

LES CAHIERS

# Louis Bachelier

*Financial Markets*  
TOWARDS  
RADICAL REFORM  
OF RISK

WITH

CHARLES-ALBERT LEHALLE  
STÉPHANE CRÉPEY  
JEAN-PAUL LAURENT  
ANDRÉA PALLAVICINI  
ALBINA DANILOVA



#15 November 2014

## PROMOTING, SHARING AND DISSEMINATING FINANCIAL RESEARCH

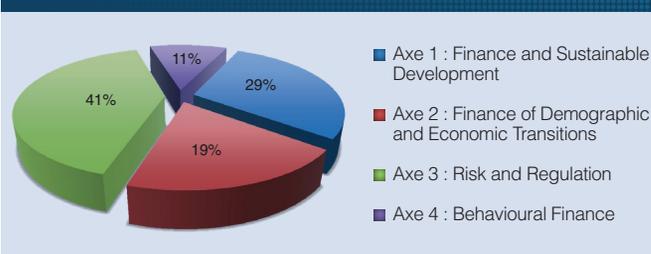
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## EDITO

In recent years, activity in the capital markets has been profoundly altered by the subprime and sovereign debt crises, particularly with respect to counterparty risk, collateral and liquidity risk. Credit and debit valuation adjustments (CVA and DVA), for taking account of parties' default risk in over-the-counter derivative contracts, along with the cost of funding these contracts (FVA) compared to the cost of margin calls under centralized trading through clearing houses, have become major concerns for banks. The market for credit derivatives has also been greatly affected. Electronic markets and high frequency trading have continued to grow, giving rise to crucial new questions with regard to risk.

Recent regulatory changes have further underscored the urgent need to acquire quantitative tools for better understanding and managing these risks. The FBF Chair "Marchés en mutation vers une refondation des risques en finance" (Changing markets: towards radical reform of financial risk), co-directed by Nicole El Karoui, Nizar Touzi (Ecole Polytechnique) and Monique Jeanblanc (EvrY University), is the outcome of synergy on these topics between research teams in financial mathematics at the Ecole Polytechnique's Centre for Applied Mathematics and Evry University's Mathematics and Modelling Laboratory. The Chair aims to provide appropriate answers to these new challenges in modelling and calculation, so as to radically reform the management of financial risks, in all their variety and complexity.

This issue of the Cahiers Louis Bachelier puts into perspective a selection of studies presented by Charles-Albert Lehalle, Jean-Paul Laurent, Albina Danilova and Andrea Pallavicini at Chair's 2013-14 workshops, as well as the recently published book Counterparty Risk and Funding: A Tale of Two Puzzles (S. Crépey and T. Bielecki, with an introductory dialogue by D. Brigo, Chapman & Hall/CRC Financial Mathematics Series, June 2014).

Stéphane Crépey

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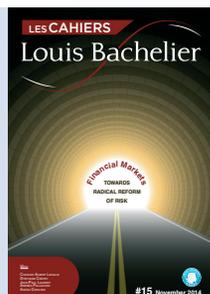
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INSTITUT LOUIS BACHELIER**  
Palais Brongniart  
28 place de la Bourse - 75002 PARIS  
Tel. 01 73 01 93 25  
[www.institutlouisbachelier.org](http://www.institutlouisbachelier.org)  
[www.louisbachelier.org](http://www.louisbachelier.org)

**PROJECT MANAGER**  
Cyril Armande  
**CONTACT**  
[cyril.armande@institutlouisbachelier.org](mailto:cyril.armande@institutlouisbachelier.org)

**EDITORIAL DIRECTOR**  
Jean-Michel Beacco

**CHIEF EDITOR**  
Isaure Du Fretay  
[idufretay@lacotebleue.fr](mailto:idufretay@lacotebleue.fr)

**JOURNALIST**  
Coralie Bach  
[coralie.bach@institutlouisbachelier.org](mailto:coralie.bach@institutlouisbachelier.org)

**GRAPHICS DESIGNER,  
COVER AND IMPLEMENTATION**  
Gael Nicolet  
La Cote Bleue  
10-12 place Vendôme - 75001 Paris  
Tel. 01 44 76 85 85  
[www.lacotebleue.fr](http://www.lacotebleue.fr)

**PRINTER**  
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## Will electronic platforms replace market makers?

Financial markets have changed dramatically in recent years. As well as being more controlled, they also use more electronic platforms, facilitating the interaction of buyers and sellers and speeding up the frequency of transactions. This new structure calls into question the traditional role of market makers. Do they still serve a purpose? And how do we redefine their position in overwhelmingly electronic markets?

Based on the book *Market Microstructure in Practice* by Charles-Albert Lehalle et Sophie Laruelle and on an interview with Charles-Albert Lehalle.

## BIOGRAPHY



### Charles-Albert Lehalle

Currently Senior Research Manager at Capital Fund Management (CFM), Charles-Albert Lehalle is an expert in market microstructure and optimal trading. Having been global head of quantitative research at Credit Agricole Cheuvreux and responsible for research on market microstructure in the Equity Brokerage and Derivatives department of the Credit Agricole investment bank, he has given careful consideration to changes in the microstructure of markets following the financial crisis and since the European and U.S. regulatory changes of 2007 and 2004. He is also a member of the ESMA Financial Innovation Consultative Working Group. Charles-Albert was recently appointed visiting researcher in the Department of Financial Mathematics at Imperial College, London.

Advances in computer technology and the Internet boom have significantly changed the financial markets. Electronic exchanges have increased in number, and are gradually taking precedence over over-the-counter transactions. This shift is encouraged by regulators, who see this operational procedure as a good way to remedy lack of transparency. Indeed the crisis has revealed the opacity of certain transactions and the resulting risk. It has been possible to acquire substantial positions in assets without the authorities being alerted. Regulations have therefore followed with a view to shifting a portion of OTC transactions to electronic platforms. The objective is clear: to improve the visibility of these transactions and thus have better control over them. The European MiFID (Markets in Financial Instruments Directive), the second version of which – MiFID 2 – is currently being implemented, also moves in this direction. But paradoxically, this gradual migration of transactions to electronic platforms, with a view to increasing the security of markets, has also promoted the rapid expansion of high frequency trading – a form of trading that is giving rise to concern and criticism.

### Do market makers still serve a purpose?

It is in this context of regulatory change that Charles Albert Lehalle has analysed recent developments in market microstructure

and the issues that these changes give rise to, particularly with regard to the role of market makers and of high frequency traders.

By agreeing to take a buy position and sell it a little later, the market maker facilitates the link between buyers and sellers, and provides liquidity. But as a result of electronic platforms, the encounter between the two parties concerned is now easier. Sellers can more easily subdivide their purchases or sales, and thus succeed in placing their operations. The need for market makers is less evident. Charles Albert Lehalle thus raises the question of the relevance of their activity in predominantly electronic financial markets. Are market makers still useful, or more precisely, when are they really of use? Asking this question involves examining the level of liquidity. At what point is it sufficient? How can market makers increase it?

### Constructing liquidity segments

The answers vary and should be considered asset by asset. Some products are fairly volatile and sensitive to various external events. New information has an impact on price. The more frequent this information, the more prices are volatile, and the more market makers are useful. Thus, equities are influenced by information arriving on an almost daily basis: the release of a new product, a change of strategy, the



“ The rules should be stricter for highly liquid assets, and it is here that market makers can be really useful. ”

emergence or disappearance of a competitor, etc. For such assets, the role of market makers is essential, but also complicated to define. Since the price formation process is continuous, it is difficult to determine exactly when liquidity needs are high. Even within equities, there are differences in terms of liquidity levels.

In contrast, exchange rates are relatively stable. Their evolution is mainly linked to changes in the rates of central banks. Liquidity needs arise at specific times and are centred on these periods. The intervention of market makers should therefore focus on these precise moments.

#### High frequency traders: a danger or a necessity?

This new organization of the market has also seen the emergence of new actors. Sustained by the introduction of electronic transactions, high-frequency traders are on the rise – a trend that is likely to accentuate with the rise of electronic stock exchanges. Indeed, the more electronic transactions advance, the greater the frequency of transactions. This acceleration in trading gives rise to questions about the possible adverse impact of high frequency traders on market stability. Are they dangerous? Should they be controlled? The subject is controversial.

In the opinion of Charles Albert Lehalle, these questions should be viewed in the more general framework of market microstructure. Like any other market maker, high-frequency traders manage aspects of the bidding process between buyers and sellers, providing a millisecond match between supply and demand, “In this respect, they serve a purpose,” says Charles Albert Lehalle. “However, regulation is certainly necessary, but it must be based on the definition of the profession of market maker.” In other words, the framework has to adjust in accordance with liquidity needs. The rules should be stricter for highly liquid assets, where market makers should really prove useful, and more flexible for other assets.

It would be a matter firstly of distributing financial products within liquidity segments, then, in a second step, of introducing rules adapted to each category. “The regulator has various tools to slow down or speed up trading,” says Charles Albert Lehalle. “The most liquid securities may, for example, be subject to a higher tick size<sup>1</sup>, or greater transaction costs.” The debate on regulatory changes should in any case not be limited to high-frequency trading. Rather, the market and its actors should be considered as a whole in order to best redefine the role of each player.

1. The smallest gap between two directly consecutive quoted rates. The quoted price may, for example, change a cent at a time

## Recommendations

- The role of market makers is changing with the implementation of electronic trading. It must be redefined in accordance with liquidity segments.
- This new definition should serve as the basis for the supervision of high-frequency traders, which should not be isolated from the rest of regulation.
- The opening up of European data to researchers would allow comparative studies to be conducted and would put the debate on an objective basis.

## Key points

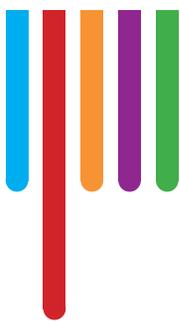
- The regulators are encouraging the migration of OTC transactions to electronic trading platforms.
- While this development increases the transparency of operations, it also calls into question the traditional role of market makers and favours the growth of high frequency trading.
- In this new context, it is important to review the function of market makers with regard to the need for liquidity.

### Further reading...

- D. Weild, D. E. Kim, L. Newport (2013) “Making Stock Markets Work to Support Economic Growth”
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- Albert J. Menkveld (2013) “High Frequency Trading and The New-Market Makers” *Journal of Financial Markets*, Vol. 16, No. 4., pp. 712-740



Find the Charles-Albert Lehalle's article on [www.louisbachelier.org](http://www.louisbachelier.org)



# When risk becomes bilateral – or how to take account of the new banking environment

The crisis revealed the fragility of banks. They must now take into account their own credit risk in managing their funding, as well as their hedging. These new issues necessitate reviewing traditional methods of calculating adjustments related to counterparty risk.

Based on the book “Counterparty risk and funding: A tale of two puzzles” by Stéphane Crépey, Tomasz R. Bielecki and Damiano Brigo and on an interview with Stéphane Crépey.

On 15 September 2008, Lehman Brothers officially closed its doors. The fall of the American banking giant ended the myth of the unsinkable bank, forcing financial actors to review their risk management. Banks, like any other investors, can now go bankrupt. As a result, the risk of counterparty default becomes bilateral and gives rise to the need for additional hedging. Bank funding is also affected. While financial institutions previously borrowed and lent at the same rate, the risk-free rate, they now face higher borrowing cost. The pricing of rates is no longer linear.

tion of the cost of funding? How are the specifics of certain products such as credit derivatives be to managed? Answering these questions becomes even more crucial with the development of centralized trading and clearing houses. Faced with different forms of trading (centralized trading and bilateral trading), banks must be able to implement a detailed evaluation of the respective cost of each form in order to adjust their strategy. The work of Stéphane Crépey and co-authors aims to define appropriate methods for addressing these issues.

## BIOGRAPHY



### Stéphane Crépey

*Stéphane Crépey is Professor at the Mathematics Department of University of Evry, France. He is director of the MSc Financial Engineering program M2IF at Evry University. His current research interests are Financial Modeling, Counterparty and Credit Risk, Numerical Finance, as well as connected mathematical topics in the fields of Backward Stochastic Differential Equations and PDEs. Stéphane Crépey also had various consulting activities in the banking and financial engineering sector.*

### Managing new risks

Faced with this new configuration, banks need innovative tools for calculating their financing costs. What are the consequences of this new pricing on bank funding? How are these parameters to be included in the calcula-

### From basic calculations...

The researchers carried out their work in a number of stages. First, they developed a mathematical technique capable of solving the problem of asymmetric pricing (as a result of the difference between the lending rate

## Methodology

The book Counterparty risk and funding: a tale of two puzzles develops a method of valuation and hedging of counterparty risk in the presence of financing constraints. This method uses the mathematical techniques of backward stochastic differential equations (BSDEs) and partial differential equations (PDEs), in an approach involving reduced risk of default by both parties to the contract. For counterparty risk on credit derivatives, dynamic copula models are proposed to capture the associated wrong way risk (the dynamic Gaussian copula model or the Marshall-Olkin dynamic copula model, i.e. joint default models). These dynamic credit models can be linked to the preceding reduced BSDE techniques to fully take into account the associated funding costs, leading to large-scale problems that would be numerically inaccessible with the more common PDE techniques.



and the borrowing rate). Based on the reduced credit risk approach and on the mathematical notion of backward stochastic differential equation (reduced BSDEs), this technique allows banks to calculate the cost of funding their current operations. However, it proves insufficient for complex products subject to special risks. Indeed, in some cases, the times when the counterparty has the highest

risk of defaulting are those when the counterparty guarantees the most money. Such risk is known as wrong way risk or adverse dependency risk. Credit derivatives (CDSs and CDOs), in particular, exemplify it. The phenomenon of credit contagion generates a dependency effect. Thus, if a bank fails, the institution that provides coverage of its credit also has a high probability of getting into financial difficulty. Both parties rely on the same markets. Yet the traditional reduced BSDE methods do not work in this case.

### ...to more complex operations

Adopting the so-called copula method, the researchers modelled the dependency of the two parties. The model defines the probability, at time  $t$ , of both parties defaulting simultaneously. It is thus possible to assess the potential loss to the party which purchased the product. The formula

was then made dynamic in order to calculate the cost of potential loss, at any time during the lifetime of the product.

Lastly, the researchers were able to combine the dynamic copula approach and the reduced BSDE approach so as to take account of both the funding issue and wrong way risk in calculating the hedging price. Through this model, banks can calculate all the costs asso-

ciated with the purchase of derivatives.

More generally, the work presented provides a response to the complexity of calculating ad-

justments related to counterparty risk (CVA, DVA, FVA). Investment banks are currently reviewing their methods of assessing these adjustments, on the one hand, to better reflect market volatility and, on the other, to include their own credit risk. The creation of a dedicated department, the XVA desk, comes within this framework and should be used to collect data and define hedges.

**“ Banks must be able to evaluate the respective costs of bilateral trading and centralized trading. ”**



Find the Stéphane Crépey's article on [www.louisbachelier.org](http://www.louisbachelier.org)

## Key points

- Banks are no longer immune to default and they too have become parties at risk. This new banking profile amplifies counterparty risk and makes funding operations more complex.
- Investment banks need innovative tools to better manage counterparty risk and the associated hedging. They must also be able to compare the respective costs of bilateral trading and centralized trading.
- A coherent and effective mathematical and numerical approach is possible.



## Further reading...

- S. Crépey and T. Bielecki (with an introductory dialogue by D. Brigo). "Counterparty Risk and Funding—A Tale of Two Puzzles". Chapman & Hall/CRC Financial Mathematics Series, June 2014.
- Brigo, D., M. Morini, and A. Pallavicini. "Counterparty Credit Risk, Collateral and Funding: With Pricing Cases For All Asset Classes." Wiley, 2013.
- S. Crépey. "Financial Modeling—A Backward Stochastic Differential Equations Perspective". Springer Finance Textbook Series, June 2013.

## Recommendations

- Establish a desk XVA in the front office, responsible for collecting data from the various trading desks and for calculating the corrections related to counterparty and funding risk. It is preferable to adopt dynamic modelling for these calculations.
- Use backward stochastic differential equation techniques for these models. BSDEs usefully complement the more traditional partial differential equation techniques. This applies at the theoretical level for the analysis of the problem, but also at the numerical level for solving large-scale problems.
- Credit derivatives should be subject to special treatment: the adverse dependency between the underlying exposure and counterparty risk creates a wrong way risk situation.

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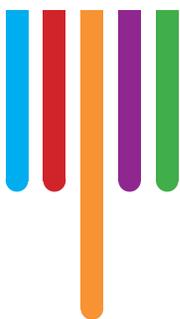
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## What is the most appropriate way to value over-the-counter derivatives?

Methods for valuing derivatives differ from one bank to another. These differences are not inconsequential since they directly affect obligations in terms of regulatory capital and thus the balance sheets of the institutions concerned. In view of this situation, Jean-Paul Laurent and his co-authors raise the question of the most appropriate method for valuing derivatives. How should the discount rate for future flows be defined according to different collateralization mechanisms?

Based on the presentation “Panorama des problématiques actuelles relatives à l'évaluation des swaps” [“Overview of current issues regarding the valuation of swaps”] and on an interview with Jean-Paul Laurent.

Over-the-counter (OTC) derivatives constitute a substantial market; yet how they should be valued is subject to debate. The not always transparent methods used vary from bank to bank, and decision as to which method to use has consequences for the accounts. Depending on whether the approach adopted emphasizes “fair value”<sup>1</sup> or “conservative value”<sup>2</sup>, the obligations in terms of regulatory capital are greater or smaller. The methodologies used therefore have a significant influence on the measurement of profitability and risk of losses on the portfolios, as well as how banks value and manage their risks. Thus the higher the discount rate, the smaller is the value of a “typical” portfolio of interest rate derivatives. A change, however small, in the discount rate can have

an impact of hundreds of millions of dollars on banks’ balance sheets, such as that suffered by JPMorgan. In early 2014, the investment bank recorded a loss of \$1.5 billion on its OTC derivatives portfolio, following a reassessment of funding costs. Regulators, including the European Banking Authority, have taken up the issue and are currently working on the introduction of a valuation framework for these products.

### Defining an appropriate method

The work of Jean-Paul Laurent and his co-authors addresses this situation. They aim to provide methods for valuing derivatives and to make explicit both the conceptual framework and the assumptions underlying such valuations. The problem

## BIOGRAPHY



### Jean-Paul Laurent

*Jean-Paul Laurent is a professor at University Paris 1 Panthéon-Sorbonne, where he leads the finance research team within the business department. He also holds the BNP Paribas Cardif “Management de la Modélisation” chair and is a member of the Scientific Committee of Labex RéFi. His research focuses on modelling and managing financial risks.*

## Methodology

The proposed methodology adapts earlier work on the valuation of interest income in the presence of different lender and borrower rates. It is based on the conventional valuation framework, combined with a unique risk-neutral probability for the savings account. This hypothesis is consistent with the large number of traded products, which is more important than the number of risk factors, thus allowing perfect hedging (redundancy of assets). Although the assumption of observability of an instantaneous short rate is not very realistic, it provides a simple calculation intermediary; the settlement prices associated with collateralized derivatives are themselves observable. Furthermore, this methodology focuses on the impact of the variability of the discount rates of the collateral, which allows a large number of practical situations to be analysed. Finally, in cases where the valuation of a new product depends on the existing portfolio of positions, the authors propose a simplified theoretical framework that should allow digital implementations to be facilitated.



is even more complex since the contracts in question vary considerably. For example, margin calls, intended to reduce counterparty risk, may be symmetric (each party may be required to transfer a guarantee deposit, known as collateral) or asymmetric (one of the two parties is exempted from the obligation to put funds aside, leaving the other exposed to counterparty risk). Similarly, the currencies and the discount rates used vary according to the bilateral agreement signed by the parties. The challenge is therefore to have available relevant valuation methods for all of these contracts. The situation varies considerably depending on the contracts and products. The valuation of derivatives handled by clearing houses is relatively simple because it is based on a liquid market benchmark. The discount rate is derived directly from the settlement prices used to calculate margin calls. The model tends to take second place. Valuation of non-cleared products is, on the other hand, much more complex. It is not based solely on observable market data. Some information, such as the cost of bank financing, is not readily available and cannot be easily inferred from market data. In this case, the valuation depends on parameters whose validity is debatable.

“ A change in the discount rate can impact bank balance sheets to the tune of hundreds of millions of euros ”

### Reducing arbitrary parameters

As a first step, the researchers produced an overview of the main methods used, establishing connections between the assessment methodology, transaction prices and rates observed in the markets. They then developed a computational framework for valuing various derivatives subject to collateralization agreements.

The proposed model thus serves various purposes. First, it ensures consistency between the prices of products traded, whatever the counterparty and form of collateralization adopted (through a clearing house or through bilateral agreement).

Secondly, it minimizes the number of arbitrary parameters used. These parameters are not based directly on market prices, and are therefore difficult to verify, while their impact on fair value or on conservative value can be significant. By drawing as much as possible on observable market data, especially on the discount rates provided by clearing houses, the model reduces the risk of error on the valuations of the most complex products. This more transparent computational framework becomes a tool for banks to manage risk and is a more reliable source of information for regulators and financial analysts.

1. Valuation of assets and liabilities based on an estimate of their market value or their utility value by discounting the estimated cash flows expected from their use. Source : *Vernimmen/ Les Echos*
2. Conservative value takes into account the uncertainty of measurements of fair value: such uncertainty may come in particular from market data used for valuations or from the risk model. Source: *Autorité Bancaire Européenne*

## Recommendations

- To reduce risk model, it is better to rely on as much as possible on observable parameters.
- Banks could benefit from being more transparent, with regard both to the valuation methodologies and to the hypotheses used. This does, however, involve sensitive information that reflects strategic choices and specific business cultures.
- It would be useful to compare the practices of different banking establishments, at an international level, without having to compensate for different national regulations (working with “a level playing field”).

## Key points

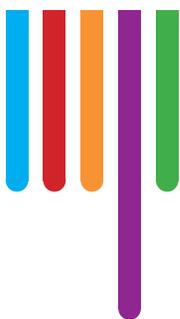
- Discounting procedures for derivative portfolios vary widely from bank to bank.
- Yet the method used has a direct impact on the capital and results of banks.
- Too great a complexity in the methods of assessment can have systemic effects by creating a feeling of mistrust between counterparties.

### Further reading...

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Find the Jean-Paul Laurent's article on [www.louisbachelier.org](http://www.louisbachelier.org)



## What is the impact of collateral on the valuation of derivatives?

Management of counterparty risk has resulted in increased use of collateral. But the assets that can act as a guarantee are becoming scarce and expensive. Investors must calculate the extra costs so as to adapt their strategies and adjust the valuation of their portfolios.

Based on an interview with Andrea Pallavicini and on the paper “Nonlinear consistent valuation of CCP cleared or CSA bilateral trades with initial margins under credit, funding and wrong-way” by Damiano Brigo and Andrea Pallavicini

## BIOGRAPHY



### Andréa Pallavicini

*Andrea Pallavicini is Visiting Professor at the Department of Mathematics of the Imperial College London. Since 2011 he has moved to Banca IMI in Milan as Head of Equity, FX and Commodity Models. Over the years he published several academic and practitioner-oriented articles in financial modeling, theoretical physics and astrophysics journals. He taught at professional training courses and at Master and Ph.D. courses in finance at different Universities and private institutions. Main contributions in finance concern dynamical loss models, risk neutral evaluation of counterparty risk, interest-rate smile modelling, and pricing of exotic derivatives.*

*He obtained a Degree in Astrophysics in 1995, and a Ph.D. in Theoretical and Mathematical Physics in 1999 from the University of Pavia for his research activity on LEP2 physics at CERN.*

All protection comes at a cost, a rule that applies to the financial sector too. To avoid a succession of bankruptcies, the regulator has encouraged the use of collateral in derivatives transactions. These assets serve as collateral against the risk of counterparty default. The trading of collateral, whether arranged by contract (CSA) for bilateral transactions or processed by clearing houses, has considerably increased in recent years. While this procedure is primarily intended to reassure the markets, it is not without consequences for the balance sheets of financial institutions. Indeed the sums involved are substantial and continue to grow. Raising funds is becoming more complex and costly, giving rise to an increase in the entry price to the market.

### Defining entry costs...

The precise amount of this increase as yet remains unclear. What are

the financing costs associated with setting up collateral? What method should be used to calculate them? And what is the ultimate impact of financing costs on the valuation of derivatives? Financing costs are in fact a direct component of the value of derivatives, but are difficult to assess. They do not always amount to a surcharge that would simply add to the transaction price without financing costs. A specific evaluation model is therefore needed. Andrea Pallavicini has accordingly developed a methodology that considers the financing costs as a value adjustment to be included in the trading book. The formula obtained takes account of insurance against counterparty risk (CVA and DVA) and dependence risk (wrong-way risk effect). Applicable both to bilateral transactions and to transactions managed by clearing houses, it allows derivative transactions to be evaluated by incorporating the various financing costs.

## Methodology

The valuation methodology consists in modelling hedging, funding and margining procedures as a strip of coupons to be added to the derivative contract. Depending on different classes of underlying risk factors the general valuation formula can be specialized to deal with specific contract issues (e.g. gap risk, cure periods). Moreover, the specific choices of close-out rules and margining procedures allow funding costs to be split into different contributions, which can be either additive or non-additive. In the case of interest-rate derivatives an explicit decomposition is achieved both for bilateral and CCP-cleared trades.



To build the model, Andrea Pallavicini first drew on the different rules regulating margin call mechanisms. The ISDA (International Swaps and Derivatives Association) and clearing houses lay down certain standards, among them, the obligation to remunerate collateral accounts at a specific rate of interest and the obligation to distinguish guarantees according to the transaction market concerned (credit, commodities, foreign exchange, etc.) by placing the associated amount of collateral in separate accounts.

He then integrated the various parameters of the cost of financing. This depends on many factors, such as the investor's strategy, the investor's credit quality and the policy of the treasury department – treasury lending rates directly affect investors' financing costs.

#### ...in order to adjust the value of portfolios

"The goal is not to find an equilibrium price for the whole market but to ascertain the price of market entry," says Andrea Pallavicini. "In reality, there is no single price because the costs vary depending on the players. The process can be compared to the cost of building a new house. Each building has a specific price, but it is based on a known list of parameters." The model thus determines the list of

costs that an investor would have to pay for the entire lifetime of the financial product, from purchase of the asset to resale, including, in the meantime, possible fluctuations in the market.

With this methodology, traders can determine the internal cost associated with the conclusion of a transaction and thus find out their market entry costs. This information is essential for estimating the value of derivatives portfolios as accurately as possible.

Such information is also necessary for the proper functioning of regulation policies. To reduce counterparty risk,

transactions are increasingly secured by margin call systems managed by clearinghouses. To be effective, this procedure requires that portfolios be properly evaluated, and that financing costs be therefore included over the entire life of the security.

“The goal is to ascertain the price of market entry”

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Find the  
Andréa Pallavicini's article  
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## Key points

- Increased collateralisation of bilateral transactions and the rise of clearing houses has increased the amount of collateral traded in markets.
- Margin call procedures have a cost: finding and financing collateral
- Funding costs should be included in the order book, to encourage less costly investments in financing.

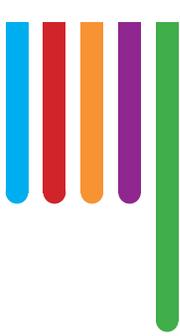


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## Recommendations

- Funding costs are a relevant issue in derivative valuation, since they directly affect the treasury funding policy.
- The development of a methodology to include such costs at trading book level allows the funding requirements of banks be optimized. Yet funding costs are not always a simple add-on to funding cost-free pricing but require a new approach to derivative valuation.
- The work of Andrea Pallavicini shows how to extend the valuation framework to include funding costs in a coherent way.



## What impact would a financial transactions tax have on market volatility?

Controlling volatility and reducing its excesses have become central issues for the proper functioning of markets and for limiting systemic risk. The introduction of a tax on financial transactions is sometimes presented as a response to these issues. But do we really know the impact of such a measure? What would be its effect on the transaction level and the degree of liquidity?

Based on the paper by Albina Danilova and Christian Julliard "Information Asymmetries, Volatility, Liquidity, and the Tobin Tax", and on an interview with Albina Danilova.

## BIOGRAPHY



### Albina Danilova

*Albina Danilova has joined the Department of Mathematics at LSE in 2009 and is currently an Associate Professor. She was awarded a Ph.D. by the Department of Operations Research and Financial Engineering at Princeton University. Before joining the LSE Department of Mathematics in 2009, she has held postdoctorate position at the Department of Mathematics at Carnegie Mellon University and Nomura Junior Research Fellowship at the Mathematical Institute, University of Oxford. Her research interests span asymmetric information, derivative pricing, stochastic calculus, insider trading, stochastic control, and equilibrium theory.*

The ups and downs of securities prices are a source of intense anxiety for investors. The subprime crisis more than ever put the question of volatility at the heart of economic concerns. The fear of again being confronted with massive price fluctuations, and a decrease in liquidity, are re-emerging. It is in this context that the proposed Tobin tax on financial transactions arises. These projects are often presented as tools to decrease volatility, and thus to better understand and manage financial risk in the markets. But how can this phenomenon be reduced, given that it is currently poorly understood? What factors are give rise to volatility? How can its excesses be identified and quantified? Though some elements are understood, many answers are still missing.

### Asymmetric information increases volatility

The study by Albina Danilova and Christian Julliard seeks to supplement this knowledge and gain a better understanding of how volatility is generated. It focuses in particular on the links between information asymmetry, trading costs, the volume and number of trades, volatility and liquidity. It also analyses, from a theoretical standpoint, the potential impact of a financial transaction tax on these different parameters.

The first point analysed concerns the relationship between volatility and the quality of information provided to the market. The authors find that volatility tends to increase when there are wide large differences between the underlying value of an asset

## Methodology

To study the connection between liquidity, volume of trade, the number of trades, volatility and market friction the authors consider a sequential trade model where: a) private information is dynamic, b) traders can choose whether and how much to trade, c) there is trading friction, in the form of a proportional trade cost i.e. analogous to a Tobin tax, and d) the volume of trade, the limit order book, liquidity, and (stochastic) volatility are all determined endogenously. In this model traders observe the market according to a weakly exogenous counting process, but this canonical assumption is later relaxed by considering a limit in which the traders' arrival rate rises to infinity, thus approximating a continuously observed market.

The authors also study the equilibrium price process at low frequency, by considering the market limiting behaviour as the number of trades per time interval rises to infinity



and the investors' perceptions of its value. Conversely, when the gap between the two is small, volatility remains low. The role of information is therefore crucial in ensuring correct price formation. If information asymmetry among traders is large, market prices are less informative, and this in turn increases volatility and reduces liquidity.

### A Tobin tax and volatility: a tale of two forces

The authors then analysed the potential impact of a financial transaction tax. The effects are twofold. On the one hand, such a tax automatically increases the transaction cost and hence increases the bid-ask spread, i.e. the difference between the purchase price and the selling price of a security set by a market-maker.

As the spread widens, volatility in terms of each transaction increases, and liquidity is reduced. In this respect, a financial transaction tax would have

negative effects on the market.

But the overall impact turns out to be more complex to evaluate. While volatility in terms of each transaction increases, this does not necessarily mean that the overall level of volatility increases. It is in fact necessary to include the number of transactions in the analysis. For the tax has a second consequence: it reduces the level of market activity. As costs increase, the number of transactions falls. With a Tobin tax, volatility per transaction is higher but there are fewer transactions, whereas in the absence of a tax, volatility per tran-

saction is low but there are more orders.

### "Asset specific impact"

It is thus difficult, in theory, to accurately determine the impact of a tax on financial transactions on volatility levels and market liquidity. Nevertheless, the study shows that a transaction tax slows the price adjustment process. When the fundamental value of an asset changes, a number of transactions are needed for the market price to correct itself. And since a Tobin tax reduces the number of operations, the adjustment process takes longer.

In their study, Albina Danilova and Christian Julliard do not pass judgement one way or the other as to the appropriateness of a financial

“ A Tobin Tax reduces liquidity, and reduces volatility in calm times while increasing it during financial crises. ”

transaction tax but they stress that such a tax would reduce volatility in calm times and increase it in hectic times (such as during a financial crisis)

– i.e. the opposite effect than what policy makers would like to achieve. Moreover, in the context of the currently proposed Tobin tax, they stress the importance of assessing in advance the impact of such a measure on an asset by asset basis, since its overall effect depends on the degree of asymmetric information and trade frictions of the individual asset. Therefore, they stress the need of further empirical studies to measure the degree of asymmetric information and trading frictions of the various financial assets available on the market.

## Key points

- Information asymmetry, trading volume, volatility and liquidity are all closely interrelated.
- A tax on financial transactions increases volatility per transaction but simultaneously reduces the number of trades. This implies an increase in volatility during market turbulences and a decrease during calm times
- The impact will in any case vary according to the financial product concerned and the level of information asymmetry.



### Further reading...

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Find the Albina Danilova's article on [www.louisbachelier.org](http://www.louisbachelier.org)

## Recommendations

- Continue research into volatility studies so as to better understand this phenomenon and be able to characterize excess volatility.
- The model presented provides a basis for further analysis, particularly on the empirical relationship between volatility and trading volume, and between volatility and the number of trades.
- If a tax on financial transactions were to be introduced, it would be advisable to adjust the level of the tax to the financial product concerned, based on trading costs and the degree of information asymmetry.



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*Université d'Évry Val d'Essonne*

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MODÉRATEUR  
**Ingrid Labuzan** (*Odénot*)

**INSCRIPTION:**  
Mail à **[cgailon@fbf.fr](mailto:cgailon@fbf.fr)**  
en indiquant Nom, Prénom, Établissement, Fonction.

**FÉDÉRATION BANCAIRE FRANÇAISE**  
18, rue la Fayette 75009 Paris

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