Carbon Taxes and Tariffs, Financial Frictions, and International Spillovers

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Introduction :
Macroeconomics and the environment in the SR

"From a regulator's perspective the point is not that a reassessment of values is inherently unwelcome. It is not. Capital should be allocated to reflect fundamentals, including externalities. But a wholesale reassessment of prospects, especially if it were to occur suddenly, could potentially destabilise markets, spark a pro-cyclical crystallisation of losses and a persistent tightening of financial conditions. In other words, an abrupt resolution of the tragedy of horizons is in itself a financial stability risk." Carney (2015)

Introduction:
SR Macro policy and the environment

Carney, 2022 "Climate Policy is Macro Policy"

"[...] climate change is now macro critical, and climate policy has become the third pillar of macro policy. The conduct of climate policy will directly impact the efficacy of fiscal and monetary policies, and its interactions with the financial system will heavily influence the pace of job and wealth creation. "

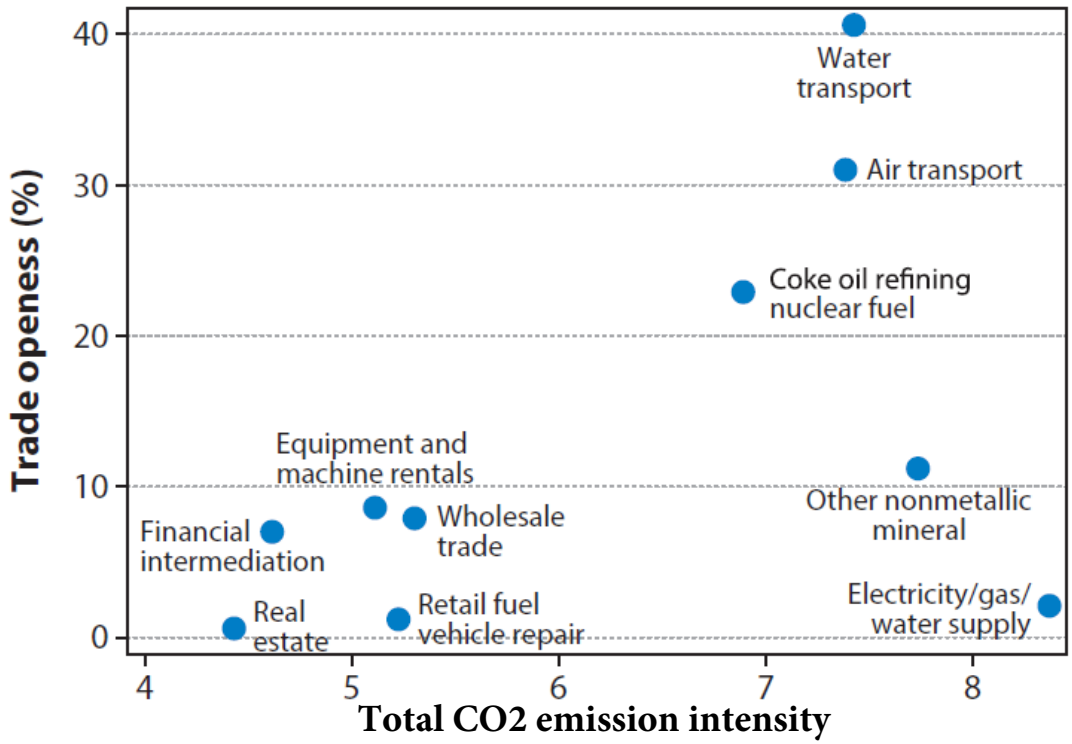
Motivation (1)

- Climate risks are among the main concerns for central banks & financial regulators
- Climate-policy-driven 'transition risk'
  - Financial intermediaries exposed to carbon-intensive sectors
  - Risk of a recession from aggressive climate policy
  - Existing E-DSGE literature: transition risk in closed economies

    (e.g., Carattini, Heutel, Melkadze 2021, Diluiso et al. 2021)

Motivation (2)

- Financial intermediaries operate globally
  - Cross-border lending important for international transmission of shocks
- Climate policies have an international dimension



5 most and 5 least emitting industries.
Emission intensity: (log) metric tCO2 per million dollars of output in 2009.
Openness: international trade divided by gross output.

Source: Fontagné and Schubert (2023)

This paper: Transition risk with international spillovers

- Study how ambitious climate policy affects the economy
- Focus on the role of financial frictions and cross-border spillovers in shaping these effects
- Implications for macroprudential regulation to manage transition risk
  - e.g., brown penalizing and green supporting factors in bank capital requirements

This paper

Two-country E-DSGE model:

- Polluting and non-polluting sectors
- Financial and trade linkages between countries
- Banks subject to financial frictions $\rightarrow$ credit supply limited by banks' net worth (Gertler & Kiyotaki 2010)

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Climate policy scenarios:

- Unilateral carbon tax in the domestic economy
- Unilateral carbon tax and carbon border adjustment in the domestic economy
- Global carbon price through harmonized carbon taxes

Macropru taxes/subsidies (differentiated) on banks' assets

Related literature

- Open economy with incomplete markets/financial frictions:

  Baxter & Crucini (1995), Corsetti et al. (2008), Devereux & Yetman (2010), Dedola & Lombardo (2012) Dedola et al. (2013), Kollman (2013), Kalemli-Ozcan et al. (2013), Cesa-Bianchi et al. (2018), Devereux & Yu (2020), Miranda-Agrippino & Rey (2020), Hale et al. (2020)

- Transition risk, stranded assets, financial policies:

  Batten, Sowerbutts & Tanaka (2016), van der Ploeg & Rezai (2019, 2020), Rozenberg et al. (2020), Campiglio & van der Ploeg (2022), Ferrari & Nispi Landi (2021), Fried et al. (2021), Carattini et al. (2021), Giovanardi et al. (2021), Abiry et al. (2022), Diluiso et al. (2022)

- Environmental DSGE models:

  Fischer & Springborn (2011), Heutel (2012), Annicchiarico & Di Dio (2015), Gibson & Heutel (2020), Annicchiarico et al. (2022), Ferrari & Pagliari (2022), Ernst et al. (2022), among others

Model: Overview

Two countries - Home & Foreign - populated by

- Households
  - Consume, save (deposits), supply labor
- Financial intermediaries
  - Collect deposits, lend to Home & Foreign non-financial firms
- Non-financial firms in two sectors
  - 'brown' (polluting); 'green' (non-polluting)
  - 'tradable'
- Capital producers
- Government
  - Implements policies

Model: Households

- A representative HH's preferences over consumption and labor hours:

$$U(C_t, L_t) = \frac{C_t^{1-\gamma}}{1-\gamma} - \varpi \frac{L_t^{1+\xi}}{1+\xi},$$

- The consumption composite C_t is

$$C_t = \left[a_b^{1-\phi} C_{b,t}^{\phi} + (1-a_b)^{1-\phi} C_{g,t}^{\phi} \right]^{\frac{1}{\phi}}, \ \phi < 1,$$

where

$$C_{j,t} \equiv \left[\theta_j^{1-\rho_j} (C_{j,t}^h)^{\rho_j} + (1-\theta_j)^{1-\rho_j} (C_{j,t}^f)^{\rho_j} \right]^{\frac{1}{\rho_j}}, \ \rho_j < 1, \ j \in \{g, b\}.$$

- The labor hours $L_t = \left[L_{b,t}^{\eta} + L_{g,t}^{\eta} \right]^{\frac{1}{\eta}}$.

Model : Households (optimization problem)

- The household maximizes

$$\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t U\left(C_t, L_t\right) \right\},$$

subject to the flow budget constraint,

$$\begin{aligned} & P^h_{b,t} C^h_{b,t} + P^h_{g,t} C^h_{g,t} + \left(P^f_{b,t} + \tau_{cba,t} \right) C^f_{b,t} + P^f_{g,t} C^f_{g,t} + D_t \\ & = W_{b,t} L_{b,t} + W_{g,t} L_{g,t} + R_{t-1} D_{t-1} + \Pi_t + div_t + \Xi_t, \end{aligned}$$

Model: Non-financial firms

- Perfectly competitive firms with Cobb-Douglas technology
- Emissions are a by-product of brown production
- Can use an abatement technology
- Firms rely on loans from (global) banks to finance capital purchases
- Firms decide upon capital and labor inputs, and abatement to maximize profits
  - Firms are subject to carbon tax

▸ more

Model: Banks

- (Home) Banks combine net worth and deposits to fund loans to home and foreign firms
- Flow-of-funds constraint:

$$\sum_{j \in \{b,g\}} \left(Q_{j,t} S_{j,t} + Q^*_{j,t} S^f_{j,t} \right) = D_t + N_t$$

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- Net worth at time t:

$$N_t = \sum_{j\in\{b,g\}} \left[R_{j,t} Q_{j,t-1} S_{j,t-1} + R^*_{j,t} Q^*_{j,t-1} S^f_{j,t-1} \right] - R_{t-1} D_{t-1}$$

- $R_{j,t}$, $R^*_{j,t}$ - returns on assets; R_{t-1} - interest on deposits

▸ more

Model: Financial friction

- Agency problem: bank may divert fraction κ of assets
  (Gertler & Kiyotaki 2010, Gertler & Karadi 2011)

  $\Longrightarrow$ Financial constraint:

$$\sum_{j \in \{b,g\}} \left(Q_{j,t} S_{j,t} + Q^*_{j,t} S^f_{j,t} \right) \leq \frac{\varphi_t}{\kappa} N_t$$

- Credit supply constrained by banks' net worth
- Shocks to the economy get amplified through fluctuations in banks' equity

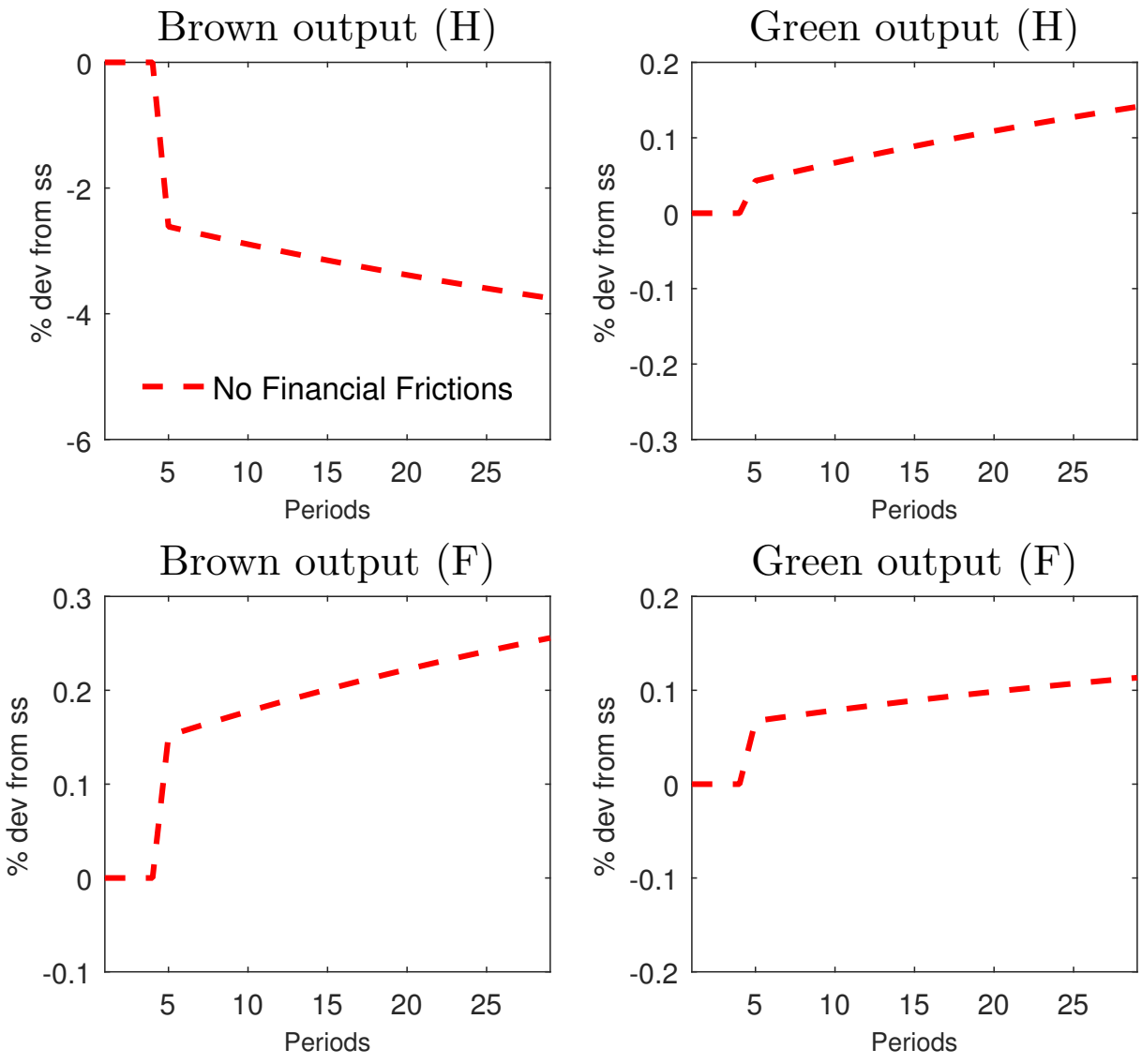
Model: Calibration

- Countries: United States and European Union (for the main calibration)
- Standard International-RBC parameters
- Financial sector parameters (target banks' leverage ratio, sectoral & cross-border exposures, credit spreads)
- Environmental parameters (match sectoral emissions intensities in the data)

Results: Home carbon tax

- Unexpected introduction of \$80 per ton tax on CO2 in Home country
  - In line with recommendations from Stiglitz et al. (2017), IMF (2019); Lower bound for recent estimates of the SCC
- Start in the baseline (no tax) steady state, hitting the Home country with a permanent carbon tax in period 5
- Compare models with and without financial frictions

Results: Home carbon tax



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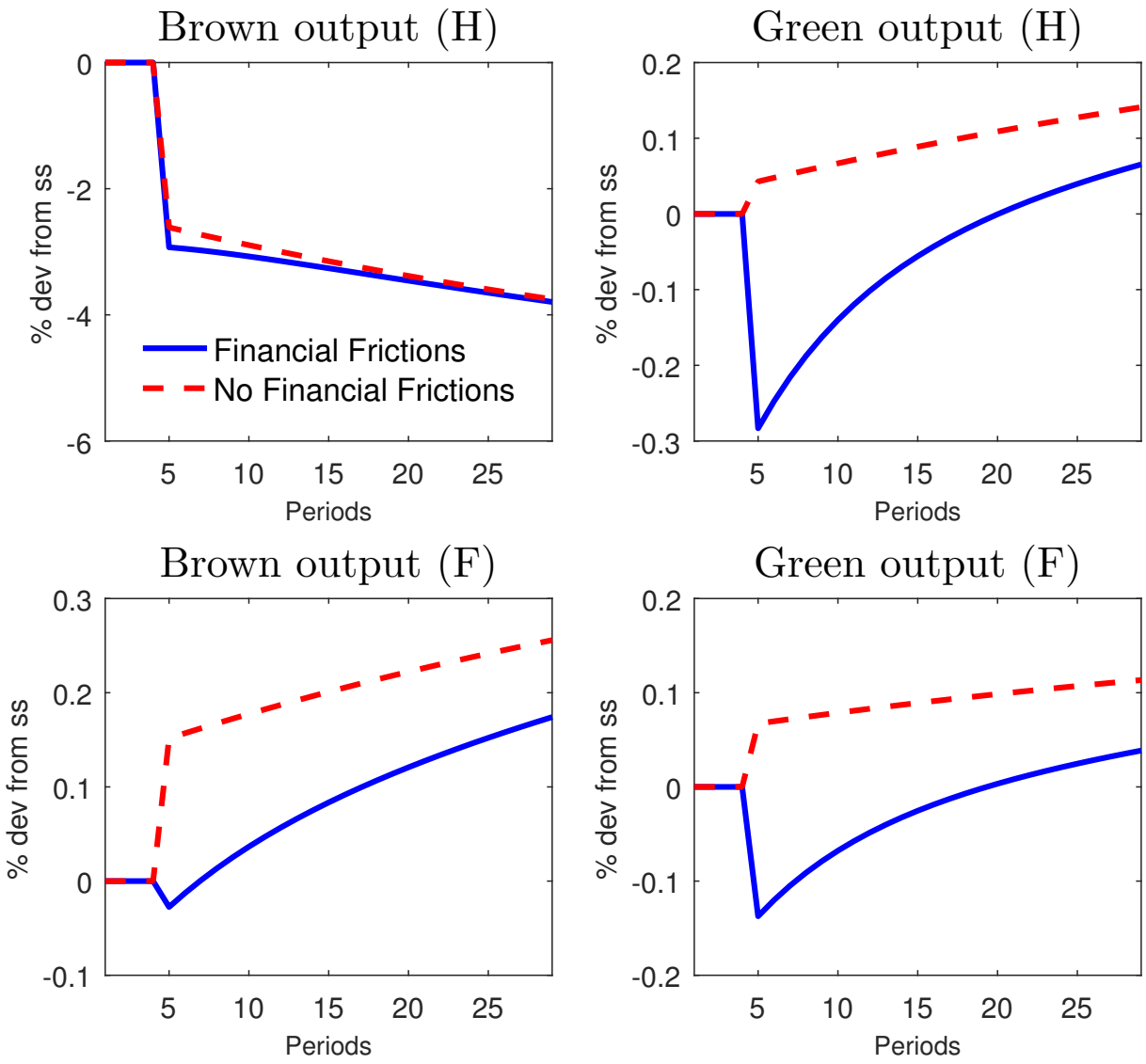

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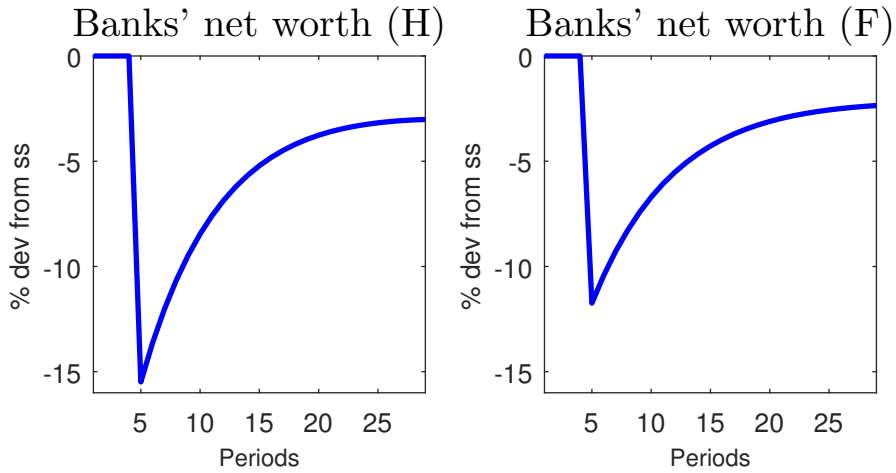
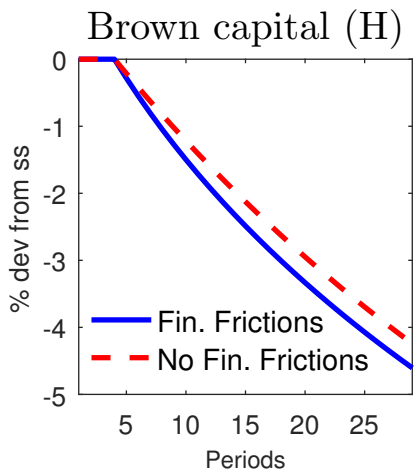
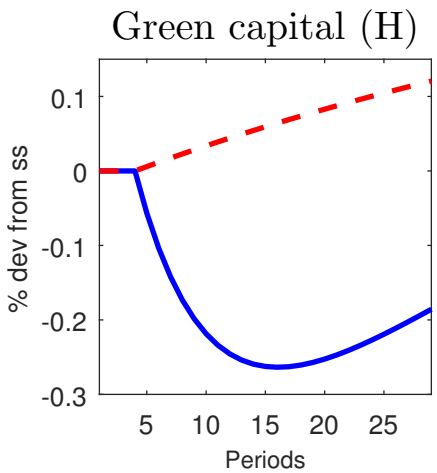
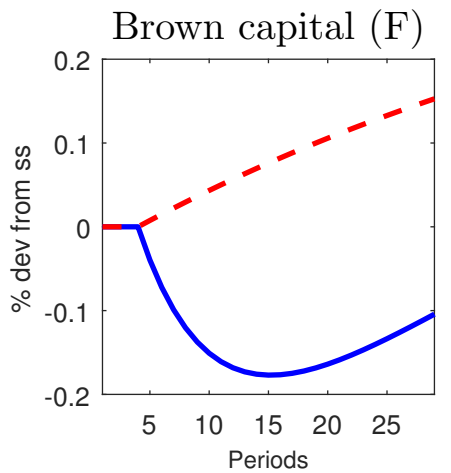
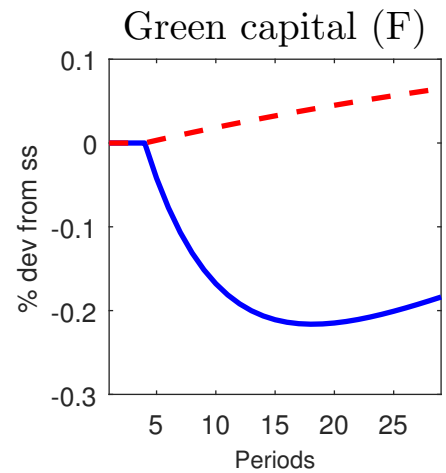










▸ more

Results: Home carbon tax

- Without Financial Frictions (FF) capital flows into green sectors and into Foreign country
- With FF, domestic transition risk transmits to the foreign country through cross-border bank lending
- With FF, there is still carbon leakage (albeit smaller)

▸ global tax

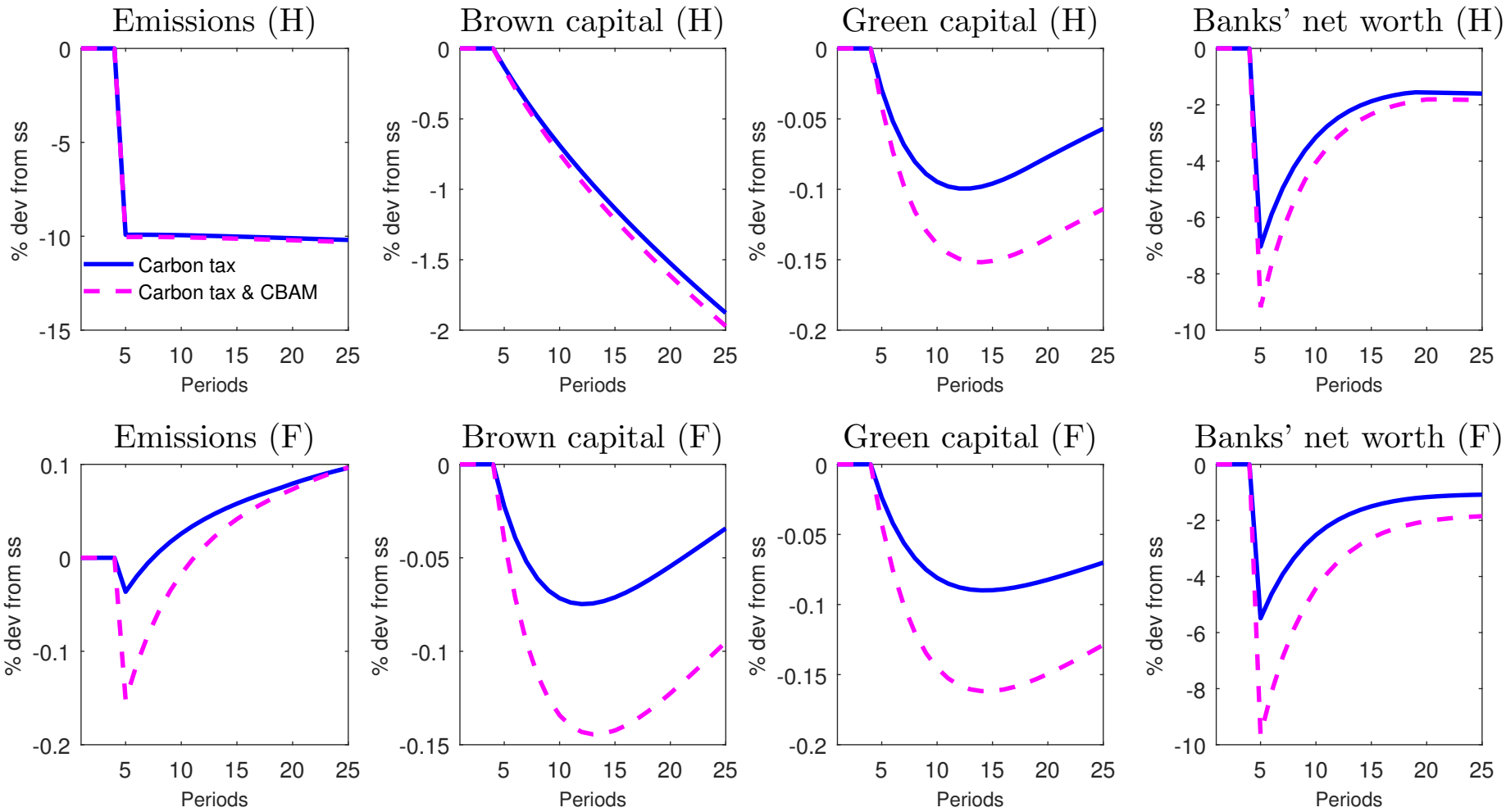
Carbon Border Adjustment Mechanism (CBAM)

- CBAM is modeled as an import tariff on Foreign polluting goods

$$P^h_{b,t} C^h_{b,t} + P^h_{g,t} C^h_{g,t} + \left(P^f_{b,t} + \tau_{cbam,t}\right) C^f_{b,t} + P^f_{g,t} C^f_{g,t} + D_t$$
$$= W_{b,t} L_{b,t} + W_{g,t} L_{g,t} + R_{t-1} D_{t-1} + \Pi_t + div_t + \Xi_t,$$

- no export rebate

Results: Home carbon tax & CBAM



Results: Home carbon tax & CBAM

- CBAM reduces leakage, although makes recession more severe at Home
  - Banks are affected negatively (through the return on foreign dirty capital) and cut back on credit supply to Home firms.
- Sensitive to the Armington elasticity
  - A small elasticity generates few substitution out of domestic consumption of foreign brown goods
  - Large proceeds of the CBAM favor all goods

Macroprudential policy

- Macroprudential policy modeled as steady-state tax (or subsidy) on banks' assets:

$$\sum_{j \in \{b,g\}} \left[(1+\tau_j) Q_{j,t} S_{j,t} + (1+\tau_j^f) Q_{j,t}^* S_{j,t}^f \right] = N_t + D_t$$

- Consider a tax on brown & subsidy on green loans to reduce banks' SS exposure to brown assets
  - Similar to brown penalizing & green supporting factors in capital requirements

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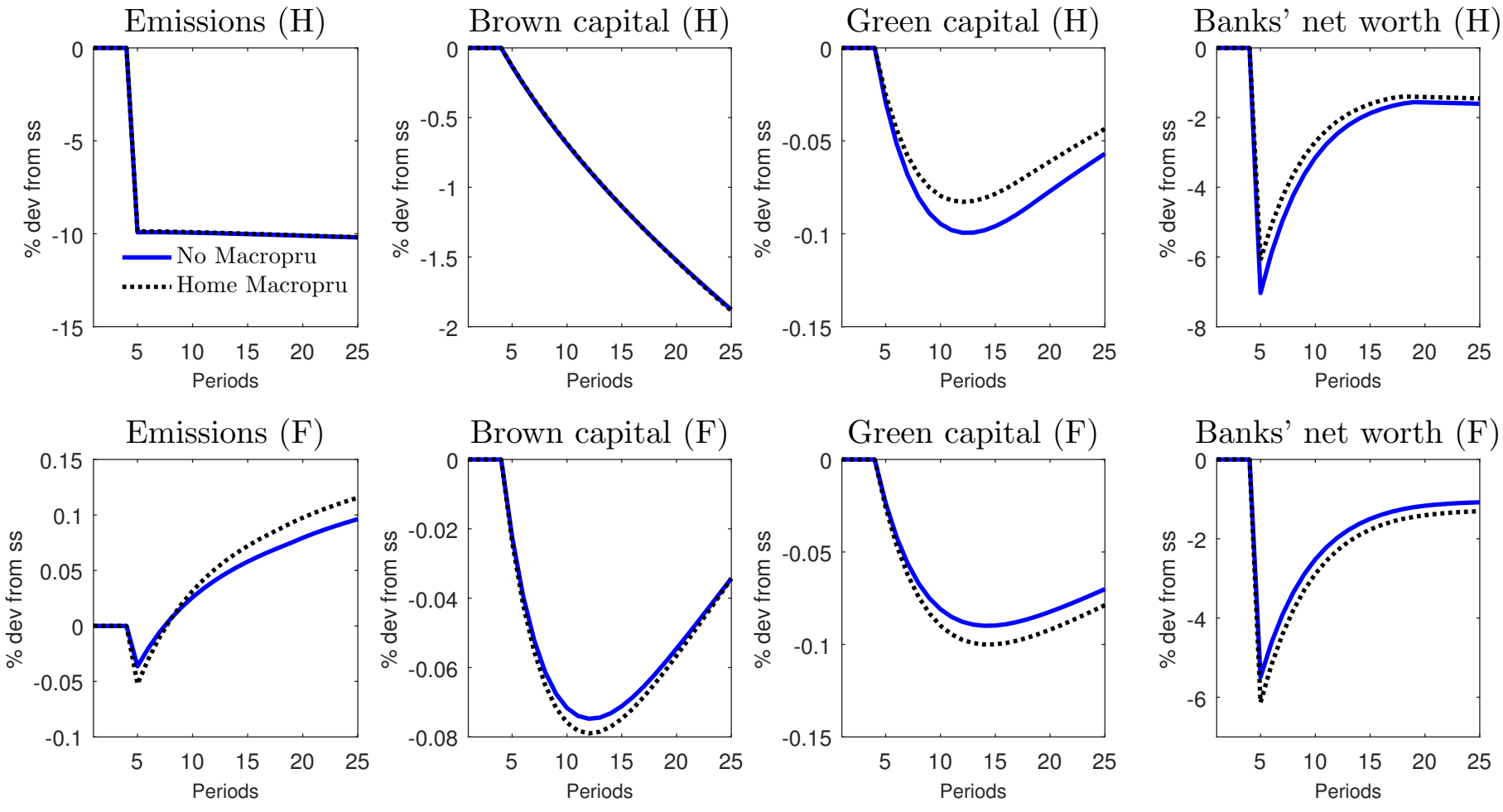
- Two policy scenarios:
  1. Home carbon tax + Home macroprud
  2. Home carbon tax + macroprud in both countries

Results: Home carbon tax with Home Macroprud

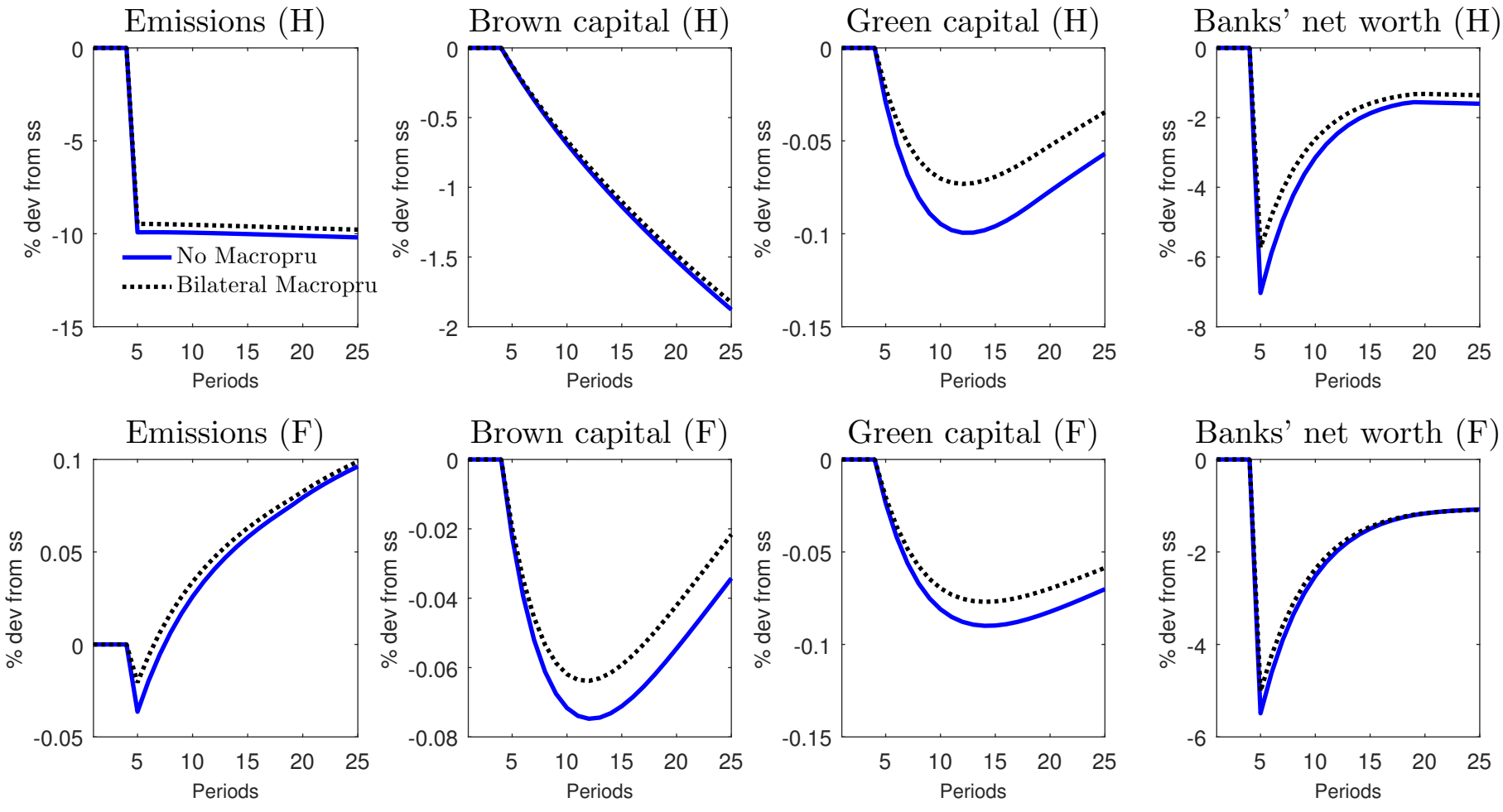


Results: Home carbon tax with Home Macroprud

- Domestic macroprudential policy mitigates transition risk at Home
- However, the negative spillovers to Foreign country become worse
  - Foreign banks hold larger share of brown assets

    $\Rightarrow$ incur larger equity losses in response to Home carbon tax shock

Results: Home carbon tax with bilateral Macroprud



Conclusion & work in progress

- Cross-country financial linkages important for understanding international spillovers of domestic climate policies
- In such a setting, non-standard impact of CBAM
- Macroprudential policies can mitigate transition risk and pave the way for ambitious climate action
  - Carbon tax+CBAM
  - Global carbon tax
- In progress:
  - Investment in abatement
  - Real exchange rate
  - Damages in a decentralized model (only to compute welfare)
  - Developing economies: other financial system

Appendix

Model: Non-financial firms 1 Back

- Perfectly competitive firms with Cobb-Douglas technology,

$$Y_{j,t} = A_{j,t} K_{j,t-1}^{\alpha_j} L_{j,t}^{1-\alpha_j}, \ \ j \in \{b, g\}$$

- Letting $\mu_{j,t}$ denote the fraction of emissions abated, emissions in sector j are given by

$$e_{j,t} = (1 - \mu_{j,t}) \epsilon_j Y_{j,t}, \ \ j \in \{b, g\}, \tag{1}$$

where parameter $\epsilon_j \geq 0$ controls the sector-specific emissions intensity, absent abatement effort. Abating $\mu_{j,t}$ fraction of emissions costs

$$Z_{j,t} = \chi_1 \mu_{j,t}^{\chi_2} Y_{j,t}, \ \ \chi_1 > 0, \chi_2 > 1, \ \ j \in \{b, g\}. \tag{2}$$

- Firms rely on loans from (global) banks to finance capital purchases,

$$Q_{j,t} K_{j,t} = Q_{j,t} S_{j,t} + Q_{j,t} S_{j,t}^{h*}, \ \ j \in \{b, g\}$$

Model: Non-financial firms 2

- Firms decide upon abatement, capital and labor inputs to maximize profits
  - Polluting firms subject to carbon tax $\tau_{e,t}$
- State-contingent return on capital (= payment on loans):

$$R_{j,t} = \frac{\alpha_j \left[P^h_{j,t} - \tau_{e,t}(1-\mu_{j,t})\epsilon_j - P^h_{j,t}\chi_1\mu^{\chi_2}_{j,t}\right] \frac{Y_{j,t}}{K_{j,t-1}} + (1-\delta_j)\, Q_{j,t}}{Q_{j,t-1}}, j \in \{b, g\}.$$

- Firm's labor FOC:

$$W_{j,t} = (1-\alpha_j)\left[P^h_{j,t} - \tau_{e,t}(1-\mu_{j,t})\epsilon_j - P^h_{j,t}\chi_1\mu^{\chi_2}_{j,t}\right]\frac{Y_{j,t}}{L_{j,t}}, j \in \{b, g\}.$$

Appendix: Bank's optimization problem

Back

- Exogenous i.i.d. bank exit probability $1-\pi$
- Upon exit a bank transfers its retained earnings to the household (e.g., dividends)
- The bank chooses $D_{i,t}, (S_{j,i,t}, S^f_{j,i,t})_{j\in\{b,g\}}$ to maximize the discounted value of the terminal dividends:

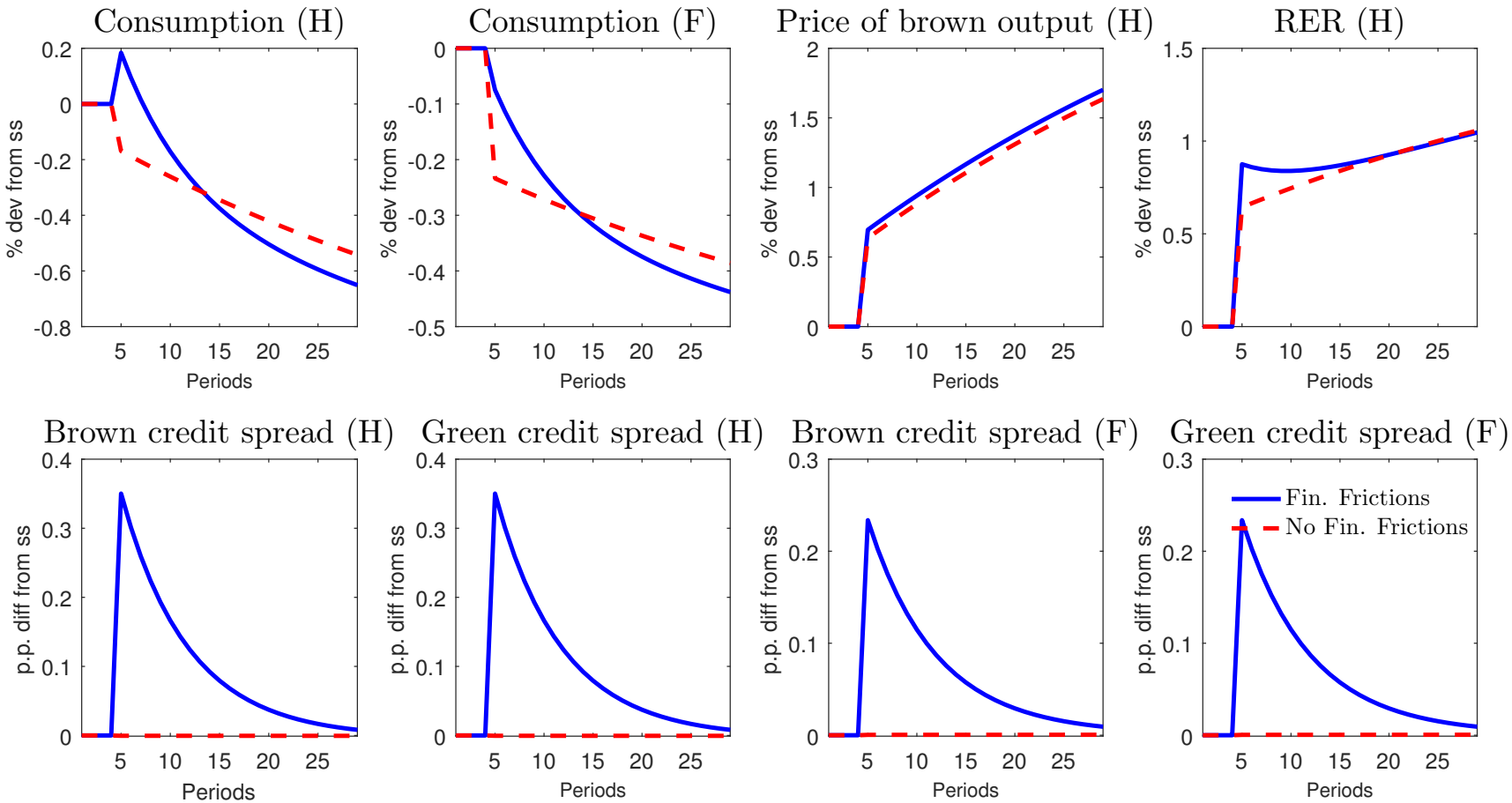
$$V_{i,t} = \max E_t \left\{ (1-\pi) M_{t,t+1} N_{i,t+1} + \pi M_{t,t+1} V_{i,t+1} \right\},$$

subject to the balance sheet constraint, leverage constraint, the evolution of net worth

- Value function linear in bank's net worth $\Rightarrow$ easy aggregation of the banking sector

Appendix: Home carbon tax

Back



Appendix: Carbon tax in both countries

Back