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Climate Change and the Financial System: A Note

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1. Introduction

There is an extensive and well-documented body of scientific evidence suggesting that global warming is the result of human activities associated with the use of fossil fuels and the emissions of carbon dioxide and other greenhouse gases (GHGs). Although there are many uncertainties, the scientific consensus is that a business-as-usual scenario might have serious negative impacts on human wellbeing (see, for example, Nordhaus, 2007; Stern, 2008). Some potential impacts could be irreversible and accelerate the process of global warming, such as the melting of permafrost, which could release huge quantities of methane, or the loss of sea-ice in the Arctic, which will reduce earth's albedo. Such feedbacks could lead to global warming much greater than current projections, resulting in temperatures higher than any in the past 50 million years.

Under business as usual, over the next two centuries we are likely to see climate changing at a very fast rate and on a scale that the world has not experienced in recent history. Science provides indications that the probability and frequency of floods, storms, droughts and similar natural phenomena is likely to continue to grow with cumulative emissions of GHGs, and that the magnitude of some of these impacts could be irreversible and/or catastrophic. Furthermore, following the most recent IPCC report (IPCC, 2018), under the business as usual scenario the change in the global average surface temperature relative to the preindustrial period – the so-called temperature anomaly – is expected to exceed the threshold of 1.5^{o}C around 2040. This implies that serious impacts and economic damages associated with climate change are expected to emerge in the near future. This scenario is not unlikely since carbon emissions increased during 2018 by more than 2%, reversing the slowing trend of emissions since 2010.

In this context, the objective of climate change economics is to use climate science and the projected evolution of climate under the impact of anthropogenic GHG emissions in order to design economic policies which will prevent or minimize undesirable events. Economic theory considers global warming and the resulting climate change an externality. Externalities and market failure are among the most fundamental concepts that have long been associated with environmental and resource economics

A classic definition, influenced by Kenneth Arrow and James Meade, is provided by Heller and Starrett (1976, p. 10), who define an externality as "a situation in which the private economy lacks sufficient incentives to create a potential market in some good and the nonexistence of this market results in losses of Pareto efficiency". As is well known, when externalities are present, the competitive equilibrium is not Pareto optimal. A market failure takes place and policy intervention in the form of regulation is required in order to correct the externality. Climate change represents the greatest and widest-ranging market failure ever seen. The main characteristics of the climate change externality can be summarized as follows:

- It is global in its impacts. GHG emissions generated in a certain location have impacts which are spread across the entire planet with different geographical intensities.
- Reducing emissions is an extreme global public good. All nations share the benefits from reduced emissions, while the nations that reduce emissions bear the cost of reduction. This generates free riding incentives which may impede nations from reducing individual national emissions.
- Some of the effects are very long term and governed by nonlinear dynamics with positive nonlinear feedbacks.
- There is a great deal of uncertainty both in terms of scientific mechanisms and economic impacts.
- The effects are potentially very large, and many may be irreversible.

The standard economic theory of externalities suggests that the resulting market failure can be corrected using policy instruments which mainly include Pigouvian taxes, or allocation of property rights through some kind of bargaining (the Coasian approach). In the case of climate change, although economic policy design follows these basic lines, it must take into account a very large number of economic considerations such as: estimating damages from climate change; dealing with deep uncertainty both in terms of climate science and economics; characterizing the impacts of climate change and of climate change policies on growth; formulating global policies in the absence of a supranational authority and under free-riding incentives; and addressing intragenerational and intergenerational distribution, which raises important ethical issues between rich and poor nations and between present and future generations.

Economic policy for climate change, under the constraints imposed by the economic considerations described above, has been formulated in terms of carbon taxes or cap-and-trade policies (e.g., Stern, 2007, chapter 14; Golosov et al., 2014). Climate change policy has therefore been predominantly fiscal policy with the main focus being on impacts on the real economy. Not much attention has been paid until relatively recently to its impacts on the financial system and the risks involved (e.g., Campiglio et al., 2018), or the implications of climate change for the conduct of monetary policy and the role of Central Banks, given that the horizon over which climate change impacts the economy has shortened (see, e.g., Couré, 2018) and that the very likely impact of climate change on growth and future output paths might require more involvement of monetary policy.

The purpose of this note is to briefly present the financial risks associated with climate change and the ongoing research in this area.

2. Climate change and the financial system

The Governor of the Bank of England, Mark Carney, was the first to highlight the threat of climate change to the stability of the financial system and to identify the risks involved (Carney, 2015). The main question is what the climate change risks are that emerge from climate change and whether they are substantial. If the risks are substantial, the next question – in the context of the financial system – is whether these climate-related risks are properly reflected in asset pricing (e.g., Monnin, 2018).

2.1 Climate-related financial related risks

It is convenient, in order to better understand the characteristics of climate-related financial risks, to consider two broadly-defined categories of assets: “brown assets” which are assets related to carbon-intensive activities (e.g., coal-fired power plants, coal mines) and “green assets” which are all the rest. There are three main types of climate-related risks relevant for market participants: physical risks, liability risks and transition risks.

Physical risks, associated with physical damages to assets, could be event-driven (such as droughts, floods, storms, wildfires and crop failures) or chronic, related to long-term climate shifts (such as more frequent and stronger heat waves, intensification of droughts, rise in the sea level of coastal areas and increasing frequency of heavy precipitation, change in tropical cyclones and risk of river flooding). In terms of impacts on the insurance sector, physical risks are separated into direct and indirect risks. Direct physical risks for general insurance liabilities are relevant to property insurance and classes of business such as marine, aviation and transport, which arise from hazards like natural catastrophes or events such as coastal or river flooding. Indirect physical risks for general insurance can arise from a disturbance of business lines, financial loss, agriculture or political risk. The frequency and severity of environmental events associated with physical risks is expected to increase as a result of rising global temperatures (Karydas and Xepapadeas, 2019). Physical risks are also related to extra burden on the insurance sector if affected assets were insured. If they were not insured, there could be difficulties in financing their replacement.

Liability insurance safeguards the policyholder from the risk of being held legally liable for loss and damage suffered by other parties as a result of the policyholder's actions. In the case of climate change, liability risks may emerge if parties who have suffered loss or damage from the effects of climate change seek compensation from those they hold responsible. Such claims could come decades in the future, but could potentially have a negative impact on carbon extractors and emitters.

Physical and liability risks relate in general to all assets, while transition risks are associated with brown assets.

Transition risks include policy risks which emerge from potential introduction of stringent carbon-pricing policies, progress of low-carbon technology, or shift in investor preferences. Stringent climate change policies are expected to negatively affect returns of assets related to carbon-intensive technologies or processes.

Carbon-intensive financial assets are expected to face a negative impact during the transition procedure to a lower-carbon economy. According to United Nations Environment Programme, global investments in low-carbon generation, energy efficiency across sectors and energy-related R&D need to increase substantially. Given that investments in the carbon-based economy are mostly irreversible, stringent climate policies and a low-carbon world economy are likely to make the operation of carbon-intensive firms unprofitable, and thus leave assets stranded. Furthermore, in an inefficient market there may be insufficient information to fully estimate the impact of global warming – for example the 2°C IPCC climate scenario – on asset prices.

The relationship between assets and risk is presented in figure 1.

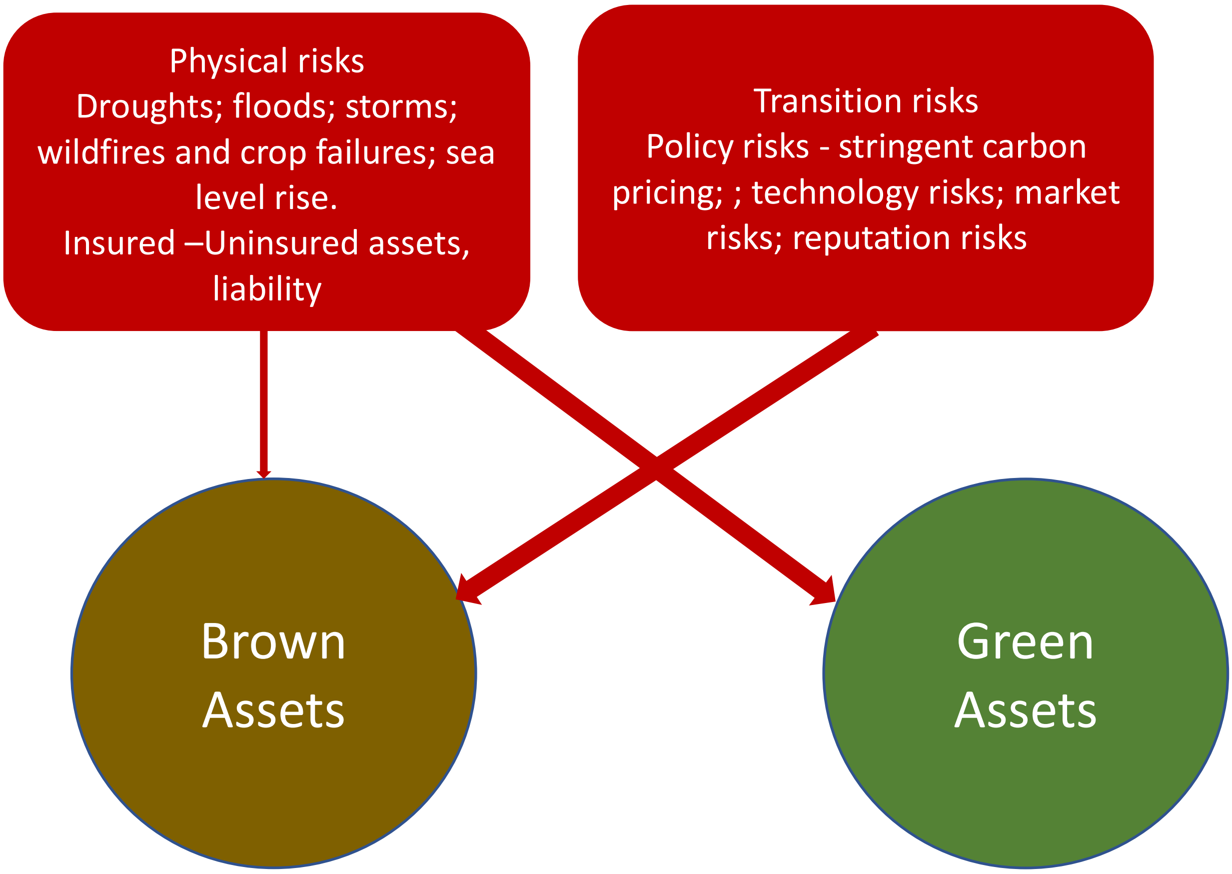

Figure 1: Risks in financial markets.

Dietz et al. (2016) found that almost 2% of the world's financial assets are at risk if the global mean surface temperature rises by 2.5°C compared to pre-industrial levels. Warming of 5°C could result in losses equal to 5% of the global stock of manageable assets.

Bansal et al. (2016) and Karydas and Xepapadeas (2019) found that climate change carries a positive risk premium which increases with global temperature, and that transition risk of climate policy substantially lowers the participation of carbon-intensive assets in the market portfolio.

2.2 Stranded assets

The finding that the transition risk of climate policy substantially lowers the participation of carbon-intensive assets in the market portfolio suggests the emergence of stranded assets (Papandreou 2019). Stranded assets are defined as those investments which have already been made but which, at some time prior to the end of their economic life (as assumed at the investment decision point), are no longer able to earn an economic return (IEA, 2013, p. 98). The Carbon Tracker Initiative uses this definition and links the economic losses to those that are "a result of changes associated with the transition to a low-carbon economy" (Carbon Tracker Initiative, 2017). It has been suggested that limiting the rise in global warming to 2°C compared to pre-industrial levels will render the majority of fossil fuel reserves stranded assets (Carbon Tracker Initiative, 2011, 2013; McGlade and Ekins, 2015). The possibility of extended stranded assets raises the issue of whether there is an overvaluation of fossil fuel reserves and related assets because the possibility of those assets becoming unusable or 'unburnable' has been neglected. That is, whether a "carbon bubble" exists. There is some evidence, although not conclusive, that after 2015 some kind of stranded asset risk is priced, especially for firms holding more fossil fuel reserves. There is also some further evidence that "green banks" charge marginally higher loan rates to fossil fuel firms (Delis et al., 2019).

2.3 Green bonds

Green bonds are debt instruments used to finance green projects that deliver environmental benefits. A green bond is differentiated from a regular bond by its commitment to use the funds raised in order to finance or refinance "green" projects, assets or business activities (OECD, 2016).

The main categories of green bonds include renewable energy and energy efficiency, pollution prevention and control, sustainable land use, biodiversity conservation, clean transportation and also climate adaptation. It is important for the growth of the green bonds market that the environmental benefits of green projects be clearly presented by the issuer and if possible quantified as well, so that they can be verified by independent evaluators.

The market for labelled green bonds[1] has expanded dramatically in recent years, from USD 11 billion in 2013 to more than triple – USD 37 billion – in 2014, with all reports projecting

[1] The term "labelled green bonds" means that the issuer of the bonds has labelled them as "green".

that green bond issuance for 2019 will exceed USD 180 billion, potentially reaching as high as USD 210 billion (Sartzetakis, 2019). However, despite this growth, the market for green bonds still remains a relatively small part of the total bonds market. The global outstanding bonds market was valued at approximately USD 97 trillion in 2014, while in the same year new bond issuance amounted to USD 19 trillion (OECD, 2017). New green bond issuance in 2014 was below USD 40 billion, constituting a very small fraction, just 0.21%, of newly issued bonds.[2]

An important issue with green bonds is whether there is a difference in yield between a green bond and an equivalent synthetic conventional bond, the so-called "greenium". Is a green bond yield lower than that of a completely equivalent non-green bond? There is preliminary evidence that the average green bond premium was negative from the green bonds' issuance date to 30 December 2016, especially in several segments such as EUR and USD bonds where the issued amount was greater than USD 100 (Zerbib, 2019).

Agliardi and Agliardi (2019) develop a conceptual model for green bond valuation, and provide an expression for the green bond value which depends on factors such as asset volatility, tax rates, effectiveness of the green technology and a parameter measuring the sustainability advantage. They show that the greenium – defined as the difference between the yields on a conventional bond and a green bond with the same characteristics – increases if asset volatility increases, the parameters governing the green technology and the sustainability advantage increase, and corporate tax rates are decreased. They suggest that in order to accelerate the green bond market:

- green bonds should have some kind of tax exemption.
- policy makers should invest in environmentally-responsible education and information provision to encourage consumers-investors' demand for green bonds.
- transparency should be increased on green projects, so as to improve the issuer's credibility.
- the cost of obtaining and monitoring the green label should be reduced.

[2] Similar estimates are also presented in the G20 Green Finance Study Group (2016).

3. Climate change and monetary policy

As mentioned in the introduction, not much attention has been paid until relatively recently to the implications of climate change for the conduct of monetary policy and the role of Central Banks. Economides and Xepapadeas (2018) develop a new Keynesian dynamic stochastic general equilibrium model of a closed economy which incorporates a climate module that interacts with the economy, with the monetary authorities following a Taylor rule for the nominal interest rate.[3] The model is solved numerically using common parameter values and fiscal data from the euro area. Results suggest that the impact of climate change for the conduct of monetary policy is not trivial. More specifically, climate change seems to act as a new propagation mechanism of the standard TFP shocks, which appears not only to lengthen the duration of the effects of disturbances, but also to cause increased fluctuations in economic activity. Furthermore, under negative (or positive) TFP shock, the adjustment in the nominal interest, although higher in the impact period relative to the corresponding adjustment when there is no climate change, should be less during the transition path. For the case of a small open economy whose carbon emissions are so small that it cannot significantly affect global warming but is damaged by climate change, Economides and Xepapadeas (2019) show that climate change implies a significant output loss and a deterioration in competitiveness.

4. Conclusions

The purpose of this note was to present – in a compact way – the link between climate change and the financial system, an issue which has started to receive more attention since it was realized that climate change may affect the stability of the financial system. In this context, areas for further research in terms of both theory and applications could include:

- The exposure of the financial system to carbon-intensive assets and the possible financial risks from the emergence of stranded brown assets (e.g., Battiston et al., 2017),
- The liabilities of the insurance system to physical climate change risks,

[3] See also Annicchiarico and Di Dio (2017).

- The extent to which assets are uninsured with respect to climate change risks,
- The structure of a potential green macroprudential policy which would facilitate the introduction of green technologies, and
- Green bonds policies which would facilitate the transition to a low-carbon economy and support programs of adaptation to climate change.

Research in these areas will not only enhance our knowledge about the links and interaction between climate and the economy, but could also improve existing – and suggest new – instruments for climate change policy.

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