ASSESSING TRANSITION RISK AT MICROECONOMIC LEVEL WITH A STRESS TEST METHODOLOGY

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1 Economic analysis of Climate Change Risks

- Ultimately, risks associated to climate change can be partitioned in **two components**:
  - **climate risk** (Carney, 2015; WRI, 2015; Schoenmaker et Zachmann, 2015)
  - **transition risk** or **carbon risk** (Aglietta et Espagne, 2016; Weyzig et al., 2014; Caldecott et McDaniels, 2014).

- **Climate risk** – changes in extreme climate phenomena are likely to cause serious damages to:
  - agriculture, coastal zones, and human health (Ackerman et Stanton, 2013)
  - growth (Pycroft et al., 2016; Dell et al., 2014)
  - productivity (Hallegatte et al., 2015; Graff et al., 2014)
  - value of financial assets (Bowen et Dietz, 2016)
  - insurance claims (Farid et al. 2016).

- **Transition risk** – the cost involved by the process of adjustment towards a lower-carbon economy
  - Mitigation efforts are essentially policy-driven but can also be autonomous, i.e. missing an explicit link to specific national GHG targets (Nobuoka, 2015).

1 Economic analysis of Climate Change Risks/2

- Economic science has generally regarded the trade-off between climate-related economic damages and anthropogenic climate change mitigation in terms of **cost-benefit analysis** (CBA), the principal economic tool for decision making (Dietz et al.,2016).
  - The present value of the damage costs of climate warming, the costs of non-action, must be superior to the present value of the cost of action for the reduction of greenhouse gas emissions.

- Damage costs and costs of action are traditionally calculated in **three ways** (Dobes et al., 2014; Stern, 2007)
  - using disaggregated techniques to consider the physical impacts of climate change and the resource costs of different technologies to reduce GHG
  - using economic models in order to estimate the impacts of climate change and the costs and effects of the transition
  - using comparisons of the social cost of carbon with the marginal abatement cost

- Nevertheless, these methodologies present limitations (Stern, 2007)
  - **Uncertainty**, whether inherent to the models or to the models' parameters, permeates the assessment of the costs of action (Dietz, 2011) and of the costs of non-action (Weitzman, 2009) and makes evaluations highly problematic.

2 Stress tests as alternative evaluation instrument

- Recently, the economic literature has proposed an alternative evaluation instrument: **stress testing**, a technique finalized at testing the stability of an entity (Bowen and Dietz, 2016; Bank of England Prudential regulation authority, 2015; Canfin-Grandjean Commission, 2015; Zenghelis et Stern, 2016; Schoenmaker et van Tilburg, 2016; World Bank, 2015)

- **Article 173**, law n° 2015-992 (August 17th, 2015) relative to the energetic transition for green growth

- In financial risk analysis a stress test, whether at micro level, i.e. at portfolio or financial institution level, or at macro level, i.e. at group of financial institution level, is characterized by **four essential features** (Borio, 2014):
  - a set of risk exposures subjected to stress
  - a scenario that defines the exogenous shocks that stress the exposures
  - a model that maps the shocks onto an outcome
  - a measure of such outcome

2 Stress tests as alternative evaluation instrument/2

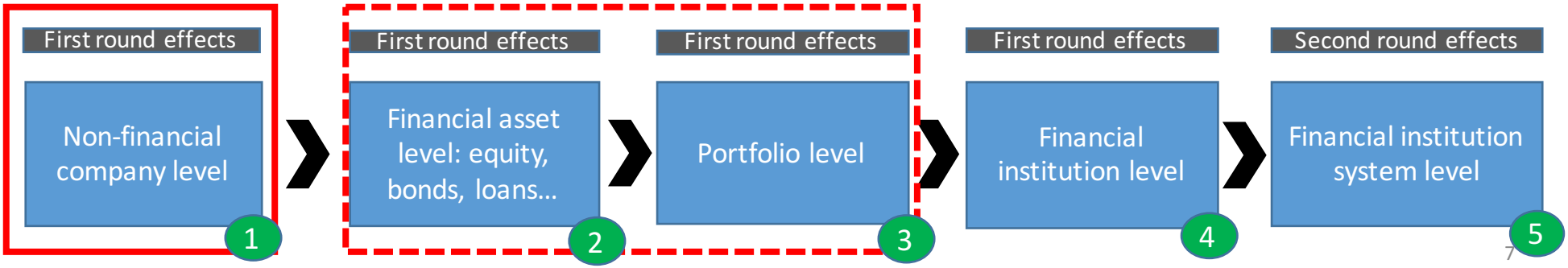
- On the transition risk side – i.e. the cost of action –, these endorsements have been followed up by **research** on carbon stress test design:

  - **Battiston et al. (2017)** study how climate policy risk may propagate through the financial system by putting forward a second round effect measurement methodology.
  - **ICBC (2016)** evaluates the impact of upcoming environmental protection policies — tightening of emission limits and raise of pollutant discharge fees — for two industries, thermal power and cement, in order to figure out the changes of the firms' financial indicators and assess their resulting new credit ratings and probabilities of default by using the bank's rating models.
  - **Cambridge Centre for Sustainable Finance (CISL, 2016)** assesses the impacts on oil, gas and utility firms' profitability of scenarios on environmental regulation and carbon pricing (45€/tCO_2).

- Both the ICBC (2016) and CISL (2016) models are **proprietary**

3 Research interest and methodology

- The research explores the microeconomic facet of one of the two climate change risks, **transition risk**, and puts forward an assessment methodology — still missing today at company level — based on stress testing: a carbon stress test
- The stress test paradigm is adapted in order to conform to the specificities of transition risk
- Objective: provide a measure of **first-round** effects (effects that come from the immediate impact of the shock on the risk exposure) at microeconomic level. The methodological framework provided is able to meet the concerns of the **production base** of the economy on the consequences of GHG mitigation efforts
- Given the superstructure nature of finance, 1 will serve as a **microeconomic foundation** of the evaluation of transition risk at financial level



4 The carbon stress test

- Three transition risk factors have been retained but reorganized: policy, market and technology.

- This taxonomic decision traces the source of the transition risk factors, i.e. public authorities and final demand, while keeping the distinction between an **explicit carbon price** and an **implicit or shadow carbon price** which is implied by the technological shift required to abate CO_2 eq. emissions.

- The three transition risk factors affect the corporation (risk exposure) under examination in different ways and are examined individually; as a second step, the three impacts are aggregated into a common outcome measurement at income statement level (**net revenue**) and then transposed on the balance sheet (**net worth**).

- Additional features: physical emissions quantification, interdependencies within a supply chain, carbon price elasticity of demand, responsiveness of productivity to environmental efficiency, marginal abatement cost

5 Conclusions and policy implications

- The original stress test paradigm is adapted to meet the specific requirements of this idiosyncratic risk
  - the paper puts forward an assessment of transition risk at company (the exposure) level by leveraging a stress test model that combines the impacts of the transition risk factors into two outcome measures: changes in net income and net worth with reference to a baseline net income and net worth with risk factors set to zero.

- The analysis also shows the available risk counterbalancing options for companies.
  - In case of a **market based mitigation approach**, a profit maximizing firm will voluntary change its technological mix Ξ if $\pi(\Xi_1,ecp) > \pi(\Xi_0,ecp)$, with Ξ_1 and Ξ_0 representing, respectively, the new and old technological combination and ecp the explicit marginal carbon price. In other words, the company will voluntary operate a technological shift if its implicit marginal carbon price (icp) **is inferior** to the explicit marginal carbon price.
  - Conversely, in case of a **command and control mitigation approach**, a company will adjust its output prices to maximize its profit under a production constraint induced by a mandatory emission reduction.

- The assessment methodology put forward can be regarded as an input in the **prudential debate** on the assessment of transition risk at portfolio, financial institution and financial institution system level.

Thank you for your attention