

**Green Swans as global risks:** 

Climate change, Covid-19, analytics and some practical policy implications

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#### The green swan

Central banking and financial stability in the age of climate change



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### Outline

- 1. Climate change as global risks, taxonomy (Green Swan) and implications
- 2. Growing social awareness about Green Swans with extreme weather events and now Covid-19
- 3. Analytical progress: complexity of models, mis-pricing of these risks
- 4. Institutional progress: need for global coordination cooperation
- 5. Policy implications (1): practical solutions offered by Green Finance
- 6. Policy implications (2): challenges and the opportunities of a "green recovery"

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### Climate Change as global risks $\rightarrow$ large shocks that affect Demand and Supply, Globally and Locally, at the same time...

#### From a central bank perspective CC will impact:

- Value of "brown" assets, then others
- Thus, Financial Stability systemic risk

#### From a macro & real economy perspective CC will impact:

- C, I, G, T, N, X, M, Y, p, r\*, U\*, K, etc
- At the same time
- Thus, about everything and more

	Type of shock	From gradual global warming	From extreme weather events	
Demand Supply	Investment	Uncertainty about future demand and climate risks	Uncertainty about climate risk	
	Consumption	Changes in consumption patterns, eg more savings for hard times	Increased risk of flooding to residential property	
	Trade	Changes in trade patterns due to changes in transport systems and economic activity	Disruption to import/export flows due to extreme weather events	
Supply	Labour supply	Loss of hours due to extreme heat. Labour supply shock from migration	Loss of hours worked due to natural disasters, or mortality extreme cases. Labour supply shock from migration	
	Energy, food and other inputs	Decrease in agricultural productivity	Food and other input shortage	
	Capital stock	Diversion of resources from productive investment to adaptation capital	Damage due to extreme weather	
	Technology	Diversion of resources from innovation to adaptation capital	Diversion of resources from innovation to reconstruction and replacement	

Source: Bolton et al. (2020), adapted from Batten (2018)

We labelled these Climate Change (CC) related risks "Green Swans", i.e. very large global risks or global negative externalities; inspired but different from Nassim Taleb's Black Swans





#### **Black Swans**

Best science says Green Swans are **highly likely or almost certain to occur** but uncertain timing and uncertain place of manifestation

- Unpredictable
- Explained ex post

- Massive impacts
- Cascading effects

- Existential risks, values at stake
- Irreversibility
- No hedging alone, cooperation

- Impacts easily estimated
- Past as proxy of the future

**Green Swans** 

#### White Swans

	White Swans	Black Swans	Green Swans
Predictability through	<u>Gaussian</u> , normal distribution	<u>Tail risks</u> , perhaps non- Gaussian. Surprise for historical data watchers. Ex-post rational explanation after occurrence	<u>Highly likely or certain</u> <u>occurrence</u> but uncertain timing of occurrence (when?) and materialization (how?). Too complex to fully understand (model?).
Main explanation by	<u>Statisticians</u> , economists	<u>Economists, financial</u> <u>analysts</u> and risk managers with some disagreement	<u>Nature Scientists</u> , disagreement with many economists and financial analysts
Impacts	Low or moderate	<u>Massive and direct impact</u> <u>mostly material</u> . Possible correction of damages after event (crisis).	<u>Massive and direct impact</u> <u>mostly to human lives (or</u> even civilisational). Irreversibility of damages in most cases.
Policy recommendations	<u>Risk models are fine (</u> can be marginally improved)	<u>Reconceptualise</u> <u>approach to risk</u> . Learn from event to design anti-fragile strategies.	Given severity of effects, even without full understanding, need for <u>immediate action and</u> <u>coordination under</u> <u>radical uncertainty</u>

### Why would the Covid-19 pandemic be a Green Swan?

- Tick all the boxes (above) for a « Green Swan ». Global massive negative effects on humans (and global sudden-stop), warnings by scientists of quasi-certainty for occurrence (SARS, H1N1, Ebola), prompted need to act immediately even without fully understanding transmission (massive unprecedented MP+FP responses)
- The destruction of our natural habitat by CC behind pandemics as Green Swans. Scientists suggest biodiversity acts as "natural health barrier" for humans; losing it is less "resilience" for life in general;
  - Huge losses of biodiversity due to urbanisation and transport, industrialization of agriculture and deforestation;
  - Human activities get closer contact to known vectors of viral diseases (eg., bats especially robust the only mammals capable of true and sustained flight). <u>Environmental and health crises can</u> <u>therefore be understood jointly</u> and as potentially reinforcing each other.
- More speculative debates about ways in CC may relate to pandemics. Beyond 2°C of global warming, the chances of reaching tipping points (such as a melting of the Arctic permafrost) become more likely (eg., IPCC Special Report on Global Warming of 1.5°C, 2018). This might unearth ancient viruses now frozen in the permafrost to which we could be as vulnerable as to Covid-19 (happened with outbreak of Anthrax spores in Siberia).

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### Growing evidence of higher frequency of extreme weather events attributed to **Climate Change**

### BlackRock C.E.O. Larry Fink: Climate Crisis Will Reshape

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#### Heat is turbocharging fires, drought and tropical storms this summer





#### Business reports increasingly recognize that CC-related events are biggest risks

## Best science today says Climate Change (global warming) linked to GHG emissions that continue to grow



- Global fossil CO<sub>2</sub> emissions: 36.6 ± 2 GtCO<sub>2</sub> in 2018, 61% over 1990
- Projection for 2019: 36.8 ± 2 GtCO<sub>2</sub>, 0.6% higher than 2018 (range -0.2% to 1.5%)
- Fossil CO<sub>2</sub> emissions will likely be more than 4% higher in 2019 than the year of the Paris Agreement in 2015

#### The 2019 projection is based on preliminary data and modelling. Source: <u>CDIAC</u>; <u>Friedlingstein et al 2019</u>; <u>Global Carbon Budget 2019</u>

## Climate Change also linked to large and growing losses & cost (uninsured weather related disasters), insurance industry says



Source: Swiss Re Institute

### One example : GHG emissions impact temperatures on where we could live → trigger complex new risks



- Human beings must regulate their internal heat, and so they are exposed to the mix of :
  - External temperatures and
  - Humidity
- In 2000\*, this was already a severe risk:
- 13.2% of the planet's land area where 30.6% of the population resides...
- was exposed to 20 or more days when temperatures and humidity surpassed the threshold beyond which such conditions become deadly.

#### By the end of the century, in a BAU scenario, entire regions of the world would be inhabitable.

\* Source: Mora et al, "Global Risk of Deadly Heat", *Nature Climate Change*, vol 7, issue 7, June 2017

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## CC-related risks have multiple ramifications, one example: involuntary migration risks complex to assess

 Changes in the global environment cause an increasing number of human displacements

"By 2050, climate change could force more than **143 million people in just 3 regions to move** <u>within</u> their countries"

– World Bank Group<sup>1</sup>



Sources: (1) Groundswell, Preparing for internal climate migration, World Bank Group, 2018 (2) Internal displacement monitoring centre database 2017

## Growing awareness in CBs of climate change as a source of financial instability, increased by Covid-19, "accelerated" image of "global sudden stop" & huge cost

- Growing awareness among central bankers, financial supervisors and regulators that climate change brings systemic risks that will impact financial stability:
  - Mark Carney (2015): "once climate change becomes a defining issue for financial stability, it may already be too late"
  - Creation of the NGFS (Network for Greening the Financial System) in 2017: "Climate-related risks are a source of financial risk. It is therefore within the mandates of central banks and supervisors to ensure the financial system is resilient to these risks" (NGFS 2018)

### Real GDP growth forecasts for 2020 - Annual % changes - Consensus Economics forecasts (Sept.20)



### .... Another example of growing social awareness, increased by Covid-19

Global (China) sudden-stop and concentration of nitrogen dioxide levels over China (during 1–20 January 2020, before the quarantine, and 10–25 February 2020, during the quarantine)



Source and photo credit: NASA Earth Observatory images by Joshua Stevens.

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# **3.** Analytical progress: complexity of models but still mis-pricing of these risks

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### **Two Main Channels for Modelling CC Systemic Risks** → **Financial Stability**

**Physical Risks** (direct impact on financial stability through cost, uninsured losses, etc) **Transition Risks** (abrupt drop in asset value in anticipation of changes, « stranded »)



Source: Bolton et al. (2020)

### Quantifying these physical and transition global risks is complex..... Mis-pricing is linked to ramifications of radical uncertainty



The individual tipping elements are colour-coded according to estimated thresholds in global average surface temperature. Arrows show the potential interactions among the tipping elements that could generate cascades, based on expert elicitation.

Impacts on socioeconomic systems are difficult:

- Tipping points are complex, trigger irreversible consequences with nonlinearity, cascading effects...
- Add global inequality effects, migrations, conflicts, etc...

Example: ramifications of "Melting of Polar Ice Sheets"?

Source: Steffen et al. (2018)

# Modelling interactions is complex..... IAMs best tools available and yet difficult to grasp all cascading effects of CC-related risks



Source: Carbon Brief Explainers "Q&A: How 'integrated assessment models' are used to study climate change", October 2018

Integrated Assessment Models (IAMs) link climate module and economic module, thru variables such as:

- accumulation of GHGs in the atmosphere; → evolution of mean temperatures;
- a measure of well-being (GDP);
- a damage function linking increases in global temperatures to losses in GDP;
- and a cost function generated by the policies aimed at reducing GHG emissions (eg a price on carbon emissions).

### IAMs and critique, global risks (Green Swans) continue to be mis-priced...

- Integrated Assessment Models (IAMs) based on cost-benefit optimization analysis (Mercure et al., 2016), (i.e. how much GHG emissions vis-à-vis a remaining budget of CO<sub>2</sub> to limit global warming to 1.5°C or 2°C?).
  - CC policy as an additional constraint in the optimization problem of the social planner, assumes a system with a unique equilibrium (Balint et al., 2017).
  - Adequate carbon price produces desired behaviours and technological breakthroughs without unintended consequences
- IAMs do not account for tail risks (Weitzman 2011); predicted outcomes and ensuing policy recommendations could be misleading (Stern 2016)
  - and CC-related risks have non-linearity, radical uncertainty, path-dependency and multiple equilibria outcomes.

# Therefore, need for an epistemological break, from risk-based, model-focussed to broader approaches

- Traditional, backward-looking risk management (e.g. VaR models) cannot model well, quantify these risks; extreme disasters cannot be ruled out with sudden realisation of extreme risks (Weitzman 2011); break away from comfortable historical, linear, deterministic models?
- Alternative (1) scenario-based forward looking risk assessment? Still faces significant methodological challenges related to inability of underlying models to capture adequate interactions large range of social, economic and geopolitical chain reactions; lack of granularity at the corporate level; uncertainty regarding adequate mitigation actions of new technologies
- Alternative (2) non-equilibrium models (such as Agent-Based Models (ABM), Stock-Flow Consistent models (SFC) and Network models (Lamperti et al., 2019)) have been increasingly promoted by some scholars (e.g. Foxon, 2013) and organizations (OECD, 2020) to capture complex, non-linear; cascading effects cross-border & cross-sectors
- Add to alternative (1) + (2) qualitative assessments the socio-technical transition approach (Geels et al., 2017). Need to picture radical uncertainty and think in terms of systemwide transition i.e. how socio-economic, biological and technological systems adapt to changes; pure risk-based approach or model-focussed frameworks might not be sufficient.

### GHGs behind Global Warming pose challenge of irreversible tipping point if CO2 maximum budget is reached



Source: Climate Action Tracker Database, Global emissions time series, updated November 2017. Time series data for INDCs, 2C consistent, 1.5C consistent time series are computed as medians of highest and lowest potential global emission level results.

### Example of non-linearity, abrupt "transition" → sudden re-pricing of assets → cascading effect → huge losses other asset classes → financial instability

#### **Oil Prices**

#### S&P 500 Oil & Gas Market Cap



Sources: Bloomberg

## Industry reports (BP 2020) are already recognizing that baseline (BAU) scenarios need to factor declining demand for oil and other fossil fuels







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## Institutional progress: because CC global and no single agent can solve it, acceptance of more global cooperation & coordination

With governments, national treasuries, development banks: improve the policy mix, including green fiscal policy; promoting sustainable investments and long-termism;

**Central banks and the NGFS:** integrate sustainability factors into central banks' own portfolios (e.g. Banque de France and others); "the fact that central banks in advanced economies are globally setting interest rates near or even below zero [...] is probably the greatest contribution from central banks";

**With regulators, financial sector:** climate-related prudential regulation surely needed, but in what form? How to coordinate with other interventions?

With standard-setters: ecological accounting frameworks; disclosure of exposures; new approaches (e.g. natural capital) to account for economy-nature interactions...

With IFIs: International monetary and financial cooperation; perhaps even new agencies and new funding (green) instruments

And of course and very importantly, with the private sector and civil society...

## Growing social awareness might trigger institutional progress: more acceptance for "insurance" mechanisms against Green Swans

- "Re-pricing" of Green Swan risk of pandemic not necessarily imposing kind of Pigovian (carbon) tax; might be more like proposing insurance: can portion of the risks of Covid19 or any pandemic be incorporated in the final costs of our GVCs, our logistical and physical transportation costs, etc.? Can <u>insurance</u> cost against pandemic be considered?
- Bad news: too late, problem of insurability: in some "red zones" risk too high; moreover CC not a "diversifiable" risk, all countries/sectors will be affected, etc
- Good news: insurance still possible mitigation strategy: illustrates benefits of cooperation and small cost of insurance
  - Ex: huge social benefits of cooperation, pooling risks and buying insurance: in 2004, the Indian Ocean tsunami (est. death toll of 227,898 people in 14 countries and billions in damage). No early warning in place; now yes, with investment of USD 200 million and annual operating costs around USD 25 million shared between 28 countries

### Distributional consequences of climate change: affect poor countries and poor households in rich countries

- **Poor countries** will be most hit by climate change related events (eg., rising sea levels, extreme weather events, lack of prevention, lack of health facilities, etc.)
- In **rich countries poor households** can be hit most by individual climate polices compared to higher-income households:
  - Face more difficult budget constraints that offer limited choice of consumption "greener" baskets;
  - Have harder borrowing constraints that constraint procuring more "green" durables;
  - Have different skill endowments, more difficult to adapt, lower wages; and
- Some climate policy tools can be regressive (eg., carbon taxes for different fuels, certain mandatory standards, subsidies and regulatory tools). Compensation & transfers during transition need to be considered

See "Distributional effects of climate policies" Bruegel, 2018 by Georg Zachmann, Gustav Fredriksson and Grégory Claeys

### Climate change affects poor countries and poor households in vicious circle



Source: Noah S. Diffenbaugha and Marshall Burkea "Global warming has increased global economic inequality" PNAS, Potsdam Institute for Climate Impact Research, March 22, 2019 Source: S. Nazrul Islam and John Winkel, "Climate Change and Social Inequality" DESA Working Paper No. 152, October 2017

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Environmental ODA, % total ODA



2017-18 • 2010-11

Note: Environmentally related Official Development Assistance is identified using the set of "Rio Markers". The Rio Markers screen for policy objectives of a cross-sectorial nature, including climate change, biodiversity and desertification. This variable includes only data on bilateral commitments and is calculated from microdata on individual projects. There is no internationally agreed methodology for tracking actual disbursements of ODA related to each environmental objective. Thus, it remains difficult to determine the environmental purpose of existing commitments and projects. There are also data gaps for some donors. Moreover, Rio markers for ODA refer to donors' commitments (i.e. policy objectives).

Source: OECD (2020), "Creditor Reporting System: Aid activities", OECD International Development Statistics (database).

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### **Private sector in Green Finance and anti-pandemic finance**

- Seize the opportunities to invest in new Green instruments, including new Green financial instruments and in co-financing anti-pandemic initiatives; being attentive to behavioural changes: ex Norway's \$1 trillion Wealth Fund excluding coal from its portfolio (Reuters, May 13).
- **Participate in improving Green financial instruments** (eg., taxonomy of ESG criteria, anti-pandemic financing, etc.); identifying and financing investment opportunities
- Strengthen research partnerships with public sector to develop Green technologies in renewable energy, carbon capture and anti-pandemic policies
- Private sector learning from this Covid-19 will react to become more resilient, including to CC; need for more "green" narrative:
  - planning alternative locations for production plants, cut down on business travel; revisiting the geography of globalization;
  - reassessing production models with zero stocks (essence of GVCs); such GVCs could be more fragile and less resilient to shocks (no room for interruptions, nature of funding, etc.).

### Financing of transition and mitigation, the example of "Green Bonds"

- Europe has led global issuance and Asia-Pacific region is catching-up.
- Green bond label granted if individual projects are deemed sufficiently in line with the Green Bond Principles (GBPs) of the International Capital Market Association (ICMA), and the use of proceeds can be ascertained.





Sources: Climate Bond Initiative, Dealogic and ICMA. Data as of-end September, 2019; BIS calculations. US = United States, CN = China, FR = France, NL = Netherlands, 1C = International Organisation.

### **Bank for International Settlements: Green Bond investment pools**

Promote green finance

- Development of Green Bond BIS investment pools (BISIPs) in USD and EUR in 2019.
- Launched in cooperation with a group of 26 global central banks to meet specific central bank needs.
  - USD Green Bond BISIP launched in Sept 2019: currently 7 central bank investors; fund size is above USD 1 billion.
  - EUR Green Bond BISIP exp. to be launched in early 2021
- Green Bonds comply with the ICMA Green Bond Principles and CBI Climate Bond Standard; enhanced due diligence process when purchasing green bonds to ensure greenness.



Government Regional

Supranationals

Central bank rationale for green bond investing

#### Portfolio Composition





85%

### Green bonds and carbon emissions: exploring the case for a rating system at the firm level

Distribution of carbon intensities – green bond issuers compared with other firms



Sources: Bloomberg; Climate Bonds Initiative; Dealogic; Environmental Finance Bond Database; S&P Trucost Limited © Trucost 2020; authors' calculations.

Source: Torsten Ehlers, Benoit Mojon and Frank Packer, "Green bonds and carbon emissions: exploring the case for a rating system at the firm level", BIS Quarterly Review, 14 September 2020

### **Research changing costs in energy production:** a shifting to "renewable"...

Summary Findings of Lazard's 2017 Levelized Cost of Energy Analysis<sup>(1)</sup> Selected Historical Mean LCOE Values<sup>(2)</sup> Mean LCOE \$/MWh \$360 \$359 330 300 270 \$248 240 Nuclear 210 20% Coal 180 \$157 (8%) 150 Gas-Combined Cycle \$135 \$125 \$124 (27%)\$117 \$123 \$11 \$112 120 \$111 \$105 \$102 \$11 STT Utility Scale Solar(3) \$95 \$96 \$102 \$109 \$104 \$108 \$102 (86%) 90 \$74 \$98 \$96 \$83 \$79 \$75 \$83 \$82 \$65 \$63 \$74 \$71 Wind \$60 60 \$72 \$64 \$70 (67%) \$59 655 \$50 \$55 \$47 \$45 30 2009 2010 2011 2012 2013 2014 2015 2016 2017 Year 5.0 6.0 11.0 LCOE Version 3.0 4.0 7.0 8.0 9.0 10.0 Source: Lazard estimates.

Note: Reflects average of unsubsidized high and low LCOE range for given version of LCOE study.

(1) Primarily relates to North American alternative energy landscape, but reflects broader/global cost declines.

(2) Reflects total decrease in mean LCOE since the later of Lazard's LCOE—Version 3.0 or the first year Lazard has tracked the relevant technology

(3) Reflects mean of fixed-tilt (high end) and single-axis tracking (low end) crystalline PV installations.

Source: Lazard 2017 Levelized Cost of Energy Analysis, The levelized cost of energy (LCOE) is a measure of a power source that allows comparison of different methods of electricity generation on a consistent basis. The LCOE can also be regarded as the minimum constant price at which electricity must be sold in order to break even over the lifetime of the project.

- Key technologies like (i)
  natural gas per
  generation (ii) utilityscale wind and (iii)
  Utility-scale solar are
  now cheaper on a life
  time basis than a
  marginal cost of running
  nuclear or coal plants
- This is different from years ago
- They could be forced to retire
- Comparison with renewable will be more favorable outside of the US where natural gas is cheap.

### **Private sector undertaking several CC-related actions**

		No/partial disclosure <sup>1</sup>	Disclosure <sup>2</sup>	and targets <sup>3</sup>	and emission reduction <sup>4</sup>	
	Overall	67	9	11	13	
Companies'	Agrifood & Forestry	74		9	9 9 974	
climate	Tech, Media & Hi-tech	66		9 1	3 <b>13</b> 882	
change- related	Transport	70	8	14 9 872		
actions	Light manufacturing	74		8	10 8 862	
% responses from 6,937	Construction & Infrastructure	71		6	10 13 819	
companies	Industrial goods	65		10	15 10 753	
	Services	72		8	6 15 492	
	Finance	41	15 10		34 424	
	Consumer & Retail	61		9 12	18 338	
	Energy Health	51 63	13	18 10 13	18 287 14 234	

1. Do not disclose/only disclose partial emissions data; 2. Say there is no facility/source of Scope 1 or 2 emissions excluded from disclosure; 3. Have any form of emissions reduction target; 4. Have reduced emissions vs last year. Note: >250m tonnes and <100 tonnes disclosures are excluded, as likely data errors Source: CDP data (2018)

Source: Boston Consulting Group analysis

See World Economic Forum Briefing Paper "The Net-Zero Challenge: Global Climate Action at a Crossroads (Part 1)", December 2019

# Environmental, Social and corporate Governance (ESG) assets → opportunities, a global \$30trn Market (even if not silver bullet)



ESG global assets are expected to surge to \$53 trillion by 2022, according to a Celent analysis. The potential growth in assets would be up from the \$45 trillion by the end of 2020 says JP Morgan. BlackRock also recently announced that it would be integrating ESG into all actively managed portfolios.

### In addition Carbon Initiatives clear acceleration in recent years



#### Source: World Bank, State and Trends of Carbon Pricing 2020

Note: Only the introduction or abolishment of an ETS or carbon tax is shown. The coverage of each carbon pricing initiative is presented as a share of annual global GHG emissions for 1990-2015 based on data from the Emission Database for Global Atmospheric Research (EDGAR) version 5.0 including biofuels emissions. From 2015 onwards, the share of global GHG emissions is based on 2015 emissions from EDGAR. In 2020, the Technology Innovation and Emissions Reduction Regulation (TIER) replaced the Alberta Carbon Competitiveness Incentive Regulation, which in 2018 had replaced the Alberta Specified Gas Emitters Regulation. The information on the China national ETS represents early unofficial estimates based on the announcement of China's National Development and Reform Commission on the launch of the national ETS of December 2017.

266

1994

993

3661 2661

### Central Banks' broad Green Agenda, several forums of debate (countries, regions, Basel, NGFS), some consensus but lots of dissent too...

### Monetary Policy

- Collateral frameworks (eg. "carbon neutral"? CC-related haircuts?)
- Open market operations, standing facilities, reserve requirements (selectivity?)
- QE and other non-standard tools (helicopter money, etc.); exclude assets?

### Financial Stability and Regulation

- Microprudential instruments (stress tests, disclosure, supervision, risk management' etc)
- Macroprudential instruments (systemic risk stress testing, new calibration with climaterelated risks, etc)

### • Other Policies

- Specific financing schemes (directed credit to specific sectors, firms, etc?)
- CB Reserve Management policies (favor green bonds? Improve definitions? etc)
- Support for sustainable green finance (avoiding "green washing"?)

# Central Banks need not be "the only CC game in town", better play a role to coordinate many actions / actors

- Conservative or Precautionary or Pragmatic / Separation approach?
  - Avoid any abrupt action that can "rock" market (transition risk); select sub-set of CC instruments and policies while building consensus
  - Or... facing radical uncertainty but "real and present CC danger" deploy ex-ante all instruments available (Aglietta & Espagne, 2016, Chenet et al., 2019)
  - Or... use separation & Tinbergen principle, use financial stability mandate to define adequate adequate objective and instrument
  - And.. preserve independence of MPFs such as IT, perhaps even adding integration in IIT (with MaPs and FXI and CFM, Agenor & Pereira da Silva (2019))
  - And avoid mixing quasi-fiscal policies and monetary financing with CC, risk of falling into fiscal dominance and MMT (especially in developing countries with low accumulated CB credibility)
- Mix the best of approaches but always look for enhancing Coordination
  - With fiscal policy (eg., carbon tax, public investment, R&D and debt-financing of transition)
  - With private sector and civil society (eg., communication, awareness, "green" approach)

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# 6. Policy implications (2): challenges and the opportunities of a "green recovery"

### Toward a "green" recovery? Never waste a crisis: mitigate the carbon footprint in the recovery to be engineered

- Already too many challenges and complexity of a recovery without adding another lower carbon footprint constraint
  - Vulnerabilities in real and financial sectors will be larger than post GFC
  - Need to minimize length of contraction
  - Traditional political economy pressures
  - Uncertainty about growth parameters (interest rate, risk premia, inflation, (r-g), (r\*) given uncertainty about effects of contraction and uncertainty on savings, etc.
- But there could be also **useful lessons to consider (never "waste" a crisis)**:
  - <u>Help from "behavioural contagion theory</u>" (van der Linden 2017). Behaviours change w/ significant amount of evidence (eg., for CC frequent extreme weather events; Covid-19 sudden stop overwhelming); both may produce tipping-point where societies begin to fully understand the danger of complex global risks. Then median voter theory applies
  - <u>Supply</u>: Fiscal and para fiscal public programs with "green" announced in Europe and Asia
  - <u>Demand</u>: Behavior change plus new regional norms in large markets (Europe?) could create market incentives to accelerate adaptation and mitigation

### Are there trade-offs for the post-Covid "green" recovery plans?

	Recovery Programs with more Consumption	Recovery Programs with more Investment
"Brown" goods & services	May boost short-term growth and income but no incentive to change and favor cuts in GHG emissions	May preserve "old" industries, maintain more employment but no guarantee against future CC- related job losses nor restructuring in MLT
"Green" goods & services	May have positive medium-LT effects but entail high cost of transition; requires "subsidies"?	May create virtuous circle for "innovative" industries. But may need restructuring in ST and job losses. Higher net job creation in MLT? Who will finance and how, debt, taxation?

### Financing the transition most important issue for Green Recovery

- Why?
  - Financing mitigation / adaptation strategies contributes to increase the odds of expansionary recovery from Covid-19 and reduces risks of Climate Change crises
  - Financing (transfers within and between countries) mitigates adverse distributional impacts of CC and smooths transition trade-offs
  - Current environment favorable (low interest rates → more fiscal space, lower cost of debt (Blanchard); society awareness → pressure on IFIs, rating agencies, Asset Managers, insurance firms, banks, etc); CBs created NGFS looking at CC-risks to financial stability
- How?
  - Public sector fiscal-monetary stimulus already in place, can expand R&D, public infrastructure, macroeconomic guidance, coordination between stakeholders
  - Private sector eager to invest in new Green financial instruments, improving taxonomy of ESG criteria and identifying and financing new investment opportunities
  - Public + private sectors + IFIs can boost research partnerships to further develop Green technologies in renewable energy, carbon capture and anti-pandemic policies
  - Consumers & producers becoming more aware, more climate friendly, asking for resilience, but both needs financing their transition to lower carbon economy





### Multipliers and CC-impact of a "green" recovery according to experts



### Multipliers and CC-impact of a "green" recovery according to OECD study (2020)

	Energy	Aviation	Ground transport	Maritime transport	Heavy industry	Buildings	Agriculture	Forestry	Waste management	Other
Tax reduction / other subsidy				2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2						
Grant/Loan (including interest-free loans)										
R&D subsidies										
Regulatory change										
Skills training										
Other										

Note: Colour shading represents the total number of measures with a clear expected positive environmental impact, tracked across OECD and Key Partner countries in August 2020.

Source: OECD "Making the Green Recovery Work for Jobs, Income and Growth" 14, September 2020

### Multipliers and CC-impact of a "green" recovery according to OECD study (2020)

Environmental R&D, % total govenrment R&D



Note: Data refer to the indicated average or to the latest available average. Government budget for R&D refers to the funds allocated to R&D. Estimates of environment-related government R&D include research directed at the control of pollution and on developing monitoring facilities to measure, eliminate and prevent pollution. It is expressed as a percentage of all-purpose government R&D budget. R&D expenditure is an input measure that indicates an economy's relative degree of investment in generating knowledge. It thus reflects intent, not an outcome: high R&D spending alone does not mean superior innovation performance.

Source: OECD (2020), "Research and Development Statistics: Government budget appropriations or outlays for RD", OECD Science, Technology and R&D Statistics (database).

Source: OECD "Making the Green Recovery Work for Jobs, Income and Growth" 14, September 2020

### Multipliers and CC-impact of a "green" recovery according to OECD study (2020)

#### Fossil-fuel support, % of GDP



2017-19 • 2005-07

Note: The 2005-07 average for Indonesia (IDN) of 2.9% was excluded to improve readability. Fossil-fuel support encompasses all direct budgetary transfers and tax expenditures that provide a benefit or preference for fossil-fuel production or consumption, either in absolute terms or relative to other activities or products.

Data on tax expenditures, which represent the majority of the support mechanisms, need to be interpreted with caution bearing in mind that tax regimes can differ substantially (e.g. depreciation allowances). Fossil-fuel support is often calculated as deviation from the benchmark taxation. However, countries define the benchmark in different ways, making international comparisons potentially difficult. This indicator features in the global list of SDG indicators and is used to monitor progress towards SDG 12.c.1.

Source: OECD (2020), "OECD Inventory of Support Measures for Fossil Fuels ", OECD Environment Statistics (database).

Source: OECD "Making the Green Recovery Work for Jobs, Income and Growth" 14, September 2020

### Conclusions (1): for Green Swans, solutions are global coordination with "all hands on deck" and immediate action

- <u>Solution requires global and local coordination between Agents</u>: Global risks require global coordination by definition plus local cooperation among many players (Governments, CBs, private sector, IFIs, regulators, standard-setters, ratings agencies, etc); the NGFS (*Network for Greening the Financial System*) playing important role for CBs
- Solution requires technology (supply) and behavioral change (demand): financing costs of transition and mitigation face old political economy, game theory, collective action issues (Olson, Ostrom) to find fair burden sharing, cooperation and incentives for action
- <u>Solution calls for immediate action given severity of CC-related events</u>, even without full understanding, because of radical uncertainty
  - Until recently, myopic behavior: **Tragedy of the Horizon** (Carney 2015),
  - Covid-19 might have changed the benign neglect, triggered behavioural change: provided overwhelming evidence of huge costs of Green Swans, convincing societies of need for action, at least with insurance & buffers

# **Conclusions (2): policies to mitigate climate change need work on systemic risk, demand & supply, attention to distributional consequences**

- Improve assessment of systemic risk in the financial system (new risk models, transmission of CC to "financial crisis", portfolio asset "temperature", disclosure of exposures – FSB-Task Force); stress-testing resilience of financial system to scenarios of CC shocks (assessment of potential losses vis-à-vis available capital for insurance companies & banks)
- **Demand side: consumer information and incentives to lower carbon economy** (public awareness, carbon pricing, GHG emission taxation & certificates, use "pragmatism" in policy responses)
- Supply side: proposing to investors practical diversification projects/paths to lower carbon economy and finance the transition, "green" research" R&D, new technologies, carbon capture, new "green" financial instruments, green infrastructure, "global funds" for MICs and LICs, etc.
- **Distributional consequences of CC policies and transition** are important; political economy of CC is pervasive issue; international (between rich and poor countries) and local compensation & transfers can be important elements to gather support and efficiency

### **Thank You**