The three ages of financial quantification: a conventionalist approach to the financiers' metrology

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Eve Chiapello & Christian Walter *

Abstract: *»Die drei Perioden der finanztechnischen Quantifizierung: ein konventionentheoretischer Ansatz zur Analyse der finanztechnischen Metrologie«.* This article presents a conventionalist interpretation of the financialization of the economy. We define three periods, each one associated with conventional calculation systems that may shape investment decisions. Each of these periods begins with the adoption by financial practitioners of a new "convention" to make investment decisions: the actuarial convention at the end of the 19th century, the mean-variance convention during the 1970s, and the market-consistent convention since the 1990s. These conventions are rooted in finance theory developments and are associated with different financing circuits for economic activity. When a new convention arises, it does not mean the disappearance of the old one, which can still be used by some practitioners for certain given matters, but it can also redefine some financial professions by fragmenting them according to the convention followed, and it can finally also give rise to new professions.

Keywords: Financialization, finance theory, quantification, quantification conventions.

1. Introduction

There are many different ways to describe the process of the financialization of the economy that has now been spreading for some thirty years: the financial markets' growing influence in economic and financial regulation of investments, the dematerialization of markets that has made global interoperability possible, the gradual decompartmentalization of banking and insurance activities, banking disintermediation, the unfettered inventiveness of financial engineering, the growing importance of financial activities in developed nations'

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GDP, etc. This financialization process, which is redefining whole sectors of the economy and transforming business operation logics as well as public policies, carries with it conceptions of the world, methods of problem analysis, calculation techniques, and decision-making principles which were originally forged for a limited number of special cases, but are now tending to spread to all questions and human activities. Structures for reasoning, representation and calculation drawn from finance can apparently be applied to and redefine all spheres of existence (Chiapello 2015).

This last aspect is the focus of this article, which proposes to define the interplay between the quantification conventions that underpin the development of finance. There has been extensive research in economic sociology to advance understanding of the forms of calculation used in the financial sector, particularly as they are considered determinant in market construction since they facilitate construction of agreement on prices. Financial theory is now seen, according to the title of Donald MacKenzie's book, as "an engine, not a camera" (2006). This stream of research considers financiers' work from the angle of the models they use, and often combines a subtle intellectual history of financial theory with the story of how a given model came to be adopted by financial actors.

Given that it is impossible to propose equally fine-grained historical research in a short article, our approach will be different, and can be summed up as "conventionalist." We consider that quantification systems have a history, and that it is possible to sketch out that history by identifying some major turning points in the conception of the phenomena we seek to model and understand. We propose to explain the history of financial modelling by introducing three main conventions which appeared successively in the financial field. After presenting our approach, we describe the three conventions, and then we outline some features of the periods they delimit.

2. Approach and Definitions

2.1 Associating Periods of History and Forms of Calculation

Following the approach taken in several works of research, this article rests on the idea that a connection can be established between changes in quantification systems and more general changes in the economic sphere.

Desrosières analyzes the relationships between conceptualizations of the State's role in economic affairs and certain statistical tools. He presents five "typical historical configurations" (the engineering state that is also a state administered by engineers, the liberal state, the welfare state, the Keynesian state, and the neo-liberal state) that are "not meant to describe successive stages in a historical progression, nor are they historically or logically exclusive. In concrete historical situations, they are often mixed together" (Desrosières 2003, 554).

Each one of these typical configurations is associated with a group of statistical practices. For example, since the very idea of the welfare state is based on the notion of insurance, it requires "statistical calculations of probabilities of the various events described by new labour statistics" (Desrosières 2003, 560), and the Keynesian state needs "national accounting tables and statistical series describing the relations among various components of supply and demand" (Desrosières 2003, 560).

Our perspective is also similar in some respects to the viewpoint discussed by Bryer (2000), who argues that it is possible to refer to accounting practices to differentiate between feudal, capitalistic, and capitalist mentalities. The types of calculation performed by entrepreneurs in different historical settings function as an "accounting signature" for the stage of the economy. Berland and Chiapello (2009) also proposed referring to accounting practices as a way to date the various stages of capitalism in different institutional and historical settings. In the same vein, we propose to show the relationship between types of financial calculus and the stages in financialization of the economy.

2.2 The Three Stages of Financialization

The idea of financialization is understood here in a fairly broad sense, designating the use of financial criteria by economic actors to make their investment decisions. Such decisions – to invest in a business sector or purchase an asset – can be based on calculation of a return on investment, which is a financial criterion, or on other considerations (herd behavior, habit, empathy with the seller, etc.). From the history of financial techniques, we identify three major ways of seeing investment in financial terms, associated with the three major groups of calculative techniques. These three calculative architectures share a common view: The return on investment (ROI) is what matters most.

The oldest configuration was linked to the calculation of discounted cash flows (DCF). This calculation method consists of forecasting the future economic flows that will be generated by the investment, and applying a discount to those flows to bring them to present value.

Financial reasoning then underwent a substantial transformation with the introduction of the mean-variance criterion in the 1950s. Under this criterion, the first two moments of the laws of probability (mathematical expectation and variance), which were previously simply measured statistically to describe financial variables, were used directly as parameters of theoretical models. Mathematical expectation and variance did not make their first appearance in the 1950s; they changed status, reproducing for finance the "probabilistic revolution" of 1930s' econometrics (Krüger et al. 1987a, 1987b; Desrosières 1998). Starting from the 1950s, these two quantities concerned not only typical values of the financial variables observed, but also the theoretical law of unobservable variables. The mean-variance criterion would lead to models of portfolio selection and reasoning combining measures of risk (volatility) with measures of return (mathematical expectation of return).[1]

The discount rate, which, in the first configuration, essentially related to what could be earned on money if it was deposited with a bank instead of being invested, was modified and now incorporated a risk premium related to the specific investment. Analysis of the behavior of stock market prices led to statistical estimates for probabilistic modelling (initially designed for a single period), assuming that successive returns are independent and stationary and thus that past statistics will give a good sample for modelling the future.

Finally, in the most recent period, investments are always considered in the light of indications given by the markets, because the markets are constantly producing information on the relative values of a certain number of standard investments, i.e. on the price other investors would be willing to pay. The key point for valuing investments has thus become the active design of efficient markets – in accordance with neo-liberal ambitions – so that they can produce the required figures (in other words, market prices). The aim is no longer to discount expected future cash flows to obtain a present value, but quite the reverse: to take the present values observed on the markets, and to deduce from them all the expected returns on possible investments. As all values for all assets must be consistent with existing market prices, financial models are now used to value investments that have no market price in the same way as investments that do have a market price. These valuations are said to be "market-consistent." They are actually "model-based valuations," whose basic tool is risk-neutral mathematics (see below).

We thus argue that three major conventions of financial quantification have arisen in a superimposed succession, progressively overlapping: the "discounting convention" (whose base form is traditional actuarial discounting, the key object of which is the actuarial rate), the "mean-variance convention" (based on the probabilistic revolution, initially in the form of the mean-variance criterion, the key object of which is the optimization technique), and finally the "market-consistent convention" (whose mathematical expression evolved from the first efficient market hypothesis (EMH) in Fama's definition of the 1960s to the no-arbitrage assumption in the 1980s). The arrival of a new "quantification convention" heralds the start of a new period, a new stage of financialization, although the old convention is not totally replaced: the new convention adds to the previ-

[1] This mean-variance criterion, coupled with the second law of errors (Laplace-Gauss) and Sharpe's common cause of market fluctuations were the drivers behind the rebirth of Quetelet's average man in the asset management industry (Walter 1996, 2002). The benchmark issues (see below) are closely related to Quetelet's view of the average man, here replaced by the average portfolio (Walter 2005a).

ous forms and merges with them to form hybrids. The story of quantification in finance can thus be told as a gradual complexification of models, as new conventions spring up to enhance and displace previous quantification systems.

This simplification of history offers two advantages. Like any ideal-type construction, it proposes analytical tools to understand specific situations (the history of a profession, a market, a firm, etc.) by reference to the three conventions identified. It also proposes an overall interpretation of the general development through identification of phases.

This means that these three major conventions, being constructed to help us outline a history, are informed mainly by finance's mainstream or dominant ideas. By dominant, we mean ideas that have been adopted by so many actors that they have completely changed financial practices, professions, and regulations. We do not claim that the three conventions take into account all the debates on financial theory or all actual practices in the financial sector, but they do concern the most popular ideas and practices. In each period of time, the conventions were challenged and discussed. But when conventionalist researchers talk about "conventions," they often mean conventions that provide a good understanding of the collective operation of a particular sector (or subsector) of activity (Eymard-Duvernay 1989; Storper and Salais 1997). We now look more closely at what we mean by financial quantification conventions.

2.3 Financial Quantification Conventions

The financial valuation of an "object" (an investment such as equity, a debt such as a bond, or other objects) involves a large number of operations and several choices. Using the DCF method, for instance, requires selection of a time horizon, sequencing periods and the year of terminal value (which often accounts for 70% of the present value), definition of the number of periods to take into consideration and projections of the economic and financial variables associated with each period, and with each economic scenario to produce an estimate of future cash flows, selection of a discount rate, by maturity or otherwise, estimation of the price of the risk associated with the object (for example market risk, credit risk, default risk, etc.). An extremely large number of choices must be made. These choices are not what we refer to here in the concept of the "quantification convention." A quantification convention is more like a meta-convention: its name covers a configuration or a coherent set of operations both cognitive and normative, including selection of the items to take into account, relevant judgement criteria, choices of mathematical schemas, etc. Every quantification convention has an epistemic, a pragmatic and a political dimension (Chiapello and Gilbert forthcoming).

Every financial quantification convention is first built on a set of *assumptions regarding what makes the value of an investment*, an asset or a good. These assumptions are used to assess the benefit and determine the decision of whether or not to invest (buy or sell the asset), or simply to manage the financial risk prudently by setting aside a provision to cover its value. Since things are always seen in terms of return on investment, financial valuation seeks to grasp a future which, by definition, is uncertain because it has not yet happened. It therefore requires *assumptions concerning what "shape" of uncertainty the future will take*, which is in practice an assumption regarding the distribution of financial and economic variables. Also required is a *selection of relevant predictive factors* drawn from today's world that can be used to construct a decision, i.e. selection of what is true. Finally, it is associated with *specific forms, calculations and mathematical models* which somewhat operationalize these choices into a calculable form that, according to Walter (2005b), could be called the "formal cause" of value, by reference to Aristotle's causality model,[2] as opposed to economic and financial information that are taken to represent the "raw material" of value, its "material cause." All these factors relate to the *epistemic dimension* of the quantification convention, as it produces knowledge about things by looking at them from a financial investor's standpoint, and seeks to state certain truths about them.

Every quantification convention also contains a *pragmatic dimension*: it makes certain actions possible, especially trade and arbitrage, as demonstrated by many studies on the economics of convention (Eymard-Duvernay 2006a, 2006b) and the sociology of market devices (Callon et al. 2007). Each convention enables actors – not necessarily the same actors for each convention, additionally conferring a *political dimension*. Through coordinated or uncoordinated action by these professionals, value can emerge. In this respect, the pragmatic dimension of the convention can be analyzed as the "efficient cause" of value. The arrival of a new convention enables the growth of certain practices, reconfigurations of some professions, and splits in others. As a result each conventional period is associated with its own breakaway changes in the form of new practices, changes in professions, and shifts in the power struggles between actors, or what MacKenzie and Spears (2014) would name an "evaluation culture."

The concept of the convention also suggests that several conventions are possible. To begin with, the financial conventions studied here only equip a specific way of valuing things from a financial investor's point of view. The financial investor sees everything as a capital good or asset, in other words something that will bring him a return. The value of the thing is thus bound up with its expected returns. Of course, this is a very specific way of assigning

[2] Aristotle identifies four types of cause: the material cause (the material that forms a thing: where does a thing come from and what is it made of?), the formal cause (the essence of the thing: what is its form or the model it is imitating?), the efficient cause or cause of change (whatever produces, destroys or modifies the thing), and the final cause (whatever the thing is "for"). Conceptually, the formal cause is expressed in the logos (definition) and in this sense, the mathematical form of the quantification refers to the idea of valuation, termed the "financial logos" (Walter 2011).

value to things, and it can conflict with other values: affective values, artistic values, etc. We suggest furthermore that there are several ways of looking at things as an investor, several forms of financial valuation itself. This means there are potential debates over values not only between financial valuation and non-financial valuation, but also involving different financial valuations, mostly promoted by different actors. Divergences on the question of financial value thus also reflect ethical divergences, because the instruments used for valuation are not axiologically neutral.

2.4 Financial Quantification Conventions and Capitalism

The financial investors' view is a capitalistic view in the narrowest sense of the term. If we consider like Marx (1867) that capitalism follows an M-C-M (Money-Commodity-Money) cycle and money is only invested in business in order to make more money, then financial quantification conventions underlie the capitalistic judgement that things are there to increase their owner's wealth. But these conventions also tell us about the way we decide, at different points of capitalism, to contribute funds to an activity, in other words to finance it. One of our hypotheses, then, is that every conventional era is associated with specific forms of financing for economic activity. These points will be developed further, after a more thorough presentation of the three conventions.

3. The Three Ages of Financial Quantification

It is possible to consider three periods in turn, showing how the expected return on investment and the related uncertainties are perceived. In particular, we first suggest that the discount rate invented by the first convention was transformed by the arrival of the following conventions. We now look more closely at this point.

3.1 The Transformations of Discounting

With the first financial quantification convention, the "actuarial discounting convention," present value is determined through a simple calculation: known cash flows were discounted to present value using a constant interest rate. Both the numerators (cash flows) and the discount factor (the inverse of the discount rate) are *deterministic*, in other words it is considered that there is no uncertainty affecting future cash flows or the discount rate. The discount rate used introduces into financial valuation a powerful simplification that is not obvious in itself: the same rate is used for all maturities of cash flows, such that the remuneration on money is considered identical for every maturity, whether one day or one year. In other words, the yield curve is flat.[3] This indicates that we have to be very careful when using this deterministic model. And finally, while a certain idea of risk is empirically taken into account by the choice of a higher or lower discount rate, that risk is not based on statistical calculation. These factors and others illustrate the numerous difficulties attached to this very simple deterministic model of valuation.

These are points that change with the second convention of financial quantification. In the "mean-variance convention," the risk is defined by the variance (or its square root, the standard deviation).[4] As a result of this convention, the level of risk premium is determined using the Capital Asset Pricing Model (CAPM) devised by Sharpe (1964). This model gives the risk premium level (using the linear relationship of the beta coefficient). In this quantification convention, the discount factor becomes *variable*, as it depends on the beta coefficient, but is not random.[5] This second convention introduces a new and extremely important idea: the relevant discount rate for calculating a present value is related to the rate of return on a specific portfolio known as the "MV-optimal tangent" portfolio; this portfolio has been considered equivalent to the "market" since the seminal paper by Sharpe, and this "market" needs a proxy representation in order to apply this theoretical research to make practical real-life decisions. Serving as proxies is precisely the function of market indexes (such as the Dow Jones Industrial Average indexes). Apart from the technicity of this change, the new development is that financial valuation is now associated with market equilibrium. In the second quantification convention, valuation of any item requires a mean-variance (MV)-optimal tangent portfolio, which in practice means actors must keep up with an index. And conversely, any MV-optimal tangent portfolio (or market index) becomes a possible instrument for asset valuation.

The third financial quantification convention, the "market-consistent convention," extends this idea. The discount factor, which in the second convention only varied with the investments studied (i.e. the risk specific to each one, measured by the beta), has now become random. "Stochastic discounting" replaces traditional discounting, whether the rate used is given (with the first convention) or results from an equilibrium model such as the CAPM (in the second convention). The stochastic discount factor is termed the "deflator," just as a traditional operation deflates nominal values to real values.

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3 The yield curve shows the relationship between the interest rate and the time to maturity.

4 We do not address the debates on the morphology of uncertainty here, but it should be remembered that the two views in competition are continuity (Brownian representation) and discontinuity (other representations). In the case of continuity, the risk is reduced to the variance. In other cases, it is necessary to complement variance with the other moments of the distributions if they exist, which is not always the case.

5 A random variable is a variable whose values depend on "events" or "possible states of the world," for example the face on which a die lands depends on the event "face that lands after the throw."

Table 1: The Three Ages of the Discount Factor

Convention	Characteristic of the Discount Factor
1	constant
2	variable but non-random
3	stochastic

The third financial quantification convention completely reshapes financial theory, with its cornerstone concept of "absence of arbitrage opportunity" (see below) in an arbitrage-free market. With this extremely strong concept, valuations of investments become "market-consistent" and pave the way for extended use of "fair market value" (FMV) as defined by international accounting standards.

3.2 The Third Convention

The intellectual cornerstone of the dominant contemporary financial approaches which we term the third quantification convention is the "absence of arbitrage opportunity" (AOA) principle in a complete market. Based on the pioneering mathematical results of Harrison and Kreps (1979) and Harrison and Pliska (1981) under the AOA assumption,[6] mathematical finance has come to consider it possible to extract expected returns on investments from market prices. In these conditions, market prices are considered the perfect measure of discounted expected cash flows and can be used to "reveal" an underlying risk-neutral probability measure, unique all tradable securities, uncertainty being governed by what Mandelbrot termed "mild" randomness (i.e. fully describable by price volatility alone).[7]

To go from market prices to expected returns, assumptions must be made about the rate of return. In this approach, the risk-free rate of return is used as the expected rate of return for investors. Changing the discount rate is equivalent to changing the numeraire of the asset (a little like an exchange rate can be used to express a value in a different currency). But this change also means that real-world probabilities are replaced by a new probability termed the "risk-neutral probability."[8] For calculative purposes the "new finance" has imagined

[6] Followed by Delbaen and Schachermayer's fundamental theorem of asset pricing (1994).

[7] This is typically the case of the Brownian representation embedded in the main financial models of mainstream mathematical finance, reflecting the persistent central role of Brownian motion in finance across the 20th century. Mild randomness is required to obtain a unique risk-neutral measure under the no-arbitrage condition. In the presence of jumps (discontinuous or "wild" randomness) a single risk-neutral measure is difficult to derive because the market becomes incomplete, and the further we move from the Brownian-based representation of risk, the weaker the AOA framework becomes. Ultimately, in a purely discontinuous non-Brownian uncertainty framework, the AOA framework fails.

[8] As MacKenzie and Spears (2014, 400) explain: "Those probabilities are simultaneously less real and more real than actual probabilities: less real, in that they do not correspond to the

a new world, the risk-neutral world, in which all invested assets are assumed to provide the same expected rate of return, namely the risk-free rate, regardless of the risk of each specific asset. This purely mathematical transformation certainly has major financial virtues. Notably, it neutralizes a form of variability in the discount rate, which now becomes the same for all assets, risky or otherwise, a situation that was impossible under the first and second conventions.

This no-arbitrage theory has played a central role in finance. It is amazing how much can be deduced from this one simple financial assumption. Practitioners in various sectors of finance have subscribed to this assumption to be able to use this new "risk-neutral" technology, which has paved the way for the total financialization of the global economy. The powerful elegance of the "no arbitrage-mild randomness" representation for market-consistent valuation is a major development which has profoundly transformed financial practices over the last thirty years.

One of the counterintuitive consequences of this new framework is the disappearance of risk for management purposes. The mathematicians of finance, basing their work on assumptions of an idealized market with a mild randomness representation of uncertainty, have shown that for any fixed amount at a given maturity (payment of an insurance claim, a guaranteed amount, etc.), it is possible to entirely tame risk, whatever the degree to which the risk on the relevant phenomenon (financial market, real economy, demographics, climate change, etc.) materializes, because of the type of randomness chosen. Practical application of these ideas to build financial models – which will then be used to value assets and make decisions – requires construction of what is termed a "replicating portfolio."

The replicating portfolio is a portfolio which shares the same properties as the asset it replicates (e.g. series of cash flows or terminal value). The replication technique can be used to hedge or value any type of asset, especially derivatives.[9] This breakthrough in mathematical financial techniques paved the way for an invasion of the "real" economy by derivatives. The pillar of this technique needs "market-consistent" valuation, whose visible mathematical trace is the risk-neutral probability.

actual probabilities of events; more real in the sense that (at least in finance) those actual probabilities cannot be determined, while martingale or risk-neutral probabilities can be calculated from empirical data, today's market prices."

9 The replicating portfolio technique was already fundamental to the Black-Scholes-Merton model, which facilitated the rise of the options market (MacKenzie and Millo 1973), and as noted by several authors, the risk-neutral approach was in fact implicit in the Black-Scholes model (1973), but not yet expressed specifically as a new probability. As MacKenzie and Spears (2014, 401) put it: "It is the strategy of Black-Scholes modelling writ large: find a perfect hedge, a continuously-adjusted portfolio of more basic securities that will have the same payoff as the derivative, whatever happens to the price of the underlying asset or assets; use that portfolio to hedge the derivative; and use the cost of the hedge as a guide to the price of the derivative."

Let us summarize our point. While the key operational concept of the 1960s was the mean-variance (MV) optimal portfolio, leading to implementation of risk-return analysis in the asset management industry, the key operational concept of the 1980s was this new idea of replication with no-arbitrage, leading to implementation of risk-neutral analysis in the derivatives industry. Given the importance of the risk-neutral property of arbitraged prices, for instance to calculate the present value of any asset with a market-consistent framework, this feature can be considered as both the cornerstone and the mark of the third quantification convention.

The change in quantification convention is, as just seen, always supported by developments in financial theory, particularly the invention of new mathematical models which make all sorts of values calculable because they are founded on very restrictive assumptions. The first convention is rooted in calculation of DCF, which proposes a mathematical form that can make very different investments commensurable: all are treated as sums paid out with a view to receiving monetarily quantified returns in the future. The second is based on a reduction of the universe of investments under the two criteria of mean (the return) and variance (volatility as a measure of risk) which makes portfolio management models possible. Finally, the third convention is built on a new mathematical expression that has facilitated the rise of derivatives.

These mathematical models have been introduced into management instruments that govern financial decisions and help to shape professional practices. In each period, it is the models with the most easily-handled mathematical forms that are incorporated into calculation systems and accompany the transformation in the professions of finance. The most reassuring branches of finance, because they are the most readily translatable into calculation machines, are the ones that have spread to the point of becoming the dominant forms.

New professions have arisen while others have been changed. Practices previously considered highly risky because they involved a kind of gambling have seen particularly impressive expansion since the new calculation methods appeared to make them calculable and optimizable, and therefore controllable and manageable. Advances in modelling, combined with the increasingly massive collection of data and rising calculation capacities, mean that in finance, as elsewhere, people are able to undertake actions every day that used to be considered risky or impossible. It is very similar to what has happened in the transport sector, for instance: the speed and number of vehicles on the move has been increased on the grounds that vehicles of all types are safer than ever and their trajectories are easier to calculate and control. Of course, the limits of such a comparison are that the test of real-life application that validates financial models is not of the same nature, and the economic models generally show low robustness.[10] We will now see how each convention can be associated with practices, professions and points of time in capitalism.

4. Of Conventions and Men

4.1 The Actuarial Convention and Direct Circuits for Financing Investments

Doganova (2014) describes the adoption of the actuarial convention by forest managers in the late 19th century. This type of mathematical calculation, although it has long been expressed mathematically, was only used in the economic world for specific, well-defined objects: the estimation of financial annuities that could be paid out and calculations by certain life insurers (even though many were still operating on speculative models) (Bühlmann and Lengwiler forthcoming). Actuarial calculation was not used for other types of investments, in which an amount was also paid out, but to plant trees or acquire shares in a company rather than to buy an annuity. Its extension to other investment objects through the use of analogy was a key moment, and can be analyzed as a point in the financialization of capitalism that was also a moment of rationalization of the investment decision through more sophisticated calculation: not content with simply ensuring that the investor would regain his initial outlay with a surplus, calculation of DCF began to take into consideration the fact that the money could be invested elsewhere and generate different amounts at different maturities. Doganova (2014) explains that the actuarial view of the forest was constantly comparing the money that could be made from cutting down the trees today and then deposited in in an interest-bearing account, with the money remaining "invested" in the forest for conversion into cash at a later date. DCF calculations facilitate a comparison that appears rational because it can calculate different investments and thus opens up the way to arbitrage.

As far as professional practices are concerned, DCF allows comparison between pairs of investment opportunities and this makes it useful to investors who choose their investments one at a time. The decision to provide finance is made by looking at an opportunity's potential. Today, according to the finance textbooks and in professional practice, ad hoc analysis of investments still involves estimating the monetary flows (cash inflows and outflows) associated with an investment, and then subjecting them to actuarial calculation to assess how attractive a prospect they are. The fund managers in private equity funds (in-

[10] Financial calculation software does not appear to be subject to the same requirements as other technical innovations before they are put on the market. For example, the assumptions of continuity used in the Brownian representation of risk were not tested, even though they were dangerous (Mandelbrot 1963).

vestment funds, venture capital funds,[11] real estate management companies, etc.) follow this reasoning: they establish scenarios and construct business plans when studying potential acquisitions. The managers of start-up companies do the same, trying to raise funds by presenting the same type of calculative argument to investors. Bankers making traditional loans also look at the same factors: Will the investment to be funded be profitable enough to repay the loan? Finally, in large organizations, firms, and States, Net Present Value calculations have also become a required step in all investment projects. The gradual spread of these practices to business managers (Pezet 1997) and top civil servants in charge of major public investments (Miller 1991) can be dated back to the 1960s.

What all these investment practices have in common is a strong connection between the financial circuit and what is sometimes called the real economy: the investor is aware that he is investing money in an activity and a business, and that the money invested soon loses its form as "money" even though the actuarial calculation tends to disregard this and focus solely on monetary flows. The actuarial convention of financial quantification in fact translates investment requirements into financial language and oils the economy's financing channels. These channels involve direct investment by individuals, firms, and States putting their savings or their surplus funds into projects directly or via banking intermediation (the banker collects deposits and makes loans for concrete projects). The provider of funds is aware that the investment he is making has low liquidity and will be difficult to withdraw from. As he bears the risk, he needs to conduct *ad hoc* analyses for every investment made.

During the first period, which we associate with the first convention, the financial markets (which represent a different financing channel from the self-financing and credit-financing channels) were of course in existence, and were even very large in certain countries at certain times (Obstfeld and Taylor 2002). But the patterns of reasoning used by their practitioners, who traded on stock exchanges and managed securities portfolios, were embedded in the first convention. Their professional approach can be found for example in the famous textbook "The Theory of Investment Value" (Williams 1938), that was used to train generations of financial analysts. This relates to the first convention, as the idea is to evaluate the discounted cash flows of a given security, and forecast the movements in an individual stock price, or predict overall stock market movements. This is still the basis of "fundamental analysis" which consists in forming a projection of future cash flows and "fundamental prediction" which consists in forming scenarios of future events.

These stock exchange professionals were the central actors of the second period, as the second convention not only produced a revolution in their standard

[11] France has venture capital funds called "FCPR" (*Fonds commun de placement à risques*), which are investment vehicles designed for investments in private equity.

practices, but was also instrumental in the rise of their professions, as we shall now see.

4.2 The Mean-Variance Convention and Disintermediated Financing

The new convention proposed a portfolio-based reasoning. In fact, Markowitz (1952, 1959) rigorously justified the concept of diversification, and demonstrated that any investor should consider not only the individual assets, searching for any theoretical under-evaluation, but the portfolio as a whole, with its total risk and total return, i.e. the overall trade-off between risk and return. The second convention gave birth to what is called the "quantitative approach to investment management" which is based upon statistical-probabilistic principles, and uses rational analysis to construct portfolios.

This convention accompanied the rise of institutional investors (particularly pension funds) in corporate financing. This rise is usually associated with the financialization process that began in the 1970s and went hand-in-hand with banking disintermediation. Funds came to be raised less through bank debt and more by issuance of securities (shares and bonds) on the financial markets. This financing channel, which had then gained importance, is generally marked by the existence of financial intermediaries who do not invest directly in projects, but buy liquid securities on a stock market. Except at the time of issuance, the money invested does not actually go to the firms being financed. Most monetary exchanges take place between professional financial actors, and the financial markets are mainly resale markets, secondary markets, not to say speculative markets.[12]

With this second period, trade in securities directly involving individuals which were still important in the first period became a very small part of the market: individuals were now putting their savings into funds that took charge of investing them for profit on their behalf. As for the companies that used the markets for financing, they had to monitor the secondary market for their securities if they wanted to raise further funds or avoid changing owner. Ultimately, the transformation of financing modes over this period was accompanied by a drastic change in governance in the name of shareholder value, as has been so

[12] In fact, Kaldor's definition is fully aligned with these practices: "Speculation [...], may be defined as the purchase (or sale) of goods with a view to re-sale (re-purchase) at a later date, where the motive behind such action is the expectation of a change in the relevant prices relatively to the ruling price and not a gain accruing through their use, or any kind of transformation effected in them or their transfer between different markets. Thus, while merchants and other dealers do make purchases and sales which might be termed 'speculative,' their ordinary transactions do not fall within this category" (Kaldor 1939, 1).

extensively described in the literature (Aglietta and Rébérioux 2005; Fligstein 1990, 2001).

Portfolio management models paved the way for a new professional figure and new professional practices, although their integration into the world of portfolio managers had its difficulties. After several years of confinement inside the academic world, portfolio theory began to enter the professional field at the beginning of the seventies, thanks to the simplification of the necessary calculations implemented by Sharpe in 1963. The mathematical complexity of the calculations was reduced so that it became possible to implement the simple linear formula of Sharpe's CAPM model. But even then, as noted by many professional investment managers, among them Andrew Rudd, "unfortunately, the computational requirements were too burdensome for the approach to be implemented on a large scale until the mid-70s" (Rudd 1989, 20).

Nevertheless, even after all these operational problems had been overcome, some asset managers decided to stick to practices we associate with the first convention, emphasizing active management, stock picking, and buy-and-hold practices, as opposed to passive or index-linked management, the watchword being: "don't tell me about indexation" (Walter 1996, 2002). The radically new and relatively provocative intellectual construction of the new quantitative way of managing funds ran counter to the traditional practices of professional asset managers, financial experts and technical analysts, who considered it possible to outperform or "beat the market" through detection of underpriced securities by traditional first-convention-based methods.

Table 2 shows how the asset management industry has evolved. Chronologically, the history of this industry began with stock selection practices that did not involve any probabilistic risk modelling: this is the "traditional" or "qualitative" conception of management, as opposed to use of probabilistic models. It was a "bottom-up" approach, where what counts is close examination of each target investment rather than an overall by-sector or by-geographical area approach, which is called "top-down." Then, from the 1960s, under the influence of Markowitz and Sharpe, the "quantitative" approach of asset management emerged. As previously remarked, a small minority of actors in the portfolio management industry refused to adopt these quantitative practices using index-linked funds and maintained a "counter-culture" of asset management called "alternative asset management," but this minority still lived in a world produced by the second convention (through the calculation software and financial bases they used, or through the applicable professional standards).

This professional revolution supported by the second convention was inseparable from the speedy growth in volumes traded on the markets. In countries that opted for a funded pension system, the apparent security of new, financial theory-based professional models led public policies to encourage the emergence of new financial actors. In the US, for instance, the 1974 Employee Retirement Income Security Act (ERISA) law triggered a general transfer of pension fund management from their traditional managers (corporate management and unions) to finance professionals (Montagne 2006, 2012).

Table 2: The Asset Management Industry and Financial Quantification Conventions

Financial Quantification Convention	"Bottom-Up" Investment Process	"Top-Down" Investment Process
First convention: actuarial, with no risk modelling "Qualitative" approach to portfolio management	*Dominant approach in the first period* Traditional management, seeking out underpriced securities using DCF and criteria such as "fundamental analysis" with no consideration of risk parameters	
Second convention: probabilistic risk modelling. "Quantitative" approach to portfolio management	*Minority approach ("alternative" management methods)* Active management by selection of securities, prioritizing separate investment decisions for each security to the detriment of "macro" decisions. Supporters of these practices are nonetheless part of a social world produced by the second convention	*Dominant approach in the second period ("orthodox" management methods)* Index-linked management, passive or semi-active management, prioritizing major "macro" level decisions (by sector or country). "Performance numbers" CAPM-based and "benchmark" paradigm Still the dominant situation today

What we call the mean-variance convention thus accompanied the exponential growth in the securities market financing channels, and this went hand-in-hand with the rise of financial actors who were now much more disconnected from the real economy than in the first convention. The new decision-makers preferred highly liquid listed securities, and no longer needed to know what real investments were being made by firms. They were mainly interested in movements in stock prices, in other words the prices other professionals are willing to pay to buy the securities they hold, and the trends on this secondary market. They were judged and controlled mainly by reference to the various market indexes that operationalize the "market." They lived in a world of purely financial returns. Since the investments they made were highly liquid, capital turnover was very fast and took on the form of "money" several times a day. Money seemed to produce returns without transiting through investments in real projects. This is the illusion of liquidity produced by the financial markets that Keynes had already denounced: while the securities are liquid and could be traded, the investments made by the firm using the money collected are not.

The second convention thus accompanied what is usually called financial disintermediation, which is the decline in bank borrowing-based financing of the economy. The intermediation that began to disappear was balance sheet intermediation, in the sense that a financial actor carries in its balance sheet the risk of the financial transformation between the funds collected in the form of deposits, and the loans it has made. The new intermediaries operated differently, only investing money belonging to others: the bearers of the risks associated with the investments selected by them were now investors who put their savings into funds which these intermediaries merely managed. The banking world itself changed: banks found it beneficial not to carry the risks in their balance sheet[13] and to receive returns not on the differences between the cost of resources and the interest rates of the loans made, but on the sale of services to issuers and the management fees charged for managing portfolios for third parties.

4.3 The Market-Consistent Convention and the Derivatives Explosion

Finally, the third convention is closely connected to the rise of derivatives, which themselves have facilitated all kinds of financial innovations by combination into what are known as structured products. These products account for a substantial portion of financial trade today and have largely contributed to a redefinition of financial actors' boundaries, blurring the lines between the traditional bank handing out loans and the asset management industry, and also the lines between these banking and financial activities, and insurance activities.

Financialization of the economy is often associated with the "3D" evolution (decompartmentalization, deregulation, and disintermediation). With the third convention, it is possible to take the decompartmentalization process to unprecedented levels, which is not unproblematic for the regulators. From the outset financial regulation has followed the silo approach: banking organizations are governed by different standards from insurance organizations, which are in turn governed by different standards from those applicable to investment funds and pension funds (Scialom and Tadjeddine 2015).

One very interesting case is the expansion of credit derivatives. The name credit derivative covers various instruments and techniques designed to separate and then transfer the "*credit risk*" (the risk of an event of default by a borrower), transferring it to an entity other than the debtholder. Most credit derivatives are credit default swaps (CDS). CDSs developed very quickly in conjunction with collateralized debt obligations (CDOs), which are bonds

[13] Securitization of debts (bonds rather than bank debts) was recognized in the 1980s as the way to reduce banking risks in a context of expensive credit (Bastidon Gilles et al. 2010). This is its oldest form. The type of securitization involved in the subprime crisis was different (because subprime securities were no longer issued by the final borrower, for instance a household taking on a mortgage, but by special entities created to pool credits) but related to the same aim to free the banks of the weight of the risks, which naturally tends to make close examination of the projects submitted less important for the banks.

issued against a mixed pool of credits. In this technique, credits are pooled into a financial vehicle (called a Special Purpose Entity, or a Securitization vehicle) used to securitize the loans by issuing obligations. The major role played by CDSs and CDOs in the financial crisis of 2008 is well known and these practices could only develop because of the integration of the third convention modelling into new software by investment banks and credit rating agencies (MacKenzie 2011).[14] The combination of CDSs and CDOs made a new strategy possible: building portfolios of debt securities, then packaging and selling off tranches based on default probabilities. Huault and Rainelli-Le Montagner (2009) studied the rise of this brand new concept of credit derivatives. They explain that with the success of the Chicago Board Options Exchange (CBOE) enhanced by the Black and Scholes Formula (MacKenzie and Millo 2003), financial engineers

> began to explore the potential of the new technology. Identifying the price variation of primary financial assets with 'risk,' they proposed to create a different kind of 'derivatives' [...]. Credit derivatives result from an extension of this logic, in which the underlying asset is replaced by the amount of the credit risk borne by a debt. (MacKenzie and Millo 2003, 549-50).

This was a complete innovation, as it meant there was no straightforward link to an underlying asset, whereas in the options valuation formula proposed by Black and Scholes the fact that the underlying stocks are traded on the market is crucial.

First CDSs, then CDOs were created in the mid-1990s by J. P. Morgan. The ISDA (International Swaps and Derivatives Association) has been fighting ever since to legitimize and obtain recognition of these practices, achieving the notable success of the decision that CDSs were not insurance contracts but financial products (Huault and Rainelli-Le Montagner, 2009, 560; Morgan, 2008). These credit derivatives are the symbol of hybridized financial practices: they are clearly providing insurance, which is traditionally the business of insurers. This insurance concerns the credit risk, which is a risk professionally managed traditionally by banks as it represents their core competence. But these products are sold neither by traditional banks nor insurers: new actors on the financial markets have arrived to compete with the more longstanding actors – who have responded by adopting the new practices themselves. As a result the banks actively participate in the securitization processes of the credits they give, and insurers too are starting to securitize the risks they insure, to fight competition from new market entrants (Bühlmann and Lengwiler forthcoming). And when the national laws allow it, the same big financial groups carry out various operations with their subsidiaries.

[14] MacKenzie and Spears (2014) mention for example the introduction of *CreditMetrics* by J. P. Morgan in 1997, to evaluate credit risk, then the adoption of CDO Evaluator by Standard & Poor in November 2001.

Thanks to the techniques of derivatives, each component of the risk can now be covered by the creation of *ad hoc* instruments that can be traded on a market; this proliferation of financial instruments and derivatives markets triggered extensive change in the international capital markets, which have become a gigantic "risks fair." In parallel, the banks and insurance companies, whose job used to be to bear long-term risks in their balance sheets, have learned to pass those risks on by securitizing them. By the grace of the models of the third financial quantification convention, all assets (credits) and all liabilities (insurance commitments) can now be securitized. This is precisely the property of market-consistent valuation models to be able to price such brand new assets.

The political clout of the third convention is so extensive today that its models are promoted by banking and insurance regulators (with the Basel III framework for banks and the Solvency II framework for insurance). Ultimately it looks as though the regulators, being unable to stem the tide, took on the idea initially advocated by the ISDA that good risk management could be carried out by well-informed financial actors practicing daily valuation of their risk exposure based on market prices. This is what the third convention's mathematical instruments propose.

And so these instruments have also overseen a general disqualification of traditional risk assessment methods, which used to be based on *ad hoc* analyses. Since bankers can rapidly pass on the risks they acquire through lending, they no longer need to know their clients. All they need is a statistical approach to the default risk by category of borrowers (Baud and Chiapello 2015). Insurers, meanwhile, are gradually abandoning the traditional risk estimation methods that until now constituted their expertise.[15]

5. Conclusion

In this paper we have proposed a conventionalist interpretation of the financialization of the economy. To do so we have identified three periods, each one associated with conventional calculation systems that inform an investment decision. Each of these periods begins with the adoption of a new convention in the field of financial decision-making.

The significant factor in the actuarial period, which started with the 20th century, was the spread of DCF calculations. This marked a moment of rationalization of investment decisions, with the possibility of choosing between different projects on a solely financial basis. This convention constructed a commensurability between essentially disparate investments, all translated into

[15] These methods largely relate to the first quantification convention (ad-hoc estimation of the probabilities of damage and the cost of that damage, adjusted to present value by actuarial techniques).

cash flow terms. This period, with the breakdown of the 1929 crisis and the ensuing substantial reduction in financial market activity until the end of the 1960s, saw broad dissemination of the associated convention beyond the restricted world of finance. DCF became the rational method of investment selection in a Fordist period that gave priority to industrial investment and employment over ROI. This period is not usually considered as a period of financialization because the financial markets had only a minor role, yet it should be considered essential in the spread of financial calculation: it actually resulted in the technique of discounting being taken for granted as the accepted method for intertemporal calculations. The key word of this first period is "discounting": the key intellectual schema is that of pulling the future closer to the present. As seen earlier, the second and third conventions did not challenge the principle of discounting, but they did change the definition of the rate used, and then the mathematical structure of the calculation.

The second period was based on the portfolio model and the efficient market hypothesis, which were developed in the 1950s and 1960s. It was associated with asset managers' adoption in the 1970s of "quantitative" or "modern" methods from modern portfolio theory; these methods revolutionized the business sector in the 1980s, but also brought it legitimacy. Without that revolution, the lawmakers would probably have been less favorable to the banking disintermediation that was set in motion in the 1970s. The key word for this second period is "diversification"; the key intellectual schema (added to the first) is the portfolio concept.

These two periods bring out two professional histories that are initially mathematically heterogeneous: the history of financial valuation and the history of fund management. These two histories first drew closer in the second period through the use of a discount rate derived from portfolio models in an efficient market in equilibrium, and then became mathematically homogeneous in the third period through the use of the replicated portfolio concept in an arbitraged market, whose rate of return became the norm for financial valuation.

The third (and recent) period, which began in the 1980s, is associated with a total overhaul of the efficient market hypothesis thanks to the invention of mathematical models able to produce values needed to market derivatives, using portfolios whose cash flows replicate the cash flow values of derivatives (hence the term "replicated portfolio"). In particular, these models have made it possible to construct derivatives from underlying assets that are not themselves traded on the markets, creating "synthetic assets" that have underpinned risk securitization. These innovations have taken our economies into a new stage of financialization that started end of the 1990s. During the second period, bank and insurance firm balance sheets were modified to incorporate much larger securities portfolios, making these two types of organization major actors in the financial markets; the third period is characterized by large-scale redefinition of the traditional businesses of banks (credit) and insurance companies. The key word for this third period is "arbitrage." The key intellectual schema (added to the first two) is the replication concept.

In the first period, any "object" could be discounted to extract a present value. In the second period, this discounting was applied to a portfolio of securities. In the third period, that portfolio has become a possible replication of any item, even non-financial.

The arrival of a new convention does not necessarily quash the previous convention, which can continue to be used by certain practitioners for certain matters (private equity funds, for example, are still working with the first convention), but it can also redefined some professions by fragmenting them according to the convention followed, as we noted for the asset management industry. It can finally also give rise to brand new organized professions like the swaps and derivatives industry (ISDA).

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