Knightian uncertainty and asset markets

SUJOY MUKERJI

PROFESSOR AND HEAD OF SCHOOL OF ECONOMICS AND FINANCE

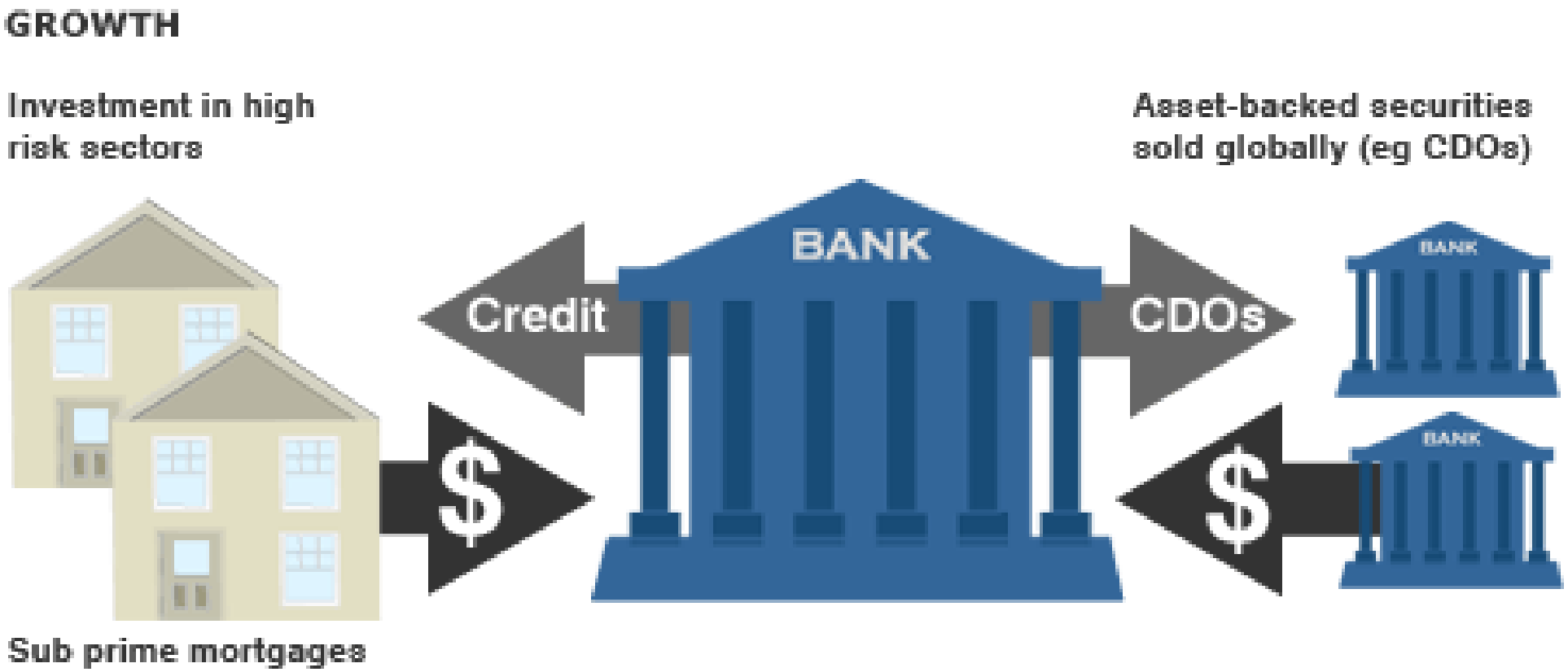
QUEEN MARY UNIVERSITY OF LONDON

Knightian uncertainty ("ambiguity/aversion", robustness/model uncertainty concerns)

The recent global economic crisis stemmed, in part, from the realisation of financial institutions of their inability to effectively judge the riskiness of their investments. For this reason, the crisis cast new attention on an idea about risk from decades past: "Knightian uncertainty."

Frank Knight pioneered the idea of drawing a distinction between risk and uncertainty in his 1921 book, *Risk, Uncertainty, and Profit*. As Knight saw it, an ever-changing world brings new opportunities for businesses to make profits, but also means we have imperfect knowledge of future events.

According to Knight, **risk applies to situations where we do not know the outcome of a given situation, but can accurately measure the odds. Uncertainty, on the other hand, applies to situations where we cannot know all the information we need in order to set accurate odds in the first place.**



Most analysts link the recent credit crisis to the sub-prime mortgage business, in which US banks give high-risk loans to people with poor credit histories.
These and other loans, bonds or assets are bundled into portfolios - or Collateralised Debt Obligations (CDOs) - and sold on to investors globally.

Between 2004 and 2006 US interest rates rose from 1% to 5.35%, triggering a slowdown in the US housing market.

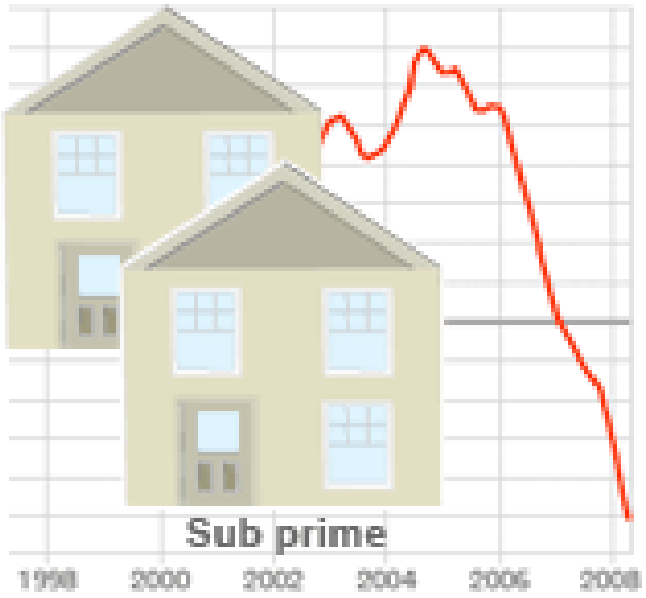
Homeowners, many of whom could only barely afford their mortgage payments when interest rates were low, began to default on their mortgages.

Default rates on sub-prime loans - high risk loans to clients with poor or no credit histories - rose to record levels (around 2007).

The impact of these defaults were felt across the financial system as many of the mortgages had been bundled up and sold on to banks and investors.

SUB PRIME PROBLEMS

Mortgage defaults increase
Flow of money stops



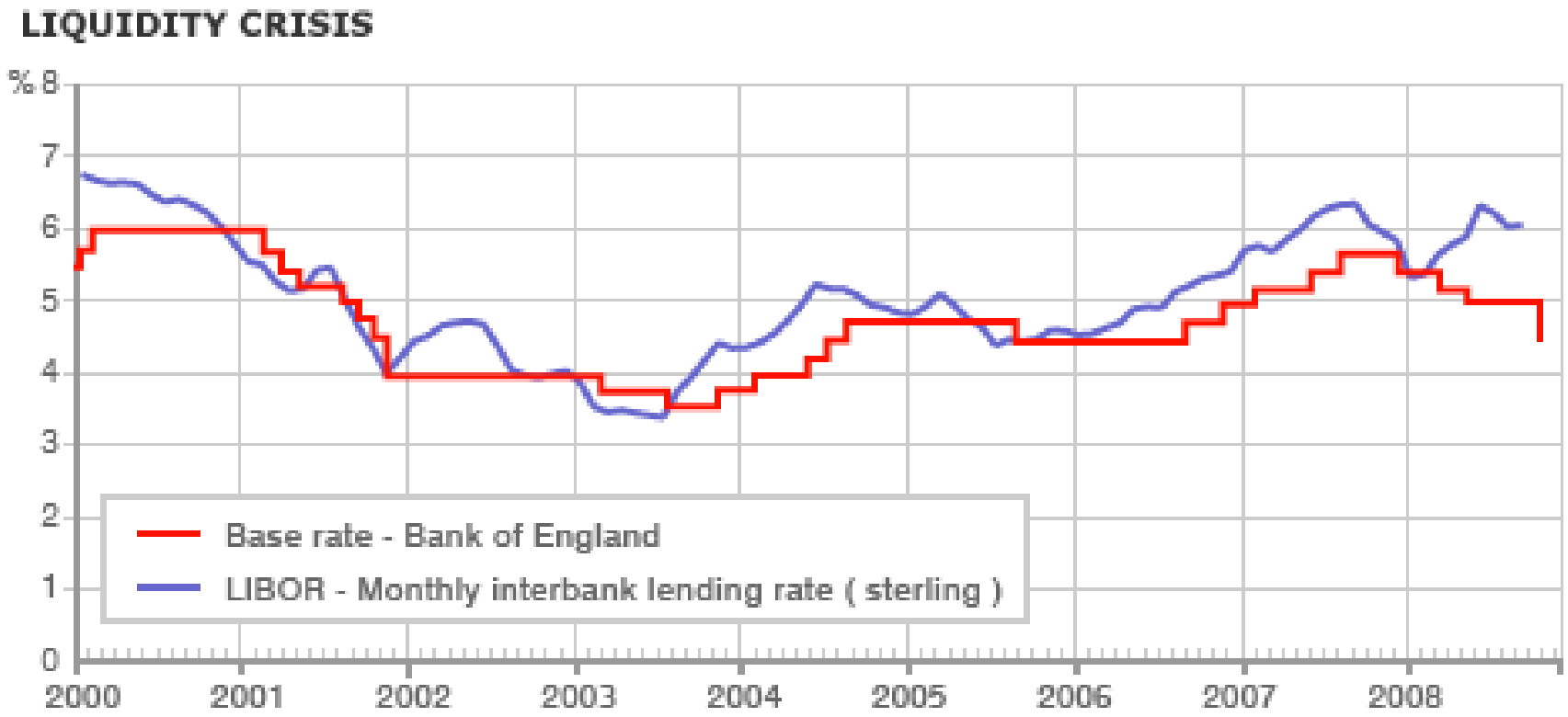
Concern over asset-backed securities
Interbank lending stops

Falling house prices and rising interest rates lead to high numbers of people who cannot repay their mortgages. Investors suffer losses, making them reluctant to take on more CDOs. Credit markets freeze as banks are reluctant to lend to each other, not knowing how many bad loans could be on their rivals' books.

CENTRAL BANK INTERVENTION

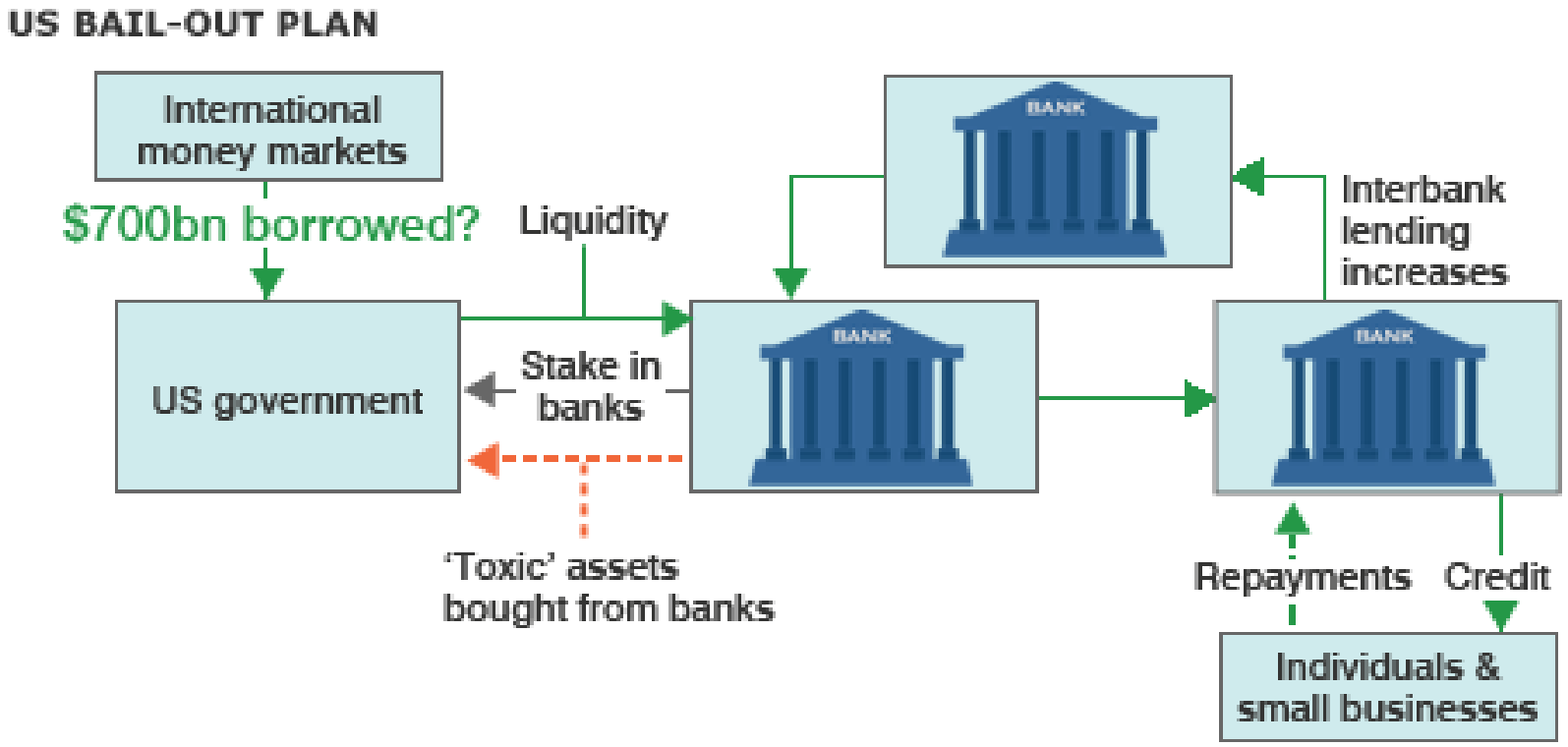
US Federal Bank and EU Central Bank make cash available for banks to borrow

The US Federal Bank and the European Central Bank tries to bolster the money markets by making funds available for banks to borrow on more favourable terms.
Interest rates are also cut in an effort to encourage lending.



But the short-term help does not solve the liquidity crisis - or availability of cash for banks - as banks remain cautious about lending to each other.

A lack of credit - to banks, companies and individuals - brings with it the threat of recession, job losses, bankruptcies, repossessions and a rise in living costs.



Seeking a long-term solution, the US government agrees a $700bn bail-out that will buy up Wall Street's bad debts in return for stake in the banks. The US government plans to borrow the money from world financial markets and hopes it can sell the distressed assets back once the housing market has stabilised.

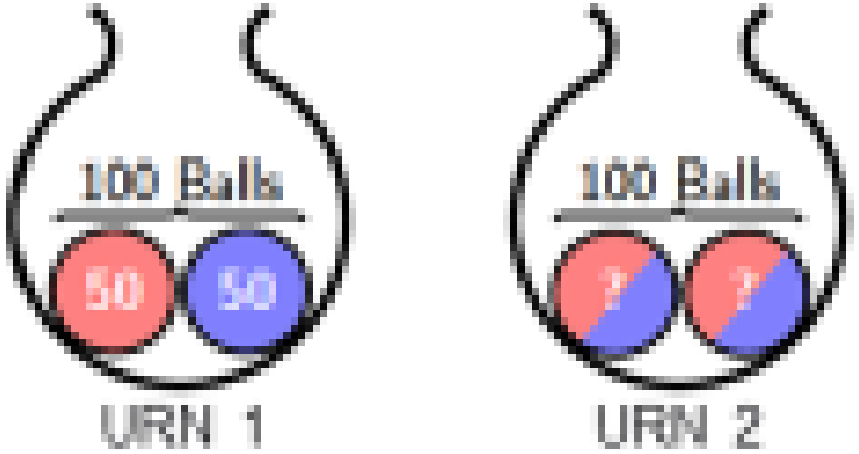
Knightian uncertainty

The recent global economic crisis stemmed, in part, from the realisation of financial institutions of their inability to effectively judge the riskiness of their investments. For this reason, the crisis cast new attention on an idea about risk from decades past: “Knightian uncertainty.”

Frank Knight was an idiosyncratic economist who formalized a distinction between risk and uncertainty in his 1921 book, *Risk, Uncertainty, and Profit*. As Knight saw it, an ever-changing world brings new opportunities for businesses to make profits, but also means we have imperfect knowledge of future events.

According to Knight, **risk applies to situations where we do not know the outcome of a given situation, but can accurately measure the odds. Uncertainty, on the other hand, applies to situations where we cannot know all the information we need in order to set accurate odds in the first place.**

Ellsberg Experiment about Knightian uncertainty



Each urn contains a mixture of 100 red and blue balls.
In urn I, the mixture is known to be 50:50. The subjects do not know the proportions of the two colours
in urn II.

A ball is drawn at random from each urn, generating events IR (i.e., a red ball is drawn from urn I), IB, IIR, IIB. DM is offered bets on these events. E.g. £10 if IR, 0 otherwise.
It is usually found that preferences in any particular experiment are: IR$\succ$IIR and IB$\succ$IIB.
Such preferences are not expected utility preferences. Suppose, we assume Pr(IR) = Pr(IB) = 0.5. Then the preferences imply, Pr(IIR) < 0.5 *and* Pr(IIB) < 0.5

Knigtian uncertainty/ambiguity, or lack of good knowledge of probabilities affecting contingent outcomes of a chosen action, is pervasive in economic decision making. It is not particular to the ill informed and less sophisticated.

Even a professional decision maker (DM) in a financial market knows it is often hard to distinguish (on the basis of historical data) between different models providing distinct (stochastic) forecasts of relevant financial variables.

Such DMs may well think it is prudent to choose actions that are robust to the uncertainty about the correct model.

An example of such a robust decision rule is Maximin Expected Utility

A basic version of the rule may be understood as follows.:

Identify a set of probability distributions consistent with available data.

Calculate the expected payoff of action for each possible probability

An action is finally evaluated by the minimum of possible expected payoffs.

The rule asks that you choose the action with the maximum evaluation.

Suppose a DM is offered a choice between a unit long and a unit short and a zero position on an asset
which pays off contingent on the draw of a ball from Urn II, as in the Ellsberg example discussed earlier.
The following table shows the contingent payoffs from each of the three choices.

Colour of ball drawn from urn II	Red	Blue
Payoff from a long position	10	0
Payoff from a short position	0	-10
Payoff from a zero position	0	0

Suppose the DM believes that the probability that a red ball is drawn (from Urn II) lies in the interval [0.4, 0.6],
with complementary beliefs about the event a blue ball is drawn.
Applying the rule, it may be checked that the DM will evaluate the unit long position as 0.4×10 = 4; similarly,
he evaluates the short position as 0.6 × (-)10 = -6.

This implies that the DM will strictly prefer a zero position when market price lies in the interval [4, 6], thereby exhibiting a "portfolio inertia".

Colour of ball drawn from urn II	Red	Blue
Payoff from a long position	10	0
Payoff from a short position	0	-10
Payoff from a zero position	0	0

Increase ambiguity or uncertainty, indicated by an increase in the size of interval of beliefs, increases incidence of no trade in risky assets by increasing the price interval where portfolio inertia occurs.

The volume of trade/lending bears an inverse relationship to the ambient uncertainty.

The increased (Knightian) uncertainty is about the valuation of securitized assets banks hold which are used as collateral for inter-bank lending.

The uncertainty is triggered by unusual events and untested financial innovations that lead agents to question their worldview of risks and risk models.

Knight’s distinction about risk and uncertainty may still help us analyse the recent behavior of financial firms and other investors.

Investment banks that regarded their own apparently precise risk assessments as trustworthy may have thought they were operating in conditions of risk.

Once the banks recognized those assessments were inadequate, however, they understood that they were operating in conditions of Knightian uncertainty — and held back from making trades or providing capital, further slowing the economy as a result.

The logic of portfolio inertia thus provides an explanation for the "seizure" of lending activity among banks based on Knightian uncertainty (aversion).

The idea explains crisis regularities such as market-wide capital immobility, agents' disengagement from risk, and liquidity hoarding.

It also gives a great insight in the working of central bank policies, why a certain policy did not work and why another policy did.

Central banks throughout the world have recently engaged in two kinds of unconventional monetary policies: quantitative easing (QE), which is “an increase in the size of the balance sheet of the central bank through an increase it is monetary liabilities”,

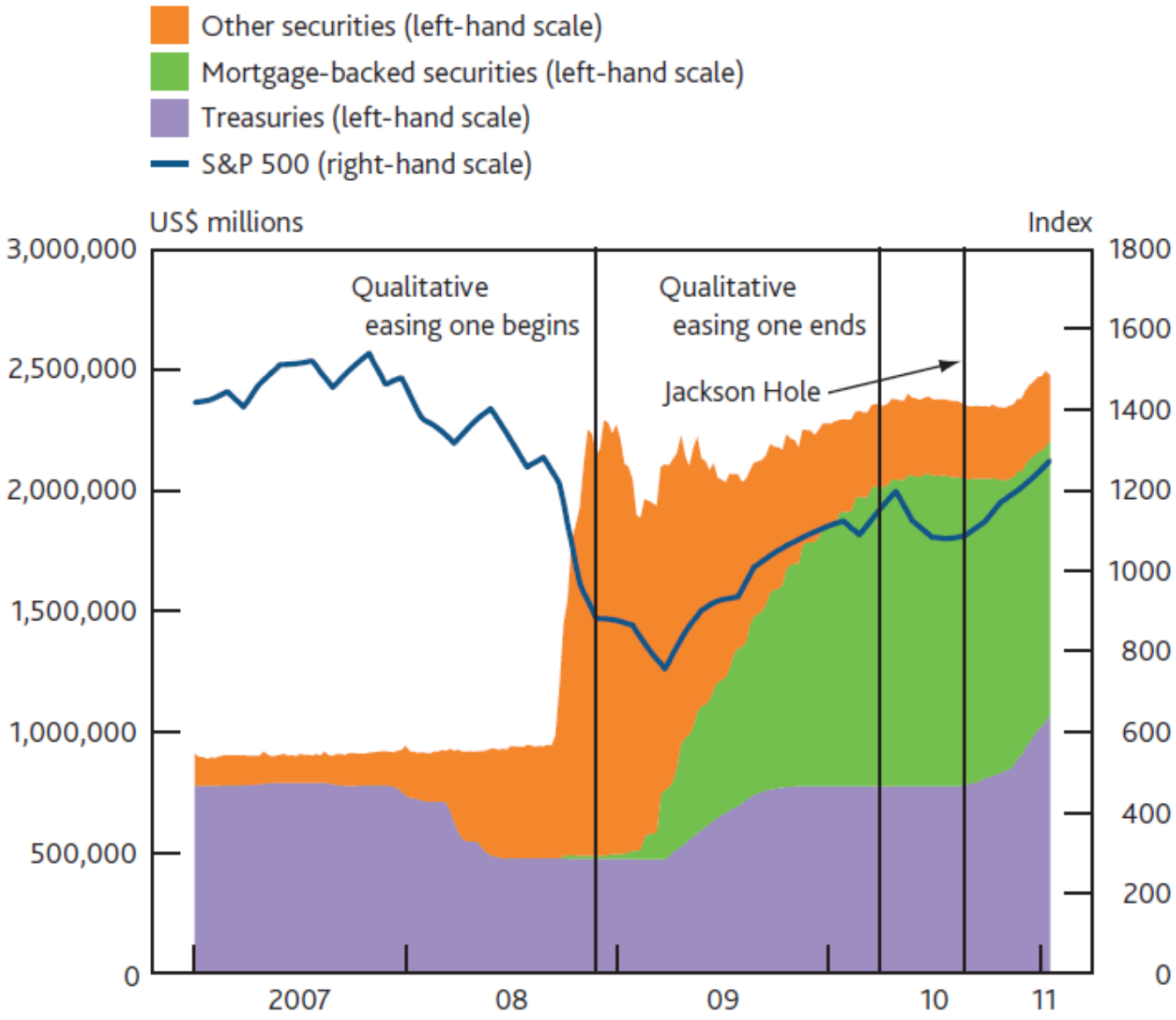
and qualitative easing (QuaE) which is “a shift in the composition of the assets of the central bank towards less liquid and riskier assets, holding constant the size of the balance sheet.”

The effectiveness of qualitative easing

A government policy that is designed to mitigate risk through central bank purchases of privately held risky assets and their replacement by government debt, with a return that is guaranteed by the taxpayer.

Policies of this kind have recently been carried out by national central banks, backed by implicit guarantees from national treasuries.

Chart 6 'Qualitative easing' and equity prices in the United States



Aggregate uncertainty and equity returns

The assumed source of the ambiguity in the agent's beliefs about macro uncertainty is the occurrence of periodic, temporary changes in the probability distribution governing next period's growth outcome due to the effect of the business cycle.

These transient deviations are assumed to be governed by an auto-regressive (AR(1)) latent variable.

The agent is, however, unsure about the value of the persistence parameter of the

process since, even with a large sample of growth rates, it is difficult to distinguish the case where the latent growth state is highly volatile but moderately persistent, from the case were the state is less volatile but highly persistent.

Macro (Knightian) uncertainty

Uncertainty about persistence, in turn makes it harder to estimate the evolving location of the latent variable precisely.

Furthermore, depending on the observed history, the imprecision of the estimate of the location will vary over time, making the uncertainty about the probability distribution governing next period's growth vary over time.

Endogenous accentuation of uncertainty

The ambiguity-averse agent's robustness concerns generate, endogenously, doubt and pessimism.

The portfolio choice of the ambiguity-averse agent in the model may be understood as that of an expected utility agent with an ``as if'' (probabilistic) belief that is more uncertain and pessimistic than the one obtained by objective inference, in the standard fashion, from data.

Endogenous accentuation of uncertainty

Moreover, the endogenous accentuation of doubt depends on the observed history and the level of ambiguity aversion, making the severity of the effect of uncertainty *endogenously time-varying*.

For instance, after a negative shock that follows a series of ``normal'' ones, the agent behaves as if the uncertainty is more severe and more persistent than what is implied by pure Bayesian inference (and the opposite, if it were a positive shock that broke the normal sequence).

Equity premium predicted by Knightian uncertainty and macro-uncertainty indices

The model generated conditional equity premium is a measure of conditional macroeconomic uncertainty as revealed by the behavior of the agent in the model.

We show its time-series properties match those of the purely statistical index of macro-economic uncertainty, recently

developed in Jurado Ludvigson Ng (2015) and Carriero Clarke Marcellino (2018).

Macro uncertainty: time-series of (model) Equity Premium vs. Uncertainty Indices

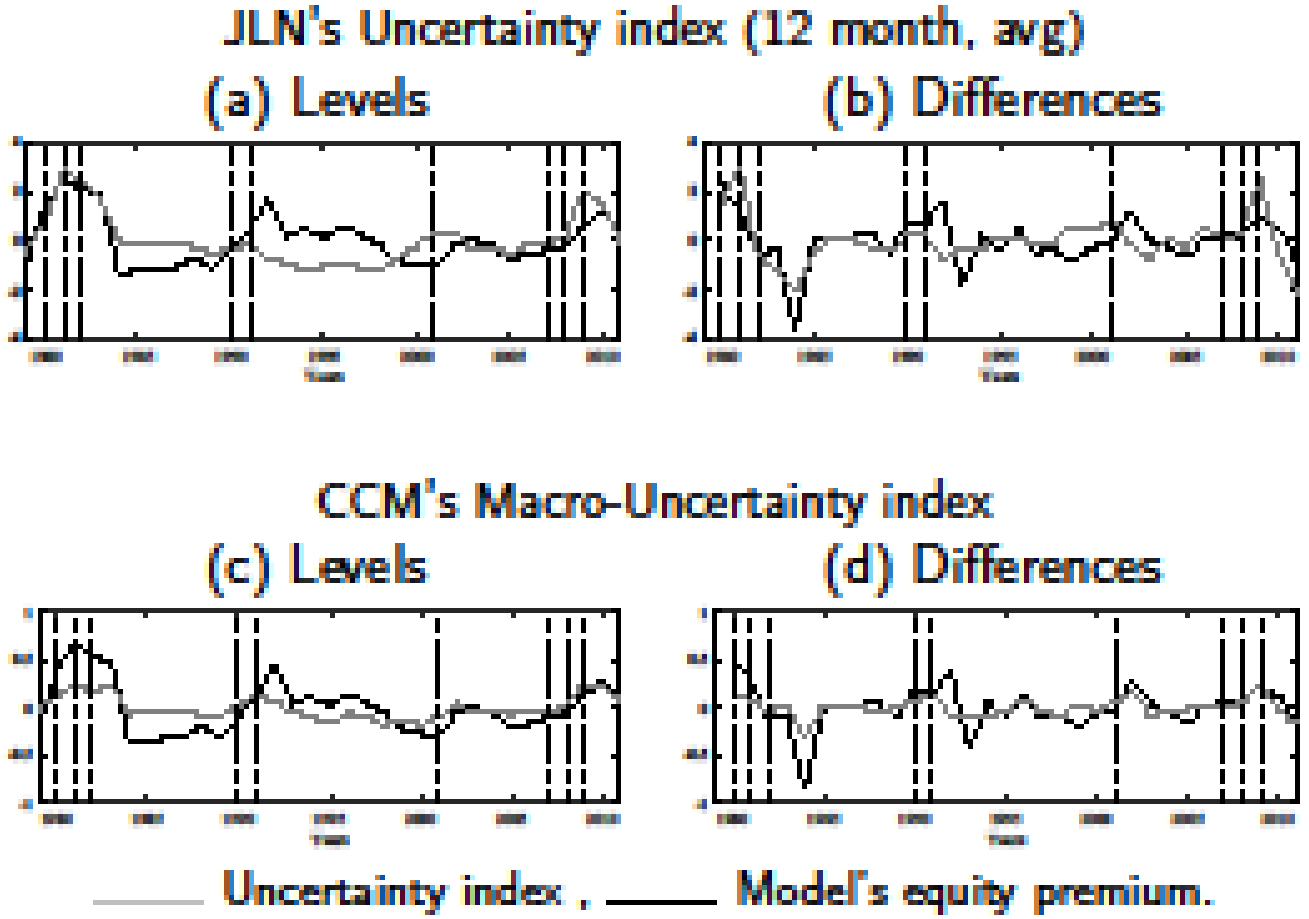


Figure: The uncertainty index and the equity premium are normalized by their respective mean levels: on the vertical axes, signed) percentage deviations from the respective means.

We discussed the idea of Knightian uncertainty
We argued that the idea is singularly useful in explaining and understanding the key facts of the 2008-12 credit crises.
The understanding has significant policy implications about how such crises may be alleviated.
Finally, we considered why episodic macro uncertainty can be understood as Knightian and how that understanding is revealed in the (excess) returns on aggregate equity.
Thank you!

(very) brief bibliography

S. Mukerji and JM Tallon (2004): An Overview of economic applications of David Schmeidler's models of decision making under uncertainty.

R. Caballero (2009): Sudden Financial Arrest

R. Farmer (2013): Qualitative Easing: a new tool for stabilisation of financial markets

F. Collard, S. Mukerji, K. Sheppard, JM Tallon (2018): Ambiguity and the historical equity premium