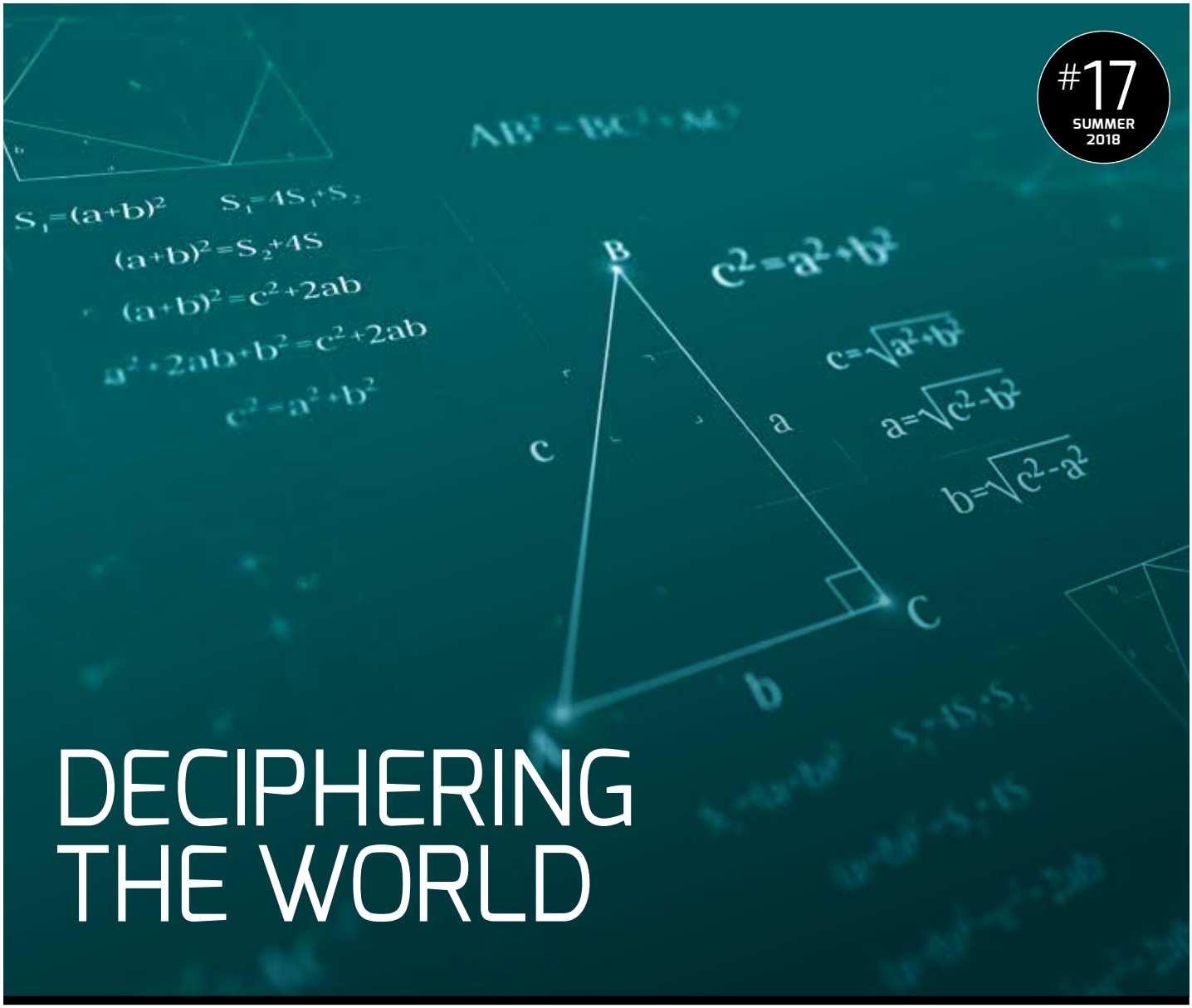
THE TOULOUSE SCHOOL OF ECONOMICS MAGAZINE

# TSE MAG

Living economics

#17
SUMMER
2018




## DECIPHERING THE WORLD

Catherine Bobtcheff & Carole Haritchabalet on biobanks

Céline Bonnet & Zohra Bouamra-Mechemache on taxing meat

Bruno Biais on derivative contracts and financial risks

Philippe Wahl on regulating the digital economy

# Deciphering the world


Christian Gollier


Jean Tirole

*Galileo stated that "nature is written in mathematical language". This might be an ethnocentric view, but mathematics for sure plays a major role in helping us to predict the world, and its practical applications have never been more important. As we embrace this digital age, we are more and more submerged in data and knowledge, increasingly reliant on artificial intelligence and algorithms to monitor and understand trends and behaviours. Math is all around us.*

*TSE has a long history of high-level research in mathematics, and the special relationship between our in-house economists and mathematicians remains very strong today. The first recruits of our institution were mathematicians: one of them, Jean-Pierre Florens, is still active in Toulouse and we are proud to feature an interview with him in this special edition of the TSE Mag dedicated to the work of our very active mathematics department. Inside the focus you will find interviews with several TSE researchers working on mathematical problems with far-reaching implications for the use of algorithms, big data, artificial and collective intelligence, optimization and machine learning.*

**TSE has a long history of high-level research in mathematics, and the special relationship between our in-house economists and mathematicians remains very strong today**

*Further on in this issue, we also feature a celebratory focus on the 25th anniversary of our research partnership with La Poste, via an exclusive interview with Chairman & CEO Philippe Wahl on the digital transformation of the company and the importance of regulating the internet, as well as the latest research results and news from TSE.*

*At this time of the year TSE organizes in Toulouse a wealth of academic events bringing our faculty together with renowned international peers in key areas. We also hold in Paris our outreach forums with practitioners: this year focusing on the impact of big data at the June Digital Forum, and on the management of renewables at the September Energy & Climate Forum. These events are open to all our readers, and we hope to see you there to better our understanding of the challenges that face our economies and societies, both today and tomorrow.*

*We wish you a pleasant read,*

***Christian Gollier,*** *TSE Director*
***Jean Tirole,*** *TSE Chairman*



## News & events





DECIPHERING THE WORLD



## Research



## Actors



## Campus

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# Appointments **& prizes**

## Fighting Terrorism at Source

This book written by Jean-Paul Azam and Véronique Thelen offers a unique and insightful evaluation of the policies used to fight transnational terrorism between 1990 and 2014. It uses game theory and structural econometrics to analyze the roles of foreign aid, educational capital, and military intervention. The authors show that US troops on the ground in foreign countries increase significantly the supply of terrorist attacks from the host countries.

## Sébastien Gadat

### appointed to the Institut Universitaire de France

The Institute distinguishes each year a small number of university professors for their research excellence. Only 2% of French university professors have been nominated by the Institute.

## ERC Advanced Grant awarded

### to Ingela Alger

Congratulations to Ingela Alger who has been awarded an Advanced Grant by the European Research Council for her research project "Evolving Economics – Human motivation: evolutionary foundations and their implications for economics". TSE consolidates its position as the second-largest European beneficiary of ERC grants.

## Jacques Crémer appointed Special Adviser

### by European Commission

The European Commission has named TSE's Jacques Crémer as one of three special advisers to Commissioner for Competition Margrethe Vestager until March 2019, focusing on the challenges of digitization for competition policy.

## Nour Meddahi

### elected to the Econometric Society

Nour Meddahi (TSE-UTC) has been elected member of the Regional Standing Committee of the Econometric Society, one of the most prestigious societies in the field of economics.

## Catherine Bobtcheff

### awarded prize

Catherine Bobtcheff has been named the best young researcher in Finance and Insurance by the SCOR Corporate Foundation for Science during the 11th International Forum on Financial Risks in March.

## Jérome Renault

### introduces game theory to Meteo France

The TSE-UTC researcher discussed the best game-theory strategies and their implications at Meteo France, for a series of scientific events called the "Découvrades".

## Jean-François Bonnefon

### on morality and machines

The TSE-CNRS-CRM-IAST researcher discussed the ethics of self-driving cars at the Quai des Savoirs in Toulouse in February.

Google self-driving car

## Queensland exchange program

TSE and the University of Toulouse Capitole are delighted to announce they have signed a new collaboration with the University of Queensland, Australia. This new agreement will allow students to join in semester or year-long exchanges in economics from 2019 onwards

## TSE water-saving project backed

### by the Occitanie region

The Occitanie administrative region has financed the C4EAU project on the use of smart water meters in agriculture. The project is led at TSE by Arnaud Reynaud (TSE-INRA), Sylvain Chabé-Ferret (TSE-INRA) and Stéphane Cézera (TSE-INRA) with researchers from Montpellier's CEEM and has the objective to test the use of innovative smart meters for water use in agriculture. Over the next two years the researchers will in particular test nudges based on real-time consumption data to optimize water use. They will also try to understand why some farmers refuse to have these new meters installed and how they could be convinced to change their mind. It is estimated that a 10% gain of water is possible through using these new technologies.

## Save the date

**28 SEPTEMBER 2018**

TSE Energy & Climate Forum Paris

**12 OCTOBER 2018**

Jean-Jacques Laffont Prize Conference Toulouse

tse-fr.eu/events

CATHERINE BOBTCHEFF AND CAROLE HARITCHABALET ON THE VALUE OF INNOVATION

# What are biobanks worth?

**By facilitating access to valuable biological samples, the growth of biobanks since the late 1990s has facilitated major advances in genetics and medical research. How can we ensure the economic viability of biobanks to encourage innovation? New research by TSE's Catherine Bobtcheff and Carole Haritchabalet underlines the importance of a biobank's strategic positioning in the marketplace, expertise and conditions of exchange. They identify information asymmetries between biobanks and research units, and suggest ways to resolve them.**

**Carole Haritchabalet**
TSE-Pau University

**Catherine Bobtcheff**
TSE-CNRS

### *What are the key challenges of running a biobank?*

The management of biobanks, which are usually attached to a hospital where patients provide the vast majority of the samples, requires considerable scientific and technical expertise. Biobanks must comply with numerous legal and regulatory requirements, particularly concerning the collection and transport of samples and the management of personal data. High-quality sample production requires a great deal of coordination between various professions. Research units then acquire samples for study that can be conducted independently or in coordination with the biobank.

### *How can we put a price on biobanks?*

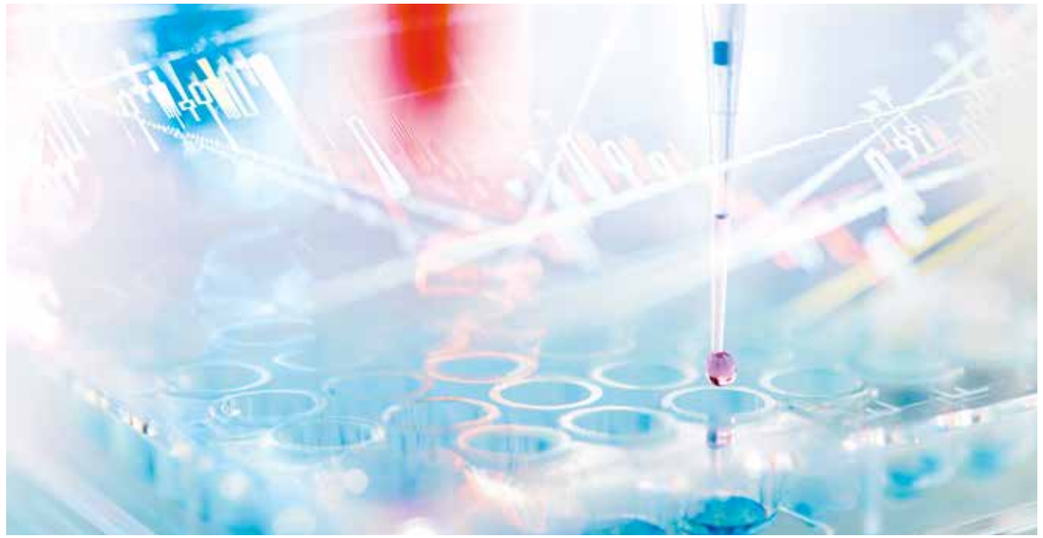
The problem of economic valorization of biobanks is mainly a problem of valorization of innovation. The success of innovation is highly dependent on the quality of the samples and on the degree of involvement of the various stakeholders in the sample production chain. This introduces significant problems of information asymmetry. Many economists, such as Jean Tirole (1999), have analyzed what the contract should be for the different parties to obtain adequate remuneration for their effort and to maintain incentives for innovation. In particular, these contracts call for distribution of innovation property rights between the different parties, and for payment of licenses and royalties.

> **The success of innovation is highly dependent on the quality of the samples and on the degree of involvement of the various stakeholders in the sample production chain**

### *How do information asymmetries impact the market for samples?*

The biobank is faced with a problem of adverse selection because the projects are carried out by different research units with different skills, proposing projects whose success and scientific impact are difficult to evaluate. This information asymmetry justifies the existence of a committee for the provision of samples, helping to identify the most promising research projects. It may also be difficult for a research unit to assess the quality of a sample at the point when the contract is signed. This forces biobanks to advertise their quality. Costly specific actions, such as certification or labeling, are often required. By establishing an academic record of its successes, a biobank can eventually acquire a reputation that mitigates this problem.

Moral hazard is the form of information asymmetry that is most often found in the operation of biobanks. The different professions can carry out the tasks of sampling, annotation and conservation with varying degrees of care and coordination. The quality of the samples can thus be manipulated by the biobank, even after the contract is signed. This problem can generally be solved by making payment of the biobank conditional on the success of the innovation.



> **In addition to providing incentive compensation for various stakeholders, biobanks must take strategic decisions about the size of their collections and the quality of their samples**

### *What market strategies are available to biobanks?*

In addition to providing incentive compensation for various stakeholders, biobanks must take strategic decisions about the size of their collections and the quality of their samples. This modifies both the degree of competition between biobanks and the biobank's expertise. By specializing in a small number of collections a biobank can position itself uniquely in the scientific community and ensure it obtains a high level of visibility and recognition, and a certain monopoly power. Its expertise and thematic coherence will be strong, reducing its operating costs. By proposing a wider range of samples, and broader (but less precise) expertise, generalist biobanks can be involved in a larger number of projects. However, the presence of several collections within the same biobank will involve professionals from several different specialties and therefore incur different operating costs.

At the same time, improving the quality of samples and their corresponding data allows biobanks to differentiate vertically from their competitors. In an economic landscape occupied by generalist biobanks, such differentiation allows all biobanks some market power. An economy composed of specialized biobanks limits competition and reduces the problem of sample quality because each biobank is positioned on a different collection. When generalist and specialized biobanks coexist, competition weakens generalist biobanks, which then limit their costs by producing lower-quality samples.

### *How can networking contribute to the success of innovation?*

Pooling several biobanks in a network reduces operating costs, increases the supply of samples, limits competition and improves the bargaining power of biobanks. It may, however, require biobanks to surrender a degree of ownership, specificity and reputation. Additional costs are linked to information asymmetries. Networking can only be successful if all partners contribute. The dilution of the responsibility of each biobank in the network leads to a free-rider problem, especially for specialist biobanks, as each biobank can benefit from the work and expertise of the others.

The positive effects of networking are more important for generalist biobanks. Increased visibility allows them to participate in more projects. Collaborations with specialist biobanks also enable generalist biobanks to increase their expertise, which in the long term has a positive effect on the quality of innovation. ■

CÉLINE BONNET, ZOHRA BOUAMRA-MECHEMACHE AND TIFENN CORRE STUDY CARBON TAXES ON FOOD

# Where's the beef?

**Food decisions can be crucial not only for our own bodies, but also for the health of the planet. Unfortunately for policymakers, consumer diets have so far proved fairly resistant to public information campaigns. Most economists instead recommend taxes as the most efficient tool for reducing the footprint of our supermarket shopping lists. In a new study featured in 'The New York Times' earlier this year, TSE researchers Céline Bonnet, Zohra Bouamra-Mechemache and Tifenn Corre suggest that the best strategy is to focus carbon taxes on beef.**

**Céline Bonnet,**
TSE-INRA

**Zohra Bouamra-Mechemache**
TSE-INRA

After the energy sector, agriculture is the industry with the greatest impact on the environment. In 2010, agriculture, forestry and other land use accounted for 24% of greenhouse gas (GHG) emissions. As well as climate change, the agricultural sector is also a significant contributor to problems of eutrophication, biodiversity, deforestation, land use, water use, and toxicity. Within agriculture, beef and dairy cattle are major polluters, producing almost two-thirds of global livestock emissions.

**Despite the health and environmental benefits of eating less meat, current trends suggest that global meat consumption will increase by 72% between 2000 and 2030**

Despite the widely demonstrated health and environmental benefits of eating less meat, current trends suggest that global meat consumption will increase by 72% between 2000 and 2030, according to the World Health Organization. Meat consumption is also expected to continue to rise in Europe, with a decrease in the share of red meat in favor of white meat.

Encouraging more sustainable consumption habits and achieving a reduction in meat consumption is a difficult task. For researchers, measuring a policy's impact is complicated as consumers can substitute the taxed products by others in patterns that are extremely hard to predict. Eating less meat, for instance, might lead to an increase in consumption of fish or dairy. Habits vary within food categories too: consumers may find it harder to give up fresh meat than to eat less processed ham.

In their paper, the researchers analyze the impact of environmental price policies that specifically target the consumption of animal products. Most studies on consumer demand for animal products use data aggregated at the country or regional level, but the TSE study uses a dataset with uniquely detailed information on food purchases by individual French households.

"The idea of taxing the consumption of animal products to guide household decision-making is not new. However, the efficiency of such taxes has not yet been fully investigated. We estimate consumption patterns for the main animal products and a vegetable-based food aggregate, allowing us to study substitution patterns very precisely.", say the researchers.

To meet European Union targets, GHG emissions must be reduced by 20% by 2020, and by 60% by 2050, and the recommended carbon price is €56 per ton for 2020 and €200 per ton for 2050. The Toulouse researchers use these carbon prices to simulate the impact of a carbon tax on the consumption of animal products.

The researchers' results show that a low tax (€56 per ton of $CO_2$-equivalent emissions) on the consumption of all animal products leads to a very small change in GHG emissions. A high tax (€200 per ton of $CO_2$-equivalent emissions), would lead to a 6% decrease in GHG emissions embedded in all considered food products, and up to a 9% reduction in acidification. Both tax levels would fail to meet the EU target of a 20% reduction in GHG emissions by 2020.

**The idea of taxing the consumption of animal products to guide household decision-making is not new. However, the efficiency of such taxes has not yet been fully investigated**

"We find that the GHG impacts are much smaller than those identified in the previous literature based on more aggregated data," says the researchers. "The reason is that the demand for animal products is less elastic at the aggregated level. A change in the price of animal products generates quite low and partial substitutions with vegetable-based food products. This is because part of the substitutions occurs within the animal product categories."

The most efficient scenario, says the researchers, is a high tax only on the consumption of beef. Such a tax would achieve a 3.2% decrease in GHG emissions, which represents more than half the environmental benefits from taxing all animal products, but it would generate only 12% of the cost to households.

Considering substitutions between all food items both within and between food categories is a challenging objective for future work. Researchers and policymakers also need to better anticipate the behavior of the meat supply chain when faced with a new tax policy. Céline has previously shown, in a 2013 study with TSE's Vincent Réquillart, that ignoring firms' strategic pricing decisions can skew estimates of the impact of a sugar tax on soft drinks.

In the context of growing health and environmental concerns such as obesity and climate change, new methodologies to evaluate public policy will require more detailed information about consumer diets and food suppliers. Economists in Toulouse will have plenty to get their teeth into. ■

**Find out more**

'An environmental tax towards more sustainable food: empirical evidence of the consumption of animal products in France' by Céline Bonnet, Zohra Bouamra-Mechemache, and Tifenn Corre was published in Ecological Economics in May.

BRUNO BIAIS ON DERIVATIVES, MARGINS AND CENTRAL CLEARING

# Risk-sharing or risk- taking?

**Can risk-sharing via derivatives perversely lead to risk-taking by financial institutions? As part of his 'Trading and Post Trading' project, which was awarded a senior European Research Council grant in 2012, TSE's Bruno Biais has published a paper in 'The Journal of Finance' which shows how margin deposits and clearing arrangements can be designed to mitigate risk. Together with Florian Heider and Marie Hoerova, his co-authors from the European Central Bank, he also provides new empirical predictions about the extent and risks of derivatives activity.**

**Bruno Biais**
TSE - CNRS

### *Why have derivatives drawn the attention of policymakers and researchers?*

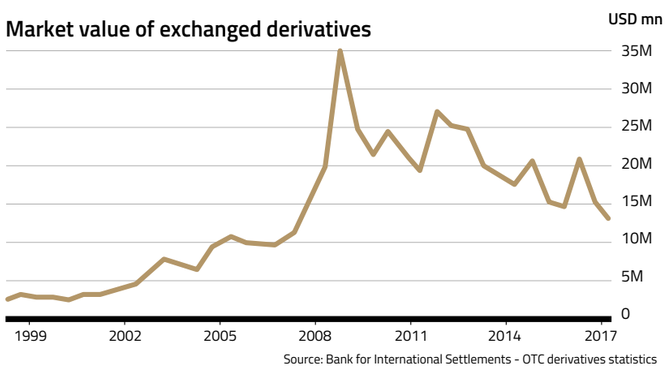
Derivatives activity has grown strongly over the past 15 years. For example, the face value of credit default swaps (CDS), which are bilateral over-the-counter contracts used to insure credit risk, increased from around $180 billion in 1998 to more than $60 trillion by mid-2008.

**Since financial institutions' activities are opaque and complex, risk-taking is difficult for outsiders to detect. This creates a moral-hazard problem for protection sellers**

But the insurance provided by derivatives is effective only if counterparties can honor their contractual obligations. When Lehman Brothers filed for bankruptcy, it froze the positions of more than 900,000 derivative contracts (about 5% of all derivative transactions globally).

### *How do you simulate the tensions involved in these complex financial arrangements?*

Our model features risk-averse protection buyers who want to insure against a common exposure to risk. These buyers contact protection sellers whose assets can be risky, but who are not directly exposed to the risk that the buyers want to insure. The sellers can prevent downside risk, maintaining sufficient value for their assets, by exerting costly effort such as scrutiny of potential investments. Alternatively, sellers can "shirk" the cost of scrutiny by relying on external, ready-made credit ratings or simple backward-looking measures of risk. Failure by sellers to exert risk-prevention effort (which we call "risk-taking") leads to counterparty risk for protection buyers. Since financial institutions' activities are opaque and complex, risk-taking is difficult for outsiders to detect. This creates a moral-hazard problem for sellers, the key friction in our model.



Source: Bank for International Settlements - OTC derivatives statistics

### *Why does this risk-sharing breed risk-taking?*

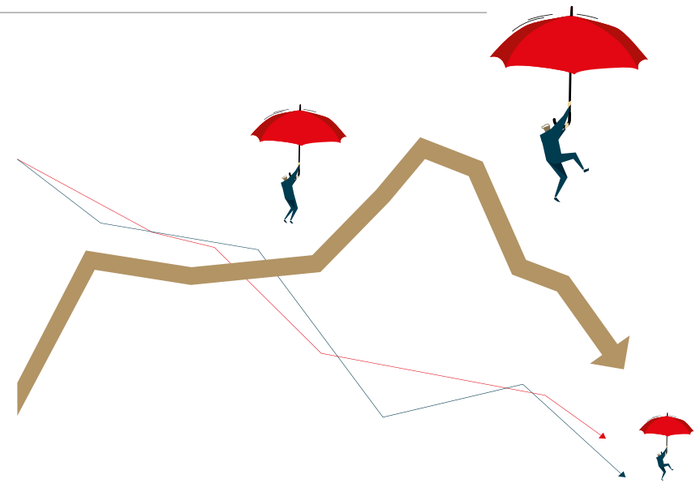
One of our key insights is that a large derivative exposure undermines a protection seller's incentives to exert the risk-prevention effort when new information makes the derivative position an expected liability. In that case, the seller bears the full cost of the risk-prevention effort while the benefit of this effort partly accrues to the counterparty in the form of payments from the derivative contract.

The optimal contract takes one of two forms, depending on the severity of the moral-hazard problem. Either the contract maintains protection sellers' risk-prevention incentives, at the cost of less ex ante risk-sharing for protection buyers, or it promises more risk-sharing but gives up on risk-prevention incentives, which creates counterparty risk for protection buyers. So the risk-sharing potential of derivative contracts is limited by the potential or actual presence of endogenous counterparty risk.

**Large derivative exposure undermines a seller's incentives to exert risk-prevention effort when new information makes the derivative position an expected liability**

### *Can derivatives generate contagion between asset classes?*

With moral hazard, bad news about protection-buyer assets can increase the likelihood of low pay-offs from protection-seller assets, because bad news undermines sellers' risk-prevention incentives. For example, before the recent crisis banks frequently reduced their capital requirements by purchasing derivatives. Our model predicts that financial institutions with larger short CDS positions exposed their balance sheets more to downside risks as bad news about the housing market emerged. Importantly, this exposure is a calculated choice, not the consequence of mistakes or incompetence.



### *How can we create safer financial markets?*

The main focus of our paper is to characterize the optimal design of margin calls and central clearing platforms (CCPs). These institutional arrangements aim to mitigate counterparty risk and were adopted by both US and European regulators following the 2008 financial crisis. Our model features a CCP that pools the resources from all protection sellers. Any losses from the default of individual sellers are therefore shared across all buyers.

The CCP is also in charge of implementing margin calls. The party subject to a margin call must hand over control of assets to the CCP, "ring-fencing" them from moral hazard. With fewer assets, the cost of risk-prevention effort is lower, which improves risk-prevention incentives. But safe assets on a margin account earn less than risky assets left on financial institutions' balance sheets. Margins will therefore be used only when the ring-fencing benefit outweighs the cost: for example, when the moral hazard problem is severe; or when the opportunity cost of depositing assets in the margin account is not too large.

### *What are the policy implications?*

Our analysis implies that margins can be an attractive substitute to equity capital. Ring-fenced from moral hazard, assets can support larger liabilities. Consequently, margins allow protection sellers to engage in incentive-compatible derivative trading with less equity. An advantage of margins is their contingent nature. They are called only when individual derivative positions deteriorate.

Our research clarifies how margins and central clearing interact and the need for them to be designed together. While central clearing mutualizes counterparty risk, margins provide incentives to avoid counterparty risk. Without margins, CCPs would bear too much risk; without a CCP, contracting parties would have to put up higher margins. And it is the CCP which must design and mandate the margin calls. Otherwise, there would be free-riding on the insurance it offers. ■

**ERC Support**
This research has received financial support from the European Research Council under the European Community Seventh Framework Program FP7/2007-2013 grant agreement N_295484 - TAP.

# DECIPHERING THE WORLD

**SÉBASTIEN GADAT ON MACHINE LEARNING**

# The maths of the future

**Sébastien Gadat arrived at TSE in 2014 from Université Paul Sabatier, and he now supervises the mathematics and statistics research group. The researcher - recently appointed at the Institut Universitaire de France - talks to us about his research into machine learning and the future of research in the field, notably in the digital era.**

Sébastien Gadat
TSE-UTC

### *What attracted you to TSE?*

I joined TSE in 2014, mainly motivated by the research group's academic ambition, which is at the forefront of the main issues in the field of mathematics, and also my desire to join an institution which gives researchers adequate resources for substantial projects. TSE is a place where things progress and work well.

**We have worked with Airbus to use these sequential decision-making algorithms to define an optimal flight path and therefore working out the journey which consumes the least fuel**

Since my arrival, the mathematics and statistics group has expanded and progressed in various fields, and I think that we are currently covering all major research trends in applied mathematics, such as Big Data, artificial intelligence, optimisation, machine learning but also the latest progress in game theory with repeated games. Scientific emulation is a real asset of TSE.

### *What are you working on?*

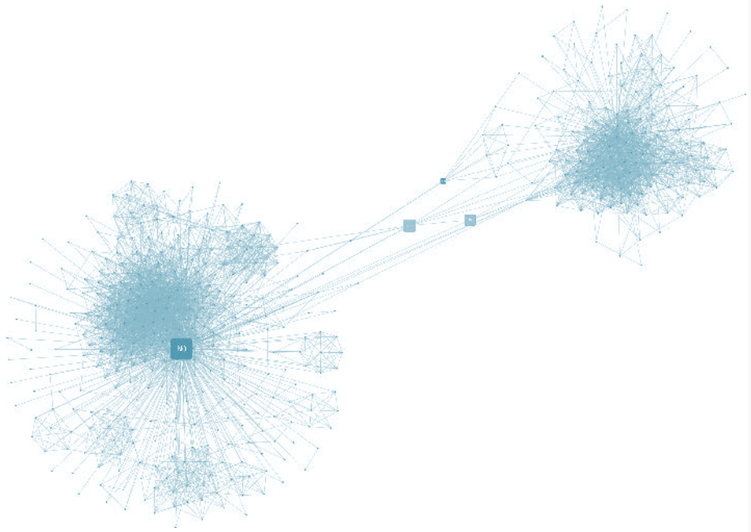
I am currently working on several research topics, notably statistical learning, which is the tool behind most artificial intelligence. For example, understanding the geometry of very large graphs, which is a problem we encounter when using Big Data. Facebook is a perfect example of this type of data. If we try to represent interactions between users, we can use mathematical tools to try and understand major trends, the centres and main axes.

I am also looking at problems of optimising functions, not necessarily convex, with a sequential algorithm. Our contribution is developing an approach which allows us to put the convexity framework and the deterministic measurement framework to one side to get valid results for a wide number of situations. I should also underline the exceptional groundwork done by Jérôme Bolte on this topic. This type of work can be used in sequential decision-making, machine learning and also finance.

More specifically, we have worked with Airbus to use these sequential decision-making algorithms to define an optimal flight path, considering the uncertainty of weather conditions or the exact weight of the aircraft, and therefore working out the journey which consumes the least fuel. We have successfully tested these algorithms with Airbus flight simulators.

We are also working on immunology with Oncopole de Toulouse to codify the remission of Chronic Lymphocytic Leukaemia, a blood cancer. We are analysing and processing data to offer a causal model which considers the different variables. Over time we hope to be able to improve the understanding of this illness and its possible treatments.

Finally, I am currently working on deconvolution of the mixing law through super-resolution. The idea is to be able to sort through the laws that code these observations. This work links optimisation (particularly the notion of duality) and statistics; it's an exciting and promising field.



A Facebook node, visualized

**We always need new algorithms to continue to process big data which arrives each second and which can signal very rapid changes in all measured fields**

### *What are the major trends in mathematics at the moment?*

Currently sequential methods are a key concern of applied mathematics (optimisation and statistics). They allow decision making with uncertainty in real time. These issues are increasingly important due to the constant increase in the amount of data collected, notably to build algorithms which govern the digital world, this is what is known as machine learning.

Deep learning is also an ongoing issue, it is a sub-section of machine learning which involves implementing a cascade of extremely complex models which, if it provides reliable predictions, is very obscure and the final algorithm is often not readable by a human. This is what sets it apart from other machine learning methods, which we can understand and visualise.

We always need new algorithms to continue to process big data which arrives each second and which can signal very rapid changes in all measured fields. These problems will be at the heart of mathematics and machine learning issues for the next ten years, and our research group is actively pursuing these crucial topics. ■

## *The 24 members*

**of the Mathematics of decision making and Statistics research group at TSE**

*Bénédicte Alziary Chassat*
*Pascal Bégout*
*Adrien Blanchet*
*Hélène Boistard*
*Jérôme Bolte*
*Michel-Benoit Bouissou*
*Sandrine Casanova*
*Abdelaati Daouia*
*Jean-Paul Décamps*
*Olivier Faugeras*
*Jean-Pierre Florens*
*Sébastien Gadat*
*Eric Gautier*
*Fabien Gensbittel*
*Christine Grün*
*Pascal Lavergne*
*Eve Leconte*
*Olivier Perrin*
*Jérôme Renault*
*Anne Ruiz-Gazen*
*Ian Schindler*
*Christine Thomas-Agnan*
*Stéphane Villeneuve*
*Ekaterina Voltchkova*

JEAN-PIERRE FLORENS ON THE POWER OF MATHEMATICS

# The pleasure of unders tanding

**Jean-Pierre Florens arrived in Toulouse in 1986 from Aix to join Jean-Jacques Laffont and Michel Moreaux and set up IDEI (later TSE) a few years later. He talks to us about his research in mathematics and econometrics, changes to the field and the history of Toulouse economists.**

### *What is your main work?*

My research work in mathematics and statistics mainly focuses on the theory of inverse problems, i.e. estimating the causes of a phenomenon from its consequences.

**It's a real pleasure to share and guide new generations of researchers and I think that's something we do very well here**

This type of work is extremely useful for satellite or medical imaging and helps deal with many statistical issues. The main original feature of my research was the use of this theory in econometrics to allow a better understanding of endogeneity, processing, auction or contract models and the introduction of big data.

Another theme of my work is studying extreme values of probability distribution applied to the problem of the efficiency frontier. This is the optimal solution for a company or decision-making body. For example, we could imagine a graph for a factory which would represent the maximum possible production for each level of stock of materials, it's a very useful tool.

Finally, more recently, I have looked at the theory of networks and more generally the introduction of geometric concepts for functional estimation. This covers the study of networks (e.g. social) and their geometry when they are very extensive. These are problems which we encounter when handling huge amounts of data on networks between individuals, helping us to understand behaviour which is unique to the individual and behaviour which is the product of the society in which they develop. We are starting to work on these topics with my TSE colleagues and notably Stéphane Villeneuve, Thomas Mariotti and Jérôme Bolte.

**Jean-Pierre Florens with his colleagues in October 1992 at the Econometrics Imperfect Competition conference in Toulouse**

**Jean-Pierre Florens**
TSE-UTC

### *What interested you about these problems?*

Above all, it was my interest in these mathematical objects which got me interested in network issues. These are complex structures and at the forefront of current research in statistics, like questions relating to Big Data or Machine Learning.

On the other hand, the pleasure of understanding and precisely defining phenomena and the resulting intellectual satisfaction are reasons for my love of mathematics. Mathematics allow unmatched reasoning where the most complex problems can be expressed and solved with a few characters.

### *Other than this love of mathematics, what have been some career highlights?*

Being able to supervise over 50 doctoral students, most of whom are now professors at the best universities across the globe. I work regularly with about ten of them on various topics. It's a real pleasure to share and guide new generations of researchers and I think that it is something we do very well here.

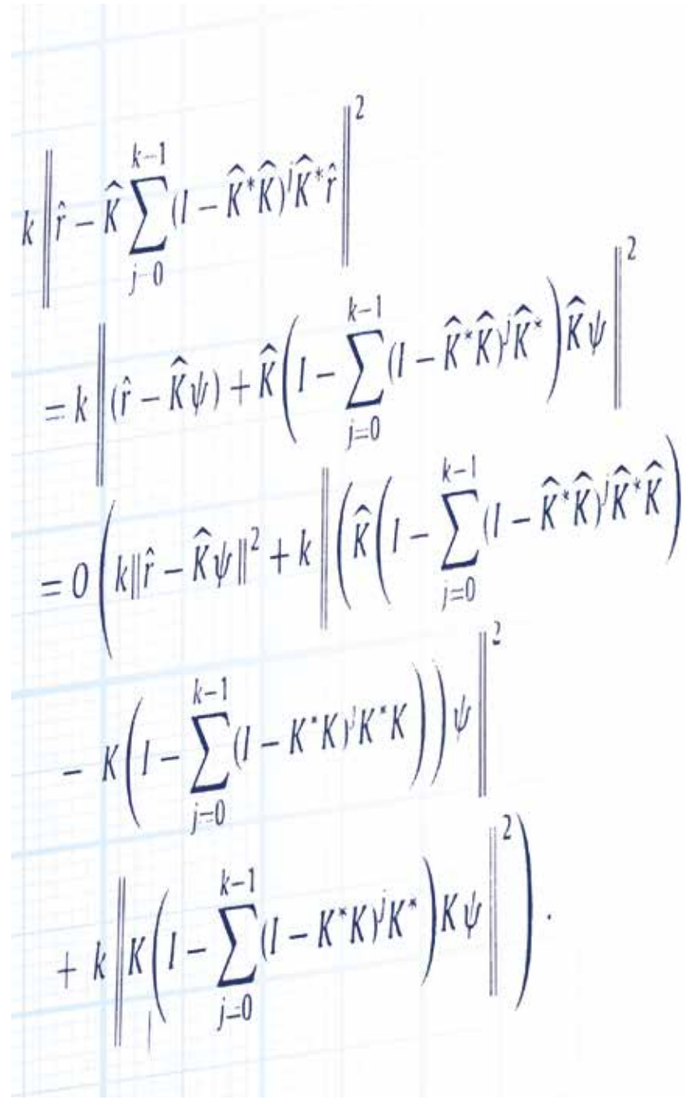
**Exchanging with companies has given rise to new research issues. This advantage has led to Toulouse's reputation in economics research, and it has allowed us to deliver unprecedented research results**

We've also built some strong research partnerships. I am convinced that exchanging with companies, like I have done with La Poste, Royal Mail, CNES, Telefonica, EDF and others, has given rise to new research issues. This advantage has led to Toulouse's reputation in economics research, and it has allowed us to deliver unprecedented research results. The contact with the real world leads to questions about undetected issues and Jean Tirole's Nobel Prize reflected work on research partnerships.

### *What was TSE like in 1986?*

Everything started in 1985 when Jean-Jacques Laffont received approval for two professor positions in Toulouse, which he immediately offered to Jean-Charles Rochet and I, and we joined Toulouse in '86 and '87 respectively. Jean-Jacques' entrepreneurial outlook and his vision allowed the institution to transform into an international research centre. On the one hand because he had this dream and outlook, and also because he knew to surround himself with excellent professors and to rely on French institutions to work together in an innovative manner.

I kind of miss the feeling of that era and the opportunities we had; everything seemed possible and our small team gave us flexibility which we have lost by getting bigger. However, our current size has given us a lot of flexibility in many other fields, such as recruitment and hosting prestigious visitors, and we have developed extraordinary scientific activities which are unrivalled worldwide. ■



$$k\left\|\hat{r}-\hat{K}\sum_{j=0}^{k-1}(I-\hat{K}^*\hat{K})^j\hat{K}^*\hat{r}\right\|^2$$
$$=k\left\|(\hat{r}-\hat{K}\psi)+\hat{K}\left(I-\sum_{j=0}^{k-1}(I-\hat{K}^*\hat{K})^j\hat{K}^*\right)\hat{K}\psi\right\|^2$$
$$=0\left(k\|\hat{r}-\hat{K}\psi\|^2+k\left\|\left(\hat{K}\left(I-\sum_{j=0}^{k-1}(I-\hat{K}^*\hat{K})^j\hat{K}^*\hat{K}\right)\right.\right.\right.$$
$$\left.\left.\left.-K\left(I-\sum_{j=0}^{k-1}(I-K^*K)^jK^*K\right)\right)\psi\right\|^2$$
$$\left.+k\left\|K\left(I-\sum_{j=0}^{k-1}(I-K^*K)^jK^*\right)K\psi\right\|^2\right).$$

ANNE RUIZ-GAZEN ON STATISTICAL UNCERTAINTIES

# Margins of error and Big Data

**Anne Ruiz-Gazen arrived at the University of Toulouse Capitole in 1993 and works with the TSE decision mathematics group, focusing on margins of error. She talks to TSE Mag about a number of challenges in the field, as TSE prepares to welcome the useR! conference in July 2019, dedicated to the R statistical and data science software environment.**

**Anne Ruiz-Gazen**
TSE-UTC

Anne Ruiz-Gazen works on statistical methodologies, in particular on understanding and improving margins of error. "My mathematical work can be applied to numerous fields, such as socio-economic surveys, or in industry, for detecting anomalies." she explains.

**There is no doubt that Big Data is the future, but one of the often-forgotten challenges of this revolution is the reliability of the data published**

## Margins of error

For example, to assist major national bodies such as INSEE (the French national institute for statistics and economic studies), INED (national institute for demographic studies) or INSERM (national institute of health and medical research) when they carry out national surveys. Anne Ruiz-Gazen works on improving and understanding the reliability of these types of survey. "We recently collaborated with INED on a major survey connected with tracking individuals from birth to the age of twenty. We calculated the reliability of their results on the basis of their sampling methods." Her research showed that the chosen protocol was not optimal and had increased the survey's margin of error. "The survey uses the same child birth dates for all the deliveries sampled, which increases uncertainty, because this choice potentially reduces variability within the sample."

She also works on electoral polling, and particularly on spatiality of the data. "For the last French Departmental elections, we work with Christine Thomas (TSE - UTC), Thibault Laurent (TSE - UTC) and An Huong Nguyen (doctoral student – TSE – UTC) on prediction models that take the specific nature of this type of data, known as composition data, into consideration; we also look at geographic location, so as to anticipate the effects of an economic or demographic change on the results."

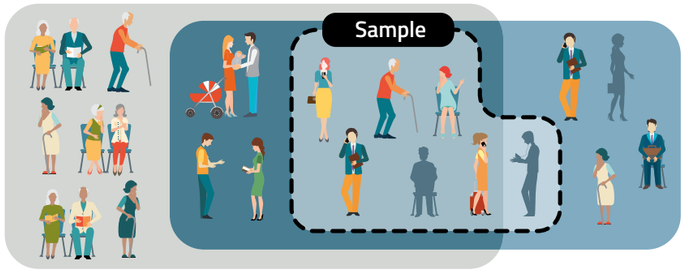



Illustration of the major risks of a bad sample: not considering a part of the population either because of bad selection or because of non-responding individuals.

## "Clean" data

With the aim of improving data, Anne Ruiz-Gazen works with Dr Aurore Archimbaud of TSE on ways to detect anomalies using applications in industry. "With the exponential increase in the number of measurements taken using electronic components, there are problems of scale when searching for anomalies. The results of this work have since been used by several companies to reduce manufacturing flaws."

**We are proud to organise useR! at TSE**

Most economists and statisticians agree in saying that the arrival of Big Data - the exponential growth in quantities of data available for processing - represents a major development for society in years to come. "There is no doubt that Big Data is the future, but one of the often-forgotten challenges of this revolution is the reliability of the data published. Improving the accuracy of estimates combining survey data with huge volumes of data is a difficult topic with plenty to consider."

## useR! 2019

This annual conference dedicated to the R free software was first held in 2004, and since 2006 has alternated between European and US cities. After Rennes in 2009, Toulouse will be the second French city to host the event, which brings together over 1000 researchers and economic decisions makers to consider the latest developments in the software. "We are proud to organise useR! at TSE, in partnership with Paul Sabatier University and the INRA (French National Institute for Agricultural Research); it is excellent news for all the companies and scientists who use this tool, a touchstone in the field." ■

**Find out more**
on useR! 2019 on the official website: **www.user2019.fr**

ADRIEN BLANCHET ON INTERDISCIPLINARITY AT TSE

# The universality of mathematics

**Adrien Blanchet (TSE/IAST-UTC), who arrived in Toulouse from Cambridge University in 2008, is working on numerous projects associated with mathematical analysis. Fascinated by interactions between mathematics and other scientific disciplines, he tells us why interdisciplinarity is fundamental to his research.**


Adrien Blanchet
TSE-IAST-UTC

### *What convinced you to join TSE?*

When I arrived in 2008, I chose Toulouse above all to join an excellent research group working on applied mathematics and for the opportunity to explore interactions with Toulouse economists. I took part in seminars, particularly on theoretical economics, and held discussions with many colleagues, which enabled me to use my own expertise to respond to various economic questions and develop new research avenues at the crossroads between our disciplines. For instance, I worked on Beckmann-type models for urban economics that use mathematical theories of optimal transportation to help understand how people choose their spatial allocations.

Economists, and this is especially true at TSE, are advanced mathematicians, and we have a natural shared understanding of the problems we face, which makes it very easy to collaborate. Mathematics can of course be a great help in other disciplines. I have, for instance, done a lot of work with biologists on modelling the emergence of a population of multicellular organisms from single-celled organisms. For several years, I have been conducting a general exploration of emergent properties in various applications.

### *How would you define emergent properties?*

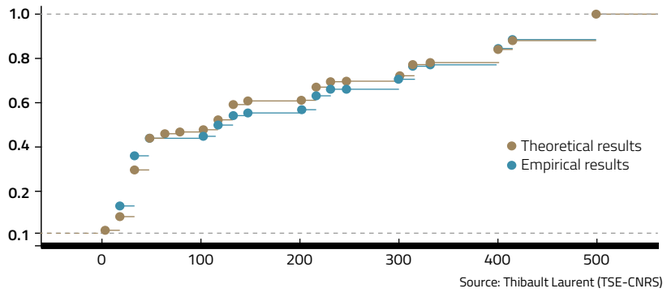
An emergent property is a system property that is not a property of any of the system's components, but of the system as a whole. This idea featured in the work of the first economists like Bernard Mandeville, David Hume, and of course Adam Smith with his famous "invisible hand". These systems are very interesting to physicists and mathematicians, since they become more and more organized without using a centralized command system. Emergent properties are an inexhaustible well of interactions between scientific disciplines.

I have, for instance, been working for several years with biologist Guy Theraulaz (CRCA) and physicist Clément Sire (LPT) on emergence in collective intelligence. More specifically, we're looking at the question of information transfer between individuals within a population so that the group as a whole can solve a problem that an individual could not solve alone. We construct robust mathematical models to deliver forecasts based on analyzing data from experiments we have conducted ourselves at TSE.

### *What does interdisciplinarity mean for your work?*

Interdisciplinarity is fundamental to my way of conducting research. It means combining approaches that are not usually used together, and above all, learning and questioning. The Institute for Advanced Study in Toulouse is an important asset in this context. Discoveries from research into social sciences and biology always raise new questions and exciting avenues for investigation. These interactions are extremely precious to me and provide a challenge that is intellectually stimulating. ■

**Comparison of empirical and theoretical results following the experiment**



Source: Thibault Laurent (TSE-CNRS)



EVE LECONTE ON CENSORED DURATION DATA

# The power of statistics

**How long does it take female graduates to secure a job? Which combination of genes best predicts the survival of cancer patients? What impact do socio-economic and geographical characteristics have on regional elections? Finding answers to such diverse questions and providing their students with the powerful tools of statistical analysis are key challenges for Eve Leconte and other members of TSE's expert group on the mathematics of decision-making and statistics (MADS).**


Eve Leconte
TSE-UTC

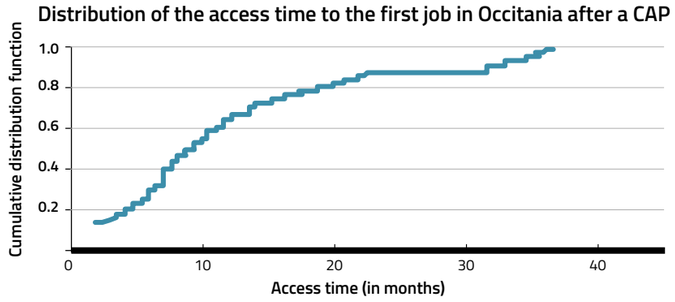
Eve's research area is the set of statistical methods for data which correspond to durations – such as lifetimes, or periods of unemployment or marriage – and are often censored. Censored data are among the complex data structures in which only partial information on the variables of interest is available. Censoring occurs when the event of interest – such as death, finding a job or divorce – does not happen during the follow-up time for some individuals.

**Statistical analysis can provide more accurate estimates of cancer patients' survival duration which are extremely useful to adapt treatments to each patient**

Within this field, Eve works on competing risks. These scenarios occur when an individual is at risk of several types of events, as is the case for cancer patients in the post-therapeutic phase. She is also interested in variable selection in survival models in high dimension, which is particularly relevant to oncology. Since the sequencing of the genome, a colossal amount of genetic information is now available to clinicians. Statistical analysis can establish which combination of genes best predicts the survival of cancer patients, providing more accurate estimates of survival duration. This information can be extremely useful in adapting treatment to the needs of the patient.

The goal of MADS is to animate and develop research activities in mathematics applied to economics. Topics include operations research, the mathematics of finance, statistics, econometrics, game theory, optimization, calculus of variations and PDE, mathematical models in economics, finance, and social sciences. One example of the MADS group's application of statistical methodology to economic data is Eve's joint project with **Sandrine Casanova**. This research aims to model the cumulative distribution function of a censored duration in the context of survey sampling, in a finite population or in domains which may be small. The estimators they propose are based on nonparametric quantile regression adapted to the censored case. This work has, among other things, made it possible to estimate the distribution of access times to their first job for female graduates in the Occitania region, depending on their education type and level.

**Distribution of the access time to the first job in Occitania after a CAP**




In another project for the MADS team, **Christine Thomas-Agnan, Thibault Laurent** and **Anne Ruiz-Gazen** are working with PhD student **Nguyen Huong An** on the modelling of data from French departmental elections, taking into account some socio-economic and geographical characteristics. This requires specific statistical methodology and the researchers aim to provide new regression estimators in this context. More information on this project on page 18. ■

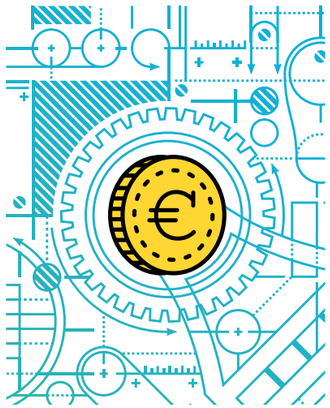
STÉPHANE VILLENEUVE ON ALGORITHMS

# Industrial economics engineering

**Stéphane Villeneuve joined TSE in 2002 from the Université d'Evry and works on the problem of a rigorous formulation of the principal-agent model in dynamic models. He works to offer quantitative decision-making tools and describes his work as a real toolbox for economists.**

Stéphane Villeneuve was working in mathematical finance when he met Jean-Paul Décamps, Thomas Mariotti and Jean-Charles Rochet, who convinced him to join TSE: "they showed me that there were great mathematical problems in industrial economics", he explains. "Industrial economics systematically considers the friction inherent in the real world, whilst mathematical finance is based on a theoretical perfect market."

The Toulouse economists notably study friction due to information asymmetry and moral hazards, or moral risks, for example when an insurer cannot verify prevention put in place by the insured party. "I study principal-agent type dynamic problems in a quantitative manner. This quantitative approach links probability, control theory and optimisation and looks to describe contracts explicitly or in a digital manner." These questions cover various fields: insurance, portfolio management and investment decisions.



Stéphane Villeneuve
TSE-UTC

## Bonus-malus system for managers

The researcher has worked with quantitative tools on issues including paying managers and refinancing companies: "with regards to manager payment, our results confirm that a bonus-malus approach is best. The idea is to block manager payment in an escrow account which develops in line with performance. The manager receives payment only after a long period of success has been observed. Inversely, their area of action is reduced after poor results to limit losses linked to the manager's decisions." For company refinancing, Stéphane and his co-authors demonstrate that they each have a cash reserve threshold when it is in their interest to pay dividends to shareholders. This cash reserve buffer level helps avoid the use of the costly refinancing market when new investment opportunities arise. Stéphane has worked with EDF R&D to build investment policy management tools "EDF wanted to understand how improved management of their liquid asset reserve could help them to finance their huge nuclear investments."

## Obscure algorithms

The dynamic and quantitative approach to industrial economics by Stéphane has a major advantage: it allows the analytical characterisation of optimal contracts through partial differential equations which require digital approaches when the model becomes complex. Stéphane wants digital methods used in economics and finance to become more transparent: "many authors do not provide the code or even a description of the algorithm which allows them to obtain their digital results, therefore making their work unclear." The researcher would like a greater number of reviews to verify digital methods used to prevent approximation or simulation errors. He notes progress, however, "some reviews have started to require an accurate description of digital methods and the provision of calculation codes before publishing research articles; it's a good start." ■





PHILIPPE WAHL, CHAIRMAN AND CEO, GROUPE LA POSTE

# Reinventing the postal sector

# 25 YEARS of partnership

Philippe Wahl
La Poste CEO

**This spring, the 10th Postal Economics Conference on E-commerce, Digital Economy and Delivery Services coincided with the 25-year anniversary of La Poste's research partnership with TSE. As Groupe La Poste prepares to take on new roles and responsibilities in the digital era, Chairman and CEO Philippe Wahl discusses the role of economic analysis in helping both businesses and society to adapt.**

***How has the postal sector changed since the La Poste-TSE partnership began?***

Over the past 25 years, the postal sector has been shaken by two major revolutions. First, the complete opening of the European postal market to competition, initiated at the same time as our partnership with TSE in the early 1990s.

> **Economists' analysis of competitive practices and the structure of data-driven markets in the digital economy is essential to adapt competition rules to the new ecosystem**

Second, and probably the most important, was the digital revolution that hit postal operators with the dematerialization of correspondence between individuals, professionals, the state and its citizens. Between 2008 and 2017, we went from 18 billion to 11 billion addressed mail items. Our traditional role is progressively disappearing. This is an invitation to conduct an in-depth analysis of our business model, and the viability and utility of our services of general economic interest (SGEI), focused on the delivery of mail and print media, as well as physical accessibility to postal and banking services.

***Is La Poste prepared for the digital era?***

In the face of adversity, La Poste has always been able to reinvent itself while preserving its core identity: to be a local actor, prioritizing the interest of its users, guarantor of the SGEI that the state has entrusted to it. To this end, La Poste has begun its most complex transformation in more than five centuries, focusing on diversification.

Since 2006, we have developed our financial activities by creating a common law bank, fully integrated into our business. International parcel and express activities have also been regularly expanded. Today, we are developing local services, ranging from recycling of office waste to organization of the highway code test, and personal services, especially for the elderly. We are also developing digital services such as our digital safe, Digiposte +, which makes it possible to securely store personal documents (payslips, certificates, medical data, etc.). We are reinventing the role of the postman and our physical-presence network.

At the same time, we need to broaden the scope of postal regulation to that of the entire digital economy, to redefine the SGEI. For this, economists' analysis of societal changes and new competitive mechanisms is essential.

***Which new fields have opened up for economic analysis?***

Two examples are close to my heart: the definition and fair compensation of SGEI; and the establishment of a fair competitive playing field.

Economists have developed very sophisticated methods for doing cost-benefit analyses and valuing sometimes intangible elements (such as the impact of the postal presence on social connections or the externalities it generates for related commercial activities). Once the SGEI have been properly defined to meet the needs of users, the operators responsible for these SGEI must be compensated for the additional costs. At the beginning of the 2000s, economists defined the most relevant method of calculating these net costs, corresponding to the difference in profits made with and without the public service role. This calculation involves a scenario that is expected to remain theoretical, in which the operator is relieved of its obligations. Mobilizing economic analysis to build these counterfactual scenarios can only make them more credible and robust, and less susceptible to challenge before the competition authorities and the European Commission.

TSE and La Poste teams met in May for the anniversary conference

Critics might, as in the past, denounce La Poste's diversification strategy, accusing it of relying on its SGEI and its dominant position in the mail market to expand into new business sectors. But can we compare a company in a dominant position in a declining market that attracts no rational investor and a company in a dominant position in a growing market? What power does one derive from being not the only company in a market, but the last? What power do we derive from a dominant position in an intermediate market, providing an input (I am thinking here of parcel delivery) to economic players with quasi-monopsony power?

***What other issues will be the focus of future partnership research?***

Economists' analysis of competitive practices and the structure of data-driven markets in the digital economy, characterized by the presence of network externalities that inevitably lead to the creation of dominant positions, is essential to adapt competition rules to the new ecosystem. Issues relating to the dominance of certain players, competitive distortions based on tax optimization strategies, the exploitation of collaborative work, personal data, etc., must be at the heart of the debate. These projects, and many others, will mobilize the teams of economists in Toulouse and at La Poste in the years ahead. ■

CATHERINE CAZALS ON POSTAL ECONOMICS

# A partnership that delivers

**When the partnership between La Poste and TSE started, the debate about opening up the postal sector to competition was in full swing. As one of the TSE researchers invited to analyze the optimal structure of the postal market, Catherine Cazals says that La Poste's data was instrumental in the production of pioneering research.**

To begin with, it was essential to acquire a thorough understanding of the economic characteristics of the postal sector. Among these characteristics, the cost function of the postal service initiated a quarter century of applied econometric work under the leadership of Jean-Pierre Florens at TSE. One of the main objectives was to better understand the cost drivers and to quantify potential economies of scale.

**These 25 years of econometric analysis have only been made possible by La Poste's continued efforts to provide us with databases of great richness**

La Poste gave us access to an incredibly rich database: "Statistics 742". This contained information broken down to the level of the delivery rounds of postal workers in more than 10,000 delivery offices. The first articles using this data demonstrate the existence of relatively large increasing returns to scale in the delivery activity.

"Statistics 742" was then made available as a panel, allowing us to refine our estimates and evaluate the "size" effect of delivered items on cost. Econometric work to identify the cost drivers has continued using another, more aggregated dataset of about 4,700 delivery offices and their "satellite" offices.

We also focused on an analysis of efficiency, identifying the offices delivering a given volume of mail at the lowest cost, then measuring an efficiency score with respect to this frontier. This led to the implementation of an original method for analyzing the cost of delivery. We also investigated the role of environmental features such as the size or density of a delivery office's local area.

The network of contact points was also the subject of pioneering cost analysis. We estimated the production cost elasticities for activities carried out over the post office counter, showing that returns

Catherine Cazals
TSE-UTC

to scale are relatively high in smaller offices, but constant for larger offices. This analysis is currently being updated with a new dataset for a network that has changed a great deal, notably with the transformation of post offices into an Agence Postale Communale (APC) or Relais Poste Commerçant (RPC).

This work is only a sample of all the econometric work done during these 25 years. Another theme that has given rise to many studies is that of demand, which has been treated using individual or aggregated data. Of course, these 25 years of econometric analysis have only been made possible by La Poste's continued efforts to provide us with databases of great richness ■



E-COMMERCE, DIGITAL ECONOMY AND DELIVERY SERVICES

# Should platforms be regulated?

**Among the highlights of the 10th Postal Economics Conference, a talk by Emilio Calvano (University of Bologna) on the ability of algorithms to learn collusive strategies preceded a round-table discussion on digital regulation. Here, we present excerpts from a debate that featured key decision-makers and TSE's Jean Tirole.**

## Werner Stengg

*Head of E-Commerce and Online Platforms, European Commission*

Platforms are fantastic and scary. Despite an avalanche of initiatives in Brussels to tackle platform phenomena, we don't have an anti-platform reflex. Platforms have contributed to welfare immensely. But the dependency of businesses on digital platforms is growing, along with an imbalance in power and size. Transparency is part of the solution.

We want to increase predictability. Platforms must have clear terms and conditions, and give basic information about how their ranking functions. We're not asking them to reveal their algorithms or share their data, but to be crystal clear about what data they share and on what basis. If they give preference to their own services, that has to be spelled out. There must also be better mechanisms for resolving complaints. Delisting can be deadly to businesses, so the rules of the game need to be clear.

## Philippe Wahl

*Chairman and CEO, Groupe La Poste*

Amazon is our number one client, and it's becoming our number one competitor. It has very positive impacts: the convenience for clients, the quality of service which is stimulating us to improve, and a fantastic ability to innovate. At the same time, Amazon is paying very low tax and it's hurting fair competition.

There is an obvious need for regulation because of the market power of these platforms. Thanks to Jean Tirole and TSE, we are working on that key question: what is the best regulation for the common good? Digital platforms give us a lot of convenience. But what is the price of these services, in terms of freedom and sharing intimacy? Is there voluntary servitude in the digital world?

## Jean Tirole

*Chairman, TSE*

With more and more technological monopolies, much of what we knew about regulation is obsolete. It's very hard to keep up. Contestability is very important, not to create artificial competition, but to ensure that efficient entrants won't be blocked by the incumbent. So we must pay attention to tie-ins, bundling, preference for own services, multi-homing… Economists have looked a lot at best price guarantees, or most favored nation status. Unless we intervene, platforms will keep using their access to customers to hold other merchants to ransom.

It's overwhelming to think about privacy. I have no clue what my behavior entails, and no time to read: those terms and conditions are pretty awful. I don't want to kill innovation and platforms' services should not be a free lunch, but we need help from the regulator. There's so much to do for the next 50 years. It's a new world and we're not ready for it .

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## BUSINESS NETWORKING DAY

## 55 COMPANIES, & YOURS?

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**9H - 17H / TOULOUSE**
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Toulouse School of Economics

GUIDING STUDENTS THROUGH THE DIGITAL AGE MAZE

# EMO: the TSE Master's Course on the Economics of Markets and Organizations

**In the past 15 years the digital economy has significantly affected market organization and the supply and demand of different economic players. The historical flagship TSE "EMO" course has integrated these changes into its program, and our future economists benefit from the TSE faculty experts' latest insights into today's industrial and digital economy.**

In the past 15 years the digital economy has significantly affected market organization and the supply and demand of different economic players. The historical flagship TSE "EMO" course has integrated these changes into its program, and our future economists benefit from the TSE faculty experts' latest insights into today's industrial and digital economy.

**Most of today's digital giant companies including the GAFA [Google, Apple, Facebook, Amazon] are platforms**

Understanding how markets work, the strategic decisions made by companies, the structure of demand, costs, and the link between market structure and company behavior are essential concepts taught in the EMO master's degree.
At the end of the course, students are able to model interactions between companies within a market, identify the key factors of their operations, carry out a quantitative analysis to assess effectiveness, ascertain competition and regulation policy tools as well as assess the impact of such tools, if implemented.

For several years, the rapid development of digital tools and standards has continued to impact the operation of all economic sectors, either by affecting consumer behavior or competition between companies, as they seize new opportunities or as innovative companies enter their market. In this context, it is vital for future TSE economists to consider the consequences of this digital revolution.

As emphasized by Doh-Shin Jeon, TSE professor specialized in digital competition and market strategies, "most of today's digital giant companies including the GAFA [Google, Apple, Facebook, Amazon] are platforms." Given the importance of digitalization, the EMO program directors have chosen to dedicate an entire course to the digital economy from next term. The theoretical aspects of this course will be supervised by Yassine Lefouili, while Daniel Ershov will focus on the empirical perspective.

In addition to many other topics essential to digital economics (such as mergers, collusion, exclusion or tied selling), platforms are studied with classic industrial organization theory in mind, as well as the concept of two-sided markets. Developed by TSE researchers around 15 years ago, the two-sided market model has struck a chord with both the scientific community and companies, and is regularly referred to by management researchers and economists. This conceptual framework is taught from scratch so that students can analyze industrial economy questions from this angle, where relevant.

To better understand how competition in platform markets works, the EMO course looks for example at the compatibility of certain systems or technologies. What competition and regulatory tools need to be implemented to deal with digital players (e.g. Apple, Microsoft…) wanting to keep their advantage by not making their system compatible with their rivals?

**The media tends to exaggerate certain aspects of e-commerce and the internet while ignoring other key features**

As Daniel Ershov tells us, "the media tends to exaggerate certain aspects of e-commerce and the internet while ignoring other key features, which is why it is important to analyze these matters using economic models." Students will be able to understand the inner workings of the digital revolution, in terms of what it is changing but also what remains unchanged. ■

**More information:**
**tse-fr.eu/EMO**

sept
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2018

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**AXA FRANCE,**
**23 AVENUE DE MATIGNON, 75008 PARIS**
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Toulouse School of Economics | Energy & Climate Center