

 Open access • Journal Article • DOI:10.2139/SSRN.1289588

The naturalistic turn in economics: implications for the theory of finance

— [Source link](#) 

Carsten Herrmann-Pillath

Published on: 25 Oct 2008 - Social Science Research Network

Topics: Social studies of finance, Behavioral economics, Naturalism and Causation in economics

Related papers:

- [Equity gap? - Which equity gap? On the financing structure of Germany's Mittelstand](#)
- [Heterogeneous multiple bank financing: does it reduce inefficient credit-renegotiation incidences?](#)
- [Staatsfonds - neue Akteure an den Finanzmärkten?](#)
- [Temperaturderivate zur strategischen Absicherung von Beschaffungs- und Absatzrisiken](#)
- [The endogeneity approach of the theory of optimum currency areas: what does it mean for ASEAN + 3?](#)

Share this paper:    

View more about this paper here: <https://typeset.io/papers/the-naturalistic-turn-in-economics-implications-for-the-1tx2w4jjfb>

Herrmann-Pillath, Carsten

Working Paper

The naturalistic turn in economics: implications for the theory of finance

Frankfurt School - Working Paper Series, No. 105

Provided in Cooperation with:

Frankfurt School of Finance and Management

Suggested Citation: Herrmann-Pillath, Carsten (2008) : The naturalistic turn in economics: implications for the theory of finance, Frankfurt School - Working Paper Series, No. 105, Frankfurt School of Finance & Management, Frankfurt a. M., <https://nbn-resolving.de/urn:nbn:de:101:1-2008121076>

This Version is available at:

<http://hdl.handle.net/10419/27874>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Frankfurt School – Working Paper Series

No. 105

The Naturalistic Turn in Economics: Implications for the Theory of Finance

by Carsten Herrmann-Pillath

November 2008



**Frankfurt School of
Finance & Management**
Bankakademie | HfB

Sonnemannstr. 9–11 60314 Frankfurt am Main, Germany

Phone: +49(0)69 1540080 Fax: +49(0)69 154008728

Internet: www.frankfurt-school.de

Abstract

Economics is increasingly adopting the methodological standards and procedures of the natural sciences. The paper analyzes this ‘naturalistic turn’ from the philosophical perspective on naturalism, and I discuss the implications for the field of finance. The theory of finance is an interesting case in point for the methodological issues, as it manifests a paradigmatic tension between the pure theory of finance and Behavioral Finance. I distinguish between three kinds of naturalism: mark I, the reduction of behavior on psychoneural phenomena, mark II, the transfer of patterns of causal explanations from the natural sciences to the social sciences, mark III, the enrichment of the ontology from observer-independent to observer-relative facts. Building an integrated naturalistic paradigm from these three ingredients, I show that naturalism in economics will only be completed by a simultaneous linguistic turn, with language being analyzed from the naturalistic viewpoint. I relate this proposition with recent results of research into finance, especially connecting Behavioral Finance with the sociology of finance.

Key words: naturalism, causation in economics, neuroeconomics, Behavioral Finance, social ontology, sociology of finance

JEL classification: A12, B41, D87, G00

ISSN: 14369753

Contact:

Carsten Herrmann-Pillath
Academic Director, Sino-German School of Governance
Frankfurt School of Finance & Management
c.herrmann-pillath@frankfurt-school.de

Content

1	The naturalistic turn: Resolving the tension between the pure theory of finance and Behavioral Finance	4
1.1	The uneasy relation between economics and the sciences	4
1.2	A third methodological alternative: The naturalistic view on markets as systems of distributed cognition	5
1.3	From the naturalistic turn to the linguistic turn	7
2	Naturalism, mark I: Approaching the limits of neuroeconomics.....	8
2.1	Economics with brains that evolved.....	8
2.2	The essential incompleteness of human brains.....	10
2.3	Language and the unity of the brain	11
2.4	Implications for the theory of finance	13
3	Naturalism, mark II: The naturalistic approach to causation in human behavior and interaction	15
3.1	Towards a unified conception of causality in the sciences, the social sciences, and the humanities	15
3.2	Gestalt theory and emotions as framed affects.....	16
3.3	Implications for the theory of finance	18
4	Naturalism, mark III: Language and social ontology	20
4.1	Social ontology	20
4.2	Identity economics and the role of groups in social coordination.....	22
4.3	Implications for the theory of finance	24
5	Conclusion: The broader picture and the research agenda for finance studies.....	25

1 The naturalistic turn: Resolving the tension between the pure theory of finance and Behavioral Finance

1.1 The uneasy relation between economics and the sciences

Economics is undergoing profound changes of its foundations (for a survey, see Davis, 2006). On first sight, these are associated with the increasing importance of methods and paradigms of the natural sciences in advancing economic knowledge. This is very different from the first wave of introducing methods and models from the sciences into economics, which took place in the late 19th century: This was mainly the transfer of analytical approaches without any reductionist claims. Central paradigms and concepts of physics were introduced into neoclassical modeling of equilibrium forces in the economy, without implying that this would turn economics into a subsection of applied physics (Mirowski, 1989). This interaction is taking place recurrently throughout the history of economics, as in the field of finance theory recently, with the emergence of the “econophysics” stream of research, which transfers analytical methods such as the notion of scale-free networks, or even quantum physics into the study of finance (for surveys, see Mantegna and Stanley, 2000; Baaquie, 2004).

However, one of the main protagonists of econophysics research into finance argues that this more recent transfer also raises a methodological challenge at economics in general and finance theory in particular. Roehner (2002: Chapter 1) criticizes the established approach in economics as being aprioristic in the sense that economic research does not start out from the identification of empirical regularities (i.e. phenomenological laws), and then moves on to the construction of falsifiable theories that might explain these regularities, but firstly posits theories, and then tries to confirm or refute them. Thus, economics directly confronts relatively simple, highly abstract and tightly organized theories with overwhelmingly complex economic systems, and just skips the most onerous part of the work in the sciences, that is, trimming down complexity into smaller domains of the potential application of theories, and then to develop on an observational methodology that allows for the identification of empirical regularities in these domains. As a result, economics is very often missing the central explanatory concept of the sciences, namely causation. One important illustration is the perennial concern for the microfoundations of macroeconomics, which reveals the fact that important economic concepts such as the existence of equilibria are not necessarily related with causal explanations of the mechanisms generating these phenomena (Hausman, 2006: 10). Thus, natural scientists often comment on the perceived distance between economics as an allegedly exact social science and the methodological stance of the natural sciences (for another example, a leading biologist, see Wilson, 1998: 216ff.).

This criticism directly reflects the situation in the theory of finance, too, where a dualism has surfaced between the standard paradigm of finance theory and the so-called ‘Behavioral Finance’. The standard paradigm was created in the 1950s and 1960s in order to provide a strong theoretical foundation for the study of finance, which was until then a mere set of institutional knowledge and practical experience, mostly taught at business schools in the United States (for a survey on the history of finance theory, see MacKenzie, 2006). Major theoretical breakthroughs such as the Modigliani-Miller theorem or the Capital Asset Pricing Model are

firmly rooted in theoretical notions of risk and an abstract conception of arbitrage. However, these notions are aprioristic in the sense that they do not start out from observed regularities in the capital market, and do not concentrate on causal processes that actually generate observed phenomena on the capital markets.

In fact, for example, the Black-Scholes formula could not be empirically supported in the initial years, thus might have been regarded as refuted, according to the standards of the sciences. However, in economics the logic of decisions and arbitrage is such a powerful systematizing force, and has a fundamental paradigmatic significance, so that these refutations did not lead to a redesign of the theory. Instead, two other movements were started. The first one is to adapt the existing institutional framework of capital markets such that the conditions of the theory might begin to hold, which indeed also contributed to improving its empirical validity. That is, the modern theory of finance was a driving force of massive regulatory changes on the capital markets, especially with regard to options and derivatives (MacKenzie, 2007). The second one is to further differentiate the theory, especially in the analysis of risk factors, with the result of reinstating the validity of the fundamental principles of rationality and arbitrage (for a prominent example, see Fama and French 1993).

Thus, the standard theory of finance qualifies as a progressive research program in the sense of Lakatos, although its approach does not match with the methodological standards of the sciences. This tension has become evident in the rise of Behavioral Finance, which, in principle, follows the methodology of the sciences, that is, to identify regularities on the financial markets. Behavioral Finance was built on the anomalies of the standard model that shows up in its empirical tests. However, this implies that the established regularities are always dependent on the standard theory that is (pace Roehner) they rarely are purely phenomenological laws. Behavioral Finance grew with the accumulation of anomalies, which sum up to an impressive collection of observations on ‘irrational’ investor behavior and limits to arbitrage (for recent surveys, see Subrahmanyam, 2007, or van der Sar, 2004). This conceptual dependency reveals that it suffers from the lack of an independent paradigm.

1.2 A third methodological alternative: The naturalistic view on markets as systems of distributed cognition

Behavioral Finance does not really challenge the established paradigm in the theory of finance, which is easy to understand in the context of the Lakatos approach to methodology. It is missing an alternative paradigm with equal theoretical consistency and logical strength as the fundamental theory of rationality and arbitrage. As a research program, it has not yet been weaned off from its dependency on the standard model, which provides the very criterion to define ‘anomalies’ and ‘irrationality’. So we face a dilemma, which is a challenge not only for theory, but also for policies, such as the need to develop the regulatory framework of capital markets. On the one hand, we have a powerful theory, and on the other hand we have a number of loosely connected empirical observations, which contradict the theory. Should we base our regulatory design on the former or the latter?

Recent advances in the sociology of finance have shown that this question has no simple answer, because economics differs from the sciences in a substantial way. In the past, methodological discussions of economics have frequently pinpointed the tension between its normative and its positive approaches. This is evident from finance theory, too, which can also be interpreted as a normative theory how rational investors should behave.

The sociology of finance has introduced a third interpretation, which is crucial for resolving our problem: Economics is performative (Callon, 2007). This means, as been already mentioned previously, that economics is endogenous to the institutional evolution of its object, the economic system. Economic theories contribute to the emergence, diffusion and stability of institutions that frame the behavior of economic agents. Thus, the controversy between Behavioral Finance and the pure theory misses a crucial part of the story. This is that ‘rationality’ is not simply a cognitive property of agents, but an emergent property of systems of agent interaction.

This sociological viewpoint matches the so-called ‘externalism’ in the cognitive sciences, which highlights the role of phenomena external to the human brain to enable and organize human cognition (for a survey, see Wilson, 2004; see also Sterelny, 2004). In a nutshell, this approach implies for the study of finance that financial markets have to be analyzed as systems of distributed cognition. This approach differs from the well-known Hayekian use of the term of distributed knowledge, which also underlies the firmly established view on financial markets as information processing systems. These views interpret information processing in purely mentalist terms, in the sense that the notion of market efficiency does not refer to causal mechanisms of information processing in physical terms (leading into fundamental logical troubles such as the no-trade theorem, surveyed in Samuelson, 2004). In contrast, the externalist notion of distributed cognition approaches information processing in terms of causal connections in social networks among agents as biological entities (i.e. brains), which are scaffolded by technological devices both in the sense of social technologies (e.g. institutions) and physical technologies (such as computers). That is, financial markets are envisaged as networks of peoples and things that process information in real-time (Callon et al., 2007).

Subsequently, I wish to present some preliminary thoughts on these new developments in theory. I claim that the tension between Behavioral Finance and the pure theory of finance can only be resolved if the former is embedded into an entirely new paradigm, which combines the sciences with a theoretical perspective on human creativity and the endogenous emergence of novelty in human systems of social interaction involving technology. The latter is defined in evolutionary terms, as far as conceptual tools and modeling approaches are concerned. The two are synthesized in a fundamental methodological and philosophical proposition, which is ‘naturalism’ (for a survey, see Papineau, 2007). Thus, I wish to present some first thoughts on a naturalistic theory of finance (for more background in my own research, see Herrmann-Pillath 2008a, b).

1.3 From the naturalistic turn to the linguistic turn

In the context of contemporary economics, and on first sight, the term “naturalism” grasps phenomena such as the explanation of economic behavior by direct reference to research in the brain sciences, i.e. neuroeconomics, the embedding of decision theoretic models in evolutionary theory, or the advance of the ‘lab’ as a new form of the social organization of economic research. These changes are coupled with more theoretically guided reorientations, such as the move from rational choice to the analysis of rule-based behavior in evolutionary game theory. Although these changes mainly take place with regard to the theory of behavior, the signs are strong that other fields of economics will also be affected, such as macroeconomics (Akerlof, 2007). However, there is a conspicuous lack of philosophical references in the economic literature delving into the naturalistic stream. As is evident from Behavioral Finance, the major consequence is a lack of paradigmatic force. In particular, neuroeconomics is generally missing an explicit dialogue with the philosophy of mind. By mobilizing the philosophical resources, I will arrive at a surprising conclusion: The *naturalistic turn* in economics will only be completed if it is accompanied by a *linguistic turn*, with a naturalistic twist. This linguistic turn allows unifying Behavioral Finance with neuroeconomics on the one hand, and the sociology of finance on the other hand. So, philosophy may act as a midwife for the creation of a paradigmatic framework of Behavioral Finance.

Whereas the naturalistic turn does not meet much resistance in economics, the linguistic turn seems to be out of reach currently. The reason is simple. The naturalistic turn clearly supports a further move of economics into the direction of the ‘hard’ sciences, whereas the linguistic turn is associated by many with postmodernism, relativism, or skepticism and hence, heterodox economics of a bunch of brands (epitomized, for example, by the contributors such as McCloskey 1994, who reduces methodology to rhetoric). However, this association is very misleading and reveals a distorted reception of modern philosophy in many parts of the social sciences in general, and economics in particular. In fact, the naturalistic turn needs to be accompanied by a linguistic turn in the sense of recognizing the empirical fact that language and the processing of symbols are a fundamental and constitutive property of the human species. In economics, this turn is already manifesting first signs, which have emerged in the study of culture (e.g. Greif, 1994; North, 2005). Auspiciously, culture has become an empirical category in certain areas of experimental economics (for a survey, see Bowles, 2004: 114ff.). Thus, orchestrating the ‘two turns’ will certainly help to systematize recent advances in economic research. This is also important for finance, as many anomalies can be actually reframed as phenomena that emerge from a certain symbolic representation of facts on capital markets, and because the performative role of theory essentially is a linguistic activity (actually, the term “performative” is borrowed from linguistics).

I achieve this conceptual coordination in three steps. To avoid confusion from paying too much attention to the vast possibly related literature, I shall concentrate on core contributions that help to make the argument clear. This limitation is particularly relevant for the treatment of the philosophical issues, because I just develop one particular position, without putting it into the context of the philosophical debate. I begin with an analysis of the current state of neuroeconomics, brilliantly elucidated in several recent contributions by Camerer and colleagues. This is *naturalism, mark I*. Building on an early and influential model of the brain by Gary Edelman, I follow Ross’s recent philosophical analysis and conclude that neuroeconom-

ics will remain incomplete without including language as an analytical category. From this, the methodological challenge emerges how to approach language in a naturalistic sense. Therefore I move on to *naturalism, mark II*. This has been proposed by Roy Bhaskar, among others, namely to follow basic explanatory schemes of the natural sciences in all human sciences. The core category is causality. From this consideration the question emerges how a naturalistic approach to language can be meaningfully applied in economics. This is tantamount towards a transformation of hermeneutic patterns of argument into hypothetico-deductive explanations. This leads toward *naturalism, mark III*. One central philosophical contribution to this is John Searle's social ontology. I argue that this approach helps to integrate neuroeconomics with the study of institutions via the concept of language. I illustrate this point by means of a brief discussion of the 'economics of identity' as proposed by Akerlof and Kranton and 'team preferences' advanced by Sugden. In all steps of the argument, I venture at a reformulation of some recent contributions of Behavioral Finance in order to demonstrate that naturalism might lend paradigmatic force to its endeavor.

2 Naturalism, mark I: Approaching the limits of neuroeconomics

2.1 Economics with brains that evolved

There are two different interpretations of neuroeconomics: One is economics as applied on neuroscience, one is neuroscience as applied on economics. The link between the two is the common use of concepts and analytical tools mainly developed in economics and decision theory. It comes at a surprise that the former interpretation is often maintained by neuroscientists (as a representative, take Glimcher, 2003), the second by economists (as a representative, take Camerer, 2007).

This apparently strange combination occurs because in economics the use of neuroscience emerged out of experimental and behavioral economics, and thus was propelled by the ongoing research on anomalies of rational choice and on the specific behavioral patterns in strategic interaction (the former is surveyed in Camerer, 2003; for a seminal statement of the latter research tradition, see Thaler, 1994). Thus, neuroeconomics is part and parcel of what I have described as a naturalistic turn in terms of a switch to natural science style of experimental research and the physical move of economists from the armchair to the lab. It is driven by the availability of experimental methods of neuroscience which allow opening up the 'black box' of the brain and directly observing neurophysiological causation in human behavior. To summarize the foundations of human behavior as derived from this approach (following Camerer et al., 2005, or Park and Zak, 2007), we can safely state:

- The human brain is weakly modular, which means that there are functionally specific procedural patterns, which are not coordinated by a central agency but under special conditions.

- There is a fundamental interaction between cognitive and affective dimensions of brain activity, and in particular, the human capability to evaluate environmental states is rooted in emotions.
- There is a second fundamental interaction between processes which are reflected in consciousness, and those which are not.
- Human decisions are not the outcome of a unified and coherent decision calculus, but result from the interaction of different subsystems of the brain competing for behavioral control, sometimes reflected in conscious struggles over decisions.
- There are cortical areas which are designed to imagine the other, and to ascribe consciousness to others.

This state of the art in the brain sciences clearly poses a principled challenge at the standard notion of economic rationality, because this starts out from the notion of a ‘general purpose rationality’, which displays certain systemic features such as logical consistency, and which applies domain-independent. The view of the brain sciences receives strong support by evolutionary psychology, which can explain facts such as the modularization of the brain as the outcome of the evolutionary history of the human species (Tooby and Cosmides, 2005). Thus, there is the clear opportunity to relate behavioral economics and finance, neuroeconomics, and Darwinian Theory within an evolutionary approach to human decision making (for an earlier attempt, see Herrmann-Pillath, 1994; compare Elworthy’s (1993) notion of *Homo Biologicus*).

Based on these fundamental notions, it is relatively straightforward to explain many facts of experimental economics and Behavioral Finance in terms of results of the brain sciences, supported by the application of diagnostic and empirical methods of the latter. For example, we have neuroeconomic evidence for hyperbolic discounting, which implies that there is a bias to immediate gratification in human choice (McClure et al., 2007). This vindicated earlier theories about multiple selves competing for behavioral control (Elster, 1986; Ainslie, 1992). Strategic interaction is crucially determined by specific determinants of imagining the other and developing trust, which in turn depend on environmental triggers of certain hormonal reactions. There is clear neuroscientific evidence for specific weightings of probabilities (much discussed in the literature on anomalies, triggered by Kahneman’s contributions, summarized in Kahnemann, 2003). Or, reward mechanisms include money as an independent determinant of satisfaction. There are straightforward ways to relate these insights to empirical phenomena in money and finance, such as in the seminal study by Laibson (1997) on the implications of hyperbolic discounting on savings behavior and credit card uses.

This list of evidence is certainly biased, as it focuses on the deviations from standard conceptions of the economic model of rational choice. Therefore it needs emphasis that neuroeconomics also provides strong support for established conceptions of rationality, in particular Bayesian rationality. This evidence mainly relates to single behavioral mechanisms and is firmly founded in a broad range of biological applications of economics in general (a classic is Kagel et al. 1995). From this observation a crucial general insight emerges. Standard economic notions of optimization seem to apply on more simple, phylogenetically more uni-

versal mechanisms of behavior, whereas the behavior on the integrated level is determined by much more complex interactions of mechanisms, which cannot satisfactorily fit into the mould of the standard conception of Bayesian optimization (Ross, 2005: 250ff., 345ff.). This is why experimental economics has accumulated a long and impressive list of anomalies of rationality in human behavior. However, it is very important to note that this distinction is not directly related to consciousness, that is, various conscious choices may fit or may not fit to standard rationality, depending on context. Vice versa, there is no necessary connection between unconscious behavior and ‘irrational’ behavior. Quite the other way round, from an evolutionary perspective there are strong reasons to assume that precisely the easier, automatic decision procedures might have approached a state of optimality, whereas the more complex procedures might display a correspondingly complex dynamics which cannot be fit into the mould of rational optimization.

I now wish to raise the question whether or not this approach implies that human decision making might be eventually reduced to neuroscientific facts. This question might be perceived to build a strawman, as few economists would really adopt a fully reductionist approach. But still, neuroeconomics cannot simply leave the question in the dark, whether or not neuroeconomic research would suffice at some later time to explain economic behavior (thus finally substituting the standard utility theory), and if not, what else we will need. There is a strong argument against the relevance of neuroeconomics which has been presented by Gul and Pesendorfer (2005), the “case for mindless” economics. In principle, this is the argument that rationality is not a property of agents, but of economic systems, such that neuroeconomics commits a categorical confusion.

2.2 The essential incompleteness of human brains

The Gul and Pesendorfer argument concentrates on the equilibrium approach in economics and is close to standard ‘money pump’ arguments which state that irrational behavior cannot persist in a competitive market because it will open up arbitrage opportunities, such that eventually irrational agents will be driven out of the market. This argument is also well known from the finance context.

Following the thoughts presented in the first section, I do not pursue this argument further, because it relies on the standard economic methodology. Once it is accepted as the benchmark, the argument holds, in principle. However, it does not result into a causal theory, because it directly replicates the logical problems with the arbitrage argument of the corresponding notion of rationality which is treated as an equilibrium phenomenon. Therefore, I accept the fundamental point that rationality might be a systemic property, not a property of agents, but I open up another possible interpretation (for an early institutionalist argument in the same vein, see Frey and Eichenberger, 1989). This interpretation asks for the medium through which causal connectedness among brains can emerge at all, which might then underlie the emergence of systemic properties of cognition. I posit that this medium is language.

The main argument on this has already been presented by brain scientist Gary Edelman (1987) twenty years ago (for a recent statement of his views, see Edelman, 2006). Edelman

has developed a special neuroscientific model of the brain which he dubbed “neural darwinism” (for a summary, see Edelman and Tononi, 1995). This peculiar model does not affect the interpretation of neuroeconomic results, as it is operating on a more foundational level of brain research. Anyway, it fits the main conceptual building blocks of neuroeconomics that I identified above, in particular the notions of weak modularity and of competing processes for behavioral control. As an important footnote to intellectual history, it is remarkable that Edelman’s model is very close to Hayek’s (1952) model of the ‘Sensory Order’ which anticipated the fundamental modern paradigm of neuronal connectionism developed by Hebb (Steele, 2002), and which provides the epistemological pillar on which the Hayekian vision of economics rests.

One of the crucial questions of these approaches is how to explain the human capability of categorization by means of fluid and complex neuronal interactions. Note that categorization underlies all neuroeconomic experiments in the sense that behavior is matched to certain ‘definitions of the situation’, namely the categorization of current states and the elicitation of the appropriate behavioral patterns, which might in turn be reflected upon by means of higher level cognitive mechanisms of categorization. Categorization is the basic element in Edelman’s neuronal theory of learning (as well as Hayek’s). For example, in the context of finance categorization takes place when certain states of the markets and the implied prices of stocks are implicitly treated as ‘reference points’.

Now, Edelman (1987: 308ff.) argues that neuronal processes alone can never end up in an adaptively functional system of categorization because they remain solipsistic (basically, this is a neuroscience version of Wittgenstein’s famous argument against the possibility of a private language, see Candlish, 2007). The only way how categorization can become fixed in a neuronal system is via communication systems. Thus, Edelman arrives at an interactive model between genetic evolution and neuronal development in the sense that evolution supports the emergence of the capability of communicative information processing, which in turn provides the basis for the capacity of adaptively positive categorizations in neuronal systems. In case of the human species, this implies that the capacity for language, language and neuro-mechanisms should be inextricably related in an evolutionary process (for a more recent view on this, see Millikan, 2005). Thus, Edelman proposed an externalist approach to brain research in the sense that the neurofoundations of the cognitive capacities of humans can only be identified by means of analyzing systems of brains, not single brains. This precisely reflects the transition from the individual to the system in Gut and Pesendorfer’s argument against neuroeconomics.

2.3 Language and the unity of the brain

From the perspective of economic methodology, a similar conclusion has been reached by economists and philosopher Don Ross recently, mainly reflecting upon the results of neuroeconomics as summarized above.

Ross (2005) picks up threads of arguments that have been fore mostly developed by Daniel Dennett, who is presumably one of the most radical neurophilosophers. In the past four dec-

ades, Dennett has elaborated extensively on a naturalistic theory of mind, which explains consciousness as a result of complex and dynamic neuronal processes (in particular, Dennett 1991). His main target of criticism is the so-called Cartesian theatre, i.e. the belief that there is ‘someone’ (the ‘homunculus’) in the brain who actually perceives images, choices or memories, and proceeds with processing these to arrive at certain actions. In our context, this closely fits the standard ‘as if’ construction in economics, which assumes that choices are represented to a decision maker who selects the optimum. Instead of this, Dennett has proposed the ‘multiple drafts’ model of consciousness, which is very similar to Edelman’s conception of competing processes and mutual mappings in the brain. Another similarity with Edelman is the explanation of consciousness and the self as a ‘narrative’, which explicitly links up language with the continuous construction of identities. This role of language is theoretically founded in the concept of ‘memes’, which we do not need to investigate further here (see Dennett, 1995: Chapter 12; for a fully-fledged theory of meme-based communication among brains, see Aunger, 2002).

Against this background, the main point put forward by Ross is that language is the only way how the fragmented and fluid nature of the brain can be cast into the mould of a mind and self. He summarizes a great deal of psychological and economic literature to state that the only conclusion can be (Ross 2005: 186) that “people are politically complex societies of temporally located selves.” This ends up in radically deconstructing any idea of a coherent ‘individual’ for guiding analysis into behavior, in the sense of standard methodological individualism. But where does observed stability of agents come from, then (Ross, 2005: 286 ff., 351ff.)? It stems from the constraints on variability that emerge from the linguistic and social construction of selves in the course of the history of interactions among biological individuals, in the sense of the self being a narrative structure, out of which, among other phenomena, consciousness emerges (see also Ross, 2007). This construction can by no means be anchored in some autonomous rational design, but emerges from an evolutionary process, both on the biological and on the social level. Because of the widely diverging time frames on the different levels of evolution, evolution in the symbolic realm matters much more than biological evolution (for a general Darwinian framework, see Jablonka and Lamb, 2005). Thus, the very notion of an economic agent is fundamentally embedded into the phenomenon of language.

Ross’s argument fits precisely into the fundamental insights of the analysis of framing in behavioral economics. This is where the crucial linkage between language and neuroeconomics is moving to the center stage of analysis. For example, there is a clear triggering role of different linguistic representations of the same decision problems (viewed from the formal perspective and with regard to the outcome), as far as the relative balance between affects and cognition is concerned. In the famous Trolley Dilemma people will end up in different moral judgments, when the same outcome is related with different scenario involving direct or indirect action (in this case, sacrificing a human life for a number of others either by indirectly causing a physical mechanism that ends up with this result, or by directly killing the person) (see Cohen, 2005). A resounding proof of the prime importance of language for economic methodology is the increasing use of ‘vignettes’, i.e. fine-tuned linguistic representations of imagined social contexts and constellations of choice and judgment, as an empirical alternative to extensive surveys or experimental tests (e.g. when investigating into notions of fairness, see Konow, 2003, or on risk, as in the classical experiments by Kahnemann and Tversky, see Kahnemann, 2003).

The implications for Behavioral Finance are at hand. Behavioral Finance cannot be founded on neuroeconomics alone. There is the fundamental problem of the causal incompleteness and indeterminacy of brain processes. Neuroeconomics can only turn into a relevant foundation for Behavioral Finance if it starts to consider systems of brains, which are systems of communication mainly based on language (but also other symbolic media, such as body language on physical trading floors). Behavioral Finance needs a linguistic turn, precisely if it realizes a naturalistic turn.

2.4 Implications for the theory of finance

The significance of this methodological step becomes evident if we consider the standard foundation of Behavioral Finance in psychology. Psychology consists of systematizations of empirical regularities in human behavior, such as in prospect theory, which states a relation between reference points and asymmetric valuations of losses and gains. This corresponds to the neuroeconomic perspective as those regularities are seen as being rooted in individual behavior. The linguistic turn implies that research needs to concentrate on the way how frames, reference points, and other forms of categorization emerge from the communicative interaction among agents. Cases in point are the central categories in finance theory, namely the constructs of expectations and risk. Pure theory treats these as mathematical entities, whereas a linguistic approach would ask for the specific symbolic frames of expectations and risks that underlie the cognitive processes on capital markets. These frames are the medium of distributed cognition. Psychology and the underlying neurophysiological mechanisms can only explain the link between frames and actions, but do not suffice to explain the action alone.

A good example for this research perspective is Ehrig and Kauffman's (2007) analysis of framing in the work of analysts, which result into risk assessments. They are especially evident in the case of newly emerging business models, when analysts need to sort them into established categories in order to make them comparable. Thus, when Amazon entered the market, it made a substantial difference for risk assessments whether it was treated as a book-seller or a dot.com company. This role of frames for defining industries and classifying companies is well known from organizational demography (see Carroll and Hannan, 2000), but seems so far neglected in finance.

Interestingly, this approach is directly relevant also for the pure theory of finance and the way how it deals with the results of Behavioral Finance. The starting point is the fact that the two pivotal theoretical propositions in the pure theory of finance, the CAPM and the efficient market hypothesis, cannot be tested independently from each other (Fama, 1991). In order to check for abnormal returns, the CAPM establishes the benchmark for the normal returns and allows deducing estimates for expectations. On the other hand, the CAPM refers to the notion of a 'market portfolio' which requires a statistical delimitation of the relevant market. Theoretically, this is the portfolio of all risky assets, thus including assets far beyond the scope of the capital market in the narrow meaning. At the same time, however, it is the very notion of market efficiency in the sense of fungibility in arbitrage that determines the scope of that theoretical portfolio. This peculiar constellation between the two theories means that the modern theory of finance is a manifestation of the Duhem-Quine thesis in the philosophy of sci-

ence, that is, there is no way to empirically refute single elements of the theories, but only an 'either-or' of complete rejection or complete renunciation.

Precisely this interaction between theory and observational language (which is nothing special in advanced scientific theories, see Stegmüller, 1986) points towards the role of language as a neglected category in the theory of finance. This is because the degrees of freedom in the theory allow for an essential role of the cognitive construction of the markets, and in particular, the endogenous function of finance theory in this construction. Language is essentially involved in the ways how markets are constructed and risks are categorized and perceived. This includes scientific categorizations, such as in the case of the alternative assumptions about the underlying statistical distributions (normal distribution versus Levy, for example). Thus, Fama and French have shown in a seminal series of articles (e.g. Fama and French 1993) that standard anomalies of Behavioral Finance such as the impact of book-market values and size on returns could be explained as a compensation for 'distress risk', thus actually fitting into the established model.

The Fama and French argument is intriguing because it raises the question how far the conceptualizations of risk in the theory are reflected in the conceptualizations of risk that are involved in the practices of the finance industry, and to which extent these conceptualizations need to converge in order to lend empirical validity to the theory. This clearly was the case in the first decades of the CAPM, when precisely the diffusion of the CAPM and the fixation of traders' behavior on the betas contributed to a better fit between model and reality (in detail, MacKenzie 2006). But the same argument applies for the Fama and French approach. All categories used in the empirical tests can be also the conceptualizations of risk that guide the behavior of agents on the financial markets. If that were true, we end up in reconciliation between Behavioral Finance and pure theory. The market risk is only secondary to the framing of conceptions of risk. As Statman (1999) has it, this implies that 'market efficiency' in the sense of the theoretical rationality criterion is either false or futile, whereas the proposition that nobody can beat the market still holds.

However, such kind of direct convergence between theoretical categorizations and factual framing does not seem to be a necessary condition. The case in point is the resilience of technical analysis in the practices of the financial business. Technical analysis projects an entirely different linguistic scheme on the interpretation of market data than mainstream finance theory. As Menkhoff and Taylor (2007) have shown recently for the case of forex markets, it is extremely difficult to prove that technical analysis is wrong in the sense that forex traders using technical analysis rely on a wrong theory that would show up as 'irrational' behavior in terms of the pure theory. That means, there is the possibility that a wrong theory might guide the right decisions. This observation highlights the need to investigate into the specific communicative means and symbolic representations that actually underlie the abstract notion of information processing on markets. This amounts to a causal analysis of financial markets, as compared to the theoretical concept of arbitrage. Thus, a reconciliation of Behavioral Finance and the pure theory is possible if both are embedded into a causal model that rests upon language. This methodological difference leads us to the second interpretation of naturalism.

3 Naturalism, mark II: The naturalistic approach to causation in human behavior and interaction

3.1 Towards a unified conception of causality in the sciences, the social sciences, and the humanities

It can be fairly stated that, conventionally, language analysis and naturalism would seem to be methodological antipodes. That might not be true for the explanation of the human capacity for language, but certainly for specific functions and uses of language, which rely on central aspects of language such as meaning and reference. Understanding a poem seems to be a far cry from naturalism. We have already mentioned in the initial section, that this is the main reason why a linguistic turn is avoided in economics. Economists feel deep suspicions about the application of hermeneutic methods, which seem to lead into the trap of analytic arbitrariness and relativism.

However, this attitude is not warranted, as there are naturalistic approaches to language based on the claim that naturalism has to be fore mostly understood as a particular methodological stance (in language theory, this has culminated in the so-called ‘teleosemantic’ approach, see Macdonald and Papineau, 2006). This is to adopt a view of explanation and causality that follows the natural sciences.

To get this point clear, it is of utmost importance to distinguish between models of explanations and reductionism. Naturalism mark II does not imply reductionism, but does imply that there are universal patterns of scientific explanation that apply for both the natural and the social sciences or the humanities. These happened to emerge mainly in the natural sciences, but this does not mean that the theories generated in their domain become the exclusive means of explanation.

One approach to naturalism in this sense has been proposed by Bhaskar’s (1987) version of ‘transcendental realism’. Bhaskar argues that the main difference between the natural and the social sciences does not lie in the methodology, but in that the former mainly refers to closed systems and the latter to open systems. The core concept unifying both domains is causality. Resembling approaches to causality developed by philosophers such as Nancy Cartwright (1989), Bhaskar (1987: 18ff.) argues that the notion of a ‘causal power’ is central to any scientific explanation. This notion is an ontological one, which means that analyzing causality ends up with the identification of structures of reality that generate the observed phenomena (for example, a frame can be such a structure with causal power). These structures enrich ontology in the sense of the identification of elements of reality that are not directly observable. Thus, the social sciences identify ‘real things’ in explaining social phenomena, just as the physicists discover elementary particles. What are these things?

Mantzavinos (2006) (without referring to Bhaskar) has recently developed a more detailed, related view that explicitly deals with the core concept that might stand in the way of a naturalistic approach to the social sciences, namely hermeneutics. His argument is that every supposedly hermeneutical analysis can be reformulated according to the basic model of the sciences, the hypothetico-deductive model. His approach is as follows.

Mantzavinos argues that every nexus of meaning can be transformed into a causal nexus if invariance can be identified across different nexi which are related to same referents, such as the same persons. The invariance attains the methodological status of a law-like statement, such that the hypothetico-deductive pattern of explanation applies. For example, in using the expressions of a language we can identify invariants in terms of certain mental states which are intentions to express a certain meaning. A linguistic law-like statement can be constructed if invariant intentions under similar circumstances have always led to the same utterance. In this case, the intentions assume the role of causes, so that there is no need to refer to a special category of actions supposedly transcending causality (needless to say, there is a plethora of deep philosophical issues behind this use of the concept of intentions, for a survey, see Jacob, 2003).

Bhaskar would reject this reference to the hypothetico-deductive model, as he argues that there are no time-invariant regularities in open systems (Bhaskar, 1987: 128ff.), but apart from this the basic point is the same: The hermeneutic approach is superseded by a causal explanation which refers to structural determinants such as intentions. This is precisely the same point as has been made by Bhaskar (1987: 90ff.) regarding reasons as causes. Bhaskar has a very simple, almost naïve, yet convincing argument here (again, I should be fair in noting that there are tough philosophical quarrels over the issue of mental causation, see Robb/Heil, 2005): How can it be that a linguistic utterance of *A* leads to an action of *B*? The only way is to assume that the utterance causes a change in *B*'s state of mind, which then causes the action. In *B*'s linguistic reflection, the utterance may be regarded as a 'reason' in the teleological sense, but in fact the reason becomes only effective because it ultimately refers to a state of mind. Thus, a 'reason' is just a linguistic representation of the real causal processes in which symbolic patterns attain the role of causes mediated through mental states.

It is interesting to note that from this perspective the standard conception of rational choice in economics does not count as a causal explanation, but merely a rational reconstruction of action (Mantzavinos, 2006: 97ff.). This is because the utility function cannot be stated as invariance, i.e. the maximization hypothesis remains a tautological statement. In this sense, standard economics is hermeneutics in disguise of mathematics. This is precisely why the move to neuroeconomics may attain a foundational status in economics, because only neuroeconomics can turn even the standard approach into an explanation following the hypothetico-deductive method, with the mental states qua states of the brain becoming observable invariants, such that causal analysis can apply.

3.2 Gestalt theory and emotions as framed affects

How can we apply these arguments on the main result of the previous section, namely that neuroeconomics needs to be necessarily supplemented by the analysis of language? The simple point is that neuronal processes are only a necessary, but not a sufficient condition for eliciting a behavior. A clear proof of this is the lack of an unequivocal neuronal determinism, i.e. the mapping between behavior and the brain is flexible and multivalued. The sufficient condition is the causal connection between symbolic representations and a neuronal process. For example, symbolic representations may be conceived as higher level constraints on neu-

ronal activity which result from activating stable structural patterns of neuronal interaction (for a related view, see Calvin, 1998). However, this explanation would only end up in a 'solipsistic' model again in the sense of Edelman's, if we did not accept language to be an emergent level of independent causal power, which cannot be entirely reduced to a neuronal fact. After all, what arrives at receiver *B*'s brain is not a neuronal impulse, but an utterance transmitted via sound waves (compare Aunger, 2002). In other words, any attempt at reducing language to pure neuronal phenomena will drive the model into the trap of infinite regress (on this, see already Hayek, 1952: Chapter 8). Thus, language is considered as supervening on neuronal processes. This is precisely to accept meanings as causes.

One way to understand these causal forces in economics has been shown by Kubon-Gilke (1997) and Schlicht (1998) who introduced Gestalt theory into the analysis of institutions. Gestalt theory is a psychological approach that assigns specific causal mechanisms to cognition that root in certain tendencies to complement imperfect perceptions and conceptual constructs. It starts off with the assumption of a fundamental correspondence between the brain and cognitive processes and posits that the brain generates regularities from sensory inputs, based on certain fundamental rules or cognitive laws, which all relate to the principle of *Prägnanz* (translated by Schlicht as "clarity", by other authors as "conciseness"). *Prägnanz* means that there are different mechanisms by which the mind completes incomplete sensory inputs to coherent and meaningful wholes. In particular, cognition tends to build collectives from single observations. For example, the "Law of Proximity" implies that individuals tend to see things that are spatially close as totalities, or the "Law of Continuity" implies that cognition tends to extrapolate movements etc.

The Gestalt theoretic approach complements the linguistic turn because it provides a conceptual bridge between the notion of symbolic representations and brain processes. The relation between a symbolic representation and its referent is always fuzzy and leaves many possibilities of interpretation open. Perception provides hints at completing those fragmented and fuzzy relations into categories that ultimately impose patterns of perception on the brain that do not directly reflect 'reality'. The most famous examples for this are the cognitive biases in visual perception, in which incomplete pictures are complemented automatically by the brain, switching between different interpretations, depending on the context into which the fragments are put. Thus, symbolic representations obtain causal power on actions, mediated via brain processes which reflect the workings of fundamental Gestalt theoretic laws.

Clearly, Schlicht's notion of Gestalt is akin to the concept of frame, which implies that Gestalt theory can undergird the economic approach to framing with a theory about causation. This is particularly important for integrating another important concept in neuroeconomics, namely the role of affects and emotions. As I have mentioned in the previous section, brain research clearly shows that all human decisions are based on an interaction between a cognitive and an affectual subsystem. Further, following Damasio's (1995) seminal contributions, the crucial input to decisions, namely valuation, is based on affects ('emotional markers'). Now, Tooby and Cosmides (2005), in their systematic approach to evolutionary psychology, argue that emotions are the unifying mechanisms in the modularized human brain. That means they establish a bridge between the effectual and the cognitive modes of the brain, because emotions can be defined as 'framed affects'. Affects can be classified into human universals such as lust or hunger. Emotions establish a relation between those affects and action

contexts that are categorized cognitively. Thus, sadness is a universal human affect, but its expression differs across cultures and is related with certain contexts, in which everybody expects sadness to occur.

From this follows that Gestalt theory is central for economic analysis for two reasons. Firstly, Gestalt theory identifies a special form of categorization based on induction, which follows the laws of *Prägnanz*. It can provide a causal analytics for the explanation of the cognitive processing of economic data, especially in uncertain environments, where sensory inputs are fragmented and chaotic. This is an alternative to axiomatically based theories of risk. Secondly, Gestalt theory may provide a more detailed view on the dynamics of the interaction between cognitive and effectual modes of the brain, which translates into the empirical strategy to analyze the role of emotions in economic behavior. We can even submit the strong proposition that causation in economics depends crucially on emotions as causal intermediaries.

3.3 Implications for the theory of finance

Emotional factors are frequently alluded to in popular comments on the financial markets, such as when invoking ‘greed’ as a cause of the recent crisis. The approach sketched above allows for a more differentiated view on emotions. I give two examples.

The question what role money actually plays in the economy has been rarely investigated empirically by economists, in the sense of its causal effects. This is because money has been excluded from the list of goods that carry utility and assigned to the role of a mere medium of exchange. However, in recent brain research it could be proven that money is a primary reinforcer, comparable in its neurophysiological effects with stimuli such as food and sex (for a brief report, see Camerer et al., 2005: 35f; for a broader biological, psychological and sociological perspective, see Lea and Webley, 2005). Thus, money appears to be related with fundamental effectual structures in the human brain. However, this clearly does not directly allow for the identification of ‘money’, as money is not a simple given, such as the nutrients of food, but is a pure social construct. In this regard, behavioral economics research could show that money is simply cash, in the sense that other forms of money, such as substitutes in the shape of frequent-traveler miles, are treated differently. Interestingly, these results can explain an important insight by research into Behavioral Finance, namely that investors treat capital gains differently from cash gains, i.e. dividend payments. In the context of applications of prospect theory, it has been shown that cash payments move reference points, whereas capital gains leave them unaffected. If money is a primary reinforcer, this result is entirely plausible. Thus, a common conceptual tool in Behavioral Finance, mental accounts, can be directly related with neuroeconomic phenomena, while being a case of framing at the same time.

Another topic in Behavioral Finance, which has also received strong attention in anthropological research on financial markets, is the role of direct physical communication among traders, and in this context also the gender dimension in the finance business. Regarding the latter, Barber and Odean (2001) have produced evidence that male investors show a higher level of overconfidence than female investors, which they explain by an evolutionary psy-

chology argument on the neurophysiological differentiation between the sexes during human phylogeny. Needless to say, that this argument faces considerable criticism by sociological theories about gender versus sex. However, the sociological perspective might even lend further support to the general thrust of the argument presented by Barber and Odean, because there is ample evidence that the practice of the business of finance is highly loaded by gendered linguistic performances and by habits of male groups. For example, the vernacular of financial traders is marked by sexist expressions, which give a sexual meaning to trading prowess and success (for examples and analysis, see Hassoun, 2005). Thus, overconfidence might be explained as the result of an interaction between neurophysiological dispositions and symbolic representations in the social context.

Indeed, the highly abstract approach of the modern theory of finance simply distorts our view of the actual process of trading in financial markets. As recent anthropological research has shown, the gender dimension of financial markets should not simply be viewed in terms of political concerns about gender discrimination, but actually touches on more fundamental aspects of human social organization. The neutralized notion of risk in the pure theory blocks the view on the fact that trading is a highly intensive emotional experience, and that risk taking is a process that encompasses the entire spectrum of bodily experiences, especially in trading pits where traders gather collectively (Zaloom, 2004). In these contexts, the abstract notion of information processing on markets corresponds to a dense and intensive interaction among physically close, mostly male individuals, who have to use all means to signal their engagement of risk taking, and who have to decode emotional signals sent by others. Tacit knowledge accumulated in long years of trading experience is crucial for managing the inextricable interplay between emotions and cognition.

Clearly, there is a technologically induced change of the context of trading, often explicitly linked to the expectation that the seemingly ‘irrational’ aspects of trading might be substituted by the neutral automaticism of computer programs. Yet, this does not necessarily imply that emotions cannot be processed electronically. Knorr-Cetina and Bruegger (2002) have produced much evidence that even in the most ideal-typical market, the global forex market, actual transactions are embedded into what they call ‘global microstructures’. In these microstructures emotional markers are communicated with great speed and efficiency via computer communication, without any spatial contiguity. The screen becomes a central stage for the display and signaling of emotions, and seems to be an excellent example for the externalization of brain processes, which, in terms of Knorr Cetina’s and Bruegger’s sociological approach, are treated as intense forms of intersubjectivity.

One can even argue the other way round, namely that it is the markets themselves which recurrently reconstitute the role of emotions, albeit in a new symbolic frame (following Frank, 1988). This is because actual trading activity can lock up traders in situations of strategic interaction, which formally corresponds to the chain-store paradox and related games where ‘irrational’ aggression might deter other agents, such that in the end the ‘irrational’ strategy turns out to be the more successful one. For example, DeLong et al. (1991) argue that overconfident traders, who act aggressively, might end up with bearing more risk and hence, with higher expected returns. In fact, in the social organization of trading pits there is a clear status hierarchy of traders, which reflects their relative trading volumes (their ‘sizes’, with sexual connotation) and past success. Such kind of emotional signaling does not depend on physical

presence, but can be reconstructed in the electronic trading places, where groups of traders develop identities and forge strategies against each others, such as in the competitive relations between traders at different financial centers (Zaloom, 2003).

Statman (1999) confronts the “rational-utilitarian” approach of the pure theory of finance with the “value-expressive” approach of Behavioral Finance. I think that this distinction neatly fits into my naturalistic reconstruction. To complete this, we need to turn to naturalism, mark III, which allows putting Statman’s notion of “value-expressive” action into a broader philosophical context.

4 Naturalism, mark III: Language and social ontology

4.1 Social ontology

Our argument now closes a circle. How can we interpret the fact that in different cultures, even as simple forms of social interaction as the ultimatum games are played in a significantly different fashion (Henrich, 2000; Bowles, 2004: 114ff.)? The only way is to introduce frames, that is, the same game structure is given a different meaning in different cultures (Gintis, 2006). Following the methodological stance developed in the previous section, this implies that the frame is assigned causal power in the explanation. The frame establishes the invariance needed to turn the rational choice model of game theory into an empirically meaningful theory.

John Searle (1995; 2004a) has developed a naturalistic approach to language and social interaction which extends this point to the notion of a social ontology (I should fairly note that there is a considerable tension between Searle’s notion of naturalism and “antianthropocentric” versions, which have so far dominated my argument, see Ross, 2005: 18ff.). The crucial conceptual device is the distinction between observer-independent and observer-relative facts. For example, a physical phenomenon like a rock exists independently of an observer, whereas money as an institution exists only with reference to an observer. This is the same as stating that money has a meaning, and only exists by that meaning, whereas the rock is a rock independent of a possible assignment of meaning by an observer. Still, both money and the rock cause something in the context of processes. They are facts of reality. This distinction is very useful to systematize research in neuroeconomics and behavioral economics. Neuronal processes are observer-independent facts; frames are observer-relative facts. Applied neuroeconomics would explain observed behavior as the *conjunction of observer-independent and observer-relative causes*.

The relevance of this conceptual distinction becomes evident when we consider Searle’s explanation of a social institution. Institutions are complex phenomena, and in the context of this paper we do not need to proceed in a comprehensive fashion. The core notion is the formula “*X counts as Y in context C*”. Searle argues that institutions ultimately rest on chains of transfers of meanings that follow this formula. For example, fiat money can be created by stating the pertinent “count as” relation. However, this certainly is not sufficient to establish

the institution of money. Ultimately, this institution goes back to some fundamental physical relations between agents, such as in the punishments against counterfeiters. The “count as” formula is infinitely productive, because it can always be applied on itself.

The “count as” formula is essentially dependent on language, because it is a transfer of meaning through the manipulation of symbols. Its activation happens through collective intentionality, which is in turn a linguistically mediated phenomenon. An institution is based on a “count as” relation that is valid for *us*, and not only for *me*. This “us” (see below) is only constituted by linguistic reference to the collective. Behind this relation, there is a set of what Searle calls “deontic powers”. Language is a major vehicle to express and activate deontic powers, and at the same time it depends on deontic powers (Searle, 2006). One of the most fundamental aspects are certain rules of speaking, such as that normally we assume that somebody means what he/she says. Meanings are also obligations in the sense that everybody normally expects that I adhere to a meaning commonly agreed upon. Based on this, language enables me, for example, to express commitments in a collective, such as making promises. As Demichelis and Weibull (2008) have shown recently, this functioning of language can change many established propositions in economics, especially in the context of game theory, which up to now tended to neutralize language as ‘cheap talk’ (Farrell and Rabin, 1996).

There would be much more to say, of course, on Searle’s approach (for a concise summary directed at economists, see Searle, 2005). But in the current context, we are only interested in the narrow issue, how can we relate the Searle approach to economics, in particular including the neuroeconomic dimension? Firstly, Searle adheres to a non-reductionist naturalist theory of mind. In this regard, there is a clear antagonism to Dennett, which is most evident in the “Chinese room” thought experiment, in which Searle attempts at demonstrating that neuronal connectionism cannot be a model for both brain-mind monism or Artificial Intelligence (in the strong version), which Dennett claims to be possible (for a survey on this, see Cole, 2004). In my treatment of the issue, this echoes Edelman’s argument that neuronal processes remain incomplete in explaining information processing in the brain. That means neuroeconomics without an explicit analysis of meaning remains an incomplete endeavor. Secondly, Searle gives a very straightforward account of consciousness, which in turn has to play a central role in any economic conception of an agent. This is that consciousness is an observer-relative fact. As a fact, consciousness can be a cause of action.

From this viewpoint, it is easy to deal with the cultural frames in the aforementioned experiments with ultimatum games. Economists normally assume that rational actors perceive the structure of a game and in particular, the pay-offs, in the same way. This is wrong, as a game is an institution, and thus it always has to be seen as being a part of a “count as” relation. Thus, “sharing” is a word which can have very different meanings, dependent on its use in different institutional settings and ways of life. A game is always a language game (in the sense of Wittgenstein’s, 1958; compare a similar view in Ross, 2005: Chapter 7). This necessarily translates into the behavior in ultimatum games, which “count as” something different in different cultures, such that the meaning of “sharing” is simply not the same. The game and the pay-offs are observer-dependent facts, which in turn are dependent on the use of a particular language.

Thus, Searle provides another element of a causal theory of economic behavior that fits the Gestalt theoretic argument of the previous section, but concentrates on the level of the symbolic representations exclusively. This implies that a crucial analytical category in economics should be collective intentionality, as opposed to the methodological individualism that so far reigns supreme.

4.2 Identity economics and the role of groups in social coordination

The Searle approach lends a powerful conceptual framework to the naturalist interpretation of many foundational issues in economics. I give two examples. The first is the recent efforts to establish an ‘economics of identity’; the other is the role of ‘team preferences’. In both regards, collective intentionality looms large.

As we have seen, neuroeconomics clearly supports the idea that the individual cannot be modeled as a monolithic calculus of decision (even when referring to isolated decisions), but as a fragmented system of competing, balancing or conflicting forces, triggered by contextual factors. This raises the question how the coherence of behavior is constituted at all that we certainly observe in reality. In economics, the solution lies in the concept of identity that has been recently introduced into standard utility theory by Akerlof and Kranton (2000; 2005). However, in the Akerlof and Kranton approach identity is just treated as a given in a modified utility function, adding the important aspect that identity causes externalities between actions of different agents (for example, if I have a group identity, and others start to behave differently, they cause a negative externality on my identity). But how can we explain identity as such?

I propose that identity is an emerging pattern on the language side of brain processes which operates as a higher-level restriction on the variability and indeterminacy of neuronal processes (following Ross, 2007; this is akin to Davis’, 2003, emphasis on the social embeddedness of identity). This idea has already been adumbrated by Ainslie’s (1992: Chapter 5) psychological analysis of hyperbolic preferences (such as in the context of personal rules; there is a close affinity to personal construct theory in psychology, which also has received some attention by economists, see Earl, 1990). In other words, identity works as a precommitment device to solve conflicts among diverging forces of motivation (ultimately explained as competing neuronal patterns), which is mediated via the symbolic representation of a self-image. This image is continuously negotiated in communicative acts among people. For example, my emotional attachment to the identity as a ‘man’ is continuously reinforced by the processing of symbols in advertisements, and by communicating with other males and females. In this way, neuronal processes in the brain are inextricably linked up with a symbolic environment, coalescing in certain states of mind which make up my identity. Even if I wished to change my identity, that would require to change all the symbolic connections in which my identity is embedded, which is a difficult feat, because the meaning of the symbols is only marginally determined by myself, but by the understanding that prevails in a community of users of those symbols (dubbed ‘externalities’ by Akerlof and Kranton: If I change my identity, this also affects the others’ identity).

This implies that many of my actions are based on what ‘we’ want in a particular situation, and not simply what ‘I’ want. Many if not all decisions flow out from the identity of an agent, which is in turn a social category. As Davis (2007) has argued, this does not simply mean to reduce identity to social identity, because fundamental valuations of different possible social identities must be rooted in personal identity, which is related to the aforementioned ‘narratives of the self’, i.e. the history specific to an individual. That is, collective intentionality can be neither reduced to the individual nor to group level, but is precisely an interactive phenomenon. Such a notion of identity is directly relevant for finance studies, as it draws attention to the specific nature of the agents on financial markets, beyond the mere construct of ‘rational agent’. For example, the ‘investor’ is in fact a specific sort of identity, with deep ramifications in culture and social context (Preda, 2005).

Identities are directly related to human groups and find expression in the possibility of so-called ‘team preferences’. Team preferences have been proposed in different contexts to solve dilemmas of rational coordination among economic agents (e.g. Hollis, 1998). A very simple and straightforward device to explain transitions from egoistic to altruistic or collectively-minded behavior is the transition from the linguistic form ‘I’ to ‘We’, i.e. the constitution of collective intentionality à la Searle. This shift can be caused both by me and by the others. Uttering ‘we’ is inclusive, and might be related to the reinforcement of identities that I discussed in the previous paragraph. This does by no means imply that there is now a collective agent ‘existing’. In this sense, the ontological commitment to methodological individualism seems to be vindicated. But at the same time, the collective can be seen as supervening on individual states of mind that are triggered by the linguistic expression ‘we’ (for an extensive analysis of this, see Tuomela, 1995). This is precisely the notion developed by Sugden (2000) in a stringent economic approach. Sugden shows that team preferences do not eschew the analytical reliance on individual agency, but at the same time substantially modify the standard approach to rational choice. This is a model of ‘team-directed reasoning’ establishing actions as members of teams, and hence being directed at goals of teams. Thinking in teams and thinking in individuals depends on the framing of the decision problem. As we have seen, frames ultimately root in linguistic representations of the relevant situation. For example, joining a football team implies that I put myself into another decision context, which coalesces around the notion of the “we” of the team.

This transition is backed by particular emotions, as we have discussed in the previous section. Joining the football team triggers a manifold of emotional and cognitive mechanisms which steer my decision making, effort and judgment when playing the game. The core issue is how we can explain that out of a complex and fluid interaction of neuronal processes ordered patterns of behavior emerge. This is only possible via the causal loops that connect different brains through communication. Out of this, phenomena such as the identity of an actor emerge. In this sense, the Akerlof and Kranton approach falls into the trap of the ‘homunculus’ fallacy in assuming that identity can be the object of maximization – by whom? Identity is constitutive of the agent. It cannot be a part of a utility function, because the specific form of the utility function depends on the identity, such as in the case of the switch towards team preferences. Thus, the notion of identity implies a fundamental paradigmatic shift in the theory of decisions.

4.3 Implications for the theory of finance

The concept of identities is immediately relevant for Behavioral Finance, as there much evidence for an impact of identities on the market performance. It provides the perspective on the agent in Statman's (1999) notion of 'value-expressive' action, because value-expressive action confirms and signals the identity of the agent. It is the historical sequence of value-expressive acts which constitute the agent, which therefore cannot be taken as being given exogenously, as in the theory of rational choice.

For example, identities of individual and institutional investors are vastly different, and market valuations depend on identities of corporations. Several anomalies in finance theory are related to identities, such as the home market effect, which implies that the assignment of investors to particular countries impacts on their investment behavior, or the conscious social framing of investment decisions by means of mental accounts or collective actions such as joining an investor's club. Following Searle's approach, all these phenomena are constitutive for individual decisions by means of embedding these decisions in patterns of collective intentionality. For the observer, this translates into the notion of the normative and institutional structuring of behavior on the financial markets, beyond the mere rational optimization calculus.

An important issue is the question what makes financial markets work at all, which is related to one of the fundamental 'anomalies' in finance, namely the large volume of transactions taking place, which contradicts criteria of market efficiency. The pure theory of finance does not make the social structure of trading explicit. Interestingly, in Knorr-Cetina and Bruegger's (2002) work it was proposed that even the almost 'perfect' global forex markets manifest a social microstructure with global reach that is mediated via information technology. They argue that the continuous flow of deals is supported by a social network among traders which is driven by conversations, in which reciprocal exchange of information is mediated. Further, they show that markets require a special form of limited altruism, which is institutionally reflected in the role of 'market makers', but is also present in the actions of other traders. This means that traders sometimes act against their short-term financial interest in order to maintain the market, i.e. provide the market with liquidity. Such behavior can be supported by reciprocal transactions among trader dyads, which allow for sanctions in case of violations of reciprocity. Thus, traders develop an identity as a group, which relates with the global market as a social institution, and they manifest team preferences, beyond their basic profit motivation. In illuminating case study for this role of group identity is the creation of new markets, which requires the creation of collective intentionality as a public good in the first stage, until sufficient liquidity is provided (see MacKenzie, 2006, on the creation of the first forex option market in Chicago). Group identity also plays a crucial role in maintaining the information flows between traders, which are governed by reciprocal altruism and run alongside the profit-maximizing market transactions.

This sort of altruism is fundamental to understand the phenomenon of 'trust' in financial markets. Trust, though obviously essential for exchange, cannot be explained by the standard model of rational decision making (Nooteboom, 2002). In the standard approach of finance theory, trust is mainly seen as a macro-economic variable, with no microfoundation. The concept of global microstructures establishes such a linkage, while eschewing standard rational

choice. Granted, once this level of analysis is introduced, the entire gamut of game theoretic approaches to cooperation and enforcement comes into play which offers many explanations of the possibility of cooperation among self-interested players. In principle, the argument would run in that way that in small groups with longer time horizons, cooperation becomes possible. But this argument does not question the essential fact that cooperation among non-anonymous agents is a necessary condition even for financial markets to work.

It is important to notice that this does not necessarily imply that the agents really know each other. With the intervening variable of identity, even unknown individuals might obtain identities which make them 'familiar', such that group-related mechanisms supporting cooperation may be triggered into operation. For example, traders at different financial centers have group identities, which are related with particular reputations (Zaloom, 2004).

In sum, naturalism mark III guides research into the direction to ask for the creation of a social ontology of financial markets, in the sense of asking for the specific deontic powers involved in the linguistic categories that structure the perception and the actions of agents. Here, naturalism clearly transcends neuroeconomics and turns into a sociology of financial markets, that is informed by insights of evolutionary psychology and biology (for a related approach, see Seabright, 2004).

5 Conclusion: The broader picture and the research agenda for finance studies

I have tried to show that the naturalist turn in economics will only be completed if it is accompanied by a linguistic turn. This linguistic turn is conceived as being naturalist, too, in the sense that linguistic phenomena become a part of causal explanations of observed phenomena. This does not imply reductionism, because the analysis of specific uses of language requires the application of specific methods. There is no feasible way to reconstruct the meaning of the symbols by reference to mere neuronal facts. They are causally related with neuronal facts only through being meaningful. On the other hand, neuroeconomic research might show that some symbols are linked up with certain neuronal or even hormonal patterns and others are not. This methodological position can be tagged with the label of 'emergentist psychoneural monism' (see Bunge, 1979). To my mind, this is most appropriate for economics.

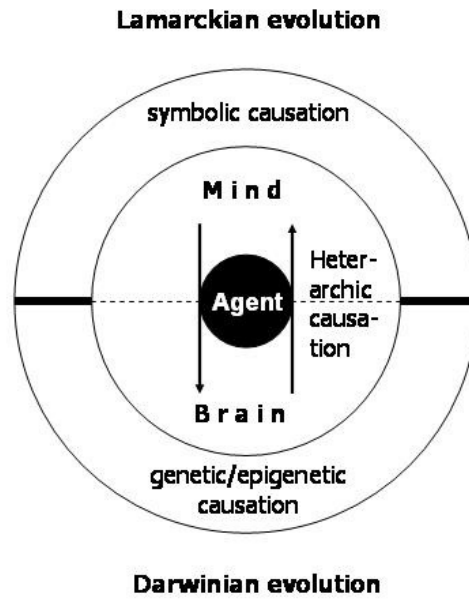


Fig. 1: The structure of the naturalistic paradigm

Thus understood, economic naturalism is embedded into a larger naturalistic paradigm which builds on evolutionary theory (Witt, 2003: Chapter 1). The main principles are illustrated in fig. 1. Within the naturalistic framework we distinguish two fundamentally different, yet interacting evolutionary processes, namely Lamarckian evolution that takes place in human culture and symbolic systems, and Darwinian evolution, that operates on the genetic base (for a related approach in biology, see Jablonka and Lamb, 2005). Though interacting, the two are autonomous (indicated by the thick bars between the two outer circles). There are competing claims about how these two evolutionary processes actually work, such as with reference to the relative role of epigenetic mechanisms or the modeling of cultural evolution by memes. But these differences are all discussed within the broader framework of naturalism, so they do not affect the argument in this paper.

In this view, human mind emerges from the interaction of these two evolutionary processes, which implies that it cannot be treated as an individual entity in the sense of methodological individualism. Emergent psychoneural monism posits that the borderline of the processes becomes blurred here, because human behavior or, generally speaking, the human phenotype, is a vehicle for both. This translates into the interaction of two essentially different kinds of causation, namely symbolic and genetic/epigenetic. Mind and brain are two sides of the same coin, but this is only a static perspective. Dynamically, we deal with a case of ‘downward causation’ (Campbell, 1974), which is the condition for establishing the co-evolution of human culture and biology (which might be better dubbed ‘heterarchic causation’ because it works both ways). Causation operates via two opposing movements, with language emerging

from biological processes, and at the same time language operating as a constraint on a subset of biological processes, namely neuronal phenomena.

This is the general setting for the development of a paradigm for economics that can, in the longer run, substitute for the standard paradigm of rationality and equilibrium. For the field of finance, this approach would end up in the following research agenda.

1. The existing insights of Behavioral Finance need to be grounded in an evolutionary explanatory framework. This framework consists of functional analysis (i.e. proximate causes), mainly along the lines of neuroeconomics plus psychology, and of evolutionary analysis (i.e. ultimate causes), which provides an explanation of the behavioral patterns by reference to human phylogeny. Evolutionary psychology appears to be most appropriate inter-disciplinary counterpart.
2. This approach is non-reductionist in the sense that finance research has to make the causal processes on markets explicit, which boils down to the analysis of the interactions and communication between agents, or, systems of brains. This implies that the evolutionary explanation of functional characteristics of human behavior has to be enlarged by the evolutionary analysis of language and symbolic systems that are complementary to the coordination mechanism of prices and quantities. An essential dimension is the role of emotions in decisions and interactive behavioral patterns. Given the strong attention paid to the “rational” side of finance in the past, emotions should turn into the center of attention from now on.
3. The analysis of language needs to be related with the analysis of social networks that underlie the flow of market transactions. The notion of social network follows the approach of actor-network theory, that is, explicitly includes the role of technologies and other media of communication / interaction into its scope. A central concern is the construction of knowledge in financial markets, that is, to make the ‘socio-physical’ causation in information processing explicit. This also relates to research into market infrastructure, in the sense of which concepts, things and patterns of action concur in the emergence of financial markets.
4. This approach does not mean that mathematical modeling becomes less prominent. Rather, it means that a particular element of the traditional approach, namely the pure arbitrage mechanism, is less important. Instead, tools of network analysis, of complex adaptive systems, or of evolutionary game theory will become more important.

As a result, Behavioral Finance would emerge as an alternative paradigm and would overcome its current state, which is just a collection of anomalies and a number of fragmented law-like propositions. This paradigm would draw on biology, neuroscience, psychology and sociology, integrated by means of evolutionary theory. The pure theory of finance would be a part of that paradigm, because its most fundamental proposition, the theory of arbitrage, is also a building block in evolutionary theory. However, it is removed from the role as the pivotal point for the construction of theoretical hypotheses.

References

- Ainslie, George (1992): *Picoeconomics. The Strategic Interaction of Successive Motivational States within the Person*. Cambridge et al.: Cambridge University Press.
- Akerlof, George (2007): The Missing Motivation in Macroeconomics, *American Economic Review*, 97(1): 5-36.
- Akerlof, George A. and Kranton, Rachel E. (2000): Economics and Identity, *Quarterly Journal of Economics* CXV(3): 715-753.
- Akerlof, George A. and Kranton, Rachel E. (2005): Identity and the Economics of Organizations, *Journal of Economic Perspectives* 19(1): 9-32.
- Aunger, Robert (2002): *The Electric Meme. A New Theory of How We Think*. New York et al.: Free Press.
- Bhaskar, Roy (1989): *The Possibility of Naturalism. A Philosophical Critique of the Contemporary Human Sciences*, New York et al.: Harvester Wheatsheaf.
- Bowles, Samuel (2004): *Microeconomics. Behavior, Institutions, and Evolution*. New York, Princeton and Oxford: Russell Sage and Princeton University Press.
- Bunge, Mario (1977): *Treatise on Basic Philosophy, Volume 3. Ontology I: The Furniture of the World*. Dordrecht et al.: Reidel.
- Bunge, Mario (1979): *Treatise on Basic Philosophy, Volume 4. Ontology II: A World of Systems*. Dordrecht et al.: Reidel.
- Buss, David M., ed. (2005): *The Handbook of Evolutionary Psychology*, Hoboken: Wiley.
- Callon, Michel (2007): What Does It Mean to Say That Economics is Performative? In: MacKenzie et al. (2007): 344-357.
- Callon, Michel / Millo, Yuval / Muniesa, Fabian, eds. (2007): *Market Devices*. Malden et al.: Blackwell.
- Calvin, William H. (1998): Competing for Consciousness. A Darwinian Mechanism as an Appropriate Level of Explanation, *Journal of Consciousness Studies* 5(4): 389-404.
- Camerer, Colin (2007): Neuroeconomics: Using Neuroscience to Make Economic Predictions, *Economic Journal* 117(519): C26-C42.
- Camerer, Colin / Loewenstein, George / Prelec Drazen (2005): Neuroeconomics: How Neuroscience Can Inform Economics, in: *Journal of Economic Literature* Vol. XLIII: 9-64.
- Campbell, Donald T. (1974): 'Downward Causation' in Hierarchically Organized Biological Systems, in: Ayala, Francisco J./Dobzhansky, Th., eds. (1974): *Studies in the Philosophy of Biology. Reduction and Related Problems*, Berkeley/Los Angeles: University of California Press, 179-186.

- Candlish, Stewart (2004): Private Language, The Stanford Encyclopedia of Philosophy (Spring 2004 Edition), Edward N. Zalta (ed.),
URL = <<http://plato.stanford.edu/archives/spr2004/entries/private-language/>>.
- Carroll, Glenn R./Hannan, Michael T. (2000): The Demography of Corporations and Industries. Princeton: Princeton University Press.
- Cartwright, Nancy (1989): Nature's Capacities and Their Measurement, Clarendon: Oxford.
- Cohen, Jonathan D. (2005): The Vulcanization of the Human Brain: A Neural Perspective on Interactions between Cognition and Emotion, in: Journal of Economic Perspectives 19(4): 3-24.
- Cole, David (2004): The Chinese Room Argument, The Stanford Encyclopedia of Philosophy (Fall 2004 Edition), Edward N. Zalta (ed.),
URL = <<http://plato.stanford.edu/archives/fall2004/entries/chinese-room/>>.
- Cornwell, John, ed. (1995): Nature's Imagination. The Frontiers of Scientific Vision, Oxford / New York / Melbourne: Oxford University Press.
- Damasio, Antonio R. (1995): Descartes' Error. Emotion, Reason and the Human Brain. New York: G.B. Putnam's Son.
- Davis, John B. (2003): The Theory of the Individual in Economics. Identity and Value. London and New York: Routledge.
- Davis, John B. (2006): The Turn in Economics: Neoclassical Dominance to Mainstream Plural-ism? Journal of Institutional Economics 2(1): 1-20.
- Davis, John B. (2007): Akerlof and Kranton on Identity in Economics: Inverting the Analysis, Cambridge Journal of Economics 31(3):349-362.
- Demichelis, Stefano / Weibull, Jörgen W. (2008): Language, Meaning, and Games: A Model of Communication, Coordination, and Evolution, American Economic Review 98(4): 1292-1312.
- Demichelis, Stefano / Weibull, Jörgen W. (2008): Language, Meaning, and Games: A Model of Communication, Coordination, and Evolution, American Economic Review 98(4): 1292-1312.
- Dennett, Daniel (1995): Darwin's Dangerous Idea. Evolution and the Meanings of Life, New York: Simon & Schuster.
- Dennett, Daniel C. (1991): Consciousness Explained, Boston et al.: Little, Brown and Company.
- Earl, Peter E. (1990): Economics and Psychology: A Survey, Economic Journal, 100: 718-755.
- Edelman, Gerald M. (1987): Neural Darwinism. The Theory of Neuronal Group Selection. New York: Basic Books.
- Edelman, Gerald M. / Tononi, Giulio (1995): Neural Darwinism: The Brain as a Selectional System, in: Cornwell, John, ed. (1995): Nature's Imagination. The Frontiers of Scientific Vision, Oxford / New York / Melbourne: Oxford University Press: 78-101.
- Ehrig, Timo / Kauffman, Louis H. (2007): Framing Landscapes – Mathematical Modeling of the Frame-Making of Securities Analysts, Paper presented at the European Group for Organization Studies Conference, Vienna, July 5-7 2007.

- Elster, Jon, ed. (1986): *The Multiple Self*, Cambridge et al.: Cambridge University Press.
- Elworthy, Charles (1993): *Homo Biologicus. An Evolutionary Model for the Human Sciences*, Berlin: Duncker & Humblot.
- Fama, Eugene (1991): *Efficient Capital Markets: II*, *Journal of Finance* 46(5): 1575-1617.
- Fama, Eugene / French, K.R. (1993): *Common Risk Factors in the Returns on Stocks and Bonds*, *Journal of Financial Economics* 33: 3-56.
- Farrell, Joseph / Rabin, Matthew (1996): *Cheap Talk*, in: *Journal of Economic Perspectives* 10(3), 103-118.
- Frank, Robert H. (1988): *Passions Within Reason. The Strategic Role of Emotions*, New York/London: Norton.
- Frey, Bruno S. / Eichenberger, Rainer (1989): *Anomalies and Institutions*, *Journal of Institutional and Theoretical Economics* 145: 423-437.
- Gintis, Herbert (2006): *A Framework for the Unification of the Behavioral Sciences*, *Behavioral and Brain Sciences* 30: 1-16.
- Glimcher, Paul W. (2003): *Decisions, Uncertainty, and the Brain. The Science of Neuroeconomics*. Cambridge and London: MIT Press.
- Greif, Avner (1994): *Cultural Beliefs and the Organization of Society: A Historical and Theoretical Reflection on Collectivist and Individualist Societies*, in: *Journal of Political Economy*, Vol. 102, No. 5, S. 912-950.
- Gul, Faruk / Pesendorfer, Wolfgang (2005): *The Case for Mindless Economics*, <http://www.princeton.edu/~pesendor/mindless.pdf>
- Hassoun, Jean-Pierre (2005): *Emotions on the Trading Floor: Social and Symbolic Expressions*, in: Knorr Cetina and Preda (2005): 102-120.
- Hausman, Daniel M. (2006): *Philosophy of Economics*, *The Stanford Encyclopedia of Philosophy* (Summer 2006 Edition), Edward N. Zalta (ed.), URL = <<http://plato.stanford.edu/archives/sum2006/entries/economics/>>.
- Hayek, Friedrich August von (1952): *The Sensory Order. An Inquiry into the Foundations of Theoretical Psychology*. Chicago: University of Chicago Press.
- Henrich, Joseph (2000): *Does Culture Matter in Economic Behavior? Ultimatum Game Bargaining Among the Machigienga of the Peruvian Amazon*. *The American Economic Review* 90(4): 973-979.
- Herrmann-Pillath, Carsten (1994): *Evolutionary Rationality, "Homo Economicus" and the Foundations of Social Order*, in: *Journal of Social and Evolutionary Systems*, Vol. 17/1, 41-70. <http://ssrn.com/abstract=950590>.
- Herrmann-Pillath, Carsten (2008): *Consilience and the Naturalistic Foundations of Evolutionary Economics*, forthcoming in: *Evolutionary and Institutional Economics Review*.

- Herrmann-Pillath, Carsten (2009): Elements of a Neo-Veblenian Theory of the Individual, <http://ssrn.com/abstract=1017785>, forthcoming in: Journal of Economic Issues.
- Hollis, Martin (1998): Trust Within Reason, Cambridge et al.: Cambridge University Press.
- Jablonka, Eva / Lamb, Marion J. (2006): Evolution in Four Dimensions. Genetic, Epigenetic, Behavioral and Symbolic Variation in the History of Life, Cambridge and London: MIT Press.
- Jacob, Pierre (2003): Intentionality, The Stanford Encyclopedia of Philosophy (Fall 2003 Edition), Edward N. Zalta (ed.), URL = <<http://plato.stanford.edu/archives/fall2003/entries/intentionality/>>.
- Kagel, John H. / Battalio, Raymond C. / Green, Leonard (1995): Economic Choice Theory: An Experimental Model of Animal Behavior, Cambridge et al.: Cambridge University Press.
- Kahnemann, Daniel (2003): Maps of bounded rationality: psychology for behavioral economics, AER 93(5), 1449-1475
- Knorr Cetina, Karin / Preda, Alex, eds. (2005): The Sociology of Financial Markets, Oxford et al.: Oxford University Press.
- Konow, James (2003): Who Is the Fairest of All? A Positive Analysis of Justice Theories, Journal of Economic Literature XLI(4): 1188-1239.
- Laibson, David (1997): Golden Eggs and Hyperbolic Discounting, Quarterly Journal of Economics, May 1997: 443-477.
- Lea, Stephen G. / Webley, Paul (2005): Money As Tool, Money As Drug: The Biological Psychology of a Strong Incentive, Behavioral and the Brain Sciences 29: 161-209.
- Macdonald, Graham / Papineau, David, eds. (2006): Teleosemantics. New Philosophical Essays, Oxford / New York: Oxford University Press.
- MacKenzie, Donald (2006): An Engine, Not a Camera. How Financial Models Shape Markets. Cambridge and London: MIT Press.
- MacKenzie, Donald (2007): Is Economics Performative? Option Theory and the Construction of Derivatives Markets, in: MacKenzie et al. (2007): 54-86.
- MacKenzie, Donald / Muniesa, Fabian / Siu, Lucia, eds. (2007): Do Economists Make Markets? On the Performativity of Economics, Princeton and Oxford: Princeton University Press.
- Mantegna, Rosario N. / Stanley, H. Eugene (2000): An Introduction to Econophysics. Correlations and Complexity in Finance, Cambridge et al.: Cambridge University Press.
- Mantzavinos, Chrysostomos (2005): Naturalistic Hermeneutics, Cambridge et al.: Cambridge University Press.
- McCloskey, Donald N. (1994): Knowledge and Persuasion in Economics, Cambridge et al.: Cambridge University Press.
- McCloskey, Donald N. (1994): Knowledge and Persuasion in Economics, Cambridge: Cambridge University Press.
- McClure, S.M. / Ericson, K.M. / Laibson, D.I. / Loewenstein, G. / Cohen, J.D. (2007): Time Discounting for Primary Rewards, The Journal of Neuroscience 27(21):5796-5804.

- Menkhoff, Lukas / Taylor, Mark P. (2007): The Onstinate Passion of Foreign Exchange Professionals: Technical Analysis, *Journal of Economic Literature* XLV(4): 936-972.
- Millikan, Ruth (2005): *Language: A Biological Model*, Oxford: Clarendon.
- Mirowski, Philip (1989): *More Heat Than Light: Economics as Social Physics, Physics as Nature's Economics*. By. Cambridge: Cambridge. University Press.
- Nooteboom, Bart (2002). *Trust. Forms, foundations, functions, failures and figures*. Cheltenham / Northampton: Edward Elgar.
- North, Douglass C. (2005): *Understanding the Process of Economic Change*, Princeton and Oxford: Princeton University Press.
- Papineau, David (2007): Naturalism, *The Stanford Encyclopedia of Philosophy* (Spring 2007 Edition), Edward N. Zalta (ed.), URL = <<http://plato.stanford.edu/archives/spr2007/entries/naturalism/>>.
- Park, Jang Woo / Zak, Paul J. (2007): *Neuroeconomic Studies*, *Analyse & Kritik* 29: 47-59.
- Preda, Alex (2005): The Investor as a Cultural Figure of Global Capitalism, in: Knorr Cetina / Preda (2005): 141-162.
- Robb, David and John Heil (2005): Mental Causation, *The Stanford Encyclopedia of Philosophy* (Spring 2005 Edition), Edward N. Zalta (ed.), URL = <<http://plato.stanford.edu/archives/spr2005/entries/mental-causation/>>.
- Roehner, Bertrand (2002): *Patterns of Speculation. A Study in Observational Econophysics*, Cambridge et al.: Cambridge University Press.
- Ross, Don (2005): *Economic Theory and Cognitive Science: Microexplanations*, Cambridge and London: MIT Press.
- Ross, Don (2007b): *H. sapiens as Ecologically Special: What Does Language Contribute?* *Language Studies* 29: 710-731.
- Samuelson, Larry (2004): Modeling Knowledge in Economic Analysis, in: *Journal of Economic Literature* XLII(2): 367-404.
- Schantz, Richard, ed. (2004): *The Externalist Challenge*, Berlin: de Gruyter.
- Seabright, Paul (2004): *The Company of Stangers: A Natural History of Economic Life*, Princeton NJ: Princeton University Press.
- Searle, John R. (1995): *The Construction of Social Reality*, New York: Free Press.
- Searle, John R. (2004a): Biological Naturalism, <http://socrates.berkeley.edu/~jsearle/articles.html>
- Searle, John R. (2004b): Social Ontology: Some Basic Principles, <http://socrates.berkeley.edu/~jsearle/articles.html>
- Searle, John R. (2005): What Is an Institution?, in: *Journal of Institutional Economics* 1(1): 1-22.
- Searle, John R. (2006): What Is Language: Some Preliminary Remarks, <http://socrates.berkeley.edu/~jsearle/articles.html>

- Smith, Vernon L. (2003): Constructivist and Ecological Rationality in Economics, *The American Economic Review* 93(3): 465-508.
- Steele, G. R. (2002): Hayek's Sensory Order, in: *Theory & Psychology* 12(3): 387-409
- Sterelny, Kim (2004): Externalism, Epistemic Artefacts and The Extended Mind, in: Schantz (2004): 239-254.
- Stegmüller, Wolfgang (1986): *Probleme und Resultate der Wissenschaftstheorie und der Analytischen Philosophie, Band II: Theorie und Erfahrung, Zweiter Teilband: Theoriestrukturen und Theoriendynamik*, Berlin und Heidelberg: Springer.
- Subrahmanyam, Avaniidhar (2007): Behavioral Finance: A Review and Synthesis, *European Financial Management* 14(1): 12-29.
- Sugden, Robert (2000): Team Preferences, *Economics and Philosophy* 16: 175-204.
- Thaler, Richard H. (1994): *Quasi-Rational Economics*, New York: Russell Sage.
- Tooby, John / Cosmides, Leda (2005): Conceptual Foundations of Evolutionary Psychology, in: Buss (2005): 5-67.
- Tuomela, Raimo (1995): *The Importance of Us. A Philosophical Study of Basic Social Notions*. Stanford: Stanford University Press.
- Van der Sar, Nico L. (2004): Behavioral Finance: How Matters Stand, *Journal of Economic Psychology* 25: 425-444.
- Wilson, Edward O. (1998): *Consilience. The Unity of Knowledge*, London: Abacus.
- Wilson, Robert A. (2004): *Boundaries of the Mind. The Individual in the Fragile Sciences: Cognition*, Cambridge et al.: Cambridge University Press.
- Witt, Ulrich (2003): *The Evolving Economy. Essays on the Evolutionary Approach to Economics*, Cheltenham and Northampton: Edward Elgar.
- Wittgenstein, Ludwig (1980/1958): *Philosophische Untersuchungen*, Frankfurt a.M.: Suhrkamp.
- Zaloom, Caitlin (2003): Ambiguous Numbers: Trading Technologies and Interpretation in Financial Markets. *American Ethnologist* 30(2): 258-272.
- Zaloom, Caitlin (2004): The Productive Life of Risk, *Current Anthropology* 19(3): 365-391.

FRANKFURT SCHOOL / HFB – WORKING PAPER SERIES

No.	Author/Title	Year
104	Schalast, Christoph (Hrsg.) / Schanz, Kay-Michael / Scholl, Wolfgang Aktionärsschutz in der AG falsch verstanden? Die Leica-Entscheidung des OLG Frankfurt am Main	2008
103.	Bannier, Christina / Müsch, Stefan Die Auswirkungen der Subprime-Krise auf den deutschen LBO-Markt für Small- und MidCaps	2008
102.	Cremers, Heinz / Vetter, Michael Das IRB-Modell des Kreditrisikos im Vergleich zum Modell einer logarithmisch normalverteilten Verlustfunktion	2008
101.	Heidorn, Thomas / Pleißner, Mathias Determinanten Europäischer CMBS Spreads. Ein empirisches Modell zur Bestimmung der Risikoaufschläge von Commercial Mortgage-Backed Securities (CMBS)	2008
100.	Schalast, Christoph (Hrsg.)/ Schanz, Kay-Michael Schaeffler KG/Continental AG im Lichte der CSX Corp.-Entscheidung des US District Court for the Southern District of New York	2008
99.	Hölscher, Luise / Haug, Michael / Schweinberger, Andreas Analyse von Steueramnestiedaten	2008
98.	Heimer, Thomas / Arend, Sebastian The Genesis of the Black-Scholes Option Pricing Formula	2008
97.	Heimer, Thomas / Hölscher, Luise / Werner, Matthias Ralf Access to Finance and Venture Capital for Industrial SMEs	2008
96.	Böttger, Marc / Guthoff, Anja / Heidorn, Thomas Loss Given Default Modelle zur Schätzung von Recovery Rates	2008
95.	Almer, Thomas / Heidorn, Thomas / Schmaltz, Christian The Dynamics of Short- and Long-Term CDS-spreads of Banks	2008
94.	Barthel, Erich / Wollersheim, Jutta Kulturunterschiede bei Mergers & Acquisitions: Entwicklung eines Konzeptes zur Durchführung einer Cultural Due Diligence	2008
93.	Heidorn, Thomas / Kunze, Wolfgang / Schmaltz, Christian Liquiditätsmodellierung von Kreditzusagen (Term Facilities and Revolver)	2008
92.	Burger, Andreas Produktivität und Effizienz in Banken – Terminologie, Methoden und Status quo	2008
91.	Löchel, Horst / Pecher, Florian The Strategic Value of Investments in Chinese Banks by Foreign Financial Insitutions	2008
90.	Schalast, Christoph / Morgenschweis, Bernd / Sprengetter, Hans Otto / Ockens, Klaas / Stachuletz, Rainer / Safran, Robert Der deutsche NPL Markt 2007: Aktuelle Entwicklungen, Verkauf und Bewertung – Berichte und Referate des NPL Forums 2007	2008
89.	Schalast, Christoph / Stralkowski, Ingo 10 Jahre deutsche Buyouts	2008
88.	Bannier, Christina / Hirsch, Christian The Economics of Rating Watchlists: Evidence from Rating Changes	2007
87.	Demidova-Menzel, Nadeshda / Heidorn, Thomas Gold in the Investment Portfolio	2007
86.	Hölscher, Luise / Rosenthal, Johannes Leistungsmessung der Internen Revision	2007
85.	Bannier, Christina / Hänsel, Dennis Determinants of banks' engagement in loan securitization	2007
84.	Bannier, Christina "Smoothingversus "Timeliness- Wann sind stabile Ratings optimal und welche Anforderungen sind an optimale Berichtsregeln zu stellen?	2007
83.	Bannier, Christina Heterogeneous Multiple Bank Financing: Does it Reduce Inefficient Credit-Renegotiation Incidences?	2007
82.	Cremers, Heinz / Löhr, Andreas Deskription und Bewertung strukturierter Produkte unter besonderer Berücksichtigung verschiedener Marktszenarien	2007

81.	Demidova-Menzel, Nadeshda / Heidorn, Thomas Commodities in Asset Management	2007
80.	Cremers, Heinz / Walzner, Jens Risikosteuerung mit Kreditderivaten unter besonderer Berücksichtigung von Credit Default Swaps	2007
79.	Cremers, Heinz / Traughber, Patrick Handlungsalternativen einer Genossenschaftsbank im Investmentprozess unter Berücksichtigung der Risikotragfähigkeit	2007
78.	Gerdemeier, Dieter / Roffia, Barbara Monetary Analysis: A VAR Perspective	2007
77.	Heidorn, Thomas / Kaiser, Dieter G. / Muschiol, Andrea Portfoliooptimierung mit Hedgefonds unter Berücksichtigung höherer Momente der Verteilung	2007
76.	Jobe, Clemens J. / Ockens, Klaas / Safran, Robert / Schalast, Christoph Work-Out und Servicing von notleidenden Krediten – Berichte und Referate des HfB-NPL Servicing Forums 2006	2006
75.	Abrar, Kamyar Fusionskontrolle in dynamischen Netzsektoren am Beispiel des Breitbandkabelsektors	2006
74.	Schalast, Christoph / Schanz, Kai-Michael Wertpapierprospekte: Markteinführungspublizität nach EU-Prospektverordnung und Wertpapierprospektgesetz 2005	– 2006
73.	Dickler, Robert A. / Schalast, Christoph Distressed Debt in Germany: What's Next? Possible Innovative Exit Strategies	2006
72.	Belke, Ansgar / Polleit, Thorsten How the ECB and the US Fed set interest rates	2006
71.	Heidorn, Thomas / Hoppe, Christian / Kaiser, Dieter G. Heterogenität von Hedgefondsindizes	2006
70.	Baumann, Stefan / Löchel, Horst The Endogeneity Approach of the Theory of Optimum Currency Areas - What does it mean for ASEAN + 3?	2006
69.	Heidorn, Thomas / Trautmann, Alexandra Niederschlagsderivate	2005
68.	Heidorn, Thomas / Hoppe, Christian / Kaiser, Dieter G. Möglichkeiten der Strukturierung von Hedgefondsportfolios	2005
67.	Belke, Ansgar / Polleit, Thorsten (How) Do Stock Market Returns React to Monetary Policy ? An ARDL Cointegration Analysis for Germany	2005
66.	Daynes, Christian / Schalast, Christoph Aktuelle Rechtsfragen des Bank- und Kapitalmarktsrechts II: Distressed Debt - Investing in Deutschland	2005
65.	Gerdemeier, Dieter / Polleit, Thorsten Measures of excess liquidity	2005
64.	Becker, Gernot M. / Harding, Perham / Hölscher, Luise Financing the Embedded Value of Life Insurance Portfolios	2005
63.	Schalast, Christoph Modernisierung der Wasserwirtschaft im Spannungsfeld von Umweltschutz und Wettbewerb – Braucht Deutschland eine Rechtsgrundlage für die Vergabe von Wasserversorgungskonzessionen? –	2005
62.	Bayer, Marcus / Cremers, Heinz / Kluß, Norbert Wertsicherungsstrategien für das Asset Management	2005
61.	Löchel, Horst / Polleit, Thorsten A case for money in the ECB monetary policy strategy	2005
60.	Richard, Jörg / Schalast, Christoph / Schanz, Kai-Michael Unternehmen im Prime Standard - „Staying Publicoder „Going Private“? - Nutzenanalyse der Börsennotiz -	2004
59.	Heun, Michael / Schlink, Torsten Early Warning Systems of Financial Crises - Implementation of a currency crisis model for Uganda	2004
58.	Heimer, Thomas / Köhler, Thomas Auswirkungen des Basel II Akkords auf österreichische KMU	2004
57.	Heidorn, Thomas / Meyer, Bernd / Pietrowiak, Alexander Performanceeffekte nach Directors Dealings in Deutschland, Italien und den Niederlanden	2004
56.	Gerdemeier, Dieter / Roffia, Barbara The Relevance of real-time data in estimating reaction functions for the euro area	2004
55.	Barthel, Erich / Gierig, Rauno / Kühn, Ilmhart-Wolfram Unterschiedliche Ansätze zur Messung des Humankapitals	2004

54.	Anders, Dietmar / Binder, Andreas / Hesdahl, Ralf / Schalast, Christoph / Thöne, Thomas Aktuelle Rechtsfragen des Bank- und Kapitalmarktrechts I: Non-Performing-Loans / Faule Kredite - Handel, Work-Out, Outsourcing und Securitisation	2004
53.	Polleit, Thorsten The Slowdown in German Bank Lending – Revisited	2004
52.	Heidorn, Thomas / Siragusano, Tindaro Die Anwendbarkeit der Behavioral Finance im Devisenmarkt	2004
51.	Schütze, Daniel / Schalast, Christoph (Hrsg.) Wider die Verschleuderung von Unternehmen durch Pfandversteigerung	2004
50.	Gerhold, Mirko / Heidorn, Thomas Investitionen und Emissionen von Convertible Bonds (Wandelanleihen)	2004
49.	Chevalier, Pierre / Heidorn, Thomas / Krieger, Christian Temperaturderivate zur strategischen Absicherung von Beschaffungs- und Absatzrisiken	2003
48.	Becker, Gernot M. / Seeger, Norbert Internationale Cash Flow-Rechnungen aus Eigner- und Gläubigersicht	2003
47.	Boenkost, Wolfram / Schmidt, Wolfgang M. Notes on convexity and quanto adjustments for interest rates and related options	2003
46.	Hess, Dieter Determinants of the relative price impact of unanticipated Information in U.S. macroeconomic releases	2003
45.	Cremers, Heinz / Kluß, Norbert / König, Markus Incentive Fees. Erfolgsabhängige Vergütungsmodelle deutscher Publikumsfonds	2003
44.	Heidorn, Thomas / König, Lars Investitionen in Collateralized Debt Obligations	2003
43.	Kahlert, Holger / Seeger, Norbert Bilanzierung von Unternehmenszusammenschlüssen nach US-GAAP	2003
42.	Beiträge von Studierenden des Studiengangs BBA 012 unter Begleitung von Prof. Dr. Norbert Seeger Rechnungslegung im Umbruch - HGB-Bilanzierung im Wettbewerb mit den internationalen Standards nach IAS und US-GAAP	2003
41.	Overbeck, Ludger / Schmidt, Wolfgang Modeling Default Dependence with Threshold Models	2003
40.	Balthasar, Daniel / Cremers, Heinz / Schmidt, Michael Portfoliooptimierung mit Hedge Fonds unter besonderer Berücksichtigung der Risikokomponente	2002
39.	Heidorn, Thomas / Kantwill, Jens Eine empirische Analyse der Spreadunterschiede von Festsatzanleihen zu Floatern im Euroraum und deren Zusammenhang zum Preis eines Credit Default Swaps	2002
38.	Böttcher, Henner / Seeger, Norbert Bilanzierung von Finanzderivaten nach HGB, EstG, IAS und US-GAAP	2003
37.	Moormann, Jürgen Terminologie und Glossar der Bankinformatik	2002
36.	Heidorn, Thomas Bewertung von Kreditprodukten und Credit Default Swaps	2001
35.	Heidorn, Thomas / Weier, Sven Einführung in die fundamentale Aktienanalyse	2001
34.	Seeger, Norbert International Accounting Standards (IAS)	2001
33.	Moormann, Jürgen / Stehling, Frank Strategic Positioning of E-Commerce Business Models in the Portfolio of Corporate Banking	2001
32.	Sokolovsky, Zbynek / Strohhecker, Jürgen Fit für den Euro, Simulationsbasierte Euro-Maßnahmenplanung für Dresdner-Bank-Geschäftsstellen	2001
31.	Roßbach, Peter Behavioral Finance - Eine Alternative zur vorherrschenden Kapitalmarkttheorie?	2001
30.	Heidorn, Thomas / Jaster, Oliver / Willeitner, Ulrich Event Risk Covenants	2001
29.	Biswas, Rita / Löchel, Horst Recent Trends in U.S. and German Banking: Convergence or Divergence?	2001

28.	Eberle, Günter Georg / Löchel, Horst Die Auswirkungen des Übergangs zum Kapitaldeckungsverfahren in der Rentenversicherung auf die Kapitalmärkte	2001
27.	Heidorn, Thomas / Klein, Hans-Dieter / Siebrecht, Frank Economic Value Added zur Prognose der Performance europäischer Aktien	2000
26.	Cremers, Heinz Konvergenz der binomialen Optionspreismodelle gegen das Modell von Black/Scholes/Merton	2000
25.	Löchel, Horst Die ökonomischen Dimensionen der ‚New Economy‘	2000
24.	Frank, Axel / Moormann, Jürgen Grenzen des Outsourcing: Eine Exploration am Beispiel von Direktbanken	2000
23.	Heidorn, Thomas / Schmidt, Peter / Seiler, Stefan Neue Möglichkeiten durch die Namensaktie	2000
22.	Böger, Andreas / Heidorn, Thomas / Graf Waldstein, Philipp Hybrides Kernkapital für Kreditinstitute	2000
21.	Heidorn, Thomas Entscheidungsorientierte Mindestmargenkalkulation	2000
20.	Wolf, Birgit Die Eigenmittelkonzeption des § 10 KWG	2000
19.	Cremers, Heinz / Robé, Sophie / Thiele, Dirk Beta als Risikomaß - Eine Untersuchung am europäischen Aktienmarkt	2000
18.	Cremers, Heinz Optionspreisbestimmung	1999
17.	Cremers, Heinz Value at Risk-Konzepte für Marktrisiken	1999
16.	Chevalier, Pierre / Heidorn, Thomas / Rütze, Merle Gründung einer deutschen Strombörse für Elektrizitätsderivate	1999
15.	Deister, Daniel / Ehrlicher, Sven / Heidorn, Thomas CatBonds	1999
14.	Jochum, Eduard Hoshin Kanri / Management by Policy (MbP)	1999
13.	Heidorn, Thomas Kreditderivate	1999
12.	Heidorn, Thomas Kreditrisiko (CreditMetrics)	1999
11.	Moormann, Jürgen Terminologie und Glossar der Bankinformatik	1999
10.	Löchel, Horst The EMU and the Theory of Optimum Currency Areas	1998
09.	Löchel, Horst Die Geldpolitik im Währungsraum des Euro	1998
08.	Heidorn, Thomas / Hund, Jürgen Die Umstellung auf die Stückaktie für deutsche Aktiengesellschaften	1998
07.	Moormann, Jürgen Stand und Perspektiven der Informationsverarbeitung in Banken	1998
06.	Heidorn, Thomas / Schmidt, Wolfgang LIBOR in Arrears	1998
05.	Jahresbericht 1997	1998
04.	Ecker, Thomas / Moormann, Jürgen Die Bank als Betreiberin einer elektronischen Shopping-Mall	1997
03.	Jahresbericht 1996	1997
02.	Cremers, Heinz / Schwarz, Willi Interpolation of Discount Factors	1996
01.	Moormann, Jürgen Lean Reporting und Führungsinformationssysteme bei deutschen Finanzdienstleistern	1995

**FRANKFURT SCHOOL / HFB – WORKING PAPER SERIES
CENTRE FOR PRACTICAL QUANTITATIVE FINANCE**

No.	Author/Title	Year
16.	Veiga, Carlos / Wystup, Uwe Closed Formula for Options with Discrete Dividends and its Derivatives	2008
15.	Packham, Natalie / Schmidt, Wolfgang Latin hypercube sampling with dependence and applications in finance	2008
14.	Hakala, Jürgen / Wystup, Uwe FX Basket Options	2008
13.	Weber, Andreas / Wystup, Uwe Vergleich von Anlagestrategien bei Riesterrenten ohne Berücksichtigung von Gebühren. Eine Simulationsstudie zur Verteilung der Renditen	2008
12.	Weber, Andreas / Wystup, Uwe Riesterrente im Vergleich. Eine Simulationsstudie zur Verteilung der Renditen	2008
11.	Wystup, Uwe Vanna-Volga Pricing	2008
10.	Wystup, Uwe Foreign Exchange Quanto Options	2008
09.	Wystup, Uwe Foreign Exchange Symmetries	2008
08.	Becker, Christoph / Wystup, Uwe Was kostet eine Garantie? Ein statistischer Vergleich der Rendite von langfristigen Anlagen	2008
07.	Schmidt, Wolfgang Default Swaps and Hedging Credit Baskets	2007
06.	Kilin, Fiodor Accelerating the Calibration of Stochastic Volatility Models	2007
05.	Griebisch, Susanne/ Kühn, Christoph / Wystup, Uwe Instalment Options: A Closed-Form Solution and the Limiting Case	2007
04.	Boenkost, Wolfram / Schmidt, Wolfgang M. Interest Rate Convexity and the Volatility Smile	2006
03.	Becker, Christoph/ Wystup, Uwe On the Cost of Delayed Currency Fixing	2005
02.	Boenkost, Wolfram / Schmidt, Wolfgang M. Cross currency swap valuation	2004
01.	Wallner, Christian / Wystup, Uwe Efficient Computation of Option Price Sensitivities for Options of American Style	2004

HFB – SONDERARBEITSBERICHTE DER HFB - BUSINESS SCHOOL OF FINANCE & MANAGEMENT

No.	Author/Title	Year
01.	Nicole Kahmer / Jürgen Moormann Studie zur Ausrichtung von Banken an Kundenprozessen am Beispiel des Internet (Preis: € 120,-)	2003

Printed edition: € 25.00 + € 2.50 shipping

Download:

Working Paper: http://www.frankfurt-school.de/content/de/research/Publications/list_of_publication0.html

CPQF: http://www.frankfurt-school.de/content/de/research/quantitative_Finance/research_publications.html

Order address / contact

Frankfurt School of Finance & Management

Sonnemannstr. 9–11 ▪ D–60314 Frankfurt/M. ▪ Germany

Phone: +49 (0) 69 154 008–734 ▪ Fax: +49 (0) 69 154 008–728

eMail: m.biemer@frankfurt-school.de

Further information about Frankfurt School of Finance & Management
may be obtained at: <http://www.frankfurt-school.de>