Sustainable Finance Center

Toulouse School of Economics

Socially responsible investment and the challenges of sustainable development

Responsible + Investment

Common Good

Director's word

Focused on the challenges of finding sustainable finance solutions and assessing their impact on society, Toulouse School of Economics (TSE) launched the Sustainable Finance Center in 2018 to promote innovative research on emerging issues in economics and finance.

With over 20 full-time scholars who have experience in prestigious universities (including Harvard, Princeton, MIT, Oxford, Carnegie Mellon, Wharton and London Business School…), the Sustainable Finance Center is dedicated to profound and relevant research published in top academic journals in finance and economics. Combining TSE's own expertise with its private and public partners' financial support and knowledge, its ambition is to bring new skills and perspectives to bear on the issues and to disseminate TSE's research findings.

Created with the help of industrial and institutional partners, the Center facilitates a productive dialogue between researchers and industrial partners and policy-makers. For the researchers, this exchange ensures that their work is grounded in real-world problems. Discussions with the Center's partners have often enabled researchers to identify new issues, spurring innovative research on the latest developments in sustainable finance. Researchers have developed cutting-edge expertise on these topics, strengthening their reputation as leading researchers in their academic community. Two-sided markets, high-frequency trading, and blockchain technology are just a few examples of research areas where TSE partnerships are reshaping the frontiers of knowledge.

Challenging and being challenged by partners' perspectives - as well as fresh data sets - may provide new dimensions to academic research. Partners benefit from these interactions, and also from privileged access to the Center's research output via issue-specific conferences or workshops that gather leading academics and practitioners.

Monitor our website to avoid missing out on our scientific and policy-oriented events, along with other outreach activities planned for 2019.

The Center is structured around four main themes, as outlined in the following pages: Sustainable Finance and Responsible Investments, Financial Technologies and Digital Markets, Financial Intermediaries and Regulation, and Financial Markets (in) Efficiency. Discover our current work on ethical asset valuation, cryptocurrencies, shadow banking, and risk sharing, and enjoy your reading!

Sophie Moinas

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- Ying Liang

Focused research programs

- Responsible Finance & Long-term Investments
- Financial Technologies & Digital Markets
- Financial Behaviors, Welfare & Market Inefficiencies
- Financial Intermediaries & Regulation

Responsible Finance & Long-term Investments

Introduced by
Catherine Casamatta

Professor of Finance at University of Toulouse Capitole (UTC) and a member of TSE, Catherine was Dean of TSM from 2010 to 2015 and head of UTC's PhD program in Management from 2006 to 2010. She is now in charge of the Master 2 Corporate Finance.

Catherine obtained a PhD in finance from the University of Toulouse. Her research focuses on corporate finance and governance, venture capital, financial intermediation, the organization of the fund management industry, and more recently, blockchains and cryptocurrencies.

She has published papers in leading international journals including the Journal of Finance, the Review of Finance and the Review of Financial Studies.

Her recent paper "The Blockchain Folk Theorem" (co-authored with Bruno Biais, Christophe Bisière, and Matthieu Bouvard) received the Swiss Finance Institute Outstanding Paper Award 2017.

Sustainable Finance and Responsible Investments

Financial markets are often blamed for inducing firms to adopt short-term strategies that have a negative impact on society. These critiques raise concerns about whether the invisible hand is able to allocate scarce capital efficiently in our decentralized economies. They also question the financial sector's ability to sustain long-term investment and growth.

The Center's members aim at developing research to answer the following set of questions: Do we invest enough in long-term assets? How should we value immediate benefits compared to distant ones? How can we measure and evaluate externalities imposed by firms on society? How can we provide incentives for economic agents to incorporate these externalities in their decisions?

Finding answers to these questions is crucial to address the current concerns in our society about climate change, nuclear risk, education and training, customer safety, and employees' and communities' welfare.

Investing in a better world

Christian Gollier
on ethical asset evaluation

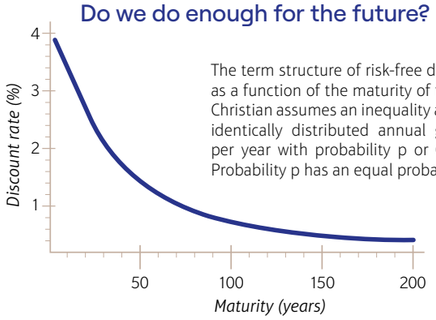
By controlling the allocation of capital, financial markets hold the key to the great challenges of our time, such as the fight against poverty, climate change, and cancer. In his latest book, 'Ethical Asset Valuation and the Good Society', TSE co-founder Christian Gollier suggests that this power can only be harnessed if we can determine the financial prices that are compatible with the public good. In particular, he shows how the valuation of long-term risk and time, based on transparent moral principles, can help to guide our choices for the future.

Can financial markets decentralize an efficient allocation of scarce resources? There are strong arguments, well studied at TSE, for believing that markets are not good at eliciting our collective values or aligning private interests with the public good. Agency problems such as moral hazard and adverse selection inhibit market efficiency, and the inability to trade with future generations prevents markets from efficiently valuing assets and investments that benefit future generations. More importantly, corporate profits do not fully internalize the impacts from production on social welfare. For example, the emission of greenhouse gases remains mostly free of charge, despite their destructive impact.

If markets are unable to aggregate our collective values, how can we evaluate private and public acts? How should we, for example, compare environmental protection with job protection, lives in Bangladesh versus purchasing power in Europe, workplace safety against corporate profits, reduced inequality versus growth, or more consumption today or in 200 years? Debating social values should be at the root of our democracy. If these values are incompatible with observed market prices, then public authorities should implement corrective actions.

Two prices drive most financial decisions: the price of time, which is the interest rate, and the price of risk. The choice of interest rate determines whether we do too much, or too little, for future generations. Too high an interest rate inhibits investment for the future. Too low an interest rate induces excessive investment, forcing people to sacrifice too much current well-being.

Do we do enough for the future?



The term structure of risk-free discount rates (in percent per year) as a function of the maturity of the sure benefit to be discounted. Christian assumes an inequality aversion of 2, and an independent, identically distributed annual growth rate of either 2 percent per year with probability p or 0 percent with probability 1 – p. Probability p has an equal probability of being either 0.1 or 0.9.

The price of time

The level of our collective aversion to inequality is a key determinant of the socially desirable interest rate. In a growing economy, investing for the future increases intergenerational inequality. So the interest rate should be the minimal rate of return on a safe investment that compensates for this increased inequality. If Western consumption per capita continues to grow at 2 percent per year, people living two centuries from now will be more than 50 times wealthier. This context justifies a high discount rate of 4 per cent per year.

Two prices drive most financial decisions: the price of time, which is the inteest rate, and the price of risk

The price of risk

Many investments for the future increase collective risk, as their benefits are larger when consumption is greater. Penalizing risk-increasing actions therefore reduces investment, which inhibits innovation and growth. Has the tradeoff favored the maximization of growth, or the minimization of risk?

It is socially desirable to adjust the discount rate to the risk profile of each investment project by adding an investment-specific risk premium. In keeping with the calibration of the interest rate, a risk premium of around 1 percent should be used at short maturities, for projects whose risk profile is similar to the macroeconomic risk. But because of the deep uncertainty surrounding the distant future, an aggregate risk premium of 2.5 percent should be used for very long maturities.

Financial markets penalize firms that increase the aggregate risk by raising their cost of capital. A 1-to-2.5 percent risk premium is in line with the equity premium imposed by markets on riskier firms. Much more worrying is the absence of any formal penalization of risk in the evaluation of public policies in most countries.

Cost-benefit analysis

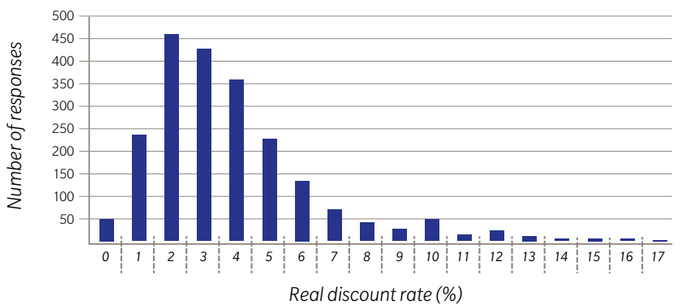
Many countries have established implicit prices to evaluate the actions of public institutions. These include prices for human lives, time lost, natural assets, and carbon, in sectors as diverse as energy, transportation, health, science, and education. These prices are subject to much debate among experts; but these debates remain inaccessible to the public, and this is unacceptable.

As well as improving our decisions, cost-benefit analysis is an important tool in the fight against populism

Ultimately, collective decisions should be made by comparing costs and benefits, using a coherent system of values. This includes a value for delaying consumption (an interest rate), a value for risk acceptance (a risk premium), and values for all the non-monetary impacts of our actions.

As well as improving our decisions, cost-benefit analysis is an important tool in the fight against populism. Lack of evaluation reinforces the impression that policies are driven by ideology rather than the common good. Instead, democracy can be strengthened by forcing politicians to make explicit the values on which their decisions are made.

Is the world too risky?



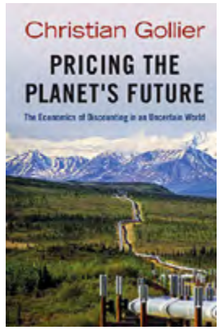
A histogram of individual estimates of the discount rate in a sample of 2,160 economists from academia. Source: Weitzman 2001

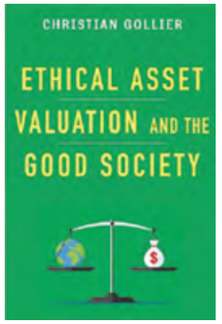
	2000 2014	1965 2014	1900 2014
China	2.3		
France	0.1	4.5	6.0
Germany	1.0	3.3	5.6
Japan	0.0	4.1	6.0
United Kingdom	0.9	4.8	4.4
United States	2.8	2.5	5.6
World	2.2	4.4	4.3

Equity Premium (annualized, in percent)
Source: Dimson, March and Stauton, 2015.

How can we encourage investors to be more socially responsible?

In conversation with
Christian Gollier





In my book, I try to combine the basic principles leading to a transparent methodology for evaluating investment choices with a socially responsible approach. I propose identifying the different sources of non-financial performance, such as safety at work or the reduction of inequalities, as well as the various emissions of pollutants.

In addressing socially responsible investment (SRI) funds, my aim is to make them aware of the importance of including carbon prices and negative externalities into their investment valuations and portfolio allocations, as well as simply maximizing returns.

For example, companies are currently obliged to publish their carbon emissions in their annual reports. SRI funds should therefore look at corporate emissions and multiply them by the price of carbon, and then re-incorporate this cost in their valuations.

They should also adopt the same method for other negative externalities, and even for positive externalities such as well-being within the company and wage increases for the lowest paid employees (possibly because of relocation), which helps reduce global inequality.

In general, SRI funds adopt a 'best-in-class' view, but without really quantifying emissions. Instead they make relative comparisons between companies according to their degree of social responsibility. My approach goes much further.

I propose using quantitative finance techniques, particularly the Markowitz model, on dividend-per-share profitability data, which includes non-financial performance ethically evaluated under an SRI filter. It doesn't matter that SRI funds post different values for positive and negative externalities. What is important is that investors can choose in accordance with their own ethical preferences. This would also make SRI funds more transparent, and therefore more attractive.

FURTHER READING: Christian refers quantitatively frustrated readers of ***"Ethical Asset Valuation"*** (2017) to his other recent book, ***"Pricing the Planet's Future"*** (2012), which provides more extensive technical details.

The carbon tax: a call to arms

A new book ***Le climat après la fin du mois*** by Christian Gollier has received widespread coverage in the French national press. According to Le Point, his book 'pulverizes' widely held misconceptions about the carbon tax.

An original and insightful thinker, Christian expresses his hope as well as his doubts about our ability to meet the climate challenge and proposes concrete economic solutions to preserve the future of all. To avoid catastrophe, he argues that we need to start making sacrifices now.

Financial Technologies & Digital Markets

Introduced by
Christophe Bisière

Professor of Finance at University of Toulouse Capitole and a member of TSE, Christophe has launched and long been in charge of the Master 2 Finance and Information Technologies. He received his doctorate in economics from Aix-Marseille University in 1994.

His recent work focuses on blockchain and cryptocurrencies. His research has been published in international academic journals such as European Financial Management, Management Science, and the Review of Financial Studies.

His recent paper "The Blockchain Folk Theorem" (co-authored with Bruno Biais, Catherine Casamatta, and Matthieu Bouvard) received the Swiss Finance Institute Outstanding Paper Award 2017.

Financial Technologies and Digital Markets

Progress in information technologies implies that more information can be disseminated, at a lower cost, to more participants. A lower search cost to find counterparties, products or services also reduces the need to transact via established centralized intermediaries and raises the scope for decentralized interactions.

Overall, this could lead to more competitive and efficient markets. But decentralizing interactions between anonymous parties from remote locations can worsen coordination, information asymmetry and market failures.

Current research questions tackled by the Center's researchers include the following:

- Can blockchain build a stable consensus among participants and thus offer a reliable infrastructure?
- What is the fundamental value of cryptocurrencies?
- What is the optimal design of digital market platforms?
- How can crowd-lending platforms minimize inefficiencies due to asymmetric information and bounded rationality?
- How should they match buyers and sellers and allocate assets, goods and services? How should they discover prices?
- What information should the platform provide to buyers and sellers?
- How should platforms and their managers be incentivized?

Bruno Biais

Do bitcoin returns reflect fundamental value?

Bruno Biais
Christophe Bisière
Matthieu Bouvard
Catherine Casamatta
on cryptocurrency pricing

Co-author: Albert Menkveld

What is the fundamental value of cryptocurrencies, such as bitcoin? Could the rising price of bitcoin reflect an increase in its fundamental value, or does it only reflect speculation? Does the volatility of cryptocurrencies suggest investors are irrational? In a new paper on 'Equilibrium Bitcoin Pricing', TSE researchers Bruno Biais, Christophe Bisière and Catherine Casamatta examine these issues by testing an equilibrium model with new data on bitcoin's transactional costs and benefits.

Several recent empirical papers have offered econometric tests of bubbles in the cryptocurrency market. While these analyses use methods developed for stock markets, cryptocurrencies differ from stocks. This raises the need for a new theoretical and econometric framework, to analyze empirically the dynamics of cryptocurrency. The goal of the our paper is to offer such a framework and confront it to the data.

Cryptocurrency can provide transactional benefits, allowing citizens of countries like of Venezuela or Zimbabwe to conduct transactions although their national currencies and banking systems are in disarray, or Chinese investors to transfer funds outside China

Costs and benefits

We consider overlapping generations of agents with stochastic endowments who can trade central-bank money and a cryptocurrency. While both currencies can be used to purchase consumption goods in the future, the cryptocurrency can provide transactional benefits that the money issued by the central bank does not. For example, citizens of Venezuela or Zimbabwe can use bitcoins to conduct transactions although their national currencies and banking systems are in disarray, while Chinese investors can use bitcoins to transfer funds outside China. We also account for the costs of conducting transactions in cryptocurrencies: limited convertibility into other currencies, transactions costs on exchanges, lower rate of acceptance by merchants, or fees agents must pay to have their transactions mined. Investors rationally choose their demand for the cryptocurrency based on their expectation of future prices and net transactional benefits.

What distinguishes cryptocurrencies from other assets (such as stocks, bonds) is the relationship between transactional benefits and prices. On the one hand, transactional benefits are akin to dividends for a stock, hence affect the price

agents are willing to pay to hold the cryptocurrency. But unlike dividends, the magnitude of transactional benefits in turn depends on the price of the currency: the transactional advantages of holding one bitcoin are much larger if a bitcoin is worth $15,000 than if it is worth $100. This point, which applies to all currencies, not only cryptocurrencies, was already noted in Tirole (1985, p. 1515-1516):

"… the monetary market fundamental is not defined solely by the sequence of real interest rates. Its dividend depends on its price. […] the market fundamental of money in general depends on the whole path of prices (to this extent money is a very special asset)."

Thus, the notion of "fundamental" means something very different for stocks (backed by dividends) and money (backed by transactional services). In particular, the feedback loop from prices to transactional benefits naturally leads to equilibrium multiplicity: agents who expect future prices to be high (resp. low) rationally anticipate high (resp. low) future transactional benefits, which in turn justifies a high (resp. low) price today.

While fundamentals are significant factors, they only explain a relatively small share of return variations on bitcoin. In the context of our model, this suggests that observed bitcoin volatility in large part reflects extrinsic noise

A tale of two currencies

We depart from Tirole (1985) in ways we deem important for the dynamics of cryptocurrencies. First, our model features two currencies, traditional central-bank money and a cryptocurrency. We thus derive a pricing equation expressing the expected return on the cryptocurrency (say, bitcoin) in central-bank money (say, dollars), which we can confront to observed dollar returns of bitcoin. Second, in addition to transactional benefits we also consider transaction costs, reflecting frauds and hacks and the difficulty to conduct transactions in cryptocurrencies. Allowing for a rich structure of transactional benefits and costs is key to our empirical approach in which we construct measures of these fundamentals. Our econometric analysis sheds light on the relationship between these random variables.

The model delivers the following insights:

- The price of one unit of cryptocurrency at time t is equal to the expectation of its future price at time t + 1, discounted using a standard asset pricing kernel modified to take into account transactional benefits and costs. These benefits and costs reflect the evolution of variables from the real economy affecting the usefulness of cryptocurrencies, such as the development of e-commerce or illegal transactions.
- The structure of equilibrium gives rise to a large multiplicity of equilibria: we show in particular that when agents are risk neutral, if a price sequence forms an equilibrium, then that sequence multiplied by a noise term, with expectation equal to one, is also an equilibrium. Such extrinsic noise on the equilibrium path implies, in line with stylized facts, large volatility for cryptocurrency prices, even at times at which the fundamentals are not very volatile. This underscores that the Shiller (1981) critique does not apply to cryptocurrencies.
- When transaction costs are large, investors require large expected returns to hold bitcoins. In contrast, large transactional benefits reduce equilibrium required expected returns. Thus large observed returns on bitcoin are consistent with the prediction of our model for currently large transactions costs and low transaction benefits. In this equilibrium, current bitcoin prices reflect the future stream of transactional benefits they will generate in the future. At that point in time, when the transactional services of bitcoin will have become large, bitcoin prices will have further increased, but equilibrium expected returns will be low.

Testing the model

Next, we confront these predictions of the model to the data. Using the Generalised Method of Moments (GMM), we estimate the parameters of the model and test the restrictions imposed by theory on the relation between the cryptocurrency returns, transaction costs and benefits. To do so, we construct a time series of bitcoin prices from July 2010 to July 2018 by compiling data from 17 major exchanges. We also construct three time series that proxy for the transactional costs and benefits of using bitcoin.

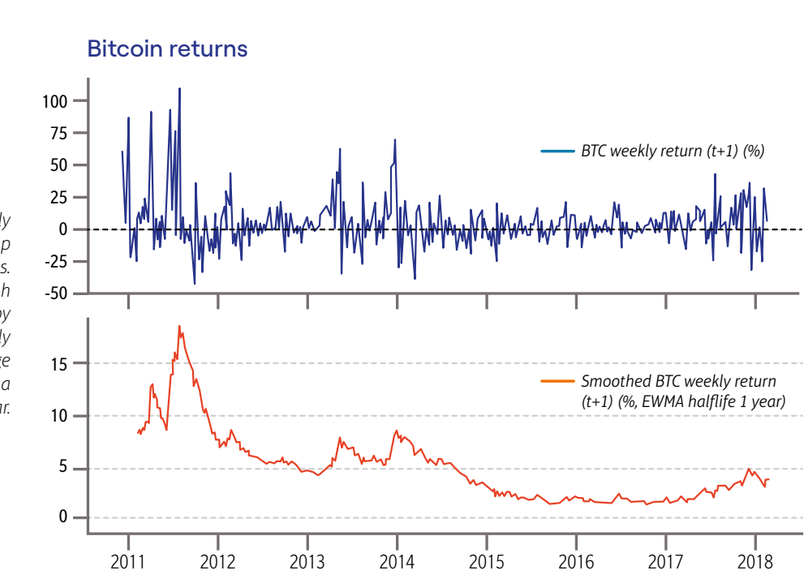
The first one captures the evolution of the transaction fees that bitcoin users attach to their transaction to induce miners to process them faster. For the other two, we collect information on events that likely affect the costs and benefits of transacting in bitcoin, and categorize them into two subsamples.

The first subsample captures transaction costs: it contains events indicative of the ease with which bitcoins can be exchanged against other currencies, such as a new currency becoming tradable against bitcoin or the shutdown of a large platform like Mt. Gox. The second subsample captures transactional benefits: it contains events affecting the ease with which bitcoin can be used to purchase goods and services, such as merchants starting or stopping to accept bitcoin as a means of payment.

Key results From these subsamples we construct two indexes that proxy for the transactional benefits and transaction costs associated with bitcoin at every point in time. Finally, we collect data about thefts and losses on bitcoin to obtain a measure of the average monetary loss incurred when holding bitcoins.

- Consistent with the model, GMM estimates show a negative and significant relation between expected return and transactional benefits and a positive and significant relation between expected returns and transactional costs.
- We also analyze how these different components affect the required return (implied by our model) over time. We estimate that the costs induced by the difficulty to trade bitcoins were large in 2011 and contributed at that time to fifteen percentage points of weekly required return. This decreased to five percentage points as investors could more easily trade bitcoins. On the other hand, transaction fees have a negligible impact on the required returns, except at the end of 2017, when they were particularly large.

Summing up We offer an overlapping generations equilibrium model of cryptocurrency pricing and confront it to new data on bitcoin transactional benefits and costs. The model emphasizes that the fundamental value of the cryptocurrency is the stream of net transactional benefits it will provide, which depend on its future prices. The link between future and present prices implies that returns can exhibit large volatility unrelated to fundamentals. We construct an index measuring the ease with which bitcoins can be used to purchase goods and services, and we measure costs incurred by bitcoin owners. Consistent with the model, estimated transactional net benefits explain a statistically significant fraction of bitcoin returns.



This figure plots weekly Bitcoin returns. The top graph plots raw returns. The bottom graph smooths these returns by plotting an exponentially weighted moving average of these returns with a half-life of one year.

The TSE work group on blockchain

In 2016 TSE launched a taskforce on blockchains: **Bruno Biais, Christophe Bisière, Catherine Casamatta, Fany Declerck, Bertrand Gobillard and Alexandre Guembel.**

The aim of the taskforce is to explain the impact of this technology on financial intermediation and payment systems.
The research paper ***"The Blockchain Folk Theorem"*** (co-authored by Catherine Casamatta, Bruno Biais, Christophe Bisière, and Matthieu Bouvard), initiated during the work group has been published in the Revue of Financial Studies.

Financial Behaviors, Welfare & Market Inefficiencies

Introduced by
Milo Bianchi

Professor of Finance at University of Toulouse Capitole and a member of TSE, Milo is currently in charge of the Master 2 Financial Markets and Risk Evaluation.

He has received his PhD at the Stockholm School of Economics and his research interests include household finance, behavioral finance and corporate finance. His research has been published in leading economic and finance journals including Journal of Finance, Review of Economic Studies, Journal of Economic Theory, and Management Science.

Milo is a junior member of the Institut Universitaire de France, he also won the 2014 AFSE Malinvaud Prize for best published paper among economists under age 40 and the 2011 Banque de France Foundation prize for young researcher in economics.

Financial Behaviors, Welfare & Market Inefficiencies The capacity of financial markets and intermediaries to price assets, finance the economy and allocate risks may be hindered by informational frictions and by human cognitive biases. A large body of research has emerged to study financial decisions and markets while relaxing standard assumptions about investors' preferences and rationality. From a theoretical viewpoint, the goal is to enrich standard finance models so as to better describe how investors process information, how they form beliefs, how they perceive risk. From an empirical viewpoint, the goal is to provide a better understanding of which informational and behavioral frictions appear of first order importance to explain financial choices and market phenomena.

The Center aims at analyzing how those frictions may impact investors' welfare and the efficiency of the financial industry, and how their effects can be worsened or mitigated by different market arrangements.

For example, how do financial and technological innovations such as the raise of fintech impact investors' behaviors and the functioning of financial markets? What is the role of regulation to improve a fair access to financial instruments and trading venues? What are the impediments to efficient risk sharing in financial markets?

Sébastien Pouget

How do we behave in a perfect market?

Bruno Biais
Thomas Mariotti
Sophie Moinas
Sébastien Pouget
on asset pricing and risk-sharing

Real-world data contradicts the theory that agents should share risk perfectly in a complete market. Is this due to irrational agents or inefficient markets? In a recent paper on 'Asset pricing and risk- sharing in a complete market', TSE researchers Bruno Biais, Thomas Mariotti, Sophie Moinas and Sébastien Pouget devise an experimental setting which allows them to test the theory of competitive equilibrium.

Since the seminal works of Debreu (1959) and Arrow (1964), the general equilibrium theory of asset pricing and risk-sharing in perfect and complete markets has offered an elegant framework and sharp implications: agents should share risk perfectly, which, in turn, implies that only aggregate risk should be priced (Borch, 1962). Unfortunately, these implications are rejected by field data. Is it because human cognition and preferences do not conform to the standard rational choice paradigm? Or is it because, in practice, markets are imperfect and incomplete?

These two potential explanations have very different implications for further research. The former calls for new models of human decision-making, whereas the latter emphasizes the need to model market imperfections. While it is difficult to disentangle these two explanations with field data, in a controlled experimental setting one can ensure the market is perfect and complete. Any deviation from the implications of rational choice and competitive equilibrium can then be attributed to human cognition.

The simplicity of our experimental setting enables us to pin down precisely the implications of rational choice for individual behavior and market outcomes for a large class of preferences

A simple setting

To study this issue, we conduct an experimental analysis of the simplest possible setting in which the basic tenets of the theory can be tested. The state of the world can take only two values and there are two non-redundant assets (a stock and a bond), so the market is complete. At the beginning of each of eight trading rounds, participants start with heterogeneous endowments (stocks, bonds and other state-contingent income). Individual demand and supply functions (specifying how many shares the participant wants to buy or sell at different prices) are elicited.

Participants are asked to choose the quantity they want to buy or sell at all prices on a grid. For half the rounds of the experiment, the market price is randomly drawn and thus participants have no opportunity to manipulate the price. During the other rounds, participants are informed that the price is set to minimize the difference between aggregate supply and aggregate demand. Empirically, we observe similar behavior within these two different price-setting mechanisms. This suggests that our experimental design is able to generate a situation in which agents behave competitively, as in the standard competitive equilibrium model.

The simplicity of our experimental setting enables us to pin down precisely the implications of rational choice for individual behavior and market outcomes for a large class of preferences.

- At the individual level, our experimental design enables us to test the hypothesis that participants are rational. We show that some actions are first order stochastically dominated. Rational choice, therefore, implies they should not be observed in the lab.
- At the market level, our experimental design enables us to test the hypothesis that participants are risk-averse and share risk efficiently. We consider two treatments. In the first treatment there is no aggregate risk. So participants can perfectly hedge their risky endowments and the price of the stock should be equal to the expected dividend. In the second treatment there is aggregate risk. So, with risk-averse agents, the stock price should be lower than the expected dividend.

Aggregate outcomes and individual behavior

We ran the experiment with 141 students in Toulouse University. There were eight cohorts. Each participated in eight replications of the experimental market. Participants' compensation was a linear function of their gains in two randomly drawn replications (with an average of €85.84 per participant).

Aggregate outcomes, in our experimental market, are consistent with the implications of rational choice. When there is no aggregate risk, market clearing prices are close to expected dividends, and average trading volume is close to that requested by perfect risk-sharing. With aggregate risk, there is a risk premium, consistent with a relative risk aversion coefficient close to .5 for the representative agent.

Observed individual behavior, however, markedly differs from that predicted by rational choice. Around 30% of observed actions are first order stochastically dominated. The frequency of dominated actions, however, declines with experience, from approximately 34% in the first replication to 24% in the last replication. Probit regressions, in which the dependent variable is the indicator that the action is dominated, confirm that there is significant learning. They also show that, when an agent opted for a dominated action in a given round, he/she is likely to continue to do so at the next round, except if the action led to a loss-making trade. The latter suggests that agents learn from costly mistakes.

Bounded rationality

To reconcile aggregate and individual findings, we propose a model of bounded rationality. In line with random-choice models, we posit that participants play randomly but put more weight on actions delivering larger value. We show that the distribution of individual actions predicted by this model is consistent with that observed in the lab. As mentioned above, first order stochastically dominated actions are less frequent than undominated ones, which is in line with the predictions of the random-choice model.

Furthermore, in our simple experimental setting we are able to identify "large" and "small" mistakes, such that, while both are dominated by rational actions, large mistakes are second order stochastically dominated by small mistakes. In line with the predictions of the random-choice model for risk-averse agents, we find that large mistakes are less frequent than small ones. We also show (analytically) that the actions generated by the random-choice model aggregate to supply and demand curves which, like those we observe in the lab, generate market pricing and average trading consistent with rational choice.

Key findings

- At the aggregate level, the experimental complete market conforms to theory. The hypothesis that participants are competitive cannot be rejected. Aggregate supply and demand cross at the expected dividend when there is no aggregate risk, and at a lower price when there is.
- Individual participants, however, frequently choose first order stochastically dominated actions. Yet, dominated actions become less frequent as participants become more experienced, and participants seem to learn from their mistakes.
- Our random-choice model reconciles the apparently contradictory findings obtained at the aggregate and individual levels. It predicts that individual deviations will average out, leading to well behaved aggregate supply and demand. The random-choice model also imposes further restrictions on the distribution of individual actions, consistent with experimental findings: dominated actions are less frequent than undominated ones, and large mistakes are less frequent than small ones.

Summing up

Our experiment closely emulates and tests the standard model of complete competitive markets, without imposing parametric restrictions on preferences. Our findings suggest that, when markets are perfect and complete, individual irrationality does not preclude aggregate outcomes consistent with the predictions of competitive equilibrium. Thus deviations from those predictions, observed in the field, could stem from market imperfection and incompleteness, rather than from limited cognition. It will be interesting, in further work, to extend our methodology to study imperfect markets in the lab.

Financial Intermediaries & Regulation

Introduced by
Patrick Fève

Professor of Economics at University of Toulouse Capitole, Patrick was previously Director of Graduate Studies at TSE from 2009 to 2016, and a scientific advisor at Banque de France from 2004 to 2012.

He received his PhD at the University of Paris I and his research interests include macroeconomics, international economics and applied econometrics.

His research has been published in international academic journals such as The Economic Journal, Economics Letters, Journal of the European Economic Association, and Journal of Applied Econometrics.

In 2010, he received the Chevalier des Palmes Académiques and the Toulouse Novela Laureate award in 2009.

Financial Intermediaries and Regulation

The financial crisis has fostered debates, changes and innovations in financial regulation. TSE researchers are interested in better understanding financial intermediation and the prevention of crises. The Center's researchers investigate various topics related to monetary economics and aggregate liquidity, payment systems, prudential regulation, market finance and microstructure.

For instance, what information should firms convey to their stakeholders, or markets to investors? How should we assess a bank's liquidity? Should we focus on a single aggregate measure or decompose liquidity requirements in multiple tiers - as is done for capital requirements? Should central-bank-eligible assets be counted as liquidity? How should we define (and understand the link between) traditional and shadow banking systems?

Shining a light on shadow banks

Patrick Fève
on financial regulation

Co-authors: Alban Moura and Olivier Pierrard
from the Banque Centrale du Luxembourg

The destabilizing influence of shadow banks was thrown into sharp relief by the 2008 financial crisis. As intermediaries that operate outside the traditional banking sector, their activities continue to escape the grasp of regulators and even sophisticated investors. Until recently, shadow banks have also been largely absent from financial experts' macroeconomic models. Research by TSE's Patrick Fève addresses this problem and suggests that regulating both traditional and shadow credit will be crucial to mitigating future crises. Here, he discusses his 2018 paper 'Shadow Banking and Financial Regulation: A Small-Scale DSGE Perspective'.

There is now a general agreement that the limited regulation of non-depository financial institutions, or shadow banks, was a major cause of the subprime mortgage crisis and the ensuing Great Recession. As a result, both academics and policymakers have called for financial regulation to move toward a more global and macro-prudential direction. However, most macro models with a financial sector feature only traditional banks, so they probably miss important considerations about macro-prudential regulation. In our paper, we propose and estimate a small-scale dynamic stochastic general equilibrium (DSGE) model with interacting traditional and shadow banks. We then use the model to evaluate alternative forms of financial regulation aimed at stabilizing economic and credit cycles.

Chasing shadows

We start from a standard real-business-cycles (RBC) model and augment it with a financial sector including traditional and shadow banks. Both types of banks intermediate credit between saving households and borrowing non-financial firms. Traditional banks mostly finance through deposits, but also hold capital to comply with macro-prudential regulation. On the other hand, shadow banks finance on wholesale markets by issuing asset-backed securities (ABS) against their pool of loans and completely escape regulation. Because they are easily tradable on financial markets, ABS are subject to less regulation than standard loans, so that traditional banks have incentives to substitute loans with ABS in order to increase their leverage. While the general logic is similar to Gertler et al. (2016) and Meeks et al. (2017), there is one key difference. In these papers, shadow banking increases the efficiency of credit intermediation by relaxing financial frictions associated with the limited pledgeability of assets. In contrast, in our framework shadow banking increases efficiency because of asymmetric regulation since shadow banks do not face the same regulatory constraints as traditional intermediaries.

> There is general agreement that the limited regulation of non-depository financial institutions, or shadow banks, was a major cause of the subprime mortgage crisis and the ensuing Great Recession

In the model, two structural parameters define the interactions between traditional and shadow banks: a portfolio cost limiting the ability to substitute traditional loans and ABS, and a bank capital cost defining how regulation affects the supply of traditional credit. To identify these parameters, we estimate the model on quarterly US data for the period 1980-2016 using Bayesian methods and a selection of observables that includes both real (consumption, investment, hours worked) and financial (the ratio between shadow and total credit, the leverage of traditional banks, and a lending-deposit spread) variables. Estimation results are plausible - in particular, the estimates imply a cost of macro-prudential regulation in line with values reported in the literature - and the model has a reasonable fit. The decomposition of business cycles is fairly standard for a real model, with the neutral productivity shock playing a leading role. Still, financial shocks explain between 30 and 40 percent of the fluctuations in output and investment, suggesting that the model is able to propagate financial disturbances to the real economy.

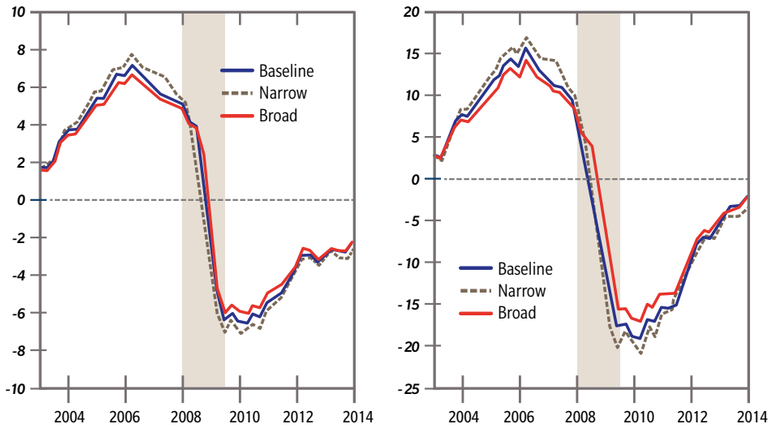
Structural shocks and asymmetric regulation

The estimated model suggests that shadow banking constitutes an important amplification mechanism in general equilibrium because it helps escape constraints arising from the traditional sector. For instance, after a positive technology shock economic activity and credit expand jointly. Because raising additional capital is slow, the leverage of traditional banks increases and this translates into higher spreads. When credit intermediation can be partly redirected toward the shadow sector, the rise in traditional bank leverage and spreads is smaller, which stimulates the expansion. Highlighting this amplification effect associated with shadow banking is our first contribution.

We also study the stabilization properties of different macro-prudential policies in presence of shadow banks. Our second contribution is to demonstrate how asymmetries between traditional and shadow intermediaries dampen the ability of regulators to stabilize the economy. For instance, the model implies that intermediation migrates to the shadow sector after an exogenous increase in the capital adequacy ratio of traditional banks, which limits the effects of asymmetric regulation. This property is consistent with Buchak et al. (2017), who find in the data that shadow banks are more likely to enter markets in which traditional banks face tight regulation.

This regulatory arbitrage also affects the ability of a countercyclical capital buffer to reduce aggregate fluctuations. Using historical counterfactual simulations, we show that a countercyclical buffer targeting and applied to traditional loans only would have amplified, rather than dampened, the boom-bust cycle associated with the financial crisis of 2007-2008 in the US. On the other hand, a broader regulation scheme targeting both traditional and shadow credit would have been more successful in stabilizing the economy. Overall, our findings thus support the recent shift in banking regulation toward a more global approach, as advocated in the Basel III package.

Counterfactual Historical Paths'



In these graphs, Patrick and his co-researchers demonstrate the effects of alternative banking regulation schemes before, during, and after the financial crisis.

As well as their estimated model (which corresponds to the baseline regulation scenario with constant requirements for traditional loans), they use a counterfactual model in which either the narrow (with a countercyclical buffer applied to traditional credit) or broad (with a countercyclical buffer applied to both traditional and shadow credit) regulations apply.

Deviations from steady states are expressed in percent and shaded areas represent NBER recession dates.

A striking result is that the narrow regulation would have amplified the boom-bust cycle. On the other hand, the broad regulation would have limited the magnitude of the collapse in investment by a non-negligible 3.5 points. The dampening effect on output, while less important, would still have represented about 1 point of GDP.

Future research

Obviously, our framework remains very stylized. We see at least two interesting extensions. First, it would be useful to extend our model to take into account monetary policy and nominal frictions. Indeed, it would be interesting to see how introducing shadow banks in a medium-scale DSGE model would change its properties. Moreover, monetary policy adds an asymmetry between traditional and shadow banks, as only the former have access to central bank liquidity. Second, it may be worth relaxing the assumption that the representative household owns the whole economy. Indeed, this simplification makes default events irrelevant and potentially prevents capturing some important dynamics of the data during the financial crisis.

Summing up

This paper estimates a small-scale DSGE model of the US economy with interacting traditional and shadow banks. We find that shadow banks amplify the transmission of structural shocks by helping escape constraints from traditional intermediaries. We show how this leakage toward shadow entities reduces the ability of macro-prudential policies targeting traditional credit to reduce economic volatility. A counterfactual experiment suggests that a countercyclical capital buffer, if applied only to traditional banks, would have in fact amplified the boom-bust cycle associated with the financial crisis of 2007-2008. On the other hand, a broader regulation scheme targeting both traditional and shadow credit would have helped stabilize the economy.

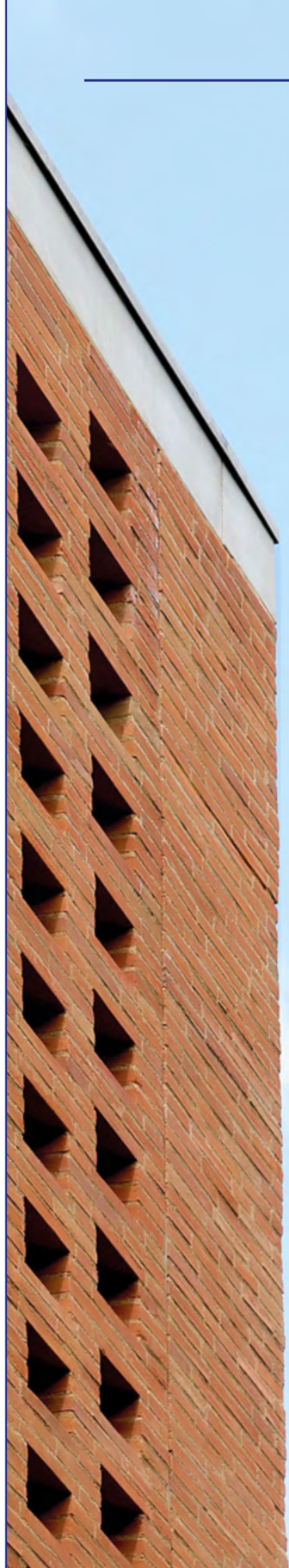
What is shadow banking?

Adrian and Ashcraft (2012) and Pozsar et al. (2013) emphasize three major differences between the traditional and shadow banking sectors in the US. First, intermediaries in each sector finance through different types of liability: traditional banks mostly rely on deposits to extend new loans, whereas shadow banks finance on wholesale markets using tradable credit instruments.

Second, traditional banks have access to public sources of liquidity (for instance from the Fed) or insurance (for instance from the FDIC), while shadow banks are excluded from official public enhancements.

Third, traditional banks generally perform the whole chain of credit intermediation between borrowers and lenders within a single institution, whereas lender-borrower intermediation is typically performed by a chain of different institutions in the shadow sector.

For simplicity, it may be helpful to think of the typical traditional bank as a single institution issuing retail deposits to fund loans, while the typical shadow bank is actually a group of institutions transforming wholesale funding into lending through a complex securitization process.Because the generic term of shadow banking refers to a wide range of activities, there has been some disagreement about how to properly measure it in the data. Patrick's paper follows Meeks et al. (2017) and Gertler et al. (2016) in restricting its definition of shadow banking to security brokers and dealers and issuers of asset-backed securities. These institutions issue tradable securities (wholesale funding) against an underlying pool of securitized assets (loans). They operate about the same economic function as traditional banks, but operate with much less capital and outside the Fed's regulatory framework.



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