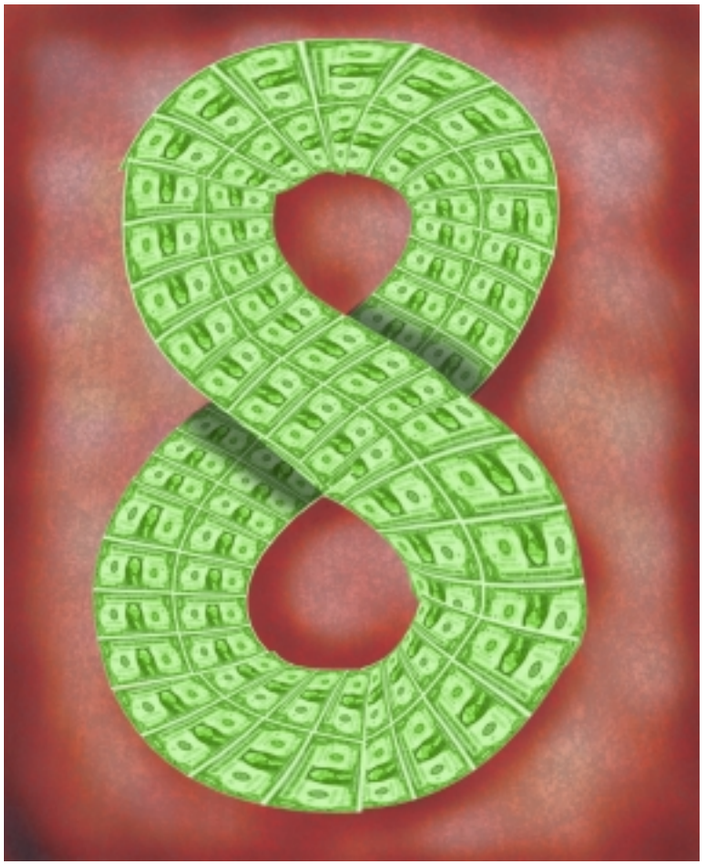
Elie Ayache

The "non-Greek" non-foundation of derivative pricing

This issue Elie Ayache croons 'Whatever will be, will not.' That is if we accept a standard definition of science



Thinking of derivatives, the first word that comes to mind is *infinity*. On the one hand, their creation process is literally infinite: derivatives can be written on everything and anything; derivatives can be written on derivatives. On the other, their fate and destination are never final. Derivatives always *restart*: they end up escaping any determined sequence that was meant to frame them in thought. If they can be summarized in one word, we can say of derivatives: "It is not what you think." No matter the initial design that may have resulted in the creation of this or that particular derivative, no matter the initial market scenarios and anticipations that the derivative was supposed to lock up in its particular payoff, sooner or later it is delivered to the market and traded in turn. It used to be an answer, a payoff supposed to settle; now it becomes the seed of renewed questioning. It used to be the end result of a pricing algorithm, now it becomes the input of a larger algorithm supposed to price more complex derivatives. Of the eternal activities ever entrusted to man, writing and trading are perhaps the two that really have no end – in a sense, they are the same thing – and they are precisely what derivatives are all about. Also derivatives are a play on the future, and the future is infinite by definition. Not mentioning the incommensurable consequences of derivative misfortune and misplay; the infinite losses, the abysmal blow-ups.

The importance of derivatives cannot be overemphasized. Some believe derivatives markets are the true drivers behind world economy. You can criticize them, you can resent them, but you cannot ignore them. All in all, derivative pricing has grown into such a body of knowledge and practice that it may be worthwhile to look at it from a broader perspective, to rise above the contingencies of its evolution and particular research programs, and try to question its foundation. I am not sure whether derivative pricing can be called a science yet. As a matter of fact, this will be one of my major questions today. So the foundation I am looking for is nothing like the axiomatic reconstruction that you would expect in formal science. Derivative pricing is not formal science because it is indissolubly linked to practice in its worldliest aspects. Beside theory and models, there is all the money involved. Derivative pricing models are not right or wrong. They make money or lose money; not mentioning the trader who will *immediately* put to practice, and trade upon, the particular pricing model that the quant hands over to him. If anything, I shall be looking for a foundation that makes sense of both the theory and practice of derivative pricing. Perhaps the unusual link between the theory and practice of derivative pricing, a link unseen in the other sciences, will yield a foundation of a very strange sort. Like the title says, I shall find a "non-Greek non-foundation" lying beneath derivative pricing. The formula is borrowed from Jacques Derrida. This is not the same as finding no foundation.

A foundational paradox

So let me first expound the fundamental paradox of derivative pricing. It is so fundamental and distinctive of derivative pricing that we might be tempted to say: "Derivative pricing *is* this paradox; this is the founding paradox of derivative pricing; this paradox is the reason why derivative pricing is so original; this is the origin of derivative pricing." Yet a paradox can hardly be the foundation of anything. The founding paradox is at the same time a foundational paradox and this is perhaps the reason why we wish to insist that, *as there is a foundation to derivative pricing (this paradox), by the same token there is no foundation*. The foundational paradox leads to a paradox in the formulation of the foundation. Writing derivatives entails strange consequences on philosophical writing about derivatives. Let us therefore turn the phrase differently. Let us say: Beneath derivative pricing *there is* a ... non-foundation.

The terms of the paradox are the following.

- *Derivative pricing theory presupposes a fixed collection of states of the world that represent all there is to know about the future*. I talk of "theory" and "theoretical representation" in order to stress the point that this is derivative pricing as it is taught in the textbooks and applied by all the quantitative analysts who are in charge of writing the pricing models and deriving the pricing equations. As such, derivative pricing theory has first to model the universe of possibilities. In the simplest case of Black-Scholes, the states of the world are different values of the underlying stock spanning zero to infinity. In more advanced pricing models you can include other state variables such as the interest rate, volatility, the hazard rate, air temperature, anything you might desire not excluding the political outlook of the country of interest. In a word, you first give yourself, you let be, a set of states of the world and the most important thing here is that this set is given and fixed once and for all.
- In the second instance, you *write a stochastic process, in the real probability measure, over those states of the world*, that is to say, you give yourself the probability distribution of moving between one state of the world and the other.
- Derivative pricing then consists of a formula, or an algorithm, or some black box, which takes the derivative as input and yields its price as output. In order to avoid internal arbitrage, this had better be some form of *risk-neutral expectation* acting on the payoff of the derivative. Indeed, by a well-known theorem, the one and only way of guaranteeing that the list of derivatives prices that you publish to the market will not allow anyone to make money out of you, by simultaneously buying from you and selling to you, is to *form* the prices as the expected value of the derivative's payoffs under some probability measure. This guarantees that the price is positive when the payoff is positive, and linearity of the pricing operator. This formal probability measure, underlying the expectation pricing operator, is called risk-neutral measure for the tautological reason that the price of a contingent claim is computed as the mathematical expectation of its payoff regardless of risk aversion or love of risk.
- Finally, we need to establish the link between the real probability measure and the risk-neutral probability measure, that is to say, we need a *pricing theory of contingent claims* running in the background. This can relate to a framework of utility functions or to a replication argument.

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Now what triggers the paradox is the simple observation that the *purpose* of derivative pricing is the trading of derivatives – or is it? – and that derivative trading will *by necessity* expand the original set of states of the world that was assumed to be fixed by derivative pricing.

Purpose

The whole paradox, and with it the foundation (or non-foundation) we are looking for, hinges on that word; 'purpose'. Is derivative trading really the purpose of derivative pricing? You may think not. You may think the trader is immersed in his market anyway and that the peculiar interaction between the trader and his market (or shall I say, between the market and his trader?), an interaction which is in any case specific to every trader and every market, is the real engine of price formation. No model or quant is needed here. At best, the model is needed by the risk manager who requires a coherent quantitative framework in order to compute theoretical risk exposures and theoretical profit and loss distributions for the trader. But then it comes to the same thing. True, the trader may not be using the outputs of the model directly, but the risk manager is ultimately helping him set up his trading. Derivative pricing may not be directly intended for trading, but the whole body of theory is directed towards trading.

Even though the trader may want to rely solely on the market to make the price or pick the price of the derivative, he will still need the model for hedging purposes. Not mentioning that the model will in most cases help him identify arbitrage opportunities. Cash and carry, or put call parity in the European case, are of course model independent. We may call them "intrinsic arbitrage" relations. General inequalities obtaining between options of different strikes and maturity dates, such as recognized by the seminal paper of Merton (1973), are also model independent (e.g. an out-of-the-money call will always be cheaper than an at-the-money call, options of longer maturity will be more expensive, etc.). The point is that, outside intrinsic arbitrage, every time somebody sells "volatility" on some option

and buys it on another, they implicitly rely on some model of the dynamics of the underlying.

This indicates that the trader is not completely independent of the model. As for the quant, he is not completely independent of the market either. Even though the model may impose some *a priori* structure on the market, it will still rely heavily on calibration to empirical market data in the most realistic and most advanced cases. The quant cannot rely solely on structural models. He has to write models that he can calibrate to the market. In sum, there exists a gray area between trader and quant, even in everyday theory and practice, and it induces us to believe that trader and quant are not that separate after all.

So far, so good. It just seems that derivative pricing theory and derivative trading practice are interconnected in the same expected, peaceful way that theory and practice are usually connected in other fields. Nothing nearly as dramatic as a paradox has been revealed, even less so, a founding paradox!

Actually, we haven't yet brought to the open the full meaning and implications of the word "purpose." To the theoretically minded, the foundation of derivative pricing may as well lie in probability theory, or economic theory, or stochastic calculus, or martingale theory, etc. And the purpose of derivative pricing may just be what it seems to be: computing the theoretical value of complex derivatives under complex stochastic processes. The trader would only *incidentally* make use of this quite interesting theory and quite interesting results! And there would really be no problem if it turned out that the traded prices of the derivatives are in all cases different from the prices predicted by the model. Indeed this would just be the ordinary story of empirical falsification of the theory and would call for no higher philosophical conclusion than the constant revision of the existing theory, the overall progress of science, the ideal end of inquiry, etc.

I say the application of derivative pricing to derivative trading should not be an aside or an afterthought. Making the trading of derivatives the *purpose* of derivative pricing is building-in the element of trading into derivative pricing *a priori*. We may be talking here of a different science than the one that the scientifically minded have in mind. Let us call *their* science – the science that is neither our intention nor the purpose of the word 'purpose' – the "theoretical valuation of derivatives." By reaction, this injects into our science and into the expression "derivative pricing" exactly what we need: an immediate affinity with the market and a propensity for trading. And now the paradox can take place. Let us it review it step by step.

As soon as the quant finishes up writing the formula, the algorithm, the model, supposed to price the given derivative and hands it over to the trader as the word 'purpose' dictates, the trader (who, of course, doesn't want to know anything about the model) will use the outputs of the model and trade the derivative. This will automatically turn the parameters of the model into stochastic variables, therefore contradicting the original model.

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Take Black-Scholes, for instance. The states of the world are values of the underlying ranging from zero to infinity, and volatility is assumed to be constant, or at least deterministic. As soon as the trader is handed over the Black-Scholes formula, he will start trading options in order to speculate on future volatility and bet against present implied volatility. As a result, implied volatility (or the volatility coefficient in the Black-Scholes formula) becomes stochastic. It becomes traded and the set of states of the world will now have to include different states of volatility. (Don't we currently refer to option traders as 'volatility traders'?)

This is our paradox. By the very mechanics of the pricing-trading process, volatility, first assumed to be constant, becomes stochastic. I say it is a foundational paradox because of the meaning of the word 'purpose' It signifies that the very thing that the derivative pricing model was designed for, trading, ends up contradicting the original assumptions of the model. How could derivative pricing, *as meant for trading*, be founded as a result of that? Pressing this question forward will lead us to the philosophical regions and outskirts announced by the title and awaiting Derrida.

From the foundational paradox to the founding paradox

Thinkers like Nassim Nicholas Taleb argue that quantitative finance will never be a science because of essential uncertainty. Essential uncertainty obtains when it appears that the next market movement is not only unpredictable because of its random nature but because no probability number can even be meaningfully assigned to it. Not only are we not certain what the moments of the random generator may be, we are not even sure that the random generator is of a certain general type. For all we know, the moments of the probability distribution may be infinite and no finite amount of data may ever help us infer its nature. Taleb goes on to criticize the ingenuity and the computational efforts that are spent everywhere on derivative pricing and risk management when it is not clear, to begin with, whether "we are playing with the right dice"!

Notice that Taleb's criticism is external to the science. He certainly reaches for the science and wishes to open the eyes of the scientists engaged in the field; he rightly distinguishes between what he calls "probability calculators" and "probability thinkers"; and it definitely is a fact, as Taleb says, that empirical reality may contradict

the model. But, then again it may not, or at least, not anytime soon; the probability calculators may consistently believe, if for a while, that their random generator is the right one (or perhaps it is not *yet* the right one, but the right one exists and will be discovered in the near future); in a word, Taleb's skepticism does not impose itself by necessity. Taleb's skepticism does not call for a new philosophy of science: it is the age-old companion of philosophy of science. When Taleb questions the working field: "Is your model, is your science, well-founded?" he means "by empirical reality."

By contrast, the paradox we have uncovered is more serious and more dramatically pressing. It is internal to the science. Taleb claims: "Derivative pricing is probably not a science. It cannot establish itself as a science by its own means; so the question is completely left open to the external world, therefore to skepticism, whether it is a science or not." We claim: "If derivative pricing should ever be the science whose purpose is derivative trading – as opposed to the theoretical science of derivative valuation –, then, *following its own logic*, it leads to a foundational paradox." Our claim is stronger than Taleb's because it amounts to a *reductio ad absurdum: If derivative pricing should ever be a science, then it can never be a science*. (Not mentioning that uncertainty about the states of the world is worse than uncertainty about the probability distribution overlying them.)

While Taleb's questioning sets us on the mission of finding out what it is, in the external world and in the nature of markets, that will always break derivative pricing as a science, ours sets us on the more intriguing mission of finding out what it is, *in derivative pricing itself*, that will always break it as a science. Of course things could have remained as disentangled and contingent and normal in our case as in Taleb's had we not insisted that our science be defined as the science-with-the-purpose-of-trading. To repeat, the explosive charge in our case is all packed in the word 'purpose,' so aren't we creating our own problem here? This takes us back to our general comments about the whole body of theory of derivative pricing being directed towards trading. What else could the quant be meant to do if not devising models and algorithms to hand over to the trader to trade the derivatives?

In Taleb's case, the questioner is ultimately led to a choice between optimism and pessimism, between (blind?) faith in the science and resigned skepticism. In our case, there is no such freedom of choice. Once we mean the science and the system of science is *go*, we can no longer abort the ignition sequence. When it later turns out, because of the paradox, that the science we meant cannot be founded within traditional philosophy, it is the foundation we will have to question not the science, perhaps even the deeper philosophical categories on which the founding character of the foundation lies. By thus changing the philosophical logic, we can hope to change a foundational paradox into a founding paradox.

The tradition

How have we traditionally dealt with the paradox? Traditionally, it is believed that writing derivative pricing models is the quant's business and trading the derivatives is the trader's business. These are two people with totally different temperaments and, sometimes, backgrounds. The quant complains that the trader is too impatient to want to understand the model and the trader complains that the quant is absolutely removed from the markets and the way the 'stuff' really trades. You sometimes wonder whether the two are in the same business at all. (My whole search for a foundation can be reinterpreted as trying to find a way to *philosophically* reconcile the two, when the paradox seems to indicate that this is not *scientifically* possible. True, quants usually strive to become traders although I haven't seen many traders wanting to become quants. I am one, by the way. I used to be a trader and now I am a quant. That I should wind up in philosophy must be an indication that the route from trader to quant is a dead end. So perhaps being a quant is but a transient state. Otherwise I wouldn't have all this trouble trying to define what the quant is doing and to what purpose.)

Like I said, we should be aware of the relativity of purposes here. To the quant sitting peacefully in his office, patiently devising the model and deriving the pricing formula, the purpose is very clear: to price a given derivative under a given stochastic process. Usually the derivative is quite complex and so is the stochastic process. This is what keeps the quant busy and gives him a feeling of depth. The paper that the quant produces invariably begins with the specification of the stochastic process and ends up with the formula for the price of the derivative. Despite the interdependencies we mentioned earlier between model and market, or quant and trader, the quant feels that his attraction towards the trader (either going to him and handing him over the derivative pricing formula, or frankly wanting to be in his shoes) is purely due to the organization he is part of. He hands over the formula because he is paid to do so and he wants to be a trader because this is the ultimate reward. In neither case is the drive or the purpose internal to the science.

As a matter of fact, the quant believes that whatever happens after he has finished writing his paper just happens by accident. He believes it is an accident that the trader should take the model from him and break it. That the derivative, whose exact pricing was his late purpose, should start leading a trading life of its own and end up contradicting the assumptions of the model is not his business. It was no part of his theory and what he had to think about *a priori*. The paper invariably ends with the formula to price the derivative and nobody says what happens afterwards. Pushing the thought to the extreme, even the *market* shouldn't exist, according to the quant. And by that I mean the market that will take over the derivative from him and make it restart at the end of the paper. Only stochastic processes exist and, like I said, they are posited at the beginning.

A foundational view of the market

This distinction between market and stochastic process will guide the rest of my reflection. While the second is a theoretical construct and is required as a first step in derivative pricing – so I am far from suggesting that we should dispense with theory and stochastic processes – the first is interesting and original *inasmuch as* it takes over the derivative after its theoretical value has been derived. The market makes its presence felt by thus taking the derivative away from the model. You may insist that the market is but an indis-

tinct arena where all kinds of things trade, derivative or no derivative. The reason, however, why I think derivatives are singular and may be the gateway to philosophical reflection about the market at large, is precisely the structuring that they impose on the story. It is all because of the dramatization, which builds up with the mathematical derivation of their value and climaxes with the paradox.

When you think about it, it is the derivative nature of the derivatives that commands the theoretical episode; the derivation of their value as a function $f(S, \dots)$ thus gives everyone the feeling of science. Yet the derivatives end up traded in the

same place, and on the same plane, as the underlying. Another way of putting the paradox is that we need both the derivation (the structure, the hierarchy) and the leveling out. To my mind, the market should strictly speaking neither be identified with the ultimate leveling out and the totally unstructured arena nor be retracted into theory and structure. I believe it lies precisely in the *movement* between the two; it gives itself at the exact transient moment when the coming to life of the derivative imposes the necessity of model change. On the one hand, the effervescent nature of the arena can make you despair of any foundation. On the other, the structural-foundational view of the market will lead, as we shall see, to the death of the market. It will be my contention that the *dynamics* that I am trying to establish between the two extremes – that the market should be interesting, even be defined, *only inasmuch as it takes over the derivative* – can take its cue from the philosophy of Jacques Derrida. Being thus displaced and unsettled between the foundation and no foundation is what earns it the title of "non-foundation."

But let us go back for a while to the structural and orderly view, and see what fate it reserves for the market. Like we observed earlier, the derivative is not supposed to trade in the quant's ideal world. Having posited the market as a stochastic process at the start, the quant has no choice but to ignore it at the end and deny the derivative any sort of trading future. Invariably the answer is a perennial pricing formula. This is the same as saying that the world is closed in a fixed set of states and will never expand. The only way to make sense of the progress of science, following that logic, is to think of the *next* quant who will expand on the previous paper and literally expand the states of the world. When the first assumes volatility is constant, the next will recognize it is stochastic. Heston follows Black-Scholes. But no sooner have implied volatility smiles become the rule than the next quant steps in and questions Heston's ability to account, say, for *both* the traded prices of the vanillas and the exotics (barriers, cliquets). In his turn, he will have to further expand the picture, by allowing the parameters of Heston to become stochastic.

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All in all, it seems that every episode, when taken in isolation, is failing to catch the meaning of the market and its significance. Only through the total chain of nested models is the market emerging as a kind of asymptotic truth, and the hope is that, in the "ideal end of inquiry," an ultimate model will be found, both global and stationary, and that historical calibration will agree with cross-sectional calibration. In other words, the ultimate model will have to instantly account for all the traded prices of derivative instruments and the agreement will have to persist. It is as if we had found at last the true random generator and derivatives were consistently priced on top of that.

But this would exactly mean the end, i.e. the death, of the market. If the market were closed in an ultimate formula, everybody would agree on the value of derivatives and nobody would trade them anymore. I am not sure anybody would want to trade the underlying either. What good is a random generator that everybody knows will never fluctuate? Markets are a much more advanced technology than roulette. Like I said earlier, markets are a much "bigger" idea than the unveiling of the next random draw of a stochastic process. Even the idea that no probability number may be meaningfully assigned to the next random draw is not big enough. The market is the process of change of the trading and pricing contexts. It is the process of change of the stochastic processes and you should not even *think* of writing down that process, or even call it a "process," for then the market will also change it, and that change will also be part of its definition. This is why derivatives are needed as both a writing concept and a trading concept. Every derivative structure and every derivative pricing model (Derrida would call them "scriptures") are but a summary of a pricing context. By placing the market at the end of the derivative structure/model/paper, by placing it at *the end that is now ready to start*, we insist on both the context and its change; we insist on the context in its change; we insist that the derivative should both be priced and traded.

Now obviously this cannot fit within the traditional foundational view. Recall that the market is absent from every local episode – for then the derivative is not supposed to trade – and

absent from the global picture, which tries to make sense of the progress of science and of the intimate purpose of every quant – for then it leads to the death the market.

The market as non-origin

Earlier I said that the market is original, and makes its presence felt, only inasmuch as it takes over the derivative and re-immerses it in trading. The derivative is interesting because of the hierarchy it entails between underlying and derivative and because of the episode of derivation of its fair value (which gives us all the feeling of science). And now the market is original, not because it removes the science and destroys the previous model and knocks down the hierarchy, not because it says "Everything is a traded price and no pricing model shall ever be needed," but because it says "Everything has always been a price, *especially when* derivative pricing models have actually been developed, and especially *through* them."

Trading concepts emerge despite the pricing concepts, or rather, they keep emerging *through* the pricing concepts. Take Black-Scholes for instance. The Black-Scholes formula is great, of course, but I believe the most original contribution of Black-Scholes, and the reason they will be remembered in the history of trading, is the concept of *implied volatility*. This is the story of the inversion of the formula. Everything is a price of course and the prices of options will always be given by the market. There is no point in debating here whether the Black-Scholes formula is the origin of option prices or whether the market is that origin. What is truly original, I think, is the step of inverting the formula and the new language it has earned us. Everybody talks today of buying and selling (implied) volatility, of trading volatility, etc. Implied volatility is important because it is a trading concept (when the Black-Scholes derivation, and the subsequent formula, are just a pricing concept).

Implied volatility is the original concept. Through it, the market restates its originality. Yet, when you think about it, implied volatility goes exactly against the origin. It sets the market as a non-origin. Indeed, *implied volatility* technically means that you invert the Black-Scholes formula against the market price of the option, and that you infer, or imply, the volatility coefficient by this inversion. But what implied volatility really means is *stochastic implied volatility*. Why? Because you are implying it from empirical data, from the options markets. Chances are the prices of options will be different the next day and you will imply a different volatility number. So as soon as you commit yourself to inverting the formula, you commit yourself to everything that went into my paradox. You commit yourself to the purpose of derivative pricing being trading, not writing a paper, and to implied volatility being stochastic.

Now think of the origin. It is as if implied volatility, the original concept, was telling us: *The initial derivative pricing model should have been written as the Heston model, not as Black-Scholes*.

Implied volatility is the real output of Black-Scholes; it is the original contribution of Black-Scholes; it is Black-Scholes; yet, by its very meaning, it is telling us that the model should have been Heston. And the same applies at the next level. You wake up to stochastic volatility and to implied volatility smiles; you calibrate the Heston parameters to the set of prices of vanilla options and the following day you re-calibrate. The parameters become stochastic. Then you realize that the market prices of exotics (e.g. barrier options, cliquets) cannot be matched by Heston. All of a sudden, smile dynamics becomes the issue and you may now read the new sentence of the market: *The initial derivative pricing model should have been written as stochastic Heston, not as Heston, and the market prices of exotics should have been used to calibrate the smile dynamics*.

Black-Scholes helped us price the vanilla options and the vanilla options were traded. Heston helped us price the exotic options (after due calibration to the implied volatility smile of the vanillas) and the exotic options were traded. It is as if the *next trading derivative* always made it apparent that the underlying stochastic process should have initially been written otherwise, or in other words, that it is always being "retroactively rewritten."

You can see here the two eternal activities at play: the writing and the trading; or rather, you can see their productive conflict. Everything is always a traded price, yet a derivative can always be written and its value derived. Now if we place the originality of the market at exactly the moment when this happens, at the exact moment of re-calibration and context change, what will become of the origin? What could ever be said of the origin of pricing, trading and writing?

The sequence leading from Black-Scholes to Heston to stochastic Heston does not occur in time. We are not talking of derivative pricing as a sequential learning process or of the market as an evolutionary organism. Indeed the word "purpose" and the word "meaning" do not unfold in time.

Once again, the *purpose* of derivative pricing is derivative trading. This means that the real output of Black-Scholes is implied volatility. And the real *meaning* of implied volatility is stochastic volatility. Putting the two together, this means that Black-Scholes is Heston is stochastic Heston is ...

The market is this infinite, non-converging, sequence, taking place all at once. Let us then recap what the market is. The market is neither a closed set of states of the world (where the derivative is prevented from trading) nor a completed whole enjoying ultimate closure. Like the character Max Cohen in the movie *Pi* put it, the market "is what's between the numbers." It finds its place in the "re-" of re-calibration.

The market as trace

We may thus lay down the agenda of a philosophy of derivative pricing.

This is a philosophy where it is both recognized that the purpose of derivative pricing is derivative trading and that, by the very meaning of the market, no ultimate, stationary model should ever be found. In other words, the question is: How not to make it an accident that the derivative model should be recalibrated, but make it its indispensable feature, and how not to make it an accident that the market should never "end," but make it its defining characteristic?

Essentially, we are insisting that the market should always be *unsettled*. And so should be its definition. We are rejecting both the views that the states of the world may be given once and for

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all and that the ultimate, stationary model should eventually be found. Both views presuppose *presence* as the ultimate grounds (presence to mind of the fixed set of states, presence to mind of the ideal end of inquiry), yet both views negate the being of the market. In the first, derivatives markets aren't supposed to exist, and in the second, the market at large will stop existing. So perhaps the market and presence are incompatible?

We seem to have gathered now all the strands that make up a non-foundational philosophy of derivative pricing, or in other words, a philosophy that falls outside the *metaphysics of presence*. To be sure, there is a sense in which the market is the origin of everything. It is the origin of the whole activity of derivative trading and writing – No derivative would exist if the market didn't exist – and our whole enterprise of looking for the foundation of derivative pricing can still be phrased in one question, probably the *arche*-typical question (Derrida calls it the "instituting question of philosophy"): What is the market? Yet we have glimpsed a sense, in the course of our analysis of the meaning of derivative pricing and its purpose, in which the originality of the market lay precisely in its being a non-origin. The market, we said, resides in the "re-" of re-calibration. The origin we are looking for resides in an endless process of re-writing which "should always have taken place initially." To borrow from Derrida, the market is a case of *originary repetition*.

As a matter of fact, the market has the character of a *trace*. Its originality implies the disappearance of the origin; it implies the abolition of such (originary) statements as: "In the beginning, there was the market; then the derivatives came along and were traded." We aren't even sure that the market has ever had the properties of permanence and presence that first give meaning to a statement such as: "The market is ..." Like we said, the "being" of the market – if there should ever be such a thing – may be altogether incompatible with presence. Yet the origin (which is still, in many ways, the market) did not even disappear, for only what is present can disappear. The market was never really constituted and never really present. It was never constituted except reciprocally by a non-origin, that is to say, by the original and unsuspected feature of re-calibration.

Yet surely there must be something, some thread, running below our whole argument for it to be possible to speak of derivatives in the first place – for how could we speak of derivatives if there were originally no market and no underlying? – then to recall their purpose as being one of trading, then to instate the originality of the market at *the end of the derivative paper* – at exactly the moment when the derivative is taken over by the market *despite-and-through* its late theoretical derivation. True, the market may have been negated as presence at every single step of the foundational argument. We still require some "marker" of the market to run below our overall argument and across our paradox, in order to allow us to set this game of hide and seek. This trace of the market, which comes "before" our argument yet is carried "within" our argument, this trace, which is the origin of derivative writing yet finds its originality in derivative trading, literally takes place below presence. It exists, yet it is not present. As Niall Lucy says, "This residue which both remains and comes before has a very strange ontology".

Suffice it to say that the trace – the market *as* trace – functions to *unsettle* the metaphysical determination of the market (i.e. its determination in presence). It is contrary to a foundation; it literally opposes the foundation; yet it is not synonymous with "no foundation." As for the epithet "non-Greek," it refers to the Greek origin of all Western philosophies and to the belief that "Before everything, there is the *Logos*, the undeconstructible origin of the meaning of being, the rationality of thought, the absolute interiority of truth". Logocentrism, as Derrida says, refers to "the determination of the being of the entity as presence". "The metaphysics of presence then, for Derrida, consists in the valorization of presence [...], that is, it consists in the validation of presence as a foundation." Leonard Lawlor, from whose book we are drawing this citation, then goes on to write:

It is important to point out immediately that Derrida never contests the founding validity of presence; there can be no foundation without presence. Yet, for Derrida, there is a non-foundation below it, what we could call, following what Derrida says in "Violence and Metaphysics," the "non-Greek" non-foundation. The metaphysics of presence, however, has decided that the meaning of being is presence either as subject or object or as their unity. Thus it does not re-open the question of being; it remains above in the security of the foundation. It remains Greek.

REFERENCES

cf. Elie Ayache, "Being and the Market", *Wilmott*, May 2005.

Trace is one of the concepts that Derrida gives to explain how meaning works. It belongs to a series that includes *différance, writing, supplement, text*, etc. As Niall Lucy remarks, the trace "functions to unsettle the sign's metaphysical determination" (Niall Lucy, *A Derrida Dictionary*, Blackwell Publishing 2004, p. 144).

op. cit. p. 145.

Niall Lucy, op. cit. p. 71.

cf. Jacques Derrida, *Of Grammatology*, trans. Gayatri Chakravorty Spivak. Baltimore and London: Johns Hopkins University Press, 1984, p. 12.

Leonard Lawlor, *Derrida and Husserl, The Basic Problem of Phenomenology*, Indiana University Press 2002.