[TSE MAG

Living economics

#19 SUMMER 2019

ARTIFICIAL INTELLIGENCE
Entering a new era

Three evenings
of public debate
at TSE

Marc Fontaine,
Airbus, on big data
for planes

Christian Gollier
on global warming
and his new book

Google visits TSE
and exchanges
with the students

Editors' message

Dear friends,

In reaction to the "gilet jaune" social upheaval, France's president Emmanuel Macron launched a Grand Débat National this Spring. Two months of debates and assemblies that could be organised by anybody and were necessarily public.

When I heard the Grand Débat announcement, I strongly felt that TSE had a duty to get involved. As academic economists at TSE, we have two main missions: to foster research aimed at improving our understanding of economics, and to transfer our knowledge to the future generations via the courses we teach to our students, tomorrow's economists. But there is also a third, core purpose, that we tend to neglect: reaching out to the public and taking part in debate in order to share our knowledge with the world.

We hence organized three Grand Débat evenings dedicated to exchanges with TSE faculty members on global warming, food, education, immigration, taxes and inequalities. Our colleagues Emmanuelle Auriol, Zohra Bouamra-Mechemache, Frédéric Cherbonnier, Paul Seabright, Nicolas Werquin and myself gave short talks on our research work and then exchanged with the public on possible solutions to the issues our country is facing.

The events were very fruitful; many constructive ideas were co-imagined there, and I was sincerely impressed by the high level of thought and effort from all involved, from the faculty to the staff to the general public. We have made sure to send the full account of these exchanges to the French government through the Grand Débat participative website, and we plan to organize a regular series of similar debates in our new building, from 2020 onwards.

One of the issues discussed at our Grand Débat evenings was the impact of technology on jobs, equality, and on society as a whole. We are living through a massive transformation of our society, as artificial intelligence becomes increasingly powerful. This AI revolution is the special focus of this TSE Mag, featuring the latest TSE Digital Center research on the subject as well as guest insights from MIT's Daron Acemoglu and Stanford's Susan Athey. A fast-paced and exciting read that I hope you will enjoy.

Best regards to all,

Christian Gollier, *TSE Director*

Christian Gollier

We are living through a massive transformation of our society, as artificial intelligence becomes increasingly powerful.

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⚲ The Deaton Review: Jean Tirole involved in a new study on Inequalities in the Twenty First Century

The Institute for Fiscal Studies (Britain's leading independent microeconomic research institute) is launching a 5-year review of inequalities, with the involvement of Jean Tirole (TSE Honorary Chairman) as well as many experts in different scientific fields which will develop proposals for the most effective policy responses to different types of inequality.

⚲ Best paper awarded to Andrew Rhodes

The TSE-UTC researcher has been awarded the Robert J. Lanzillotti prize for the best article in antitrust economics for his paper "Multiproduct Mergers and Quality Competition" (joint with Justin Johnson, Cornell the International Industrial Organization Conference in Boston.

⚲ 2018 Banque de France - TSE Prize laureates revealed

At a special conference, which took place on Thursday March 14, presided by François Villeroy de Galhau, Governor of the Banque de France, and Jean Tirole, TSE Honorary Chairman, the 2018 Prizes in Monetary Economics and Finance were awarded to Michael Woodford (Columbia University), Victoria Vanasco (CREI) and Yuriy Gorodnichenko (Berkeley University).

⚲ Fabrice Collard (TSE - CNRS) receives the 2019 Maurice Allais award

Fabrice Collard, Michel Habib (University of Zurich) and Jean-Charles Rochet (University of Geneva) received the 2019 Maurice Allais award for their paper "Sovereign Debt Sustainability in Advanced Economies". In particular, their work provides a formula to assess a country's maximum sustainablede-bt-to-GDP ratio, but also to calculate a theoretical probability of default for each country.

Upcoming events tse-fr.eu/events

JULY 9-12, 2019 — useR! 2019

SEPTEMBER 5-6, 2019 — New Challenges in Insurance

SEPTEMBER 9, 2019 — The PRI Academic Network Conference 2019

NOVEMBER 26-27, 2019 — Society for Benefit-Cost Analysis: European Conference 2019

⚲ Jacques Crémer co-wrote a report on Competition Policy

In March 2018, the European Commission appointed Jacques Crémer (TSE – CNRS), Yves-Alexandre de Montjoye (Imperial College London) and Heike Schweitzer (University of Berlin) as special advisers to Commissioner Margrethe Vestager on the future challenges of digitization for competition policy. Less than a year later, the three special advisers have delivered a report gathering most of the recent literature on competition policy and its adaptation to digitization. Jacques Crémer discussed the report with TSE Mag.

What are the objectives of this report?

The main objective is to propose guidelines for the evolution of competition policy in the digital era for the next few years. We emphasize that the economy in the digital era is very different from the economy for which competition policy was designed and thus, even though the goals of competition policy should remain the same, the tools must be adapted.

How can these tools be adapted?

The report is composed of four main chapters presenting different issues and detailing several propositions. The first is dedicated to the tools of competition policy; the second is about the treatment of platforms; the third explores how to treat data; and the final chapter deals with mergers and what are called "killer acquisitions", or "killer-mergers", which have been particularly scrutinized in the recent literature.

Where should competition policy be headed?

There is a continuous need to rethink competition policy. We're entering a world which we don't understand very well and we need to make decisions depending on how this world evolves, how new technologies develop and what we learn.

What was it like working on this report?

It was a bit scary at the beginning because the three of us are from different disciplines. Heike Schweitzer is a lawyer specialized in antitrust issues and Yves-Alexandre de Montjoye is working on computational privacy, and we didn't know each other before. I can't say it's been a perfectly smooth process but, overall, it went very well and we succeeded in finding a common language.

How is the TSE Digital Center working on these issues?

In this report, we discuss how platforms act as regulators of their economy. This is directly inspired by the recent literature on two-sided platforms, including lot of different work led by my colleagues at TSE.

Find out more
Read the report at: ec.europa.eu/competition/information/digitisation_2018/report_en.html

CHRISTIAN GOLLIER ON HIS NEW BOOK

Global warming: how to pay the bills

The director of TSE and vice-president of the European Association of Environmental Economists presents his new book, "Le climat après la fin du mois" published by Puf Editions, which explores the solutions proposed by economists to combat global warming.

Why this title?

For 30 years, citizens have been lulled to sleep by the story of a happy energy transition that creates jobs, reduces energy prices and saves the world. With the increase in fuel prices at the pump, people are realizing that this transition cost them a lot of money. They are disoriented, and many are no longer sure they want to give up some of their purchasing power to help fight global warming. Ultimately, the greenhouse effect forces us to abandon a cheap, easy-to-use fossil fuel in favor of much more expensive and much less easy-to-use renewable energies until we have a solution to store electricity on a large scale. The reality shock is severe. The rebellion is at hand. Paying the bills at the end of the month comes before the end of the world.

> **A uniform carbon price of €50 would imply a loss of purchasing power of around €300 per and per person.year and per person**

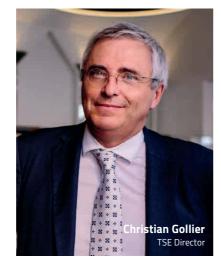### What solution does the book recommend?

People cannot be mobilized for a global climate war based on lies. The truth is that you and I are individually responsible

Christian Gollier
TSE Director

for the problem. On average, every ton of CO_2 emitted will cause more than €1,000 of damage in 80 years. Each French citizen emits an average of six tons of CO_2 every year, so everyone has a personal climate debt that is growing by more than €6,000 annually. People must be made aware of this individual responsibility. But let's not rely on their altruism to translate this awareness into action. To force them to act responsibly, economists recommend that any CO_2 emitter should be required to pay the present value of future damage caused by their behavior. This "carbon price", or ecological tax, is an application of the polluter-pays principle that the French have always supported at the ballot box. But will they accept it when it impacts upon themselves? The surveys conducted during the 'yellow vests' movement are not encouraging. This tax is not intended to be punitive. It is the ideal instrument to encourage people to take into account the climate damage caused by their behavior. This will lead them to reduce their emissions. We know that a 10% increase in the price of fuel reduces fuel consumption by 9% in the long term.

How much would this carbon tax cost?

As most of the damage caused by the emission of one ton of CO_2 will not materialize

for many decades, the value of this damage today is well below the €1,000 price tag mentioned above. Overall, climate economists believe that this discounted value is around €50 euros per ton of CO_2. Today, the carbon tax is locked at €44 per ton of CO_2, while European industrialists pay their emission permits at an equilibrium price on the permit market of around €27 per ton. A uniform carbon price of €50 would imply a loss of purchasing power of around €300 per year and per person. That's not trivial. But this price is largely insufficient to achieve the climate objective that all French governments have set themselves over the past 20 years. The plan is therefore to increase this price by 8% per year (2nd Quinet Report).

Applying this tax directly would have unequal effects. Even if the highest incomes will contribute more because their

big cars and houses consume more energy, the share of their income spent on this tax will be much smaller than that of the lowest incomes: this is what we call a regressive tax. Redistribution systems must therefore be put in place at the same time to compensate those on the lowest revenues from this tax, for example with green vouchers or a reduction in the social charges on low-skilled labor, financed by the revenues from this tax.

Does this tax have political support?

In 2007, Nicolas Hulot won almost unanimous support from the presidential candidates for his climate plan, which advocated a high carbon price. Today, no party, with the notable exception of Macron's LREM, talks about a carbon tax or the polluter-pays principle anymore. It is a disaster for our country and a Pyrrhic victory for the yellow vests. Macron has given almost all the decision-making power over climate policy to a randomly selected assembly of 150 citizens that will meet this summer. I admit that I am very worried.

If France is to respect its international commitments, the alternatives to ecological taxation are not very promising. Authoritarian solutions, such as anti-pollution regulation for cars and thermal emission standards for buildings, are bad instruments because they encourage people to consume more. We call this the rebound effect. If my new car consumes half as much fuel as before, will I not want to drive twice as much? In addition, the cost to France of its very generous prices for photovoltaic electricity is almost €1,500 for every ton of CO_2 emissions avoided, while the yellow vests are not even willing to sacrifice €50! This bill is paid by consumers in their electricity bills.

If we want to achieve a given climate objective, a universal carbon price is the solution that requires the least sacrifice from citizens. It guarantees that all efforts that cost less than the price of 50€ per ton of CO_2 will be implemented, and only them. It's simple, it's transparent and it's manipulation-proof! All other

solutions will be more damaging to the purchasing power of French households. Nevertheless, in the current political context, these other solutions have the irresistible advantage of camouflaging their costs to citizens.

Are there any other alternatives?

It's not easy. Democracy is the dictatorship of the present, since future generations are victims of our irresponsibility and they do not have the right to vote in current elections. This is why some philosophers such as Hans Jonas are advocating for an ecological dictatorship that would impose on present generations a decrease in fossil-fuel consumption compatible with the common interest of generations called upon to spend time on our planet. The other solution would be to roll the dice on the fate of humanity, betting on the emergence of competitive green technologies in the face of oil extraction costs at $2 a barrel in Saudi Arabia. This seems extremely risky. ∎

Christian Gollier

Le climat après la fin du mois

puf

French national debate at TSE

Following Emmanuel Macron's initiative to organize a major national debate on French issues and problems, TSE researchers and students welcomed interested participants for three evenings to discuss ecological transition, tax, inequality, education, immigration and public spending.

Ecological transition

Fighting global warming

Christian Gollier presented the idea of a carbon coalition in which a group of countries would agree to put a price on carbon emissions and tax all imports from non-coalition countries. This solution, defended by the 2018 Nobel prize winner in economics, William Nordhaus, has the elegance of being transparent, resistant to lobbying and, above all, it can solve the free-rider problem.

KEY PROPOSALS

▶ Implement effective policy to limit global temperature increase to 2°C
▶ Establish a global and universal carbon price of around €50 per tonne of CO_2
▶ Organize a coalition of countries willing to tax carbon and imports from non-members
▶ Promote a selective decrease in growth
▶ In France, eliminate all hidden subsidies and exemptions for CO_2-emitting products

PUBLIC PROPOSALS

▶ Implement new indicators that are more precise than GDP, taking into account environmental impacts
▶ Work with international organizations to integrate environmental dumping in their analyses
▶ Create a European budget and a climate bank to finance investments and environmental measures
▶ Promote individual behavior and collective measures useful in the fight against global warming

Food and Climate

After a short summary of the impact of food on our climate, and in particular the contribution of animal products to greenhouse gases, Zohra Bouamra-Mechemache presented her research on the impact of a carbon tax on meat production. She supports a tax on beef alone, which would have a smaller environmental impact but would be less costly for consumers. She also emphasized that supply solutions are complicated to implement and referred to initiatives that would impact demand, such as Green Monday.

KEY PROPOSALS

▶ Increase awareness of the importance of CO_2 emissions from agriculture, and livestock in particular
▶ Focus on the link between health and environmental impacts
▶ Implement combined measures to influence supply and consumption, through incentives to reduce demand
▶ Direct meat consumption towards products that are both nutritional and environmentally friendly

PUBLIC PROPOSALS

▶ Reduce meat consumption in school canteens and other public places
▶ Integrate animal welfare into policy considerations
▶ Promote consistent communication on these topics
▶ Promote existing initiatives such as Green Monday
▶ Don't ignore French culinary culture in messages on meat consumption
▶ Ensure that severely affected farmers do not suffer further, and implement targeted measures

Public services and citizenship

Immigration: Problem or Opportunity?

Emmanuelle Auriol demonstrated that immigration is above all a question of economic mobility and that the vast majority of immigrants come to find work in their host country. She also underlined that immigrants contribute to the growth and economy of their host countries. The debate then focused on the problems that immigration can pose from a sociological, urban or psychological point of view.

KEY PROPOSALS FROM THE DEBATE

▶ Improve policy for the integration of immigrant populations
▶ Implement inclusive urban policies that promote social integration and diversity to avoid the risks of communitarianism
▶ Rethink urban planning to improve immigrant integration
▶ Think about solutions to avoid creating a problem of climate statelessness
▶ Create a genuine status for climate refugees
▶ Conduct more studies on the economic impact of immigration

▶ Legalize and suppress immigration
▶ Improve organization of the legal migration market
▶ Sell visas and finance tougher measures to curb the employment of illegal immigrants
▶ Implement a paid work permit that can be financed by companies
▶ Undercut the market for smugglers who favour criminal networks
▶ Involve companies and social partners in policy considerations
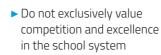
Education: A Two-Speed System

IAST director Paul Seabright presented a wealth of data showing that the French education system is unequal, inefficient, costly and lags behind international standards. He then opened the discussion on the subject with several recommendations.

KEY PROPOSALS FROM THE DEBATE

▶ Invest more in education and research
▶ Improve initial teacher training and lifelong learning
▶ Enhance the value of the teaching profession and offer more attractive salaries
▶ Encourage parents to become more involved in their children's learning
▶ Consider more participatory methods, such as allowing students to evaluate lessons
▶ Accept that students make mistakes, and use these mistakes to improve learning

▶ Do not exclusively value competition and excellence in the school system
▶ Try to identify the specific skills of each person and encourage them to find their path
▶ Improve support for the educational and vocational guidance of students
▶ Accept the evaluation of teachers by their students and a tutoring system

Tax and public spending
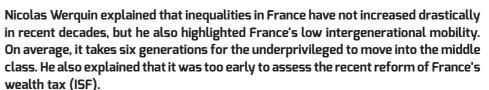
Which taxes for which France?

Frédéric Cherbonnier explained how the French tax system is plagued by many complex, inefficient and costly tax niches. In particular, he showed how housing subsidies increase rents rather than helping the most disadvantaged, and how the research tax credit and the charge reduction on employment both appear to be largely ineffective.

KEY PROPOSALS FROM THE DEBATES

▶ Remove tax niches on a case-by-case basis, starting with those on rental investment
▶ Reassess housing support policy, supporting supply so as to gradually remove policy that props up demand

▶ Reassess aid to the economy, seeking to refocus CICE or CIR (research tax credit) schemes to limit windfall effects
▶ Increase public spending on research and education

Taxation and Inequality

Nicolas Werquin explained that inequalities in France have not increased drastically in recent decades, but he also highlighted France's low intergenerational mobility. On average, it takes six generations for the underprivileged to move into the middle class. He also explained that it was too early to assess the recent reform of France's wealth tax (ISF).

KEY PROPOSALS FROM THE DEBATES

▶ Invest in education to reduce inequalities of opportunity
▶ Increase the progressivity of inheritance tax

▶ Reduce tax competition between European countries by harmonising tax bases

ARTIFICIAL INTELLIGENCE

Entering a new era

DARON ACEMOGLU ON THE FUTURE OF WORK

Will robots take our jobs?

The 2018 Jean-Jacques Laffont prize is the latest addition to MIT professor Daron Acemoglu's trophy cabinet. In recognition of his research on political economy, development, and labor economics, his awards also include the John Bates Clark Medal in 2005 and the BBVA Frontiers of Knowledge Award in 2017. Visiting Toulouse in October, he discussed his work on AI with our students.

How do you distinguish between replacing and enabling technologies?

At a theoretical level, automation technologies are AI applications that seek to replace human labor while enabling technologies are developed to increase labor productivity. In reality, of course, automation and replacing technologies merge. Literally interpreted, computer-assisted design is a labor-augmenting technology, because it makes design workers more productive. However, it may also have the same features as automation technology, because some tasks are automated.

> *We have to be alert to the possibility that AI will have destructive effects on the labor market. However, AI may also be conducive to higher wages and higher employment*

The conceptually important point is that different types of technologies have very different effects. Recognizing this is an antidote against the argument that improving productivity through technology will always benefit labor.

We need to think about what new technologies do and how the increase in productivity will affect labor. AI, as opposed to industrial robot automation, is not necessarily labor replacing. You can use it to create new tasks for labor or increase productivity, just like robot automation.

Will AI lead to job destruction?

Automation has already played a major role in the rise of inequality, such as changes in wage structure and employment patterns. Industrial robots are part of that, as well as numerically controlled machinery. Software has been a contributing factor, but probably not the driver that people expected. One might think that AI will play a similar role, although I'm not confident we can predict what AI will do.

Industrial robotics is a complex, but narrow technology – there are very simple challenges that companies trying to produce robots are trying to overcome. The software part is not rocket science, it's more about how robots interact with the physical world. AI is a much broader technology. You can use it in healthcare and education in very different ways, using voice, speech, and image recognition. Therefore, it is not clear how
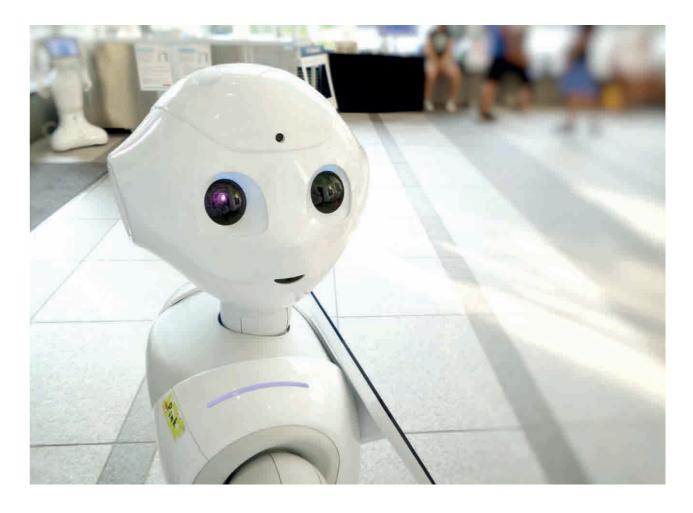
Daron Acemoglu
MIT

AI will develop and which applications will be more important.

How should we respond to the monopolies of digital platforms?

We are not used to companies being as large and dominant as Google, Facebook, Microsoft, or Amazon. When people were up in arms about the power of companies, robber barons, at the beginning of the 20th century, leading to the whole progressive sequence of antitrust and other political reforms: as a fraction of GDP, those companies were about one quarter as big as the ones we have today.

I worry about the dominance of these digital platforms: they are shaping how AI is developing. The function of their business model, the function of their priorities, may or may not be the way

that's optimal for AI to develop. We are very much at the beginning of the process of AI and we have to be alert to the possibility that AI will have destructive effects on the labor market. However, it isn't a foregone conclusion, and there are ways of using AI that will be more conducive to higher wages and higher employment.

Industrial organization theory is doing us a huge disfavor by not updating its thinking about antitrust and market dominance, with huge effects on the legal framework, among other things. I don't know the answers, but I know that they don't lie in thinking about something like: "Herfindalh [HHI] is not a good measure of competition so therefore we might have Google dominate everything, but perhaps we are OK."

Is taxing robots a solution to these inequalities?

There is certainly enough labor income to have more redistributive taxation, and no certain need to tax robots. However, we should also think about capital income taxation more generally. Singling out robots, as a revenue source distinct from other capital stock, would be a bad idea. If, for example, you want taxes to raise revenue, then land taxes will be a much better option. However, there may be efficiency reasons – giving the right incentives to firms – and revenue-raising reasons for taxing robots. But public discussions, because of Bill Gates and other people, are not helping this confusion.

In terms of sharing wealth, robots do not create new problems compared to other forms of capital. It was a confusion

of Marx to think that everything that goes to capital is somehow theft. There are legitimate reasons for thinking that there is excessive automation. And if there is excessive automation, there are Pigouvian reasons for taxing robots, or removing the many subsidies for robots. But that is the discussion we need to have.

What does the Jean-Jacques Laffont prize represent to you?

Jean-Jacques Laffont was a pioneer economist in both theory and applications of theory to major economic problems. This tradition is important for the relevance and flourishing of economics over the past two decades. It's a fantastic way of honoring his influence, and I feel very privileged to have been chosen for the prize. ∎

MASTERCLASSES BY JEAN-FRANÇOIS BONNEFON AND FRANÇOIS POINAS

The impact of AI

At the TSE Digital Forum 2019, economists, decision-makers and industry players gathered to discuss artificial intelligence and better understand the consequences of this major technological upheaval. Jean-François Bonnefon, Research Director at TSE and CNRS and François Poinas, Senior Lecturer at TSE and Toulouse 1 Capitole University, presented two masterclasses on the morality of machines and the impact of AI on employment.

"What morality for machines? Jean-François Bonnefon - Research Director, CNRS-TSE

Deprived of a moral sense, artificial intelligence nevertheless contributes to decisions with a moral significance. Thus, the study conducted by the research director focused on the decisions that future autonomous vehicles will have to make and their moral consequences. For Jean-François Bonnefon, "citizens must have a say in this debate". Should the car prefer to save its passengers or pedestrians, and on what criteria should it make its risk management decisions?

> **A new way of doing social sciences had to be invented, using the latest digital tools**

To determine socially preferable decisions and their causes, the research group designed a viral website to collect more than 60 million citizen choices in more than 200 countries. "A new way of doing social sciences had to be invented, using the latest digital tools. "Internet users were asked to choose between two accident situations, each combining up to nine factors such as the age, gender or social status of the victims. Several universal trends are emerging, with a preference to save

humans rather than animals, the largest number of individuals, and in priority the youngest.

Jean-François Bonnefon also points out the importance for designers of autonomous systems to take the public into account. The study shows that there are three main areas of choice that stand out from each other: Western Europe, Asia and South America. The researcher also denotes the special place occupied by France: "France, and its former colonies, respond in the same way as the countries of South America, we do not yet know how to explain it."

The researcher concluded that it is important to take into account the social

Jean-François Bonnefon
TSE-CNRS-CRM

preferences of individuals, particularly when designing sensitive algorithms in areas such as health or law. It also highlights the effectiveness of web-based viral methods for collecting data useful to system designers and decision-makers.

François Poinas
TSE-UT1C, TSE-INRA

Artificial intelligence and employment - François Poinas - Senior Lecturer, TSE, UT1C

The researcher began his presentation by recalling "the fear is that artificial intelligence replaces the human in all its dimensions" in many fields and many jobs. This fear is similar in many ways to past fears about the arrival of mechanization or electricity. Various economic studies justify this sentiment, predicting that machines will replace 10% to 70% of jobs in the next ten years.

For François Poinas, however, the job-destroying impact of artificial intelligence

should be put into perspective. The current development of this technology focuses on predicting missing information, resulting in lower prediction costs. While it is possible to replace humans with a more productive machine in these tasks, this replacement is not possible for every single task; the assumption of certain prerogatives by the machines will allow humans to concentrate on other more productive tasks. François Poinas also explains that there is no correlation between wage levels and the possibility of the job disappearing: "higher-paying jobs are not better protected against the advent of the AI".

> **Higher-paying jobs are not better protected against the advent of the AI**

According to the economist, the effect of artificial intelligence on employment therefore remains uncertain, and will depend on the ability of agents to "change the scope of jobs", and to take advantage of the additional productivity provided by the machine. To this end, he emphasizes "the central role of training for humans to perform tasks different from that of artificial intelligence". ∎

AI Regulatory Issues

Rémy Demichelis, journalist at Les Échos, led a round table discussion on the regulatory issues of AI, bringing together Mathieu Agogué, Deputy Director of Regulatory Affairs at Orange, Yassine Lefouili, Director of the Digital Center at TSE, Etienne Pfister, Chief Economist at the Competition Authority and Françoise Soulié, Scientific Advisor at Hub France AI.

This decade was marked by the great return of artificial intelligence: since 2012 and the success of neural network algorithms in image recognition, the technology has been constantly improved in different fields. Energy optimization of data centers, reduced trips for transport operators, diagnostics in ophthalmology are just some of the many examples where AI can improve a service or save money.

Artificial intelligence is a general-purpose technology, like electricity, steam engines or microprocessors

"Artificial intelligence is a general-purpose technology, like electricity, steam engines or mircroprocessors," explains Yassine Lefouili, director of the TSE Digital Center. The particular challenge of AI is that it creates "positive externalities", he adds, i.e. "a situation where the action of an economic agent benefits other agents". This is good for society as a whole, but it also means that the first firm, the one that produces innovations, "only manages to capture a part of their value," says Yassine Lefouili. This may lead to an underinvestment problem in the absence of adequate public support.

For Françoise Soulié, scientific advisor at the France IA Hub, the issue is less about algorithms: "The real subject of AI is data. "The question is how to get companies to work together on the data already, and then produce common models. "If we learned to share data, everyone would benefit. "The government has launched a call for projects, the results of which will be known in 2019.

Etienne Pfister, Chief Economist at the French Competition Authority, nevertheless notes that "not all data are good for sharing", particularly pricing data. This is for the simple reason that they are likely to betray the strategies of each company. Conversely, these companies may agree that these algorithms create a situation of collusion, as was observed for the sale of posters on Amazon.

[The real subject of AI is data. If we learned to share data, everyone would benefit

A second problematic configuration would be where two companies buy a pricing model from the same supplier. The latter could then have an interest in producing a model that does not threaten either of the two buyers. The third configuration would be the situation where entities would use a similar or different algorithm that would come to believe that "competition costs more than it brings", continues Etienne Pfister. In other words, the models could agree on prices without this intention on the part of the players.

One issue that appears in the background is therefore that of market access. Access that can be hindered by some agents to the extent that "they are the market", as one member of the public notes. Only algorithms, if they can encourage collusion, and if they can come to pose new barriers in customer access, can also be useful to improve the network and thus make the market more fluid. The principle of net neutrality, for example, does not allow one operator to allocate more network than another. Yet, notes Matthieu Agogué, Deputy Director of

From left to right : M. Agogué, E. Pfister, R. Demichelis, F. Soulié, Y. Lefouili

regulatory affairs at Orange, AI algorithms would offer better use of the network without harming any of them; consumers and operators would not see the difference. "There are a number of regulations that will be affected by AI," he explains. Presumably, there will be adjustments to be made, checking that all regulations are relevant."

New regulations for new markets, themselves likely to encounter new barriers: AI is still far from having revealed everything it holds in store for our society, but the questions arise today. ∎

DIGITAL FORUM TSE **4**th edition

2019 ARTIFICIAL INTELLIGENCE

2018 BIG DATA

2017 ONLINE PLATFORMS

2016 DIGITAL ORGANIZATIONS

DANIEL CHEN ON JUDGES' DECISIONS

Machine learning and the law

Can algorithms improve judges' decisions? Daniel Chen's research has provided extensive evidence documenting bias in the US legal system. Here, he argues that integrating machine learning (ML) tools and with legal data offers a mechanism to detect in real time – and thereby remedy – judicial behavior that undermines the rule of law.
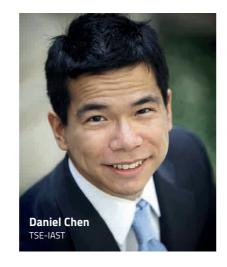
Until now, most empirical work has focused on observing the influences on judges' behavior, helping to diagnose the problem of bias but offering little in terms of solutions. There is a substantial literature showing that features that ought to be legally irrelevant – such as skin color, the weather, or judicial attributes – are in fact predictive of legal outcomes in a variety of settings.

ML offers a way to automatically detect such cases of judicial indifference – where judges' decisions appear to ignore the circumstances of the case – because they are also the contexts in which ML tools are likely to be least accurate in predicting decisions.

Equally, Daniel's research has demonstrated the possibility for ML to automate the detection of inconsistencies between judges due to legally irrelevant factors. In asylum courts, Daniel finds these influences are highly prevalent, including: the time of day; the size of the applicant's family; whether genocide has been in the news; and the date of the decision.

Daniel Chen
TSE-IAST

> Identifying judges whose behavior is predictable may enable policy intervention. Simply alerting judges that their behavior may indicate unfairness may be sufficient to change their behavior

Daniel's insight is that judges are most likely to allow these extra-legal biases to influence their decision-making when they are least swayed by legally relevant circumstances. In asylum courts, Daniel finds that judges with the highest and lowest grant rates are much more predictable than others. "However, less predictable judges tend to have middling grant rates. It may be that they lack strong preferences, and are therefore guided by random factors when making a decision – essentially flipping a coin."

Policy intervention

Identifying judges whose behavior is predictable at relatively early procedural stages may enable policy intervention. For example, training programs could be targeted toward these judges, either

BIASED JUDGES
There is ample social scientific evidence documenting arbitrariness, unfairness, and discrimination in the US legal system. Here are just some of the relevant findings by Daniel and others:
- US federal appeals court judges become more politicized before elections and more unified during war.
- Refugee asylum judges are 2 percentage points more likely to deny asylum to refugees if their previous decision granted asylum.
- Politics and skin color also appear to influence judicial outcomes as does masculinity, birthdays, football game outcomes, time of day, weather, name, and shared biographies or dialects.
- Various papers show clear judicial biases in lab environments, such as the influence of anchoring, framing, hindsight bias, representative heuristics, egocentric bias, snap judgments, and inattention.

with the goal of de-biasing or to help improve the hearing process. Simply alerting judges to the fact that their behavior may indicate unfairness may be sufficient to change their behavior.

Advances in data analysis may permit more targeted interventions. "It may be possible," Daniel suggests, "to establish the most predictable combinations of case and judicial characteristics. When such pairs are found, judges can be given a 'red flag' warning, as a counter-weight to confirmation bias or other non-legal sources of influence."

Informing judges about the predictions made by a model decision-maker could help reduce judge-level variation and arbitrariness. "If brought to a judge's attention, potential biases could be subjected to higher-order cognitive scrutiny. Such efforts would build on the push to integrate risk assessment into the criminal justice process."

Judicial education

An additional pathway for ML to improve legal decisions is judicial education. "The

first goal would be to expose judges to findings concerning the effects of legally relevant and legally irrelevant factors on decisions, with the goal of general rather than specific debiasing. For example, Pope, Price, and Wolfers (2013) found that awareness of racial bias among NBA referees subsequently reduced that bias. The second goal would be to educate legal decision-makers about inference, prediction, and the tools of data analysis, so that they can better understand available information, and the conscious and unconscious factors that may influence their decisions."

Judicial education has had considerable success. By 1990, 40% of federal judges had attended a two-week training program in economics, founded in 1976. Daniel's research has found that this training led to economics language rapidly becoming prevalent in judicial opinions. More tangibly, training changed how judges perceived the consequence of their decisions. Judges in economic regulation cases shifted their votes in an anti-regulatory direction by 10%. In district courts, when given discretion in

sentencing, economics-trained judges gave 20% longer sentences than their non-economics counterparts.

Daniel believes this training is likely to have provided structure for judges to understand patterns. "The next challenge is to see whether ML, text-as-data analysis, and other developments allow for a further step. If judges are shown behavioral findings, will they be less prone to behavioral biases? If judges are taught the theoretical structure that drives behavioral bias, will they be better judges? Could a new generation of theory and evidence from behavioral and social sciences provide better justice and increase cooperation, trust, recognition and respect?". ∎

Find out more
In a recent commentary, 'Machine Learning and the Rule of Law', Daniel presents a conceptual framework for understanding recent findings on judicial decision-making, and suggests that predictive analytics can improve fairness.

SUSAN ATHEY ON DIGITAL RESEARCH

Machine learning and economics

The first female winner of the John Bates Clark Medal, Susan Athey is Stanford's Economics of Technology Professor and has been conducting research with Microsoft for many years. Drawing on her recent working paper titled 'The Impact of Machine Learning on Economics', she talks to TSE Mag about the technological revolution transforming economics and society.

Susan Athey
Stanford University

What impact will machine learning (ML) have on research and policy?

Off-the-shelf ML methods, for tasks such as prediction, classification and clustering, will become pervasive. There have already been a number of successful policy applications. Examples by Harvard economist Sendhil Mullainathan and coauthors include predicting whether an elderly patient will die within a year to determine whether to do a hip operation. Harvard economists Edward Glaeser, Andrew Hillis, Scott Kominers, and Michael Luca have helped cities to predict health-code violations in restaurants, in order to better allocate inspector resources. Using ML together with satellite imagery and street maps can predict economic quantities such as poverty, safety, and home values.

Can ML improve scientific credibility?

When appropriate and properly applied, ML methods provide a rigorous and systematic approach. By selecting the best model for the data, ML algorithms prevent a researcher from cherry-picking the models that give the most appealing results. Transparency is improved, since the researcher can fully describe the algorithm and model selection can be easily replicated.

The model selected by the ML algorithm may be substantially more complex than a hand-selected model, and it may find interaction effects that would be difficult to hypothesize about in advance.

ML enables an increased emphasis on stability and robustness. Large tech firms release new algorithms every week, and conduct thousands of experiments per year. E-commerce firms and even physical stores change prices regularly, and scanners and transaction logs can provide this data. So we have lots of ways to test the credibility of models and counterfactual predictions.

ML is good at predictions. Why do we need anything else?

Off-the-shelf ML methods can predict which customers will click on an advertisement, or which restaurants will fail a health inspection. That's not the same as knowing how to allocate resources. Determining the units for whom intervention is most beneficial is a causal inference question, and may require different types of data from randomized or natural experiments.

Where correlation and causality are confused, prediction can be misleading. If drinking red wine is predictive of longevity,

a predictive model might lead people to conclude they should drink more, but it is possible that red wine is harmful to health, and that red-wine drinkers are different from non-drinkers in ways that are hard to control for.

> [**An emerging trend is to build the experimentation right into the algorithm**

Economists are used to throwing away most of the predictive power of a model to get unbiased estimates of causal effects. It's a very different way of thinking about things. A few research teams, including myself and coauthors, are exploiting this difference to do new

statistical science. Our research shows how existing approaches from statistics and causal inference can be combined with advances from ML to substantially improve performance.

What are some of the most promising ML innovations?

Firms like Google and Facebook do thousands of randomized controlled trials of incremental improvements to ML algorithms every year. An emerging trend is to build the experimentation right into the algorithm. Multi-armed bandits balance exploration and learning against exploiting available information about which alternative is best. Bandits can be dramatically faster than randomized experiments because their goal is to find the best alternative, not to accurately estimate the outcome for each alternative. I've been doing research about "contextual bandits", which try to learn the best personalized policies.

What effect will ML have on the way economists work?

Scholars who do a lot of complex data analysis have already begun to adopt a

"lab" model similar to what is standard today in computer science. It might include a post-doctoral fellow, multiple PhD students, pre-doctoral fellows, undergraduates, and full-time staff. Such labs are expensive, so funding models will need to adapt.

We will see increased adoption of collaboration tools; for example, my generalized random forest software is available as an open-source package (github.com/grf-labs/grf). There will be an increased emphasis on documentation and reproducibility, even as some data sources remain proprietary. "Fake" data sets will allow others to replicate analysis.

All disciplines will gain a much greater ability to intervene in the environment in a way that facilitates measurement and causal inference. When people get most of their information digitally across areas like health, education, shopping, and travel, there will be opportunities to experiment with that information provision to learn how to make it more efficient.

We will also see more interdisciplinary majors. The curricula will evolve from

a truly engineering base to being more problem-solving. That will increase the demand for economists generally, but also change the way we teach and research.

How should we prepare students for a digital future?

Students may arrive at econometrics classes having been exposed to ML, with a cookbook full of algorithms but little intuition for using data to solve real-world problems. Data-science programs will have more marketable and useful students if they bring in economists and other social scientists. At the same time, econometrics should continue to maintain its comparative advantage at things like careful attention to identification of causal effects and a focus on counterfactual estimation. ∎

Find out more
To read more about Susan's research on ML, and on a variety of other topics in microeconomic theory and industrial organization, visit:
people.stanford.edu/athey/research

YASSINE LEFOUILI ON THE DIGITAL ECONOMY

Launching the TSE Digital Center

As the TSE Digital Center was officially inaugurated on January 10, 2019 at the 12th conference of digital economics, its Director, Yassine Lefouili, TSE-UTC professor, answered our questions about the center, its objectives and the future of digital economics.

What are the objectives of the Digital Center?

The overarching aim of the Digital Center is to spur research on the rising issues in the digital economy and to serve as a platform that connects academics, policymakers and industry players interested in digital issues. The 45 members of the Center are producing cutting-edge research that is not only published in the best international research journals but is also disseminated to firms, policymakers, and the wider public through newsletters, press articles, workshops and conferences.

> **The overarching aim of the Digital Center is to spur research on the rising issues in the digital economy and to serve as a platform that connects academics, policymakers and industry players**

Another key feature of the Digital Center is the multidisciplinary nature of the research conducted by its members who contribute to several fields including economics, mathematics, law, psychology, and computer science.

Can you provide us with examples of recent events organized by the Digital Center?

The Digital Center organized TSE's 12th conference on digital economics on January 10-11. This conference, now annual, claims to be the best research forum on the digital economy in Europe. The Center also organized with the European Commission a conference on the Economics of Artificial Intelligence and Data on May 6-7 in Brussels. This conference comprised three keynote lectures by world-leading experts, two roundtables gathering academics, policymakers and industry representatives, and presentations of academic papers.

Finally, the annual TSE Digital Forum was held in Paris on May 17 and included two masterclasses on the moral aspects of artificial intelligence and its impact on jobs, as well as a roundtable on the economic opportunities and regulatory challenges brought by the development of AI technologies.

What are the main research areas of the Digital Center?

There are four major research programs in the Center, each of which is headed by a TSE research faculty who is an expert in the corresponding area. The "digital platforms" program aims at fostering

Yassine Lefouili
TSE Digital Center Director

our understanding of the economics of platforms from both a business strategy perspective and a policy standpoint. The "analytics and economics of big data" research program is conducted by a team that comprises mathematicians developing optimization and statistical techniques to analyze high-dimensional datasets as well as economists working on issues such as privacy and the market for data. The "AI and society" program examines the moral and economic trade-offs that come with the introduction of AI in high-stake domains such as health, justice, finance, and transportation.

Finally, the "financial technologies and digital markets" program aims at understanding the implications of key features of FinTech platforms and their impact on social welfare. Those four programs

Inaurugation of the Digital Center with Christian Gollier, Marc Fontaine, Jean Tirole and Yassine Lefouili in Toulouse

cover most, but not all, of the research that is conducted in the Digital Center. For instance, they do not cover the law and economics of intellectual property, which happens to be one my research fields.

Can you tell us more about your research interests?

In the area of intellectual property, I am working with my co-authors (some of whom are lawyers) on patent holders' litigation strategies and the way they depend on institutional features such as cost allocation rules and the available mechanisms to challenge patent

validity. I am also interested in the way distinctive features of digital platforms should be accounted for by competition authorities when assessing merger, abuse of dominance and cartel cases. Finally, I have been working for the last few years on firms' privacy policies and the impact of privacy regulations on investments and social welfare.

What do you think is the most important challenge facing the digital economy?

The exploitation of personal data has borne benefits to companies and consumers

alike. However, it has also led to major concerns about its impact on privacy and competition. Identifying the trade-offs underlying the collection and use of personal data and designing policies and regulations that account for those trade-offs is probably one of the most pressing issues facing the digital economy. ■

Find out more
On the TSE Digital Center website
tse-fr.eu/digital

AIRBUS MARC FONTAINE ON THE EVOLUTION OF THE AVIATION INDUSTRY

Agility is tomorrow's challenge

Airbus embarked on a technological race to digital solutions for the aviation industry. To explain the challenges and the stakes of these new technologies and trends, Marc Fontaine, Airbus Digital Transformation Officer tells us about Airbus open-data platform Skywise and how the recently-launched TSE Digital Center can be part of the solution.

What are the key strategic and technological challenges faced by Airbus and the aviation industry today?

The aviation industry is facing the third revolution of its history: the digital revolution. Digital has always been part of our business – Airbus started some 50 years ago with "fly-by-wire" digital flight control systems – but in recent years it took an exponential turn. The volume and speed of data being exchanged, the increased computing power and the democratisation of all these technologies have radically modified our ecosystem. For us this means a complete redefinition of our competitive landscape: we are no longer evolving as part of a duopoly, instead with are competing with start-ups and companies with no aerospace expertise. SpaceX and the GAFA have smashed the concept of "entry barriers" and this forces everyone to look at the world in a very different way. Which we are very happy to do!

How are you adapting to these new trends?

The biggest challenge we have set to ourselves is to be as agile as a small digital start-up, while keeping 130,000 people moving in the same direction in an industrial context. And it is possible! The prerequisite is to take a fresh look at our set-up and put a renewed emphasis on the "how". How do we capture data value and how do we share it? How do we take enlightened decisions quickly? How much empowerment do we need?

> **One of our biggest assets today is the tremendous amount and variety of data that we have – and the expertise of our employees to make sense of it**

Basically: how do we set the rules of the game so that everyone has access to the right resources, at the right time, within the right context. At Airbus the first step of that journey has been to set up our open data platform Skywise, and to bring on it not just Airbus data, but also our airline customers and suppliers. This, coupled with the right data

Marc Fontaine

governance and agile methodologies, set the right foundations which today enable us to work efficiently across the industry.

How do you envision the future of the aviation industry?

More than our planes, our satellites or helicopters, one of our biggest assets today is the tremendous amount and variety of data that we have – and the expertise of our employees to make sense of it. We are actually in a phase of total reinvention of the aviation business models, from a "produce and forget" type of mindset towards a lifelong, real-time, non-stop improvement approach. Any piece of equipment can become an element of the digital chain. So you can imagine self-adapting aircraft, in which you would just have to push a button to go from 'eco' to 'performance' mode, with the wings or even fuselage adapting in real time.

What do you expect from an institution like TSE for instance?

That we work together to take down obstacles – be it physical, digital or even cultural – and to solve exciting challenges together. This is why we are extremely happy about the setting up of the Digital centre, which will be beneficial for all involved parties. Collaboration and cross fertilisation has never been more important than today. We are happy to get fresh insights and hear about the latest research publications on state-of-the art technologies, just as much as we are excited to share our real-life use cases and compare them to the theory. We also expect schools and institutions to source new talents – with the right level of diversity! Digital offers the opportunity to finally get rid of gender bias, and I take this opportunity to call for more women to join the industry now to become the aviation leaders of tomorrow.

What advice would you give to a student in Economics, in TSE or elsewhere, wanting to get into the aviation industry?

First of all: you are making the right choice! The aviation industry is both an ambitious and extremely rewarding industry to work in. The scale of what we do never ceases to amaze me: do you know that every 1.5 seconds, an Airbus aircraft takes off or lands somewhere in the world? In a data-driven world, this means we have tons of data to pla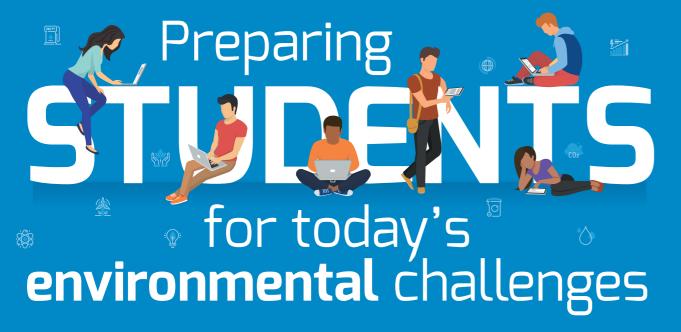y with – and very cool problems to solve! Some of them related to passenger experience, others related to urban air mobility. We have just scratched the surface here and there is a lot to be built by people willing to make a difference.

My last piece of advice to the leaders of tomorrow, is for them to get comfortable with "tightrope walking". Leadership in today's world is no longer about black and white decisions: digital or physical, high-level strategy or hands-on operations, quick wins or long-term view, institutional partners or business expectations, etc. It's always about both – and being able to find the right balance on a given spectrum and move alongside that spectrum as the world around them evolves. ◼

MASTER'S IN ENVIRONMENTAL AND NATURAL RESOURCES ECONOMICS

Preparing STUDENTS for today's environmental challenges

We live in an era of great environmental worldwide challenges: how have economic and demographic changes affected the environment? How can we control global warming and biodiversity loss to protect and respect our planet? What policies do governments and companies need to implement? Through its Master's in Environmental and Natural Resources Economics, TSE faculty takes very seriously its duty to train the new generation of top economists that will tackle these issues.

Making our climate great again

Pollution, global warming, conservation of biodiversity… mitigating and managing the impact on the planet of our ever-developing economies is a major challenge for both governments and industries worldwide. The issue tops the international political agenda; UN climate "COP" conferences regularly discuss and implement plans to combat global warming, governments design public policies such as taxes or emission-trading schemes to mitigate the impact of air or water pollution, firms launch green business strategies – such as investments in cleaner technologies, product labelling or socially responsible investments – to improve their competitiveness.

All these decision-making platforms need top environmental economists to bring the best analysis and design the best mitigation policies. In the International Master's in Environmental and Natural Resource Economics, led by TSE researchers Henrik Andersson and Ingela Alger, students benefit from the expertise of TSE and IAST faculty through two different tracks: Environmental Policy and Energy Economics (EPEE) and Ecology and Economics (EE). The first track will train economists with mainly economics-related courses whereas the second track will train students with a background in biology or economics through economics and ecology-related courses.

On both tracks, students are taught the analytical skills to assess, analyse and recommend economic policies and strategies to tackle environmental issues and manage natural resources.

> **TSE faculty takes very seriously its duty to train the new generation of top economists that will tackle these issues.**

For instance, one of the specialized EPEE courses is "Valuing the environment", taught by Henrik Andersson. Here, students learn how to value goods and services with no easily observable "price" such as clean air and water, or health and safety. The course covers the valuation of transport and health-related goods and services and introduces the theoretical foundations of environmental valuation, but its main focus is on the environment and the application of different valuation methods based on market data (e.g. hedonic pricing and the travel cost method) and survey data (e.g. contingent valuation and choice experiments). To earn hands-on experience, students are required to work with empirical problems using data; to encourage critical thinking, classes take the form of open discussions, encouraging students to reflect on the strengths and weaknesses of the different methods. On the "Cost-Benefit Analysis: Foundations and Practice" course, students learn how estimated values are implemented in practice.

In the specialized EE course "Sustainable management and evaluation of ecosystems", TSE and INRA researchers Jean-Pierre Amigues and Arnaud Reynaud also focus on environmental valuation, covering theoretical issues to understand why it is necessary to protect the environment in different contexts and how to pinpoint market failures related to scarce resource allocation. The other part of the course is dedicated to case studies applied to biodiversity and ecosystems from a local to a global scale. Students learn how to value ecosystem services and

> *"During my years at TSE and thanks to the ERNA master's, I developed a solid understanding of non-market valuation, cost-benefit analysis, risk and time, which I've since used throughout my career. Now working on wellbeing, cultural and health issues, I regularly use concepts learned at TSE like willingness-to-pay, contingent valuation or consumer surplus."*
>
> **Augustin Lagarde,**
> Economist at Simetrica – London (TSE Master's Graduate 2014)

to make them visible in order to influence public decisions. At the end of their master's, students specialized in environmental economics, or ecology and economics, are able to evaluate environmental and economic impacts of regulatory policies (taxes, average gas emissions, emission-trading schemes, etc.). They know how to use prospective and quantitative-analysis tools applied to natural resources and they have a strategic vision of how private decision-makers (firms, investors) can tackle environmental issues: innovation, green-product labelling, socially responsible investment, and environmental management systems. This gives students an excellent preparation for a professional career in the private or public sector, or in research. ∎

Master in Environmental and Natural Resources Economics

Directors:
Henrik Andersson
Ingela Alger
Monique Gardes

Find out more
www.tse-fr.eu/erna

Google visits TSE

In January, TSE students had the opportunity to exchange ideas on the future of digital marketing with Eoin Cahill, a senior account manager at Google. The event was part of a series of business and academic talks organized by the TSE careers department. During the talk, Eoin emphasized the extremely high demand for essential digital skills. He also detailed how an online presence is increasingly becoming crucial for any company and how Google can help others to take advantage of the growth in online commerce. After his talk, Eoin answered questions from TSE Mag.

What are the skills necessary for students to succeed in the digital industry?

Being a problem solver at all business levels is crucial in the digital word. The ability to go deep into a problem and dig into the data, as well as taking a step back and trying to look at the bigger picture from a business challenge is, once mastered, a great asset for a company.

Being an analytical thinker, who knows how to read and identify trends and opportunities in big sets of data. Something as simple as identifying a new target market for a business can have major impact.
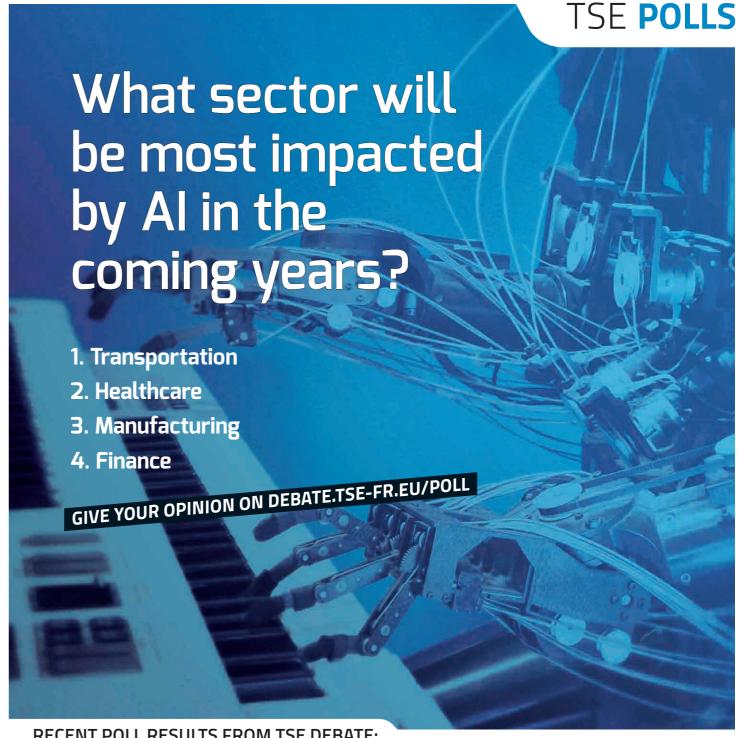
Adaptable, flexible...thrive in ambiguity.... all of the above! Digital marketing is constantly changing. With the rise in mobile and smart devices, it is changing further how companies interact with their audience. You must be OK with change and accept that your role always challenges you and develops.

> The ability to go deep into a problem and dig into the data, as well as taking a step back and trying to look at the bigger picture from a business challenge is, once mastered, a great asset for a company

What would you say to a TSE student interested in working at Google?

Go for it! If you have a passion for digital marketing and advertising and you want to gain experience speaking to businesses and learning how they operate, then simply seek out a role. No set background is needed. It's all about how you approach problems, and how you think in challenging situations.

Eoin Cahill

What sector will be most impacted by AI in the coming years?

1. **Transportation**
2. **Healthcare**
3. **Manufacturing**
4. **Finance**

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RECENT POLL RESULTS FROM TSE DEBATE:

88% believe tomorrow's Europe will be federal

80% would regulate more strictly the food industry

78% are worried about companies using their personal information

55% think the biggest hurdle towards efficient public policies is the lack of evaluation

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TSE CAREERS FORUM
BUSINESS NETWORKING DAY

**FRIDAY 29
NOVEMBER 2019
9AM > 5PM**

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