

Studies in Applied Philosophy,  
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Emiliano Ippoliti  
Ping Chen *Editors*

# Methods and Finance

A Unifying View on Finance,  
Mathematics and Philosophy

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Emiliano Ippoliti · Ping Chen  
Editors

## Methods and Finance

A Unifying View on Finance,  
Mathematics and Philosophy

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## Preface

Two views shape our understanding and approaches to finance, and stock markets in particular—as well as to a lot of other domains of human knowledge: the view from inside and the view from outside. This book examines these two views, analyzing their interconnections—when and where they clash, reconcile, or act independently—and the ways by which these views, in turn, affect various approaches to the study of finance and its branches. To this aim, the volume puts together contribution from experts from different fields: philosophy, economics, and physics. The core idea that motivates this choice is that the increasing complexity and pervasiveness of finance, and its computational turn, have to be dealt with several viewpoints.

These two views on finance employ radically different assumptions about the set of the relevant features of the domain and the way to look at them—e.g. the ontology, the methods, what counts as ‘data’, and the role of mathematical modeling. Accordingly, these views tackle very differently the two main sides of the problem of stock markets behavior—namely the quantitative and the qualitative side. The quantitative side requires figuring out an answer to prices’ series—a mathematical tool to approximate them in the most cogent way. The qualitative side requires determining the variables that affect the dynamics of stock market prices, and their “machinery”, as the result of the actions, or better interaction, of investors who sell and buy stocks.

But the view from inside and the view from outside are not necessarily conflictual. Mixed approaches emerge from a combination of the features of the two views. The two views serve goals and have scopes that might differ, but that can, and sometimes have to be used together since they can complement and extend each other. In effect, just like with triangulation, they offer distant viewpoints that can be combined in order to better map the land of financial phenomena. A conceptual triangulation that put in use a methodological pluralism.

The essays collected in this volume will provide new insights into, critical examinations of, and improvements to these approaches, dealing with both the quantitative and the qualitative approaches, the issue of prediction and the use of mathematics

philosophical and methodological implications, viz. on the very notion of data. In his chapter he examines several features of financial data, especially stock markets data: these features pose serious challenges to the interpretation and employment of stock markets data. In particular he focuses on two issues: (1) the way data are produced and shared, and (2) the way data are processed. The first raises an internal issue, while the second an external one. He argues that the process of construction and employment of the stock markets data exemplifies how data are theoretical objects and that “raw data” do not exist. Data are not clean, light and ready-to-use objects, and have to be handled very carefully and are a kind of “dark matter”. *Dark data*, for the note.

Rome, Italy  
Beijing, China

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**Part I**  
**The View from Outside**

# Quantification Machines and Artificial Agents in Global Finance: Historical-Phenomenological Perspectives from Philosophy and Sociology of Technology and Money

Mark Coeckelbergh

**Abstract** This paper raises questions regarding the societal, cultural and ethical significance of finance, mathematics, and financial-mathematical technologies, discussing in particular the phenomenon of quantification as mediated by contemporary electronic information and communication technologies (ICTS). It first relates the history of mathematics to the history of financial technologies, and argues, inspired by Simmel and Marcuse, that from ancient times to now there seems to be an evolution towards increasing quantification not only in finance, accounting etc., but in modern society in general. It shows that scientific and technological changes have social and ethical consequences, as quantification creates more distance between people. The paper then analyzes and discusses current shifts of financial agency that exemplify what seems to be a moment of hyper-quantification through the use of ICTs: experiences of “the market” as an independent agent and money machines as artificial agents in high frequency trading—perhaps the only agents still able to cope with the data-loaded and hyper-quantified world we live in. Under these conditions it becomes more difficult to exercise responsibility. The paper concludes that while we must acknowledge the human character of finance and mathematics, there are real human and social consequences of quantification, in ancient times and today, for society and responsibility. It is therefore misleading to assume that financial technologies and mathematics are ethically neutral; more analysis of ethical and societal aspects is needed, also from an “outside” perspective.

**Keywords** Quantification · Ethics of finance · Sociology of finance · Philosophy of finance · Mathematics · Artificial agents · Phenomenology · Simmel · Marcuse · Responsibility · Distance · Philosophy of technology and media

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## 1 Introduction

Quantification is widely used in mathematics and finance, as behavior of financial agents such as investors and markets is turned into numbers and modeled with the help of mathematics. Yet how this is done and its scope has changed over time, and the history of finance and mathematics is also a history of science and a history of technology, including a history of information and communication technologies (ICTs). Each of these “financial technologies” make possible a different phenomenology of markets, of financial transactions, and indeed of society. They also have consequences for how we do things.

This chapter does not contribute to financial modeling or mathematical theory, but approaches these fields from the “outside”. It uses philosophy and sociology as well as a historical perspective in order to raise critical questions concerning the phenomenon of quantification and its ethical and societal significance. In particular, developing and drawing on recent work on the ethics of financial technologies [1] this chapter focuses on some of the philosophical and social problems connected to quantification through ICTs: what happens when our experience of, and action in, markets is mediated by information technology? How do these technologies change the phenomenology of markets and financial transactions? What are the moral and societal consequences of quantification and of these technologies?

The latter are important questions given the societal consequences of finance, and hence also of financial and mathematical theory and technologies. It is assumed in this paper that people working in these fields want to do their work in a morally and socially responsible way. Therefore, it is vital to make explicit (potentially) darker sides and consequences of these practices and phenomena. This can contribute towards more critical reflection on finance and society, and may aid efforts towards more responsible practice and innovation in the sector.

The first section of the paper offers a brief history of financial technologies and shows that these technologies have always had ethical and societal consequences. In particular, using and expanding Simmel it is argued that there seems to be a tendency towards increasing quantification in finance and in society, that this also means increasing distance between people and between people and products, and that this evolution is crucially related to the history of financial technologies. In addition Marcuse is used to issue a warning about how quantification may change the lifeworld and contribute to the quantification and bureaucratization of society.

The second section turns to contemporary global finance and in particular its electronic ICTs. It is argued that, phenomenologically speaking, the new technologies and quantification tend to create increasingly autonomous non-human financial agents: “the market” appears to us as a being in itself, and financial algorithms effectively constitute artificial agents which trade on our behalf—something which seems to be needed once finance, aided by ICTs, takes on a global shape and reaches such high speeds. It is argued that this creates problems for exercising responsibility, given serious limitations to human control and knowledge. Like all automation technology, contemporary financial technologies and the

mathematics and science that go with it are in danger of creating more epistemic and social distance.

It is concluded that while this process of increased quantification and distancing does not necessarily mean a dehumanization of finance, it is clear that we have to deal with the reality of these new technologies and agents, and that—to use a metaphor of calculation which has shaped our thinking—there might be a significant moral and societal cost to them.

## 2 A Brief History of Quantification and Financial Technologies and an Argument About Distance Based on Simmel and Marcuse

### 2.1 A Brief History of Quantification and Financial Technologies

From ancient times to today, finance, mathematics, and financial technologies and artefacts have always been co-developing. New financial-economic realities required new science and technology, but also vice versa: new mathematics and new techniques made possible new forms of finance. While I have no space here to do justice to the details of this fascinating history, let me indicate some significant financial-technological developments.

From the time of the agricultural revolution it was possible to have ‘stock’, since there was more than people needed for immediate consumption. This had all kinds of social consequences, such as most likely increased competition, inequality, and domination by (male) elites. It also had an implication for technological development: stock needed to be managed, counted, calculated. At the same time new forms of social organization developed such as cities and empires, together with bureaucracies and taxation. Stock can be distributed, collected, centralized, taxed, etc. New technologies were needed to do this. An important financial technology was and is writing. In Mesopotamia, Egypt, China, and other ancient centres of civilization people needed to write down quantities for bookkeeping and administration. Writing systems were invented, for instance Phoenician and Greek writing systems, and of course also *numbers*. This made possible ancient versions of accounting and what Martin calls management information systems: techniques for quantifying stocks and flows of goods, combined with measuring of time [2, p. 43]. The abacus, for instance, is a well-known ancient calculating tool: a tablet or counting frame that was already in use in ancient Mesopotamia and Egypt.

Another important financial technology was and is of course money. Some connect the birth of money to the need for a medium of exchange. Here the idea is that first there was barter, but this only works as long as both parties want each other’s goods. If this so-called ‘double coincidence of wants’ does not happen, money provides a handy medium of exchange. Morgan has argued that to deal with

this problem a standard means of exchange was found, which first could take the form of valuable goods such as cattle, cloth, or cereals [3, p. 11] and later also silver, lead, copper, bronze, and so on. Some means of exchange, such as cowry shells, were used across continents. Other authors emphasize the role of debt as the origin of money (see for example [4–6]). Here there was an evolution from personal obligation towards other persons to more formal forms of debt, associated with the activities of what we now call “banks.” Already in ancient Babylon temples took deposits and gave loans, in 11th century China people already used paper money, and in Renaissance Italy and Flanders bank notes were used by foreign exchange dealers, so-called *banchieri* who dealt on benches [7]—the origin of our word “bank”. Goldsmiths also played a role in the history of credit and banking, as they issued receipts for gold they kept.

## 2.2 An Argument About Distance Based on Simmel and Marcuse

In these histories of financial and mathematical technologies, we can discern not only technological and scientific changes, but also social changes. In particular, put in spatial terms the development of these technologies and the related quantification process seem to go together with increased distance: from families and small communities to large bureaucracies and empires, and from personal, informal social relations to impersonal, formal social relations. As I have argued in *Money Machines* [8], from a phenomenological-geographical point of view this financial-mathematical development can be conceptualized as a process of *distancing*: distance between people and goods, but also increasing distance between people. To explain this, let me use the work of Simmel.

In this philosophy of money [9], Simmel argued that money, as it mediates the exchange relation, functions as a kind of bridge (it relates people, even strangers, when they engage in exchange) but at the same time the technology or medium also creates distance: between people and between people and objects. In order to fulfill its function, Simmel argued, money has to be impersonal, detached from specific content and value. This renders the social relation impersonal and also alienates us from the value of goods. This distancing is directly related to quantification. In the course of history every qualitative difference becomes quantified, and money becomes dematerialized: first it has the form of valuable objects, then it becomes coin money, paper money, and so on.

This process of quantification and dematerialization reaches its peak in modernity, when money becomes the symbol of ‘the modern emphasis on the quantitative moment’: objects are ‘valued only to the extent to which they cost money’ and money quantifies since it is ‘free from any quality’, cut off from the relevant relationships. [9, p. 279] Once quantified, the object is no longer of interest. According to Simmel, this makes people indifferent towards objects, but also

towards one another. Money, as the symbol of abstraction and quantification, turns people more calculating. In our lives are engaged in various processes of quantification. Simmel writes:

The money economy enforces the necessity of continuous mathematical operations in our daily transactions. The lives of many people are absorbed by such evaluating, weighing, calculating and reducing of qualitative values to quantitative ones. [9, p. 444]

The money economy promotes this kind of relations with goods, but also with people. Simmel compares the nature of money with prostitution: through money we objectify each another, degrade each another to ‘mere means’ [9, p. 377].

In Marcuse we also find criticism of quantification. In *One Dimensional Man* [10] he argues that the quantification of nature separated science from ethics, the world of rationality and the world of values. The latter, he says, are seen as not real because they cannot be quantified or scientifically described. It is not part of the objective world, it is not real. For ethics this means that ‘outside this rationality, one lives in a world of values, and values separated out from the objective reality become subjective’ [10, p. 151]. In other words, Marcuse suggests that ethics is seen as not real and as subjective; what “counts” is, literally, what can be counted, what can be quantified. But, like Simmel (and later also Habermas), Marcuse suggests that in reality this objective world is not separate at all but changes the lifeworld. In the end not only nature becomes transformed into a ‘technical reality’ [10, p. 158]; society and human beings also become rationalized and quantified, and then controlled and manipulated by means of technology. Quantification makes this control and manipulation possible. Quantification is a form of abstraction, and this abstraction has consequences for how we perceive the world and for our practices.

Marcuse specifically mentions mathematics. Commenting on Husserl, Marcuse argues that ‘mathematization’ [10, p. 141], required for technological-rational thinking, hides the ‘pre-scientific basis of science in the world of practice (*Lebenswelt*)’. It creates the illusion of a free-standing, autonomous, symbolic truth: ‘an absolute ideational reality, freed from the incalculable uncertainties and particularities of the *Lebenswelt*’ [10, p. 167]. But in reality, Marcuse says, ‘it remained a specific method and technique for the *Lebenswelt*. Based on Husserl, he writes: ‘The ideational veil (*Ideenkleid*) of mathematical science is thus a veil of symbols which represents and at the same time masks (*vertritt und verkleidet*) the world of practice’ [10, p. 166]. Mathematics makes possible a ‘specific concrete experience of the *Lebenswelt*—a specific mode of “seeing” the world. This then leads to particular kind of practical relation to the world: the domination of nature, but also domination in society. First, social reality is seen in an objective and calculable way, which misses out its ‘mysterious and uncontrollable character’ [10, p. 172]. Second, here too mathematics leads not only to a different perception but also to different practice. Again technology plays a role: ‘in the medium of technology, man and nature become fungible objects of organization’ [10, p. 172]. Quantification makes possible domination and control by means of numbers. The result is that ‘The world tends to become the stuff of total administration, which absorbs even the administrators’ [10, p. 172].



Simmel's and Marcuse's conclusions may well be exaggerated and far too pessimistic, but they invite us to further critically reflect on the nature of quantification and of the financial technologies, and attend us to their potential social and moral implications. In the next section I explore what this approach means for contemporary financial technologies and contemporary quantification.

### 3 ICTs and Artificial Agents in Finance: Markets, Algorithms, and the Question Concerning Responsibility

#### 3.1 *Markets and Algorithms in Global Finance and Their Social and Ethical Consequences*

Today we still live in a money economy, but one that is globalized and involves a range of new technologies. In particular, electronic information and communication technologies (ICTs) make possible global markets, where similar processes of quantification and hence distancing are at work. The numbers on the screens of traders express values and relations, but they abstract and impersonalize them. The concrete people and relations disappear, are invisible. Moreover, they create a world of numbers (the world of mathematics, science, economics, and finance), which hides the *Lebenswelt* and sets up the world of values (ethics) as separate from finance. It thus misleadingly suggests that its mathematical-financial operations are ethically neutral and have nothing to do with people's experience, which is seen as "subjective".

For instance, traders at a stock exchange do no longer perceive an immediate link to the goods they trade and the people they (literally) deal with. They are part of a "technical" world, which seems unconnected to the lifeworld. Like money, electronic trading platforms thus function as media that connect people and people with goods (the bridge function). Yet at the same time, as quantification machines, they also act as screens which create distance. This distance is ethically problematic, since the social consequences of finance remain hidden. In addition, the traders themselves are controlled and manipulated by the system.

Moreover, in so-called high-frequency trading and related practices, trade is delegated to algorithms. The financial world becomes a world of 'quants': mathematics experts who program computers to analyze and trade on the market. In that world of numbers, it seems, machines are more at home than humans. Technology is used to create what Simmel called 'pure quantity in numerical form' [9, p. 150]. According to Simmel, this is the nature of money. Today it is thus 'technically feasible to accomplish what is conceptually correct' [9, p. 165]: money becomes pure quantity, without a material basis. Electronic money and cryptocurrencies such as Bitcoin generated by computer algorithms are pure symbols. The financial-economic world is turned into a world of pure quantities, detached from place. The global world of electronic money and media is in this sense a "utopia": a non-place. Everything becomes quantity, information, data. Humans can no longer

cope with the speed of trade, only machines can still act at this summit of quantification.

In addition, financial products become so complex that only mathematicians know what is going on and, perhaps very soon, only computers can understand them and deal with them. The financial city has become an island and now drifts off: it alienates itself not only from all the people elsewhere on the globe and indeed even creates distance in the same city who are affected by the trade but lack any control over it; it also alienates itself from human traders. Finance then becomes a gigantic machine, served by goods and people. Its technical rationality makes possible global domination, in which both traders and stakeholders are trapped.

Even in cases when trade is (still) done by humans, it is mediated by electronic trading platforms. This means that direct contact between traders on the market or on the trading floor is replaced by numbers on a screen. Whereas for instance on exchanges trading in the 'pit' involved 'full-body experiences' including hand signaling and shouting [11, p. 263], this is replaced by abstract, de-personalized and disembodied data. This also changes the nature of the social interaction and the sense-making. Trade now appears to be about numbers only, not about people.

Furthermore, financial markets, which are supposed to be anchored in real transactions and real human beings, appear to us as separate, non-human entities: new bests and monsters, new artificial agents which are abstracted from goods and people, and reign in the world of money. "The market" thus creates new forms of global domination. Again technologies—including numbers, computers, and screens—play an important role here. As Knorr Cetina remarks about technologies on trading floors, the market becomes the market-on-screen which takes on 'a presence in its own right':

From the traders' perspective, and from the perspective of the observer of traders' lifeworld, the dominant element in the installation of trading floors in globally interconnected financial institutions is not the electronic infrastructural connections ... but the computer screens ... The market on screen takes on a presence and profile in its own right ... It is not simply a 'medium' for the transmission of pre-reflexive interactions' [12, p. 129]

Technologies are not mere instruments; they also shape our perception and our world. In this case, mathematics and financial technologies shape a world which appears to be ruled by "the market" as it appears on our screens: in the trading rooms but also on TV and elsewhere. Again this may be a hyperbolic claim. Finance remains human, in the sense that it is still humans who program the computers and make part of the decisions. In this sense to say that it is a nonhuman world is an overstatement. But overstatements can alert us to real processes, in this case processes of abstraction and quantification, which create what seems a "symbolic" world (divorced from material and social reality); but this world and its numbers have real social and moral consequences.

This analysis is not only applicable to finance. Increasing quantification processes means that *everywhere* in society, at least in so far as it is a modern society, increasing numbers of people are involved in the work of quantification. Quantification and bureaucratization happen not only in finance but in all sectors, including health care, education, and the private lives of people. But in all modern social institutions, increasing quantification and abstraction means that social relationships tend to become less personal and calculating. In so far as financial technologies and mathematical techniques function as quantification machines and money machines, they may contribute to these social and moral developments.

### 3.2 Implications for the Exercise and Ascription of Responsibility

Consider again the creation of abstract markets and the delegation of trade to machines: what are the consequences for responsibility?

It seems that it becomes rather difficult to exercise and ascribe responsibility. Who is responsible for the actions of “the market”, an artificial agent which seems to steer humans rather than the other way around? And who is responsible for the actions of trade algorithms? As Aristotle already knew, there are two conditions for responsibility: control and knowledge. We know that acting responsibly is only possible if we have some control and if we know what is going on. But with increased automation and increased quantification, can we still fulfil these conditions and exercise responsibility? If we conceptualize knowledge in purely quantitative terms, as in big data science, and delegate gaining knowledge to machines such as search engines and big data miners, then what kind of knowledge do we humans have, and is it enough for responsible action in the world of finance and beyond? For instance, do citizens and politicians have enough knowledge of the world of finance in order to make good democratic decisions concerning its practices? Even if we do not embrace everything Simmel and Marcuse say about the social and ethical consequences of quantification, at the very least these questions need to be asked.

Numbers, money, and calculating techniques are great inventions. They can do a lot of fantastic things for us. But it is worth considering what else they do. They do not only have a purely “technical” function. They also shape our (life)world, our thinking, and our social relations and social institutions. The technology may become the end and, as McLuhan said, the medium becomes the message. Money, numbers, accounting, and other financial media and techniques are not neutral; they crucially shape what it is to be human today.

## 4 Conclusion

Humans have always invented new technologies and have developed mathematics and finance to help them with various kinds of activities (e.g. trade and exchange) and with trying to reach various goals. But science and technology have always done more than acting as a docile servant. They have also changed our practices and re-shaped our aims. They have made possible new activities and new cultures. They have contributed to the creation of entirely new worlds and civilizations. This chapter has argued that this is also true for financial technologies and mathematical techniques, today and in the past: they have always been bound up with social change and they have changed the economy, finance, and society. Drawing on Simmel and Marcuse, it has been shown what kind of changes we may consider here: it has been argued that current financial-mathematical developments contribute to more quantification and that this may have social and moral consequences: more impersonal relations to goods and people, a misleading conception of science and finance as ethically neutral, an alienated understanding of markets, more bureaucracy and administration, and conditions that undermine the possibility of exercising and ascribing responsibility.

I conclude that if we want a better understanding and a more comprehensive evaluation of the social and ethical significance and potential implications of finance and mathematics, it is advisable to not only consider “inside” perspectives of these sciences and practices and the many advantages they have brought us, but also critically study the relations between finance and mathematics, technology, ethics, and society. A philosophical and sociological angle such as the one presented here may, “from the outside”, contribute to this aim. But the outside is also an inside: this is about what people experience and do, inside and outside of finance and mathematics.

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## ***Dark Data. Some Methodological Issues in Finance***

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**Abstract** The nature of the data of financial systems raises several theoretical and methodological issues, which not only impact finance, but have also philosophical and methodological implications, viz. on the very notion of data. In this paper I will examine several features of financial data, especially stock markets data: these features pose serious challenges to the interpretation and employment of stock markets data, weakening the ‘myth of data’. In particular I will focus on two issues: (1) the way data are produced and shared, and (2) the way data are processed. The first raises an internal issue, while the second an external one. I will argue that the process of construction and employment of the stock markets data exemplifies how data are theoretical objects and that ‘raw data’ do not exist. Data are not light and ready-to-use objects, but have to be handled conceptually and technically very carefully and they are a kind of ‘dark matter’. *Dark data*, for the note.

### **1 Introduction**

The nature and the role of data in the financial systems, especially in stock markets, raise several theoretical and methodological issues. These issues, on one hand, affect the very theoretical status of finance itself, while on the other reignite a philosophical debate, that is the one about the notion of data and their ‘ladenness’<sup>1</sup>—i.e. the fact that they are conceptual products, the end-point of a theoretical construction and not ‘neutral’ starting-point of it (see also [14]). This is one of the reasons why the study of financial systems is interesting also from a philosophical viewpoint. And, in turn, why a philosophical reflection can be useful for finance.

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<sup>1</sup>See in particular [3, 4, 27, 29].

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