The effects of climate change on the natural rate of interest (r)*

SUERF & OeNB Conference

“Equilibrium real interest rates – concepts, current and future drivers: new insights and policy implications“

Francesco Paolo Mongelli, Wolfgang Pointner
and Jan Willem van den End

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Introduction

Climate change (CC) is affecting structure & dynamics of the economy & financial system;

- CC increasingly an important factor for steering monetary policy:
- Poses financial risks to assets held on central banks' balance sheets; and
- Without prejudice to the objective of price stability, the ECB must support general economic policies in the Union, with a view to contributing to the achievement of objectives including a high level of protection and improvement of the quality of the environment (ECB OP 275).

This presentation is divided in two parts:

- ***Part A. What are some of the main links between CC and the foreseeable path of the natural rate of interest (r*)?***
- ***Part B. Can r* in any case be used for guiding monetary policy (in relation to climate change)?***

Part A

What are some of the main links between CC and the foreseeable path of the natural rate of interest (r*)?

Most r* estimates are backward looking, while CC is unfolding at an increasing speed.

We present some channels through which climate change can affect r*

Background

Ramsey (1928) formulation of the natural rate

$$r^* = \rho + \gamma\, g + n$$

g growth rate of labour-augmenting technological change (or TFP growth): reflects agents' expected income growth.

n is the population growth rate.

$\boldsymbol{\gamma}$ consumption elasticity of marginal utility: also denotes smoothing preference of agents, related to their risk aversion.

1/$\boldsymbol{\gamma}$ is the intertemporal elasticity of substitution in consumption: captures willingness of agents to shift consumption across time.

ρ is the pure rate of time preference: reflecting agent's patience to consume (the more patient, the more they save and the lower becomes r*).

In climate economy models ρ is discount rate and determines **Social Cost of Carbon.**
Lower ρ, the higher the SCC and in that sense ρ is also called an *"ethical discount rate".*

Demographic transition channel

Ramsey equation $r^* = \rho + \gamma\, g + \boldsymbol{n}$

- Decline of population growth (n) → low fertility rates, ageing and changing age cohorts
- Euro area → demographic trends have reduced real interest rates by ≈1 pp since the 1980s; further fall of 0.25-0.5 pp expected by 2030 (Brand et al., 2018)

Contrasting views about demographic drivers in the future:

- Higher wealth/GDP, capital deepening, savings ↑ (Auclert et al., 2021) lower r* (w/heterogeneity across countries)
- *"Great demographic reversal"*, dependency ratios up, saving↓ higher r* (Goodhart & Pradhan, 2020)

Future net effects of CC through demographics ambiguous → could impact life expectancy, health conditions (Seppanen et al., 2006), labour supply, induce migrations, and more.

Productivity channel (I)

Ramsey equation $r^* = \rho + \gamma\, \mathbf{g} + n$

- Temperatures beyond comfort zones 18^0-22^0 C affect mortality, general health, labour supply, and depress productivity (Tol. 2009), Heal and Park, 2016).
- Decline in TFP growth (g) → reduces expected future income, raises savings to smooth consumption, lowering r^*
- Unabated rise in physical risks and weather extremes negatively affects productivity: wide range of views on tipping points/thresholds effects (NGFS, 2021 and 2023 and IPCC reports). Loss of natural resources & biodiversity is receiving more attention.
- Combination of risks might suppress annual trend growth up to -0.45% (Howard & Sterner, 2017; Alestra et al., 2020; NGFS, 2021)

Several channels at work:

- Expected future climate "damages" require investments in adaptation & mitigation – "*costs more to do same things*" (Batten; 2018; Kahn et al., 2019)
- Accelerated depreciation rate of existing capital stock plus stranding of assets.
- Transition to a low carbon economy will require considerable investments & fosters (green) innovations (Porter Hypothesis), Yet, net expected productivity gains are uncertain (+/-).

Productivity channel (II)

Overall, the evidence of the impacts of climate change and climate policies on productivity is contrasting.

Yet some crucial themes emerge:

- Launch of a timely and ambitious *"orderly transition"* with coherent, well communicated & predictable climate policy paths is imperative to enable to contain physical risks (NGFS, 2021 and 2023);
- Interplay between green investments and R&D and pace of sustainable innovation is crucial (Pisani-Ferry , 2021);
- Productivity of new vs old capital and support for the Porter Hypothesis; and
- How intertemporal trade-offs play out and are accepted.

Risk aversion and savings channels

Ramsey equation $r^* = \boldsymbol{\rho} + \boldsymbol{\gamma}\, g + n$

Rising uncertainty pushes risk aversion up:

- Higher consumption smoothing preference (γ), agents save more, reinforces effect of lower g on r^*
- Lower time preference ρ, (more patience), higher supply of savings and lower r*

Climate change-related risks:

- Uncertainties about pace, thrust and modalities of green transition reduces willingness to invest and rise tail risks (Weitzman, 2009; Bolton et al., 2020) (lower $r*$)
- Higher demand for **safe assets** (Caballero & Fahri, 2019) (lower $r*$)

Empirical financial research: do investors require compensation for climate risks? Yes

- CC shocks induce higher equity risk premiums (Fernando et al., 2021 ; Bolton & Kacperczyk, 2020)
- Risk premium in bond yield are sensitive to heterogeneities and climate policy scenarios (Battiston & Monasterolo 2020; Cevik & Jalles, 2020)
- Safety premium embedded in risk-free bond yield (Hambel et al., 2020)

Steady state simulations: trend growth

Long-run (steady state) simulations (based on Bylund and Jonsson (2020))

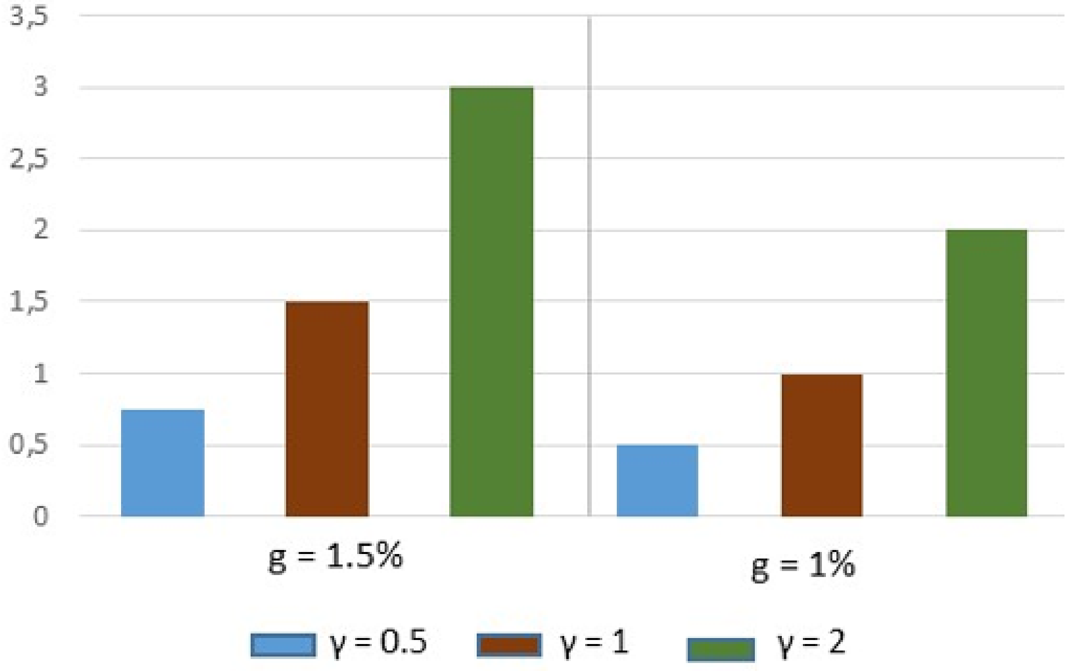
- Enables some inferences and
- Sensitivity analysis

Ramsey eq. $r^* = \rho + \gamma\, \mathbf{g} + n$

Weaker growth prospects have larger effects on r* when elasticity of marginal utility is high (high smoothing preference)

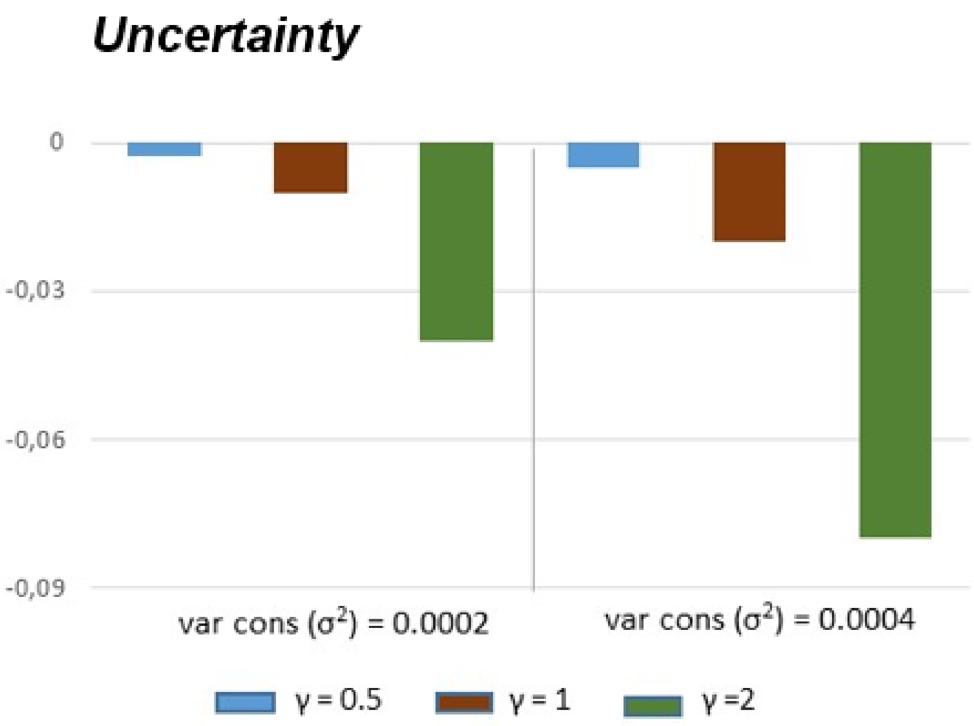
Impact lower trend growth g on r*

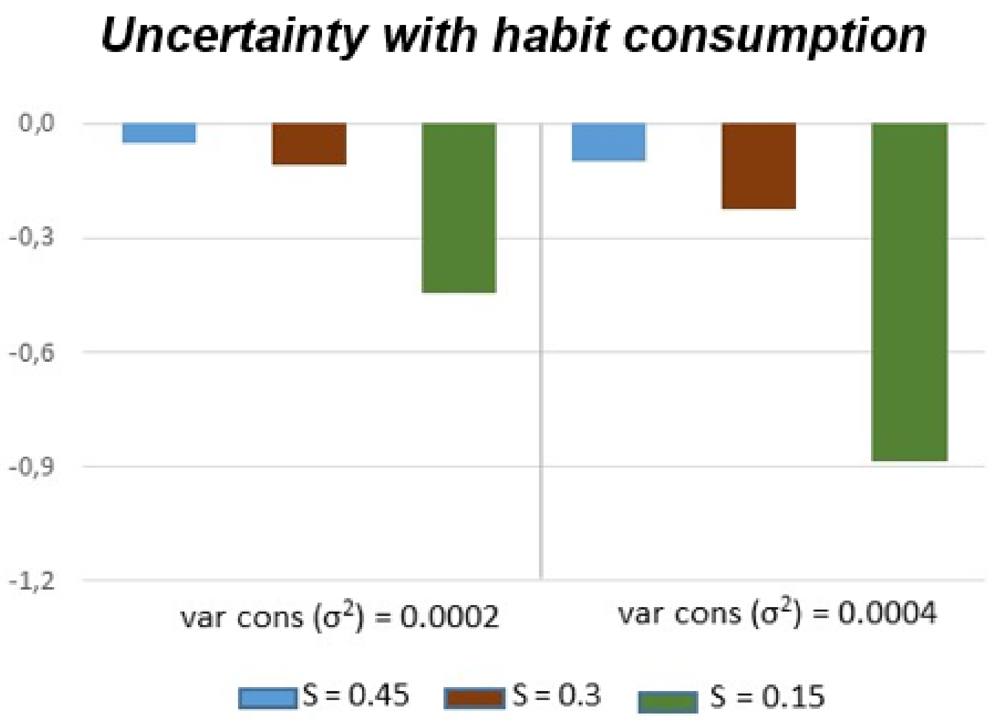
(level of r on vertical axis, $\rho = 0$)*



Steady state simulations: uncertainty

- Uncertainty affects r* through higher savings and risk premium
- $\boldsymbol{\sigma}^2$ is the variance of consumption growth (Campbell and Cochrane (1999))
- Ramsey eq. $r^* = \rho + \gamma\, g - \frac{\gamma^2}{2}\boldsymbol{\sigma}^2$ $\quad r^* = \rho + \gamma\, g - 0.5\left(\frac{\gamma}{S}\right)^2 \boldsymbol{\sigma}^2$



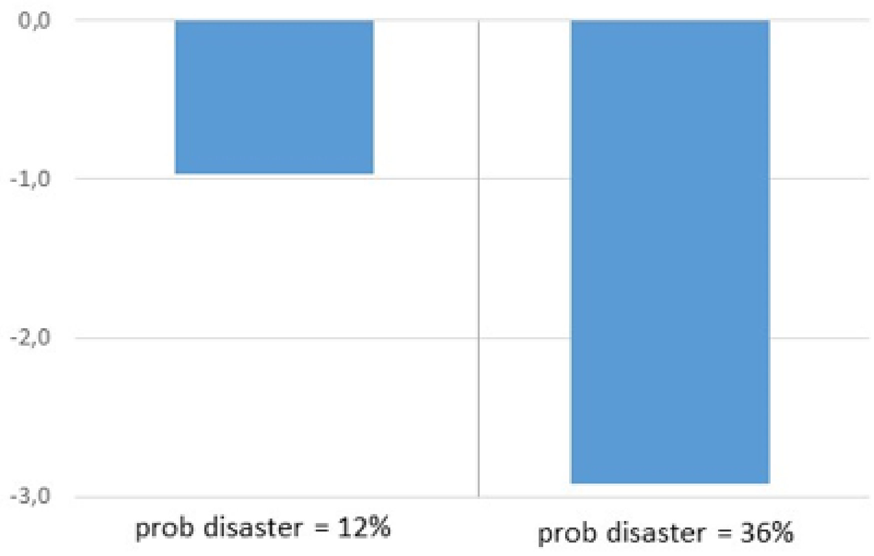


change of r in percentage points on vertical axis. Baseline scenario: r* = 0, with* $\rho = 0,\ g = 0$; *in rh-panel* $\gamma = 1$.

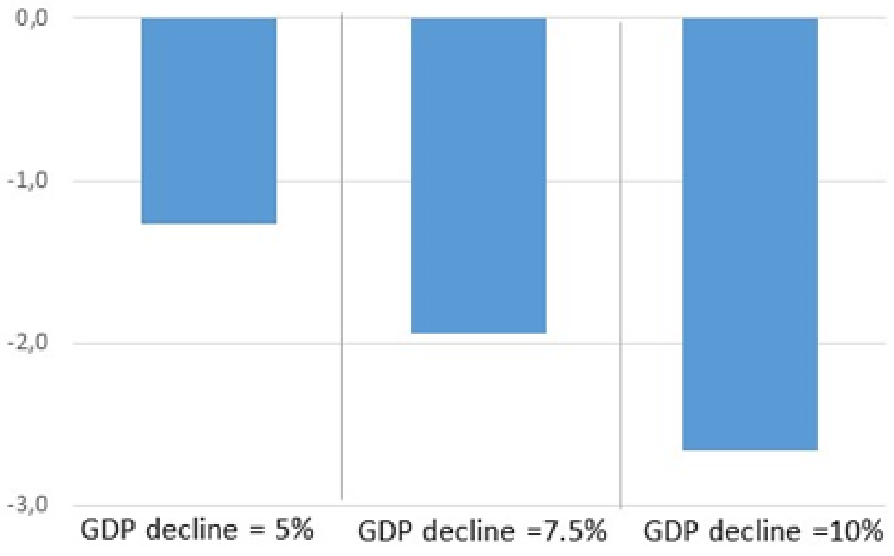
Steady state simulations: physical risk

- Physical risk affects r* through probability (**p**) & impact (**b**) of disasters
- Ramsey eq. $r^* = \rho + \gamma\, g - \boldsymbol{pb}/(1 - \boldsymbol{b})$
- IPCC scenarios → prob. of temperature >3^0 C in 2100 (RCP4.5: 12%. RCP6.0: 36%)

Climate disaster probability (b=7.5%)



Climate damage (p=24%)



change of r* on vertical axis in percentage points. Baseline scenario: r* = 0, with $\rho, g, p, b = 0$

Part B

Can r* measures in any case be used for guiding monetary policy, also taking into account the potential impact of climate change?

Endogenous monetary policy (I)

New Keynesial paradigm: monetary policy does not determine r*, that reflects supply and demand equilibria.

→ Thus r* is exogenous and can be used as a yardstick for setting the MP stance.

However, some find evidence that monetary policy can have L-T effects such as on expectations.

Thus, r* could be endogenous to monetary policy (Jordà et al., 2020; Borio et al., 2019; Gopinath et al., 2017)

- Impact on productivity growth (g), via hysteresis effects, and trend growth, which then affect climate via feedback effects of output on carbon emissions (-)
- Via influence on capital allocation (asset purchases), e.g., if higher polluting energy-intensive industries benefit relatively more from QE and monetary policy stimulus (Schoenmaker, 2021).
- Market neutrality versus the “carbon bias”.
- Debate about whether accommodative financial conditions foster finance of green innovations (+)
- Climate action plan ECB incentivizes market participants, influences capital allocation through improved price discovery mechanism (+)

Endogenous monetary policy (II)

Massonet (2015), r* might be unspecified in an economy with multiple activities.

Physical heterogeneity of capital goods prevents the determination of a unique rate of profit on the market for loanable funds: there might be various r*s.

Heterogeneity across EMU countries: i.e., country specific r*s.

“Double materiality” concept. Climate change not only affects financial institutions, but the financial system itself can also contribute to climate change and, hence, aggravate the very risks it wants to manage.

Final remarks

- Downward effects of climate change on r* can be substantial, taking into account the large uncertainty about the outcomes of unabated climate change
- Main channels for impact of climate change on r* → erosion of capital stock, declining overall productivity, rising uncertainty and risk aversion
- Policy space for central bank may further be reduced in the long run
- Heterogenous effects on country specific r* might complicate monetary policy

- Overall effects depend on the energy transition path: NGFS (2021 and 2023) scenarios, that we have not done.
- Climate-related innovations & investments could have an upward effect on r*

References:

Mongelli, Pointner and van den End (2022) “The effects of climate change on the natural rate of interest: a critical survey”, ECB WORKING PAPER SERIES - No. 2744 see: https://www.ecb.europa.eu/pub/research/authors/profiles/francesco-paolo-mongelli.en.html

Mongelli, Pointner and van den End (2024) ”The effects of climate change on the natural rate of interest: a critical survey”, WIREs Climate Change (forthcoming).

Introduction

Some cautious answers build on recent work with co-authors listed in the back of these slides.

r* is the real interest rate consistent with inflation at its target and the economy operating at its potential.

- Benchmark for assessing whether monetary policy is too tight or too loose. When the policy rate is above (below) r*, the monetary stance is deemed contractionary (expansionary).
- r* has a fair share of detractors, as it is unobservable & elusive (Borio et al (2019)).

Long decline of r* across most countries over 30-years: driven by demographic and economic factors, plus financial trends (Brand et al (2018), Rachel and Smith (2017), Holston, Laubach and William (2017).