

Is there a role of Central Banks in the low-carbon transition? Insights from the EIRIN model

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Outline

- Growing attention on role of central banks' (un)conventional monetary policies in the low-carbon transition but lack of proper models
- Limits of current modelling approaches (DSGE)
- Introducing the EIRIN model and its advantages to assess the impact of (un)conventional monetary policies on the low-carbon transition
- Focus on green sovereign bonds and distributive effects
- Conclusions

Monasterolo, I., Raberto M. (2018). The EIRIN flow-of-funds behavioural model of green fiscal policies and green bonds. Ecological Economics

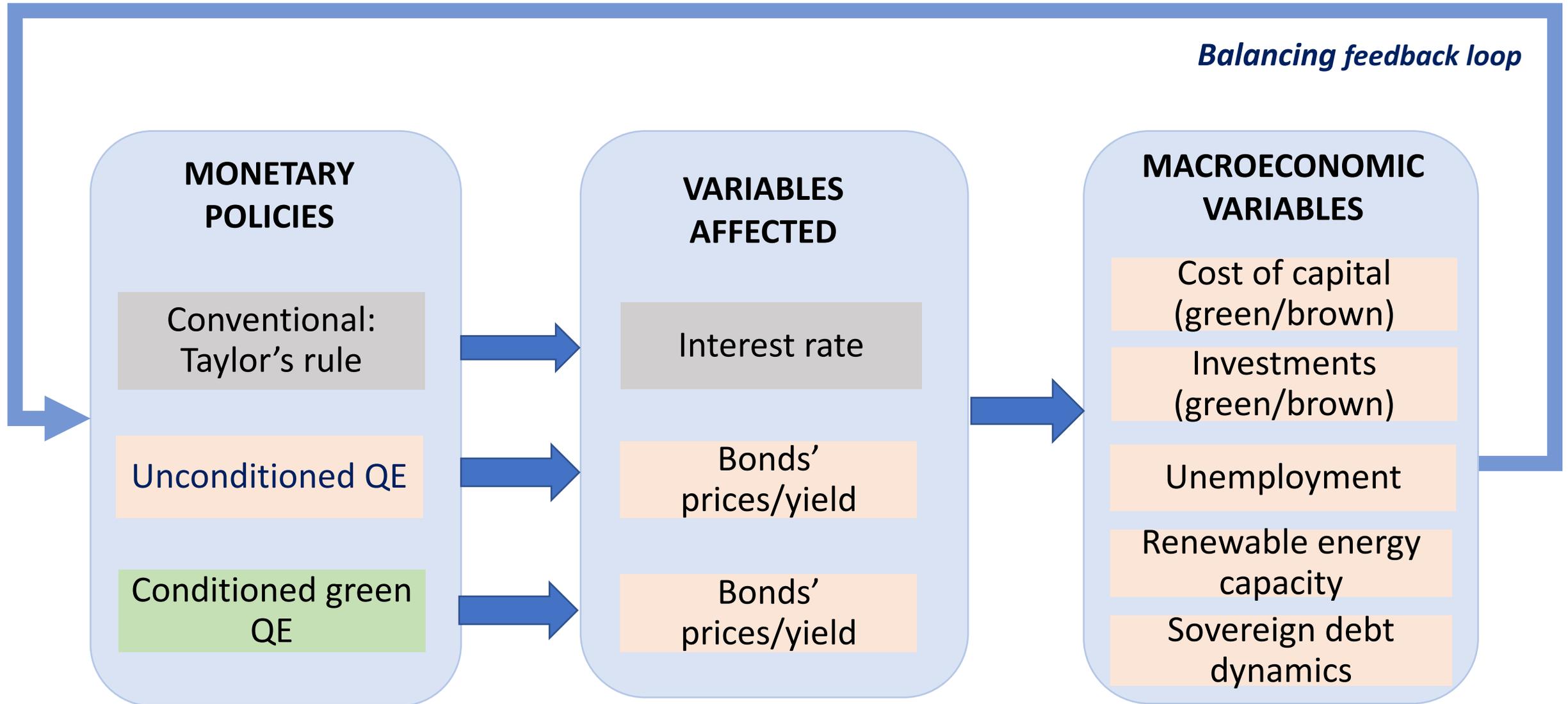
Central banks, climate change, financial stability: *a dangerous relation?*

- Central banks (CB)'s role in the economy much increased ('whatever it takes'):
 - *Unconventional measures* (Quantitative Easing (QE)) to boost economy
- CBs' *focus on financial stability*: macroprudential regulations, banks' capital requirement and stress-tests
- Recent attention on central banks' role in the climate-finance nexus:
 - *Climate change*: ECB's QE non sector-neutral but biased towards carbon-intensive sectors, increasing exposure to stranded asset (Matikainen et al 2017)
 - *Inequality*: pushing-up assets' prices, QE mostly benefitted wealthiest and most sophisticated actors (Lysenko et al. 2016, Fountan and Jourdan 2017)
- CBs' growing concern on *climate change's impact on financial stability* (Draghi 2017)

EIRIN's research questions and focus

1. *Under which conditions* could (un)conventional monetary policies and new financial instruments (i.e. green sovereign bonds) foster green investments in the EU?
 2. *What are the possible unintended effects* on financial stability and inequality?
- Focus of the analysis:
 - Climate-aligned policy options currently discussed by academics and practitioners (green QE)
 - EU's structural characteristics in the last decade (low growth, inflation, interest rates)

(Un)conventional monetary policies: transmission channels and feedbacks



Results in a nutshell

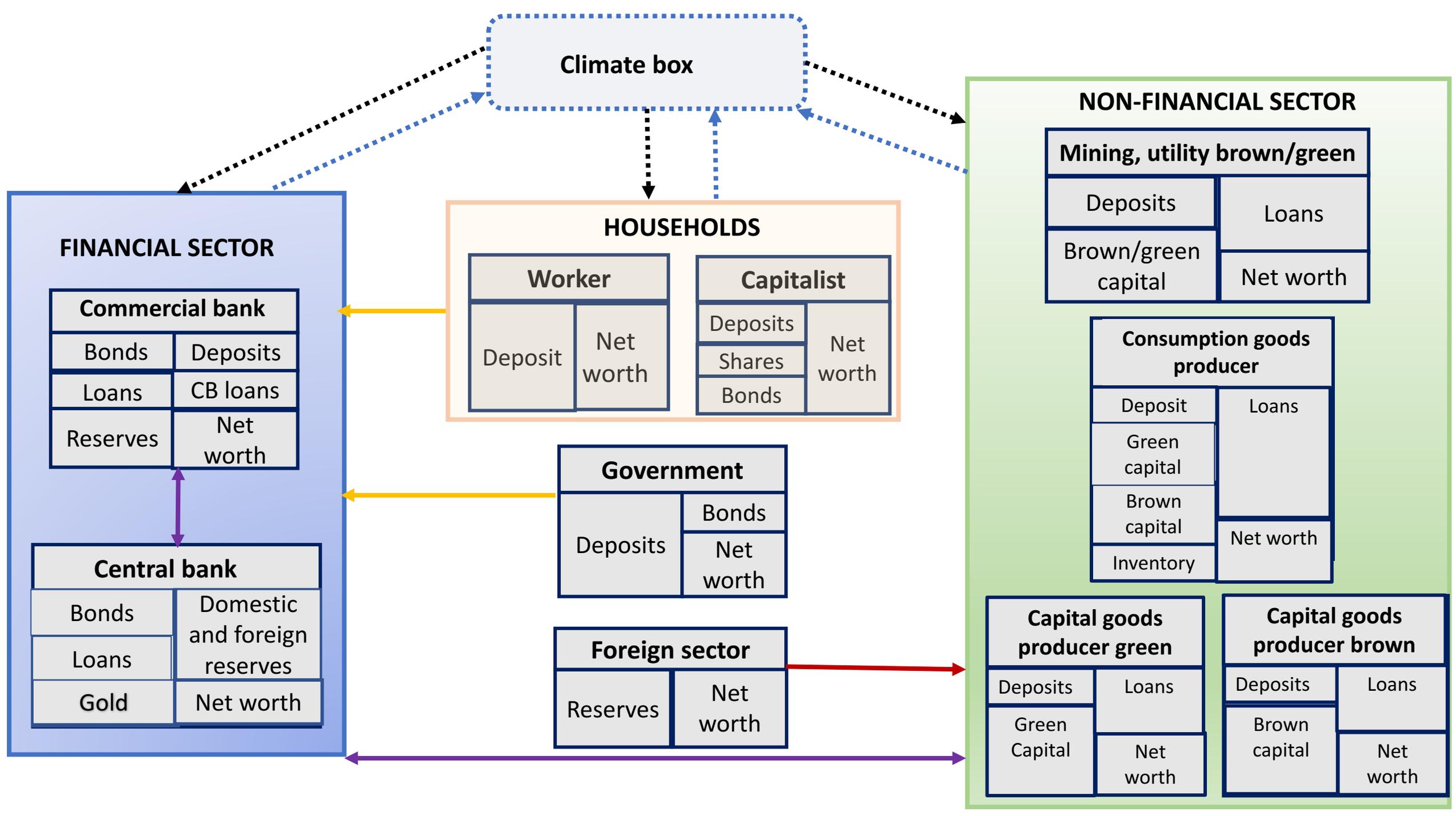
1. Green QE can foster the low-carbon transition and build resilience against stranded assets *if*:
 - targeting sovereign bonds that are conditioned to green investments
2. Green QE's transmission channels to the real economy work by:
 - improving the borrowing conditions for renewable energy investments
 - releasing government's budget conditions, while avoiding tax increase
 - supporting the development of the green bonds market
3. Unintended distributive effects depending on how QE and fiscal policy are implemented:
 - Higher households' income inequality and wealth concentration towards the banking sector

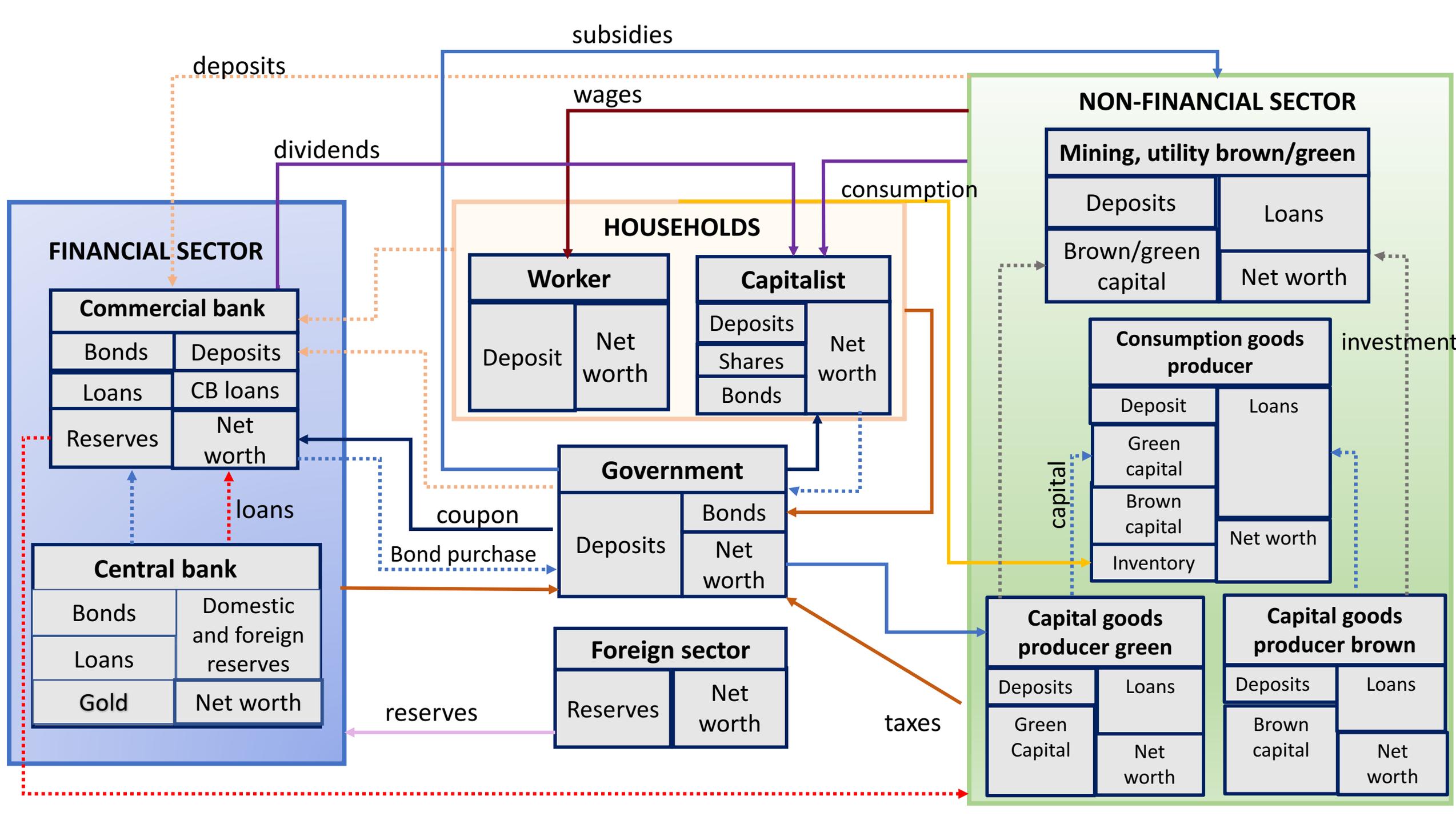
Could existing macroeconomic models answer our research questions?

- Not properly: DSGE criticized (Romer 2016, Stiglitz 2017) for inability to represent financial interconnectedness and endogenous feedbacks finance-economy.
- DSGE still exclude:
 - Origin and impact of income inequality, and the relation to private debt and finance (Piketty 2014, Kay 2015)
 - Origin of instabilities in the financial system, in particular role of climate policies
 - Central banks' unconventional monetary policies' impacts on agents' expectations
 - Endogenous feedback loops and (amplification) effects on the economy
 - Endogeneity of money (McLeay et al 2014)

EIRIN's added value with respect to existing models

- EIRIN combines advantages of SFC-ABM, being parsimonious in complexity:
 - Heterogeneous households (consumption/saving behaviour, access to financial markets and yields)
 - Heterogeneous goods and capital (green/brown)' resource intensity, R&D
 - Distinction between credit/bond/capital market for funding green investments:
 - compare conventional monetary policies (via interest rate) with unconventional ones (via bonds' prices/yields)
 - assess effect on banks' stability and on green bonds market
 - Disequilibrium model: not forced to equilibria to see emerging (often unexpected) macroeconomic dynamics.





Why green sovereign bonds?

1. Sovereign bonds main share of global bonds market (40% vs 7% corporate)
 2. Governments (Poland, France) started to issue green bonds
 3. In addition, currently, no evidence of QE's impact on new loans in EU
- In EIRIN, *QE implemented via green sovereign bonds* to overcome current credit failure through the introduction of *green public policies*:
 - Government issues green bonds to support to private investments (utility company) in renewable energy (e.g. solar pv), thus clear conditionality
 - Green *entrepreneurial* State (Mazzucato 2015)
 - CB buys green bonds on primary market in case of QE (direct intervention)
 - Both brown and green bonds are perpetuities paying a fixed coupon.

Public support to renewable investments via green bonds

- Green utility company decides to invest in solar pv based on NPV of acquiring Δn_{sp} units of solar panels at price $p_{K_{green}}$ subsidized for γ_{sp} % by the government

Total initial investment cost \rightarrow $NPV = - (1 - \gamma_{sp}) p_{K_{green}} \Delta n_{sp} + \frac{p_e \varepsilon_{sp} \Delta n_{sp}}{r_D}$ \leftarrow Total discounted cash flow

γ_{sp} = % of gov subsidy for the cost of green investments (e.g. solar panel)

Δn_{sp} : new solar panels acquired. Solar panel is identified as a unit of green capital

P_e = price of energy (based on unit costs i.e. raw material and debt

ε_{sp} = energy efficiency (parameter)

price $p_{K_{green}}$ set as a fixed mark-up μ_K on units labour costs

r_D : *cost opportunity of capital and used to discount future cash flows*

Role of bank and Central Bank in EIRIN

Commercial bank (BA)

- BA and monetary policy:
 - BA sole intermediary of CB's QE
 - BA allocates its sovereign bonds' portfolio (green/brown) according to their yields
- BA and non-financial firms:
 - provides also loans to the real economy (firms)
 - BA financing through endogenous money creation
- Bank has leverage target (ratio risk weighted assets - equity) to meet Basel III, and Capital Adequacy Ratio (CAR).

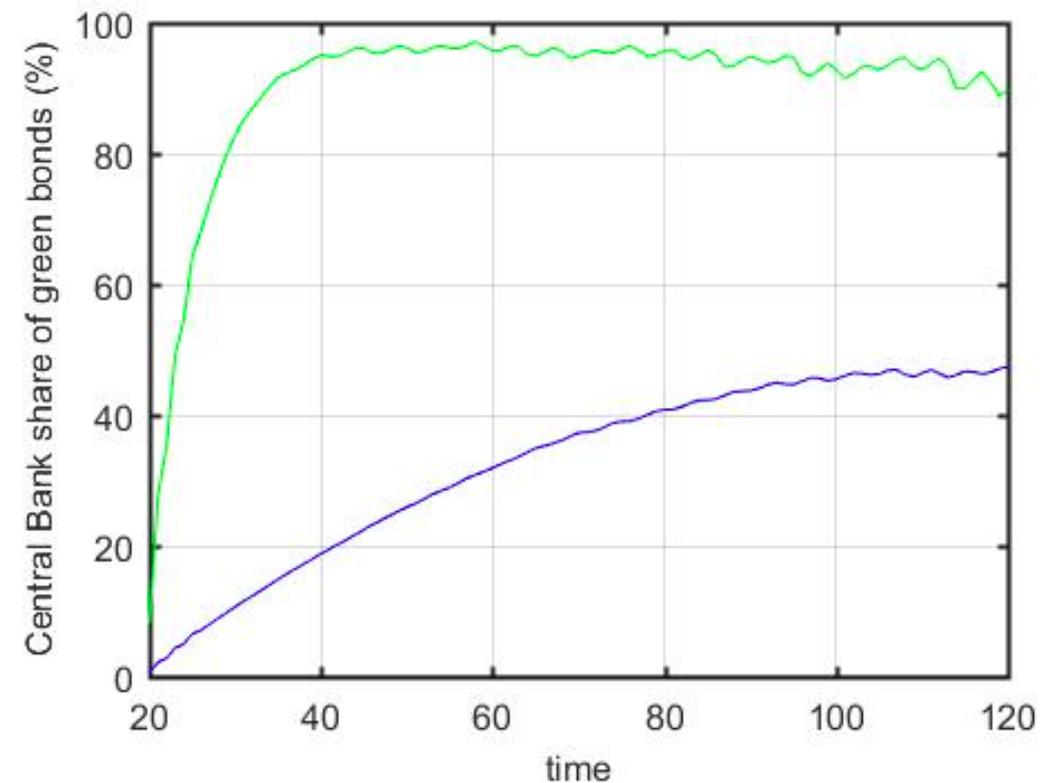
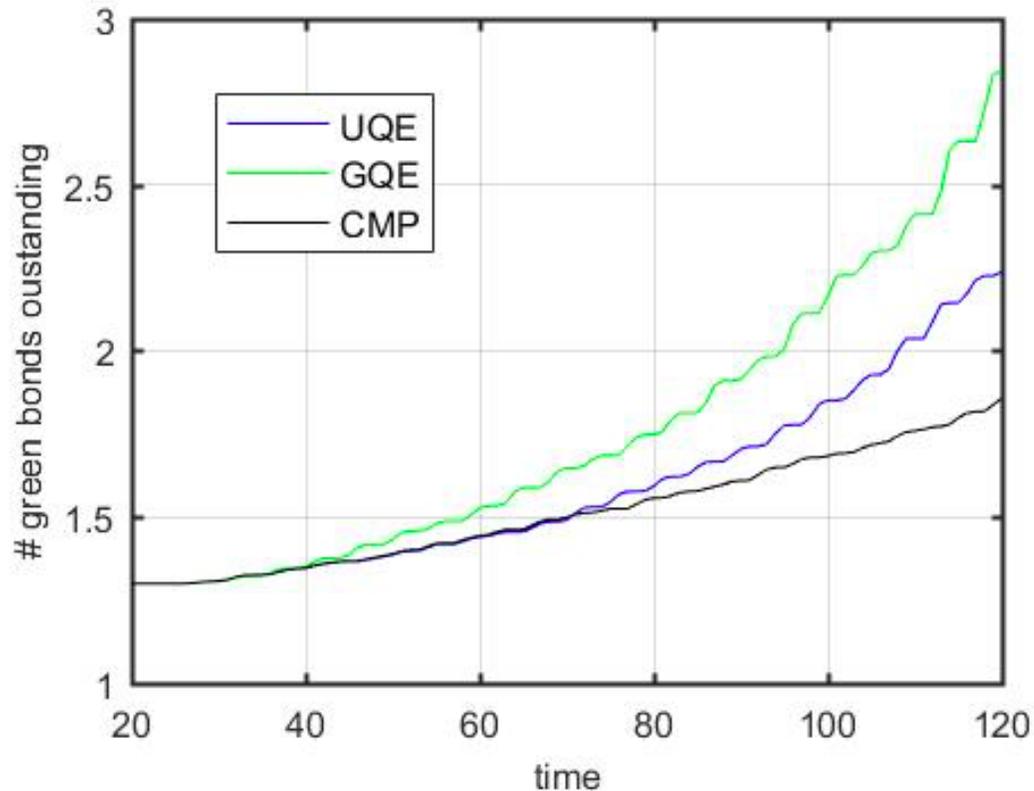
Central Bank (CB)

- CB accepts green/brown bonds as eligible asset in case of QE
- CB sets interest rate (i.r) according to a Taylor like rule:
- $r_{CB} = \omega_{\pi} (\pi - \bar{\pi}) + \omega_u (\bar{u} - u)$
 - I.r. depends on the inflation and output gap
 - I.r. influences investments through NPV
- CB provides liquidity to BA in case of shortage of liquid assets

Three scenarios

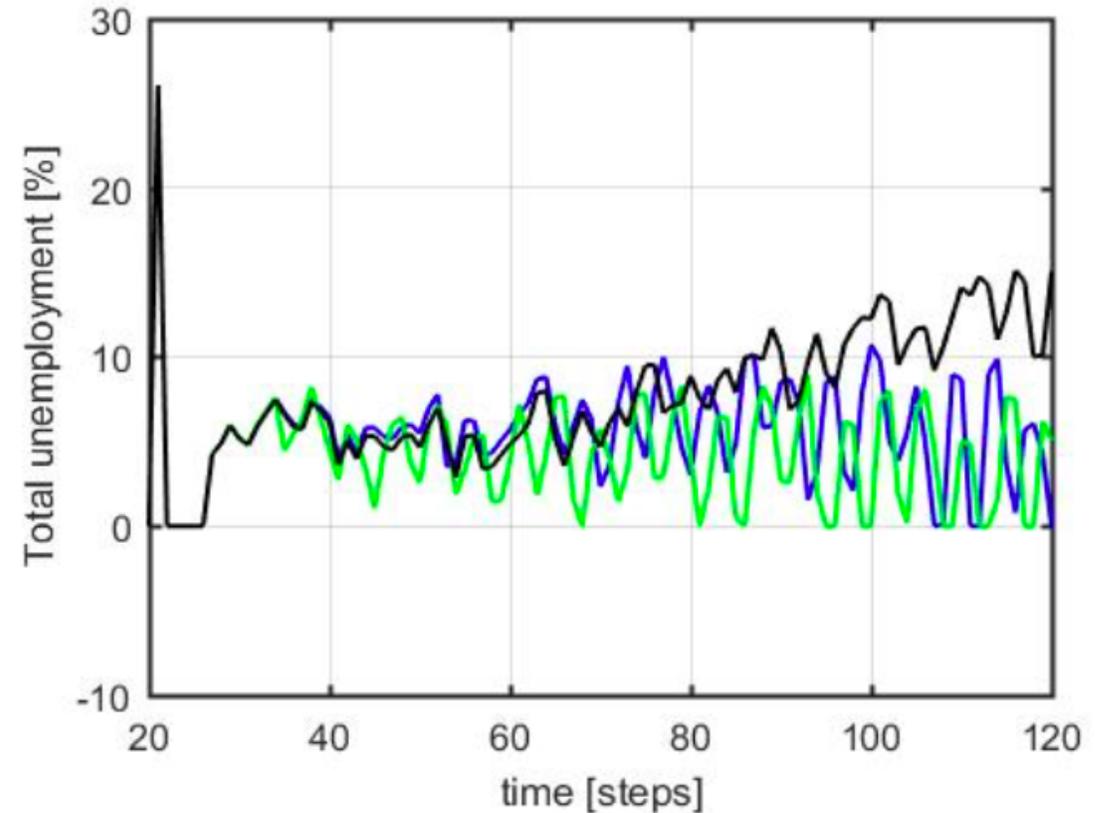
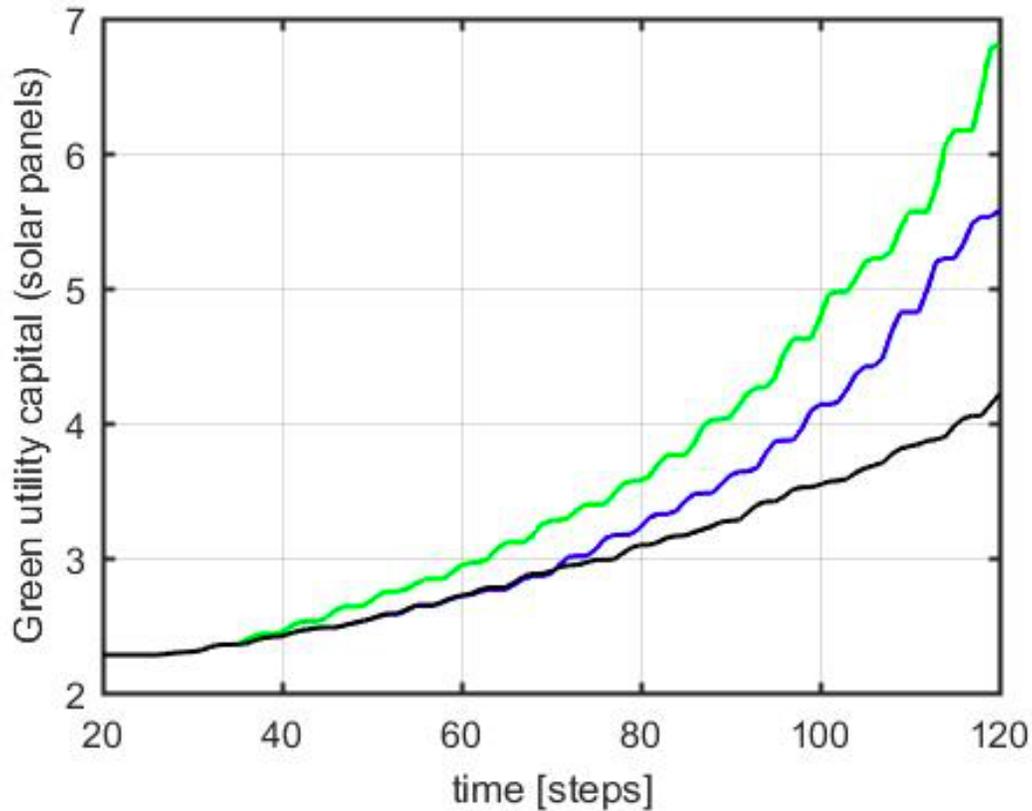
- ***CMP - Conventional monetary policy***: government issues green bonds to support private investments in solar pv, CB sets the interest rate following a Taylor rule
- ***Unconventional monetary policies***: CB purchases at each simulation step a share of outstanding sovereign bonds from BA, which is the sole financial intermediary:
 - ***UQE - Unconditioned QE***: government issues green bonds to support investments in solar pv; CB starts QE accepting sovereign bonds (green/brown) as eligible assets
 - ***GQE - Conditioned green QE***: government issues green bonds to support private investments in solar pv; CB accepts only green sovereign bonds; green capital and consumption goods producers increase production and borrow from BA.

Green bonds market mostly affected in UQE and **GQE**



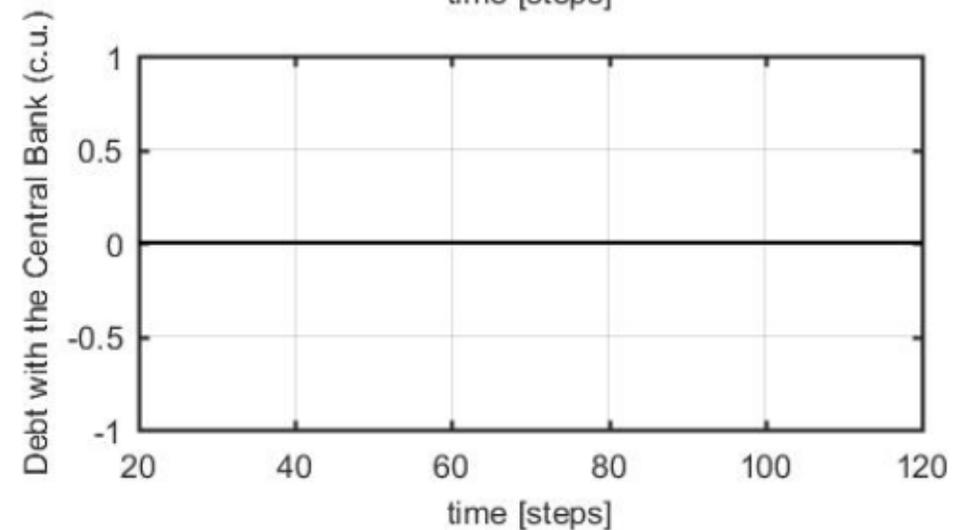
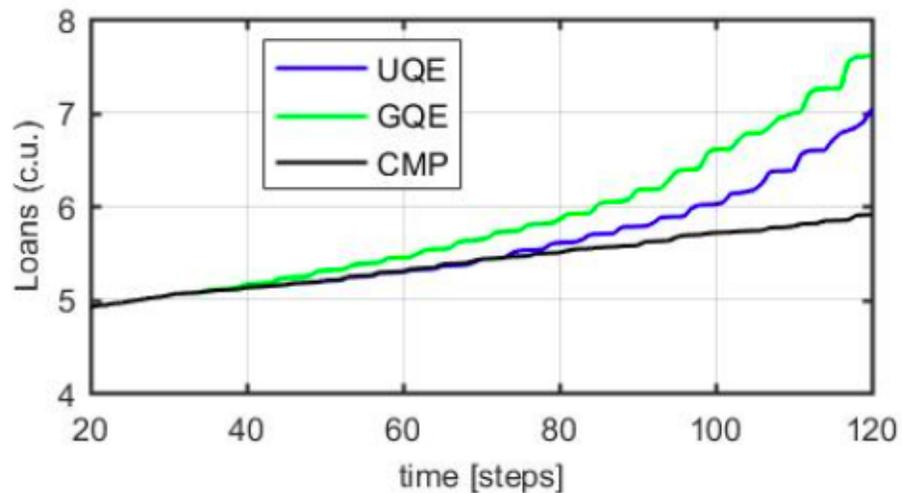
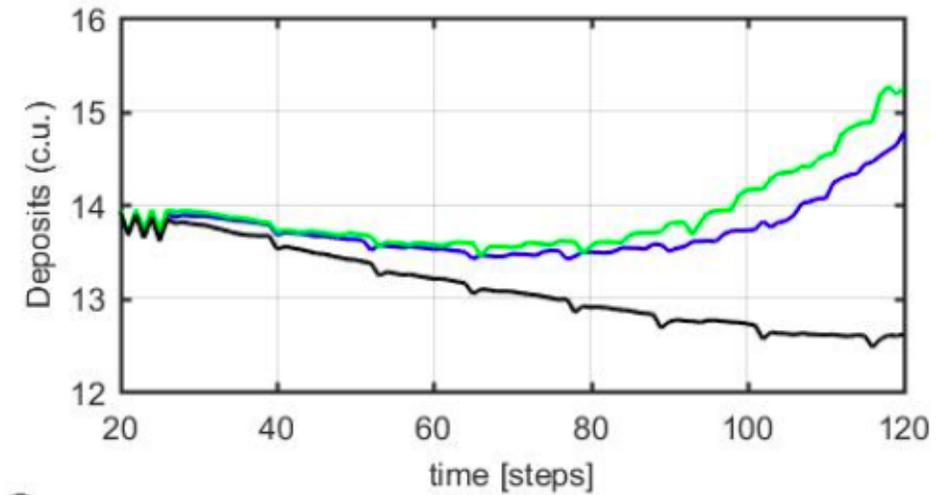
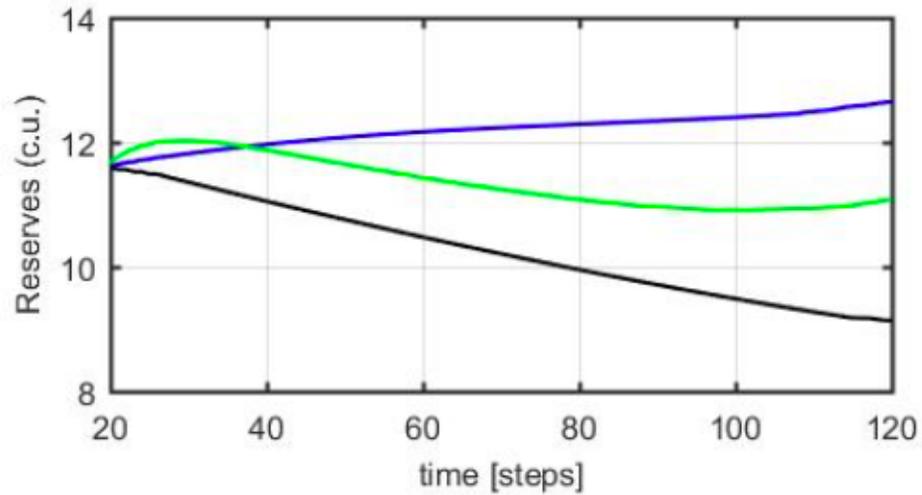
- Increase of green bonds outstanding (left) stronger in **GQE** (due to conditionality)
- Under **GQE** and **UQE**, CB increases its share of green bonds (right) on total, while BA and Hk's shares decrease as a consequence.

GQE pushes low-carbon investments and transition



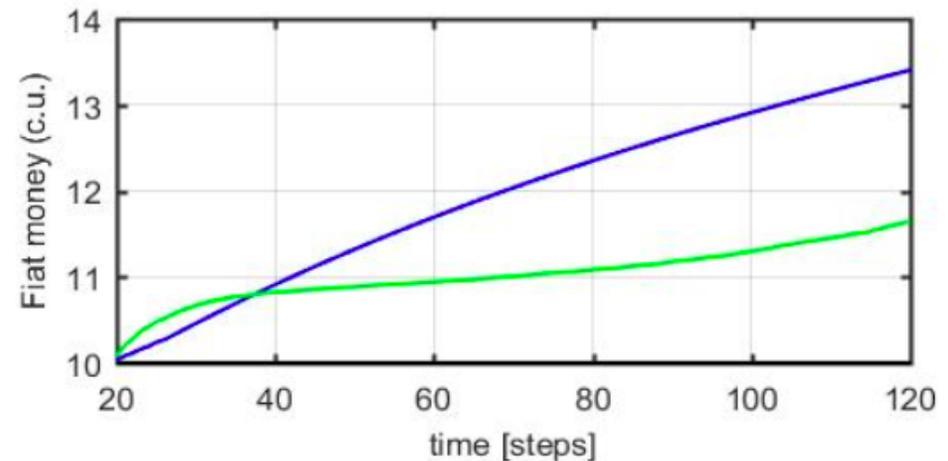
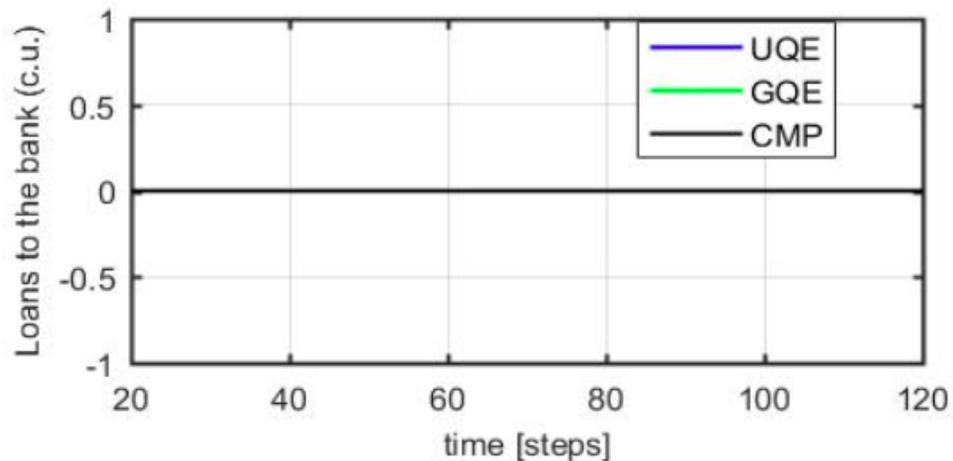
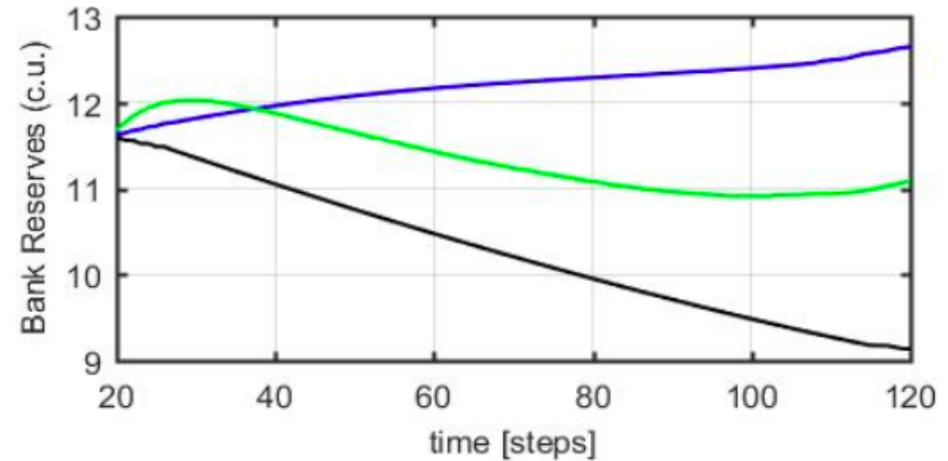
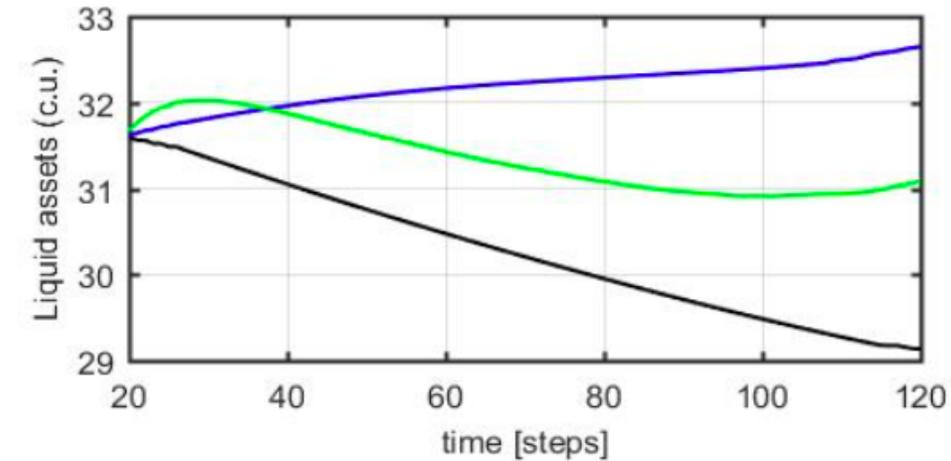
- Moving from CMP to **UQE** and **GQE**: increase in #solar pv, creation of new green jobs and decrease of unemployment
- Labour market: fluctuations depends on those in investment demand, leading to adjustment in consumption goods demand and thus labour demand
- Trend of green utility capital mirrors that of green sovereign bonds' outstanding

Credit market: endogenous money pushed by green investments



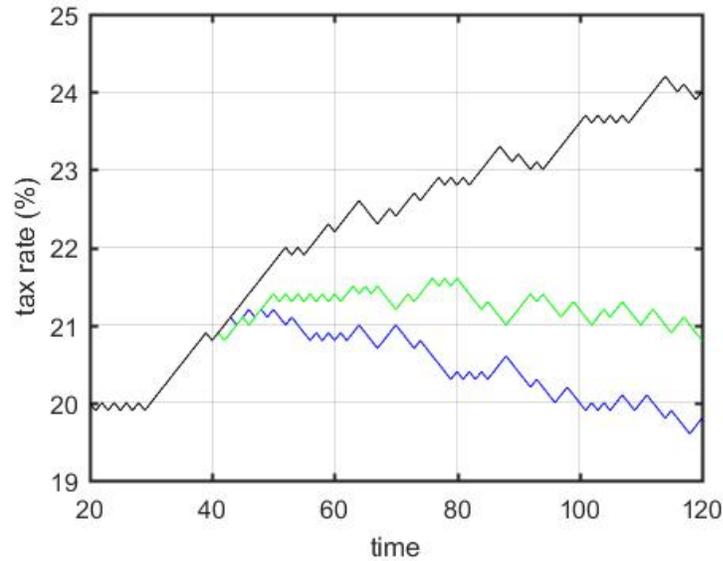
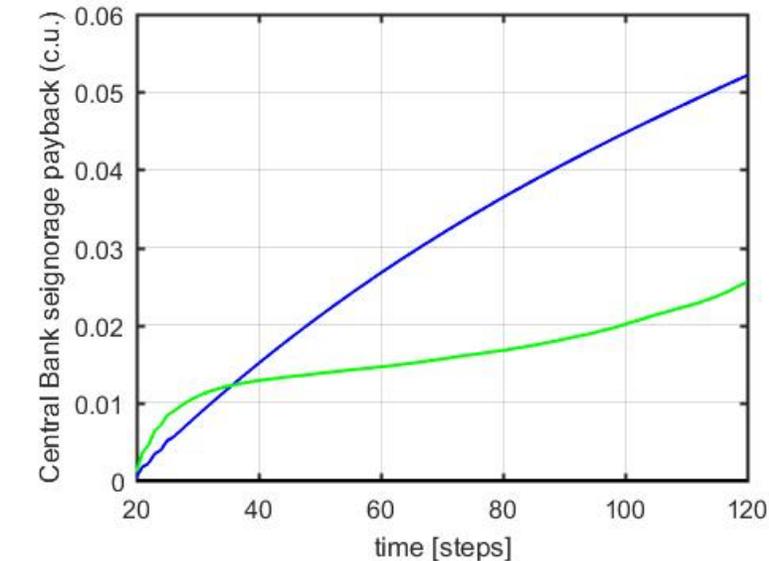
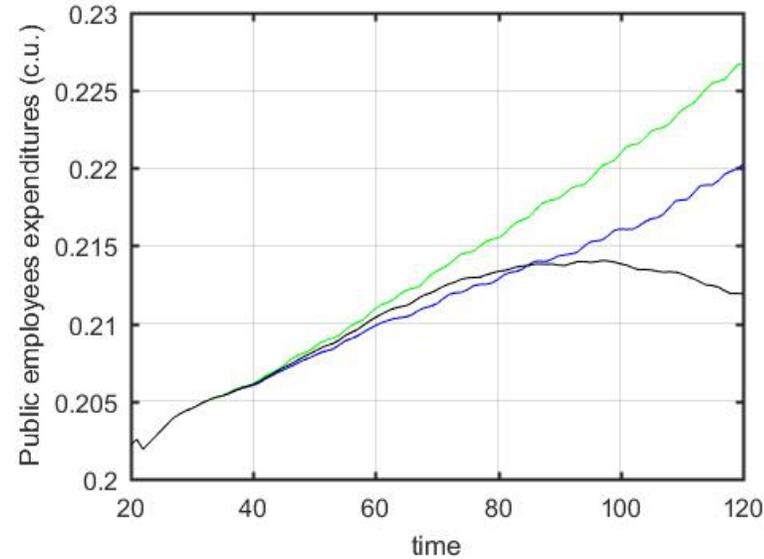
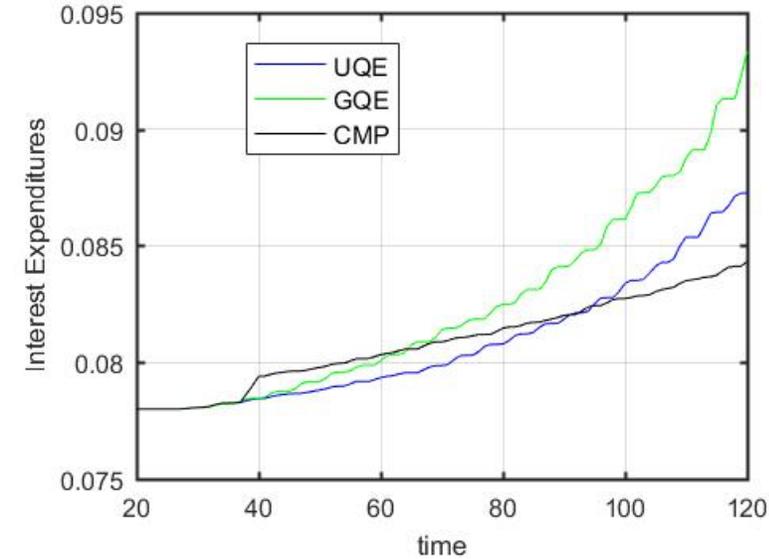
- **GQE** triggers development of green capital goods market and firms' borrowing from BA
- New green loans drive BA's profits up and thus Hk's profits (through dividends channel)
- Wealth concentration in BA increases in **UQE** and **GQE** since BA only intermediary for the QE

Central bank's liquid assets, reserves, fiat money



- CBs liquid assets and reserves increase most in **UQE** because both green/brown bonds are purchased
- Consistently, fiat money increases the most in **UQE**
- In all scenarios, trend of CB's liquid assets mirrors that of reserves

Government's interest expenditures, public employment, taxation



- Seigniorage revenues paid back by CB to the government have positive effects on tax rates (bottom right)
- Highest in UQE because both green/brown bonds coupon.
- *Strong QE helps the government to support green investments and meet its budget balance with negligible distributive effects via taxation*

Conclusion: CB could play a key role in the low-carbon transition

1. Conditioning QE to green sovereign bonds, CB contributes to sustainability and financial stability, this latter being at the core of CBs' mandates.
2. GQE has positive spillovers on the real economy, credit and bonds market:
 - Scales-up renewable energy investments
 - Supports the development of the green bonds market
 - Decreases BA's and households' exposure to stranded assets
3. However, in UQE and GQE unintended distributive effects emerge:
 - Hk and BA better off due to policies' implementing conditions
4. **Moral hazard:** CB expands green bonds' reserves but green bonds' taxonomy still missing
5. These results could not be achieved by means of DSGE modelling approach.

THANK YOU!

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The logo for WU (Wirtschaftsuniversität Wien) features the letters 'WU' in a large, bold, black serif font. The 'W' and 'U' are connected at the top, and the 'U' has a distinctive curved tail.

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Bonds market

- Both brown and green bonds are perpetuities paying a fixed coupon
- Hk and BA reallocate their financial wealth W_a among green (gB), brown bonds (bB), deposits (M), based on desired weights $\hat{\omega}_a^{bB}$, $\hat{\omega}_a^{gB}$, $\hat{\omega}_a^M$ and a risk spread
- Desired weights are based on asset capitalization weights of an ideal portfolio, determined by the number of outstanding bonds and rational bond prices, computed as the PV of the infinite stream of coupons
- Brown/green bonds' prices are set at the equilibrium value (Tobin 1969)
- Bonds' portfolio allocation depends on Hk and BA's preference structure, bonds' yields
- Total financial resources committed to each bond depend also on:
 - *Government's money drawing requests*
 - *Unconventional monetary operations (CB injecting money to purchase bonds)*

QE's effects on CB and BA balance sheets

Before QE

Central bank	
Bonds	Domestic reserves
Loans	Row reserves
Gold	Net worth

Bank	
Bonds	Deposits
Loans	CB loans
Reserves	Net worth

After QE

Central bank	
Bonds	Domestic reserves
Loans	Row reserves
Gold	Net worth

Bank	
Bonds	Deposits
Loans	CB loans
Reserves	Net worth

- CB purchases sovereign bonds from BA, and pays the BA by creating reserves, thus increasing its assets and liabilities *by equal amounts*
- BA purchase the sovereign bonds (green/brown) from the government and sell them to the CB, *modifying the composition of its assets side*:
 - the bonds' value sold to the CB is replaced by *an equal amount* of reserves deposited at the CB