could not reflect all information.

Rational expectations theory and the efficient markets hypothesis were not only academically very successful but also highly influential in business and politics.

Rational expectations theory and the efficient markets hypothesis (EMH) were not only academically very successful—Robert Lucas and Eugene Fama were both rewarded with Nobel Memorial Prizes for their work—but also highly influential in business and politics. EMH provided the theoretical foundation for "passive investing" through index funds. If no single fund manager could reliably beat the market, why pay fees for active portfolio management? Greater returns could surely be obtained by investing in the entire market at lower costs. And EMH also had a strong influence on government policies. If the market always knew best, why let government bureaucrats regulate it? "Light" regulation was in this case surely better than heavy-handed intervention.

Andrew Lo and the Adaptive Markets Hypothesis

The Efficient Markets Hypothesis suffered its first set-back in the early 2000s, when the "technology stock bubble" burst. It suffered another set-back in the Great Financial Crisis of 2007/08.

Rational expectations theory and EMH suffered their first set-back in the early 2000s, when the "technology stock bubble" burst. Apparently, market participants were not just cool-headed "homini oeconomici" but could get carried away by emotions. The experience gave a big boost to behavioral economics and finance. Before that behavioral economics had largely been an experimental science confined to the laboratories of a few universities - its key protagonists, Daniel Kahnemann and Amos Tversky, were Israeli psychologists. US economist Robert Shiller applied behavioral economics to finance. Luckily, he published a book, in which he diagnosed the wild rally of technology stocks towards the end of the 1990s as a bubble, just at the peak of this bubble.[5] Not least because of this excellent timing of the release of Shiller's book, a serious challenger to the EMH had emerged in science and financial business. Kahnemann and Tversky received the Nobel Memorial Prize in 2003, but popularity of index funds grew strongly nevertheless.

Rational expectations and EMH suffered another set-back in the Great Financial Crisis of 2007/08. The systematic mis-pricing of risk, which became apparent when the credit bubble burst, was inconsistent with the idea that people would base their financial decisions on all available information and with the full knowledge of the true "economic model". Obviously, people had acted in the credit markets based on inadequate information and on a false economic model, which indicated risk reduction through asset pooling while risks in fact accumulated as a growing number of people acted on the basis of this model.

Despite its obvious failure EMH has remained the predominant theory of market behavior in academics and large parts of the business world, simply because there has been no other theory to displace it.[6] Many investment managers have learnt their lesson and now ignore the theory, but they have not or could not formulate a counter-thesis that would displace it. In a book published in 2017, however, the US financial economist Andrew Lo came up with a challenger to EMH. Conscious of the challenge to dethrone a theory taught widely at universities and perhaps with the ambition to follow in the foot-steps of Nobel Prize winners Fama and Shiller, he named his theory the "Adaptive Markets Hypothesis" (AMH).[7]

[5] Robert Shiller, Irrational Exuberance. Princeton University Press, 2000.
[6] The confusion in academics about how markets work became evident with the award of the 2013 Nobel Memorial Prize to both Eugene Fama and Robert Shiller.
[7] Andrew W. Lo, Adaptive Markets – Financial Evolution at the Speed of Thought. Princeton University Press (Princeton and Oxford) 2017.

The Adaptive Markets Hypothesis does not reject the Efficient Markets Hypothesis but restricts its validity to times of continuous market developments.

Lo's intention is not to scrap EMH entirely, but to restrict its validity to times of continuous market developments. Then, people act rationally, based on a wide knowledge of facts and a good understanding of the valid economic model. But when markets are disrupted for whatever reason, people turn from rational analysis to instinctive behavior. They join others in either rushing into markets for the fear of missing out, or fleeing from markets for fear of losing their fortune. Specifically, Lo summarizes his theory in five key principles:

1. *"We are neither always rational nor irrational, but we are biological entities whose features and behaviors are shaped by the forces of evolution.*
2. *We display behavioral biases and make apparently suboptimal decisions, but we can learn from past experience and revise our heuristics in response to negative feedback.*
3. *We have the capacity for abstract thinking, specifically forward-looking what-if analysis; predictions about the future based on past experience; and preparations for changes in our environment. This is evolution at the speed of thought, which is different from but related to biological evolution.*
4. *Financial market dynamics are driven by our interactions as we behave, learn, and adapt to each other, and to social, cultural, political, economic, and natural environments in which we live.*
5. *Survival is the ultimate force driving competition, innovation, and adaptation."*[8]

However, why should normally "rationally" acting professional investors suddenly turn "irrational" in market downturns, and why should normally "irrationally" acting retail investors suddenly turn "rational" in normal markets? Why do environments change from "normal" and continuous to "abnormal" and discontinuous?

Thus, during normal market conditions reward increases with risk. But at times of negative disruption, people may shun risks irrespectively of the associated reward. The Capital Asset Pricing Model may work in normal times, but fail in other market environments. Similarly, portfolio optimization according to Markowitz may work in good times, but fail in bad times. When there is contagion among different markets, asset diversification may no longer reduce risk.[9]

Lo's AMH is an intriguing effort to overcome the contradiction between EMH and behavioral finance and connect both by making them state dependent. However, why should normally "rationally" acting professional investors suddenly turn "irrational" in market downturns, and why should normally "irrationally" acting retail investors suddenly turn "rational" in normal markets? And why do environments change from "normal" and continuous to "abnormal" and discontinuous? Perhaps we can get a better

[8] Lo (2017), p.188.
[9] Lo (2017), p. 282.

idea about how markets behave when we study more closely the way information is processed by market participants.[10]

The Discovering Markets Hypothesis

The Discovering Markets Hypothesis builds on the assumptions of subjectivity and the sharing of complex contents in narratives.

We begin with three key assumptions: (i) information does not exist as an object; (ii) subjective receptions of complex contents are communicated in narratives; and (iii) shared narratives shape prices and are shaped by them.

The role of subjectivity

F. A. von Hayek, a key protagonist of the Austrian school of economics, thought of information as subjective instead of objective knowledge. The knowledge in each individual head is somewhat different from that in other heads, because it reflects the individual's specific and unique ability to collect and process information. When individuals act or observe action in the market they can improve their knowledge by testing it against the knowledge of other individuals. Practical knowledge is often implicit. Actors may not articulate it and it certainly cannot be objectively measured.

"It isn't a hunch but the subconscious mind, which is creative mind at work. That is the mind which makes artists do things without their knowing how they came to do them. Perhaps with me it was the cumulative effect of little things individually insignificant but collectively powerful,"[11] explains Jesse Livermore (alias Larry Livingston) in the classic book "Reminiscences of a Stock Operator".[12]

The role of narratives

But actors also communicate with each other to crosscheck their subjective knowledge against the knowledge of others. Complex knowledge is difficult to communicate. When expressed in the form of narratives it is easier to "get across ideas". [13] As market participants share narratives and act on

[10] Lo's auxiliary assumption of shifting market environments to retain the EMH could be interpreted in Lakatos' words as a "degenerative problem shift" in a descending research program (see below).

[11] Edwin Lefevre, "Reminiscences of a Stock Operator" (first published in 1922). Annoted Edition by Jon D. Markman, John Wiley & Sons (Hoboken, N.J.) 2010, p. 410.

[12] In this book the journalist Edwin Lefevre portrays a well-known stock market speculator at the beginning of the 20th century. Until today the book is celebrated for its insights in how markets work. Paul Jones, founder of the Tudor Investment Corporation, a well-known US hedge fund, wrote in the preface to the 2010 edition: "It is a textbook for speculation. Indeed, I hand a copy to every new trader we have, regardless of his or her considerable experience."

[13] Robert J. Shiller, Narrative Economics, Cowles Foundation Discussion Paper No 2069, January 2017.

them, prices move. In turn, the movement of prices feeds back into the narratives.

"Observation, experience, memory and mathematics – these are what the successful trader must depend on…He must bet always on probabilities – that is, try to anticipate them."[14]

Battles of narratives

Narratives battle for dominance just like scientific paradigms.

To understand how new narratives replace existing ones we recur to the theory of scientific revolutions developed by Thomas Kuhn.[15] He argues that scientific knowledge normally increases around a widely accepted paradigm. In normal times, the paradigm itself is not challenged but fleshed out more by new insights. However, when a critical mass of new facts emerges that is inconsistent with the ruling paradigm a scientific revolution may occur. Previously widely shared and accepted beliefs are now being questioned and overturned. Uncertainty and confusion may reign until a new paradigm is found that better explains the new facts than the old one. After a turbulent period ("extraordinary science"), scientific work returns to its normal state of work ("ordinary science").

Imre Lakatos speaks of research programs that have a paradigm at their core. According to Lakatos, however, the paradigm shift is not abrupt, but a tough struggle between the defenders of the old paradigm in the old research programs and the challengers who question this paradigm.[16] When new facts put pressure on a paradigm, defenders find supporting auxiliary hypotheses to save it. But the original core of the paradigm is weakening. Lakatos calls this "degenerative problem shift". The challengers, on the other hand, find new explanations for the facts and develop a theory with a higher explanatory value. This leads to a "progressive problem shift". In contrast to Kuhn, who combines paradigm shifts with radical breaks, Lakatos sees continuous gains in knowledge through the problem shifts in the research programs.

The insights of Kuhn and Lakatos into the creation of new scientific knowledge are valuable guides for understanding the effects of the emergence of new knowledge in the market. Participants acting on a new shared narrative influence market prices. For some time, there may be a battle of the ruling and the new narrative. The new narrative may change or bear

[14] Lefevre (2010), p. 416.
[15] Thomas S. Kuhn, The Structure of Scientific Revolutions, University of Chicago Press (Chicago) 1970.
[16] Imre Lakatos, Proofs and Refutations. Cambridge University Press (Cambridge) 1976.

new narratives during this battle. And eventually the argument will be settled and a new narrative will rule. It is possible that the battle of the narratives is intense and the victory of the new narrative absolute, as Thomas Kuhn has described the revolutionary paradigm change in science. Or the battle is drawn out and the new narrative displaces the old narrative gradually over time, as Imre Lakatos has argued.

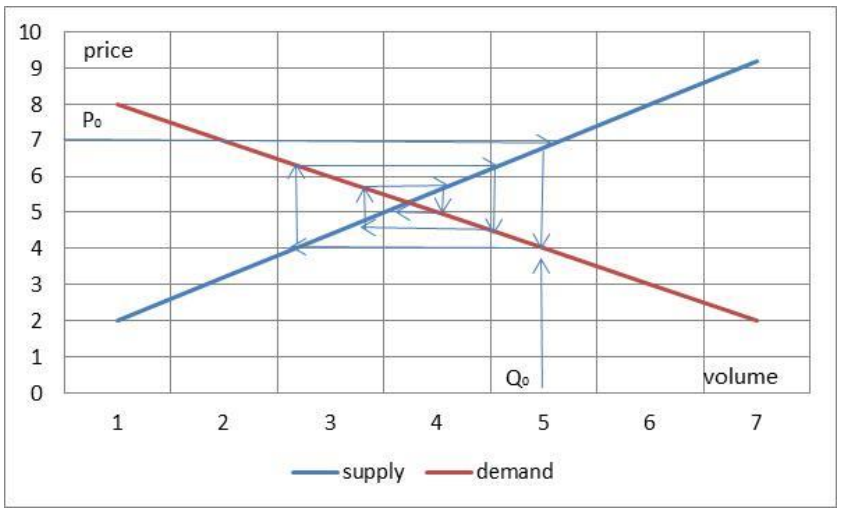
Continuity and discontinuity in price discovery

When knowledge improves incrementally narratives change only little and the process of price discovery proceeds gradually. Financial markets are then characterized by relatively small spreads between offer and demand prices (or "bid-ask spreads") for securities and moderate price volatility. This notwithstanding, market clearing prices are being found through a process of trial and error and may move around until all market participants agree on the price that best reflects their shared narrative. Only we don't see much of these movements.

In times of stable or slowly improving knowledge, prices develop incrementally.

One way to illustrate the search process for a market clearing price is the old-fashioned cobweb model shown in Figure 1. The suppliers want to supply quantity Q_0 at price P_0. However, the price they get when they offer Q_0 is much smaller than P_0. Consequently, many cut their offer so that supply now falls below demand. Excess demand brings suppliers back into the market, but at the new price there is excess supply. They cut back again, only to face now again excess demand. The process of trial and error continuous until the market clearing price is found.

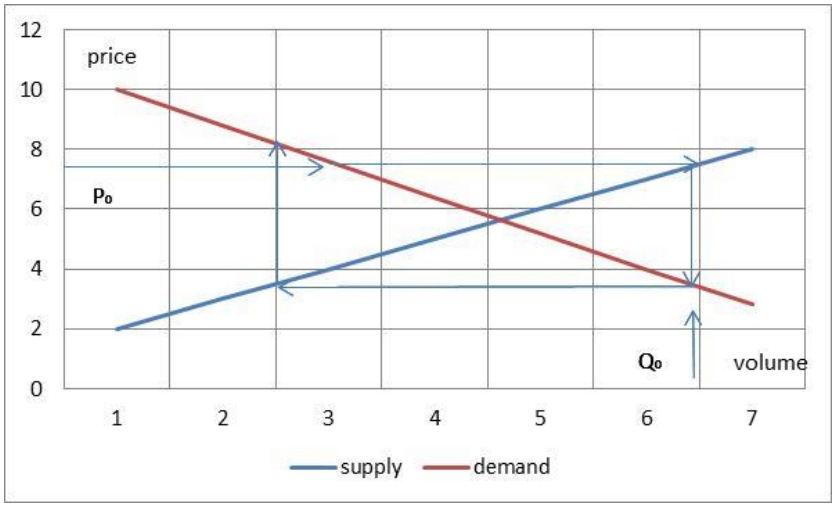
Figure 1. Finding the market clearing price in a cobweb



Source: Own exposition (Flossbach von Storch Research Institute).

In this graph, the market clearing price is found, because the supply curve is more elastic than the demand curve. As a consequence, suppliers adjust their prices by large amounts in response to excess supply or demand. But what if suppliers react less and demanders more elastically to excess supply and demand than before? In this case, excess demand and supply grow with each step and a market clearing price cannot be found (Figure 2). This is, incidentally, also true, when both sides react with the same elasticity.

Figure 2. Searching the market clearing price in vain in a cobweb



Source: Own exposition (Flossbach von Storch Research Institute).

In times of the sudden appearance of new knowledge, markets are disrupted. This is reflected by abrupt price changes.

Let's now assume that the combination of a fairly inelastic demand with an elastic supply curve characterizes a market where the demanders represent the "wisdom of the crowd" in the eyes of suppliers. This is how people intending to sell securities probably would look at the market. They would adjust their intentions relatively strongly in response to the feedback they get from the market. This is how markets normally behave, when most people share similar knowledge about market circumstances. New knowledge emerges gradually and prices converge to balance the market.

However, when new and disturbing knowledge drops like a bombshell into the market there will probably be determined (or even forced) sellers in the market and many demanders are very unsure about what to make of this. In this case, the demanders overreact to sales by the suppliers, and the suppliers in turn underreact to the demand changes by the demanders. No new equilibrium can be found. Bid-ask spreads widen and price volatility increases as suppliers and demanders are out of synch with each other. Only when the new knowledge is absorbed and evaluated by everyone can the market return to its "normal" mode of operation.

Battles of narratives and fractal geometry

There are long periods when little happens, and short periods of high turbulence.

Can we identify patterns of the emergence of gradual and revolutionary new narratives in the markets? Fractal geometry developed by the brilliant mathematician Benoit Mandelbrot may help.[17] According to Mandelbrot smoothness and roughness alternate in nature and financial markets. There are long periods when little happens, and short periods of high turbulence. To borrow from Thomas Kuhn, markets are calm when an accepted narrative is not seriously challenged, and markets experience heavy turbulence when an accepted narrative is overturned by a radically new one. Or, to borrow from Imre Lakatos, markets shift when a new narrative gradually displaces an old one. We call the evolution of prices in response to the spread of narratives the Discovering Markets Hypothesis (DMH).

AMH and DMH compared

By focusing on the process of augmenting knowledge in a battle of narratives we believe that DMH provides a more consistent framework for analyzing and predicting market behavior.

Although Lo's Adaptive Markets Hypothesis and our DMH start with the same insight that markets may alternate between continuity and discontinuity, there are important differences. First, AMH takes the change in states as given while DMH explains the change in states with the way knowledge emerges and spreads in the form of narratives. Second, AMH assumes schizophrenic minds of market participants and employs psychology to explain alternating behavior while DMH assumes psychologically stable market participants that act continuously and consistently in a way we call subjectively rationally. Thus, by focusing on the process of augmenting knowledge in a battle of narratives we believe that DMH provides a more consistent framework for analyzing and predicting market behavior.

Empirical support for the DMH

In view of the complexity of our object of research we apply the method of "pattern recognition".

Can we relate market price movements to the emergence of new facts and spread of new narratives? In the following we apply our theory to the explanation a few highly visible market movements. We are of course conscious that this does not represent a test of our theory in the spirit of Karl Popper, in which researchers aim to establish a numerically quantified causal relationship between exogenous and endogenous variables. In view of the complexity of our object of research we apply the method of "pattern recognition" as suggested by F. A. von Hayek. Hayek has argued that numerical predictions based on causal relationships between endogenous and exogenous variables are less reliable the more complex the system is to which these variables belong. The complexity of social systems in particular

[17] Benoit Mandelbrot and Richard L. Hudson, The Misbehavior of Markets, A Fractal View of Financial Turbulence: A Fractal View of Risk, Ruin, and Reward. Basic Books (New York) 2004

is such that the establishment of causal relationships between variables and their quantification are next to impossible. But this does not mean that we cannot create falsifiable hypotheses and are unable to make predictions.[18]

We can establish whether or not our theory can explain the pattern of market price movements, but we cannot expect to find a theory with which we can predict market outcomes.

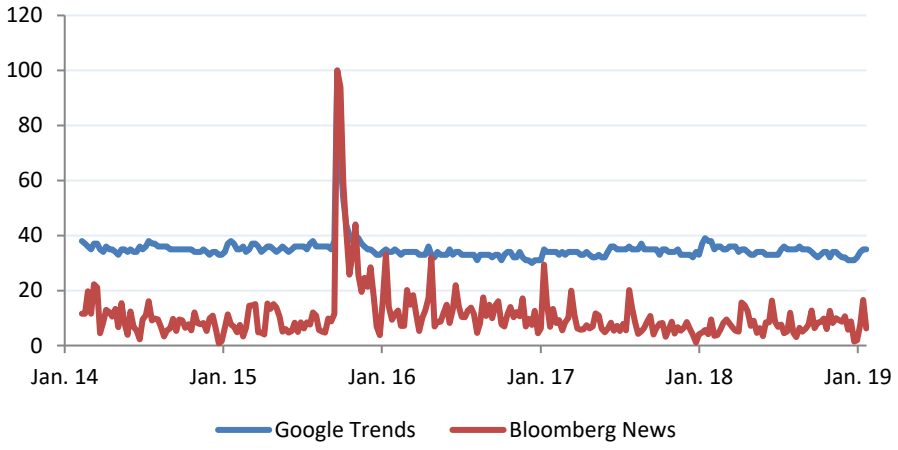
Applying Hayek's theory to the analysis of markets we can establish whether or not our theory can explain the pattern of market price movements, but we cannot expect to find a theory with which we can predict market outcomes. In the following, we first study a number of cases where existing narratives were suddenly overturned by new ones (cases 1-2). Then we turn to cases where new narratives emerged after a battle of narratives (cases 3-4), and finally we look at cases where narratives shifted more gradually (cases 5-6).

Case 1: Diesel-shock

On 22 September 2015 the German car company Volkswagen AG published a profit warning acknowledging that Diesel engines had been manipulated so as to disguise the true level of NO_2-exhausts. As Chart 1 shows this attracted a lot of public attention and news coverage of Volkswagen surged.

Chart 1: News concerning "Volkswagen", 2014-2019

When the Diesel-shock hit in September 2015, news and google searches peaked.



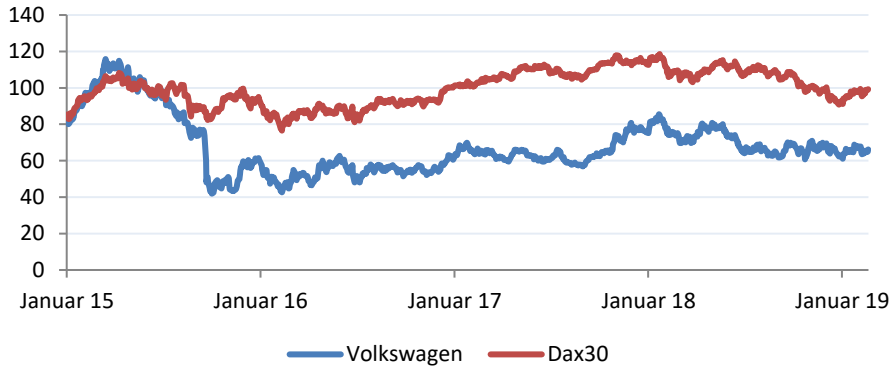
Source: Bloomberg, Google, Flossbach von Storch Research Institute

[18] F. A. von Hayek, „The pretence of knowledge", Prize Lecture to the memory of Alfred Nobel, December 11, 1974

The share price plunged on the news and then moved along with other share prices represented by the DAX30 stock market index (Chart 2). The observed share price movement is consistent with the one-off repricing in response to unexpected news as postulated by the efficient markets hypothesis. It is of course also consistent with a radical shift of the narrative about the profitability of Volkswagen. From the analysis of the share price development we cannot tell which theory gives a better explanation of the observed pattern.

VW-Shares plunged in 2015 and did not recover compared to the Dax30 index.

Chart 2: VW-Shares compared to the Dax30 equity price index, 2015-2019 (100 = 01.06.2015)



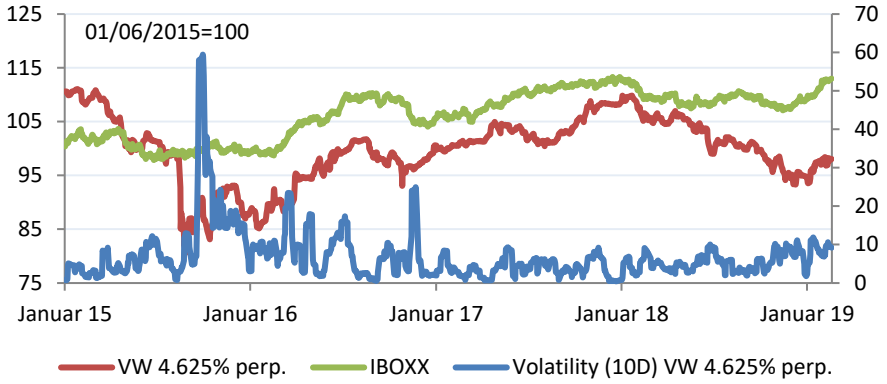
Source: Bloomberg, Flossbach von Storch Research Institute

The narrative of a company in deep trouble was superseded by the narrative that the company would survive and creditors were fairly safe.

However, things become clearer when we turn to a corporate bond of the company. Until the release of the news the bond fluctuated around the bond price index iBOXX (Chart 3). In response to the release the price plunged similar to the movement of the share price (though somewhat less). Both markets seemed to follow the same narrative. Thereafter, however, the price of the bond recovered and returned to the level of the bond price index. The narrative of a company in deep trouble was superseded by the narrative that the company would survive and creditors were fairly safe. Had the market been “efficient”, the bond price should have reacted much more calmly than the stock price. But market participants needed to digest the news and differentiate the new narrative in the stock market from that in the bond market before prices in both markets settled.

The VW-bond price also plunged in 2015, signaling a major threat to liquidity of Volkswagen, only to catch up after the scandal.

Chart 3: Price of VW 4.625% perpetual bond and iBOXX, 2015 – 2019



Source: Bloomberg, Flossbach von Storch Research Institute

Likewise, the cost of insuring Volkswagen debt against default rose significantly (Chart 4) in September 2015, but fluctuated at a lower level in the aftermath of the crisis outbreak.

Also, the cost of insuring VW debt against default peaked in September 2015.

Chart 4: Price of a Credit Default Swap for Volkswagen (in basis points), 2015-2018

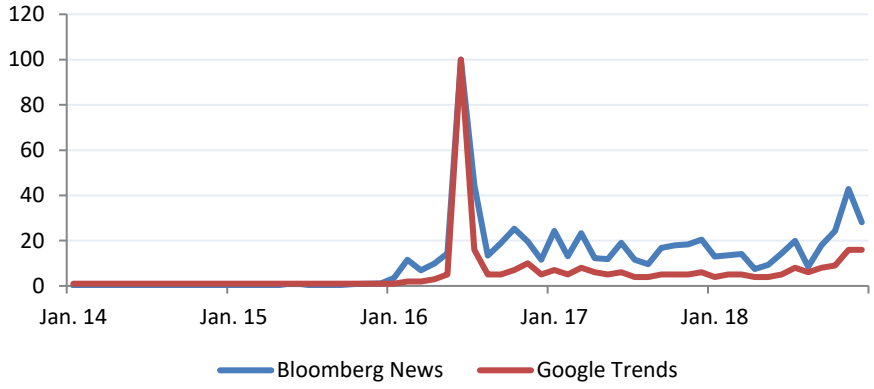
Source: Bloomberg, Flossbach von Storch Research Institute

Case 2: Brexit

On 23 June 2016, for many people unexpectedly, the British people voted in favour of the country's exit from the European Union. Unsurprisingly, news coverage surged (Chart 5). The exchange rate of sterling against the US Dollar took a dive and volatility surged (Chart 6). Following the nosedive the exchange rate of sterling continued to weaken as it had done before the unexpected news. After some time, however, the initial shock faded and the exchange rate recovered part of the lost ground. The observed pattern is consistent with a weakening of the new Brexit narrative over time. As the debate about the terms of Brexit dragged on and the eventual outcome became ever more obscure the exchange rate moved sideways. The confusion prevented any narrative to dominate the market.

Chart 5: News concerning "Brexit", 2014-2019

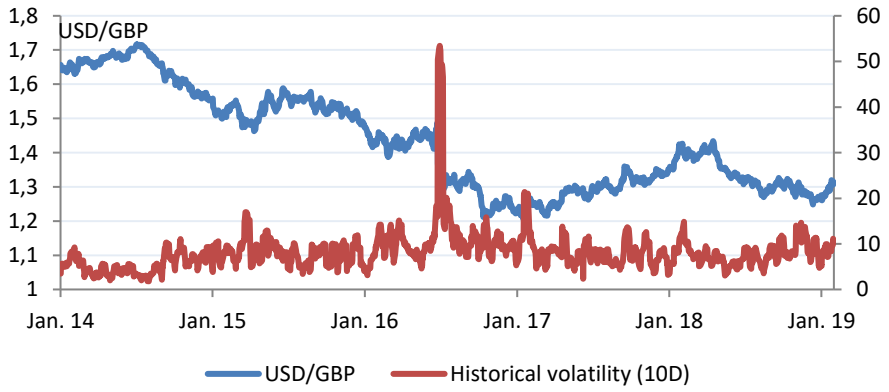
The Brexit vote caused a peak in news and google searches concerning the subject.



Source: Bloomberg, Google, Flossbach von Storch Research Institute

Chart 6: Price quotation USD/GBP and volatility, 2014-2019

The price of USD per GBP declined significantly after the Brexit vote.



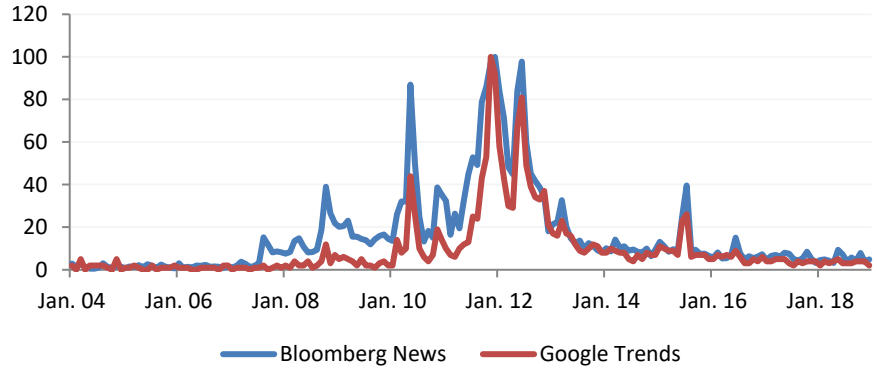
Source: Bloomberg, Flossbach von Storch Research Institute

Case 3: Eurocrisis

Following the debt restructuring of Greece in early 2012 markets moved their focus to Italy. While the Greek debt crisis had posed only a limited threat to the survival of the euro an Italian debt crisis could spell its end. Hence, news reports mentioning a "euro crisis" increased (Chart 7). At the same time, Italian bond yields rose (Chart 8). On July 26, 2012, however, ECB President Draghi said that the ECB would do "whatever it takes" to protect the euro. As a result, the Italian bond yields plunged. However, it took for the rest of the year for the new narrative of the survival guarantee by the ECB to find its way fully into market prices. The pattern observed here is consistent with a new narrative ("whatever it takes") replacing an old one ("euro crisis") in the market.

Chart 7: News concerning the "Euro Crisis", 2004 -2018

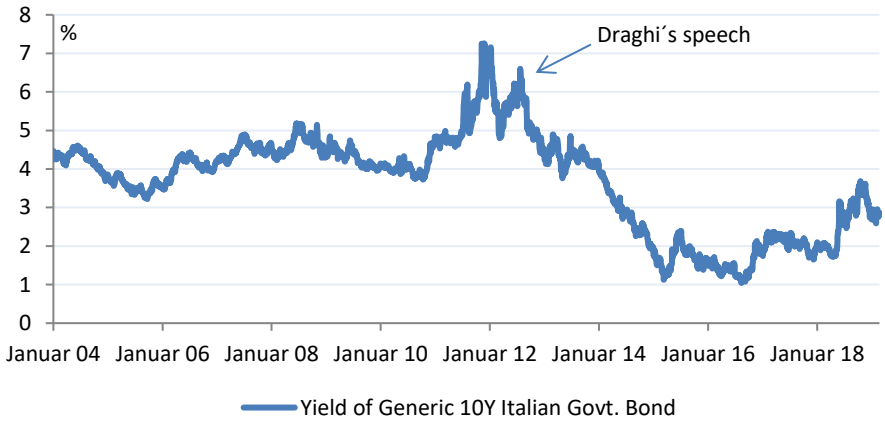
Google searches and news peaked at the end of 2011 and the beginning of 2012. People became aware of the Euro Crisis



Source: Bloomberg, Google, Flossbach von Storch Research Institute

Chart 8: Yield of 10-year Italian government bond, 2004-2013

Italian government bond spreads peaked at the end of 2011 and at the beginning of 2012. Draghi´s "whatever it takes" speech changed the dominant narrative.



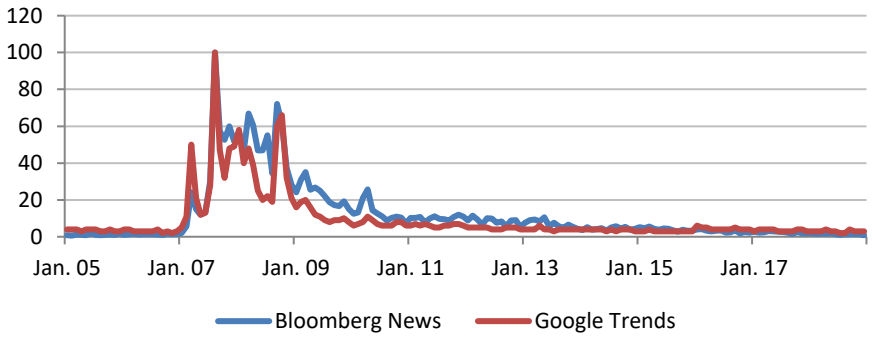
Source: Bloomberg, Flossbach von Storch Research Institute

Case 4. Subprime crisis

In early 2007 defaults in a segment of the US mortgage market – dubbed „subprime“ – received public attention. Initially the events were narrated as problems caused by the mis-selling of mortgages to financially weak debtors and hence as a limited problem in a relatively small market segment (Chart 9). Money markets in the US and Europe were affected as banks lost trust in each other's solvency, but the stock market remained calm (Chart 10). The narrative changed with the default of Lehman Brothers, causing news on the subject to surge again (Chart 9). Through the remainder of the year and into 2009 the stock market fell. However, by the end of the first quarter of 2009 the crisis narrative had weakened sufficiently to be superseded by a more positive narrative, first along the line of "the worst is over" and then of "the recovery is beginning". One of the authors was involved spreading the new narrative at the time based on improving credit flows and recalls how initial skepticism of institutional investors gradually gave way to new optimism.[19] The fear of missing out by sticking to the old narrative was a key motivation for the sceptics to turn optimistic.

Chart 9: News concerning "Subprime", 2005-2018

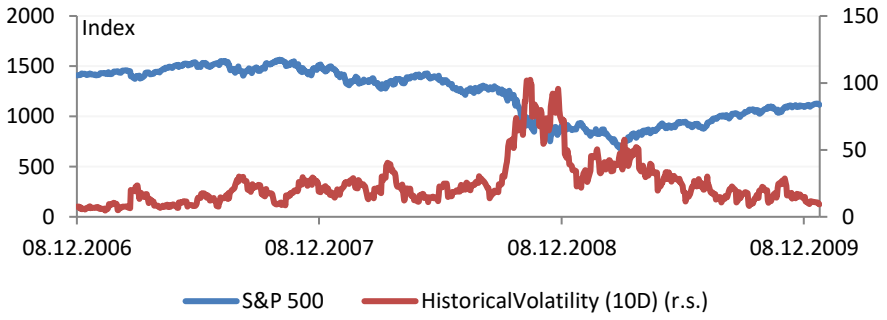
News and Google searches about "Subprime" first emerged in 2007 and stayed high between 2007 and 2008.



Source: Bloomberg, Google, Flossbach von Storch Research Institute

Chart 10: S&P 500 price and historical volatility, 2006-2009

The S&P 500 declined significantly in the fourth quarter of 2008, marking the height of the financial crisis.



Source: Bloomberg, Google, Flossbach von Storch Research Institute

[19] See https://institutional.dws.com/content/_media/1147_FiscalPolicy.pdf.

Case 5. Bitcoin[20]

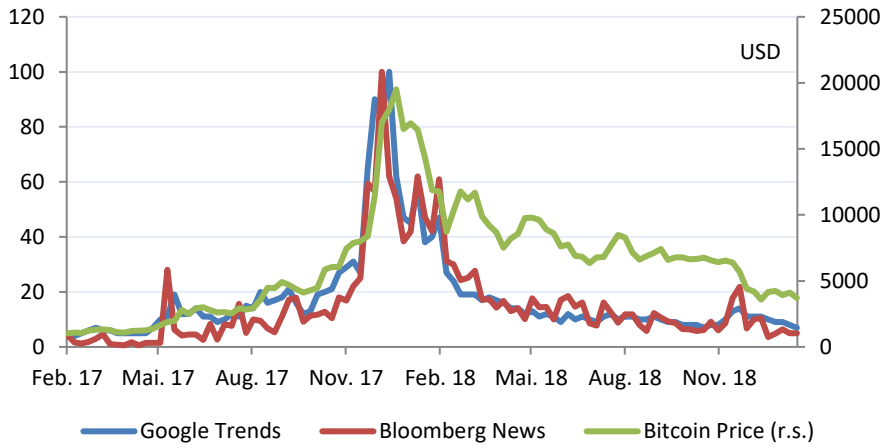
Chart 11 shows the weekly closing prices of the Bitcoin exchange rate in USD as well as indicators for Bitcoin reports in the press and search queries on the Internet. While the Bitcoin share price rose steadily from June to mid-October 2017, it exploded abruptly at the end of November and peaked in mid-December 2017.

The number of reports on Bitcoin preceded the development of the price.

The number of reports on Bitcoin preceded the development of the price. The first significant increase in the number of reports took place in October, shortly before Bitcoin first broke the USD 5,000 mark. The number of reports rose exponentially and reached its highest level in the week of December 8 (press and social media, represented here by Bloomberg News and Google Search). Bitcoin reached its highest level 10 days later, on December 18. Thus, the spread of the news about Bitcoin preceded the development of its price. It would, however, be wrong to infer from this one way causality. Rather, it seems that news and price developments fed on each other. At times when the price of Bitcoin reached certain marks, such as 5,000 USD or 10,000 USD, news reports rose. More news then led to more interest in the crypto currency and induced more purchases, which drove the price higher.

Chart 11: Bitcoin price and media references to Bitcoin, 2017-2019

The Bitcoin coin price is skyrocketing at the end of 2017 and falls on trend in 2018.



Source: Bloomberg, Google, Flossbach von Storch Research Institute

[20] This section draws on Philipp Immenkötter, „Wie sich Geschichten verbreiten – Narrative Economics am Beispiel des Bitcoin“, Flossbach von Storch Research Institute 11/4/2018.

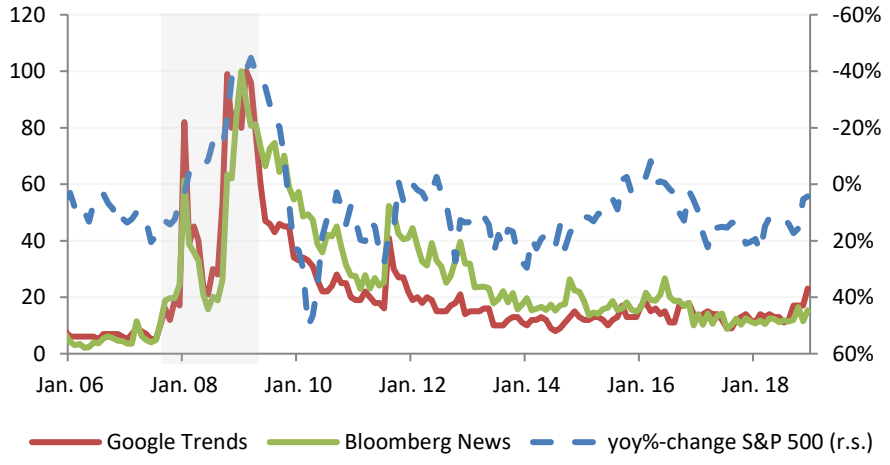
Case 6: Recession

Although during the Great Financial Crisis of 2007/08 money markets experienced already severe tensions as of mid-2007, recession fears in the US gained momentum only as of August 2007 and peaked in December 2007 (as measured by the number of queries for the word "recession" on Google, Chart 12). Fears subsided during the first half of 2008 but surged again as of August 2008 and peaked in October 2008, one month after the bankruptcy of Lehman Brothers. Recession fears then eased again during the second quarter of 2009.

The absolute peak of recession queries on Google in December of 2007 occurred just at the beginning of the recession in the US in the first quarter of 2008. And the return to a more normal level of recession fears in mid-2009 coincided with the (later proclaimed) official end of recession in the US. At the beginning of 2008 the stock market (as measured by the S&P 500 price index) broke below its 2007 trading range, but remained in its new trading range until the end of August. Only after the news of the Lehman bankruptcy on September 15 stock prices plunged. They reached a bottom in early March 2009, coinciding with the easing of recession fears (measured by the number of Google queries). Towards the end of 2018 recession fears increased again and the stock market tumbled. These developments followed an earlier cooling of the global business climate (Chart 13).[21]

Recession fears, measured by Google searches and news coverage, accompany the real recession as identified afterwards by the National Bureau of Economic Research.

Chart 12: News concerning "Recession" and year-on-year percent change of S&P 500 (inverted)

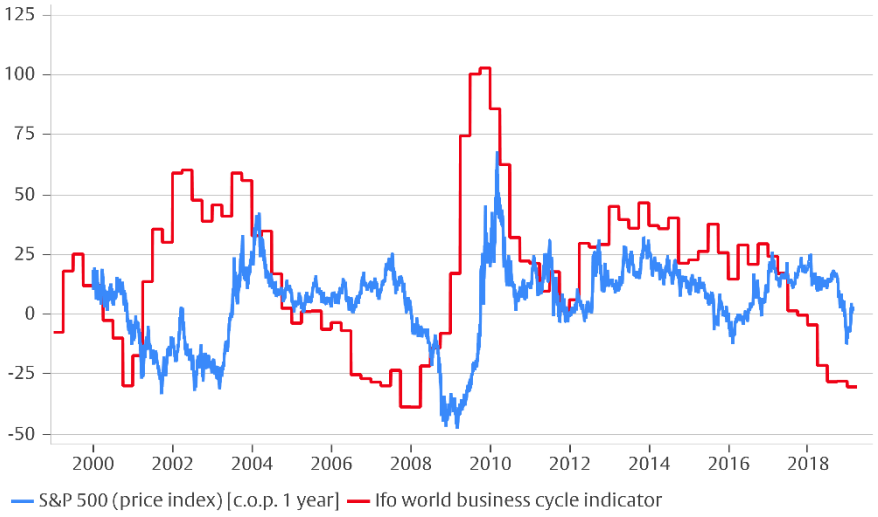


Source: Bloomberg, Google, Flossbach von Storch Research Institute

[21] In this chart the global business climate is measured as the difference between global business expectations and conditions as measured by the regular poll of the German Ifo-Institute.

The global business cycle indicator displays a negative trend, not seen since the crisis of 2008.

Chart 13. Global business cycle indicator and S&P 500



Source: Macrobond

Although the Discovering Markets Hypothesis admits the fundamental uncertainty of the future, forecasts in the form of pattern predictions are possible.

Pattern predictions with the DMH

After having found the DMH to explain the pattern of market movements as a competition of different narratives we now discuss its use for making "pattern predictions". Hayek uses the example of a ball game to illustrate what we can and what we cannot predict. If we knew precisely the skills and fitness of the members of the opposing teams in addition to the rules of the game, we should in principle be able to predict the outcome with a relatively high degree of certainty. However, the closer the team members come in skills and fitness, the greater will be the role of chance in determining the outcome.

The legendary German coach Sepp Herberger once said: "People go to soccer games because they don't know how the game ends." In reality, we of course have no precise information about the skills and fitness of the players at the time of the game so that not only pure chance but also a lack of information will prevent us from reliably anticipating the outcome of the game. Nevertheless, knowing the rules of the game helps us to focus our attention on what matters for the result. Moreover, as we observe the game we acquire more information about the ability of the players and can improve our prediction of the outcome. It is obviously easier to correctly predict the result of a soccer match at halftime than at the beginning, but even then a lot of uncertainty remains.

All this implies that we should not expect to be able to predict market outcomes. But by understanding how markets move we can better focus on what is important for the outcome. Observations of the important drivers of market developments can then help us to narrow down the possible range of outcomes. Specifically, the DMH suggests that we focus on how new facts influence narratives, which shape prices and are reshaped by them. By identifying narratives shared by a large number of people, and by finding out whether they are ascending or descending, we may be able to assess the persistence of market price movements. In some cases, we may even identify narratives that precede price movements. This is illustrated in Figure 3.

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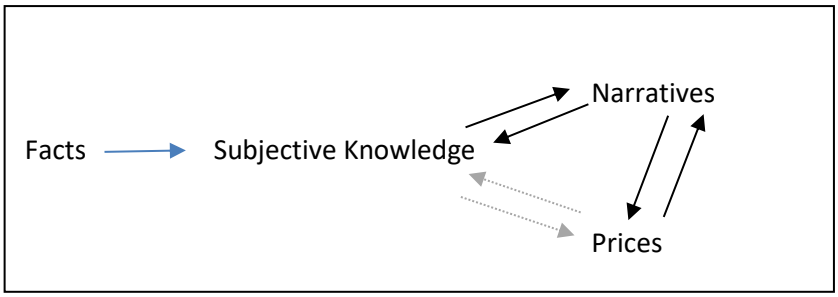
Figure 3. Formation of prices



Facts create subjective knowledge, which may induce financial market participants to act. More likely, however, they will exchange this knowledge with other market participants with a view to identifying shared narratives, which have a more powerful influence on prices than individual action.

Summary and conclusion

Expectations of the future shape the movements of market prices. In this paper we argued that market participants form their expectations on the basis of their ability to collect information and their ability to process it. They communicate their views about the future in the form of narratives and learn by listening to the narratives of others. Narratives compete and winners emerge through a knock-out or the wrestling down of competitors. Winning narratives shape market prices, until their victory is confirmed by the facts, or they are knocked out by the facts and replaced by new narratives. When we understand how market prices are formed we can predict the way they adjust to changing economic conditions.

Could artificial intelligence and machine learning replace human actors in financial markets? Those who believe in more mechanical models of expectations—assuming "rational" or "irrational" or state-dependent "ration-

al/irrational" behavior—may be inclined to say yes. However, if market participants indeed act subjectively rationally and interdependently based on proprietary knowledge accumulated through experience and incomplete information transmitted through narratives—as described in our Discovering Markets Hypothesis—the hurdle for artificial intelligence to beat human intelligence seems fairly high.

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