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Government Debt Deleveraging in the EMU

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Alexandre Lucas Cole
(co-authored with Chiara Guerello and Guido Traficante)

LUISS Guido Carli (Rome)

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Outline

Introduction - Motivation

- After the recent global crisis, there has been a great discussion on the future of European economic integration and on **the role of the austerity measures imposed by sovereign debt reduction**.

- Given a situation of high government debt in most EMU countries and **a request by the European Commission to reduce government debt positions to 60% of GDP**, finding the best way and timing for deleveraging is an important issue.

- **We evaluate the stabilization properties and welfare implications of different deleveraging schemes and instruments**, under alternative scenarios for fiscal policy coordination, bringing to policy conclusions for the proper government debt management in a Currency Union.

Introduction - Strategy and Main Results

We build a Two-Country DSGE model of a Currency Union, with a **debt-elastic government bond spread** and **incomplete international financial markets**.

Our main findings are:

- **Coordinating by reducing international demand imbalances** and creating some form of fiscal union across countries provides more stabilization when reducing government debt.
- **Using distortionary taxes** is the most stabilizing way to reduce government debt.
- By **reducing government debt more gradually over time** one can achieve greater stabilization.
- **Government debt should be reduced less during recessions and liquidity traps**.

Introduction - Literature

We follow two strands of literature:

- **Open Economy – Currency Union**: Silveira (2006), Galí (2009), Ferrero (2009), Hjortsø (2016), Cole, Guerello and Traficante (2016).
- **Debt Deleveraging**: Coenen, Mohr and Straub (2008), Forni, Gerali and Pisani (2010), Cogan et al. (2013), Romei (2015).

We focus on:

- **Public debt reduction rule** and deleveraging shocks in the Periphery.
- **Targeting rules for fiscal policy**, to allow governments to coordinate.

Outline

Households

Each Household in country H seeks to **maximize the present-value utility**:

$$E_0 \sum_{t=0}^{\infty} \beta^t \xi_t \left[\frac{(C_t^i)^{1-\sigma} - 1}{1-\sigma} - \frac{(N_t^i)^{1+\varphi}}{1+\varphi} \right] \tag{2.1}$$

subject to the following sequence of budget constraints:

$$\int_0^h P_{H,t}(j) C_{H,t}^i(j)\, dj + \int_h^1 P_{F,t}(j) C_{F,t}^i(j)\, dj + D_t^i + B_{H,t}^i + B_{F,t}^i$$

$$\leq \frac{D_{t-1}^i}{\mathcal{Q}_{t-1,t}} + B_{H,t-1}^i(1+i_{t-1}) + B_{F,t-1}^i(1+i_{t-1}^*)(1-\delta_{t-1}) + (1-\tau_t^w) W_t N_t^i + T_t^i + \Gamma_t^i + \mathcal{I}_t^{*i} \tag{2.2}$$

where $B_{H,t}^i$ are government bonds issued by country H which yield a return given by i_{t-1}, while $B_{F,t}^i$ are government bonds issued by country F which yield a return i_{t-1}^*, while $\delta_t \in [0,1]$ is a **transaction cost for households in country H on purchases of government bonds issued by country F**, given by:

$$\delta_t \equiv (1-\rho_\delta)\delta^B \left(\frac{B_{t-1}^{*G}}{P_{H,t-1}^* Y_{t-1}^*} - \frac{B^{*G}}{P_H^* Y^*} \right) + \rho_\delta \delta_{t-1} \tag{2.3}$$

where $\frac{B_{t-1}^{*G}}{P_{H,t-1}^* Y_{t-1}^*}$ is the overall real government debt-to-GDP for country F. More Details

International Assumptions

C_t^i is a **composite index for private consumption** defined by:

$$C_t^i \equiv \left[(1-\alpha)^{\frac{1}{\eta}}\left(C_{H,t}^i\right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}}\left(C_{F,t}^i\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{2.4}$$

If $1-\alpha > h$ there is **home bias** in consumption in country H, because the **share of consumption** of domestic goods **is greater than the share of production** of domestic goods.

- $\alpha \in [0,1]$ is a measure of **openness of the economy to international trade**.
- $(1-\alpha)$ is a measure of the degree of **home bias** in consumption.

The **terms of trade** are defined as the price of foreign goods in terms of home goods:

$$\mathcal{S}_t \equiv \frac{P_{F,t}}{P_{H,t}} \tag{2.5}$$

Although deviations from *Purchasing Power Parity (PPP)* may arise because of home bias in consumption, we assume that the **Law of One Price (LOP)** holds for every single good j:

$$P_{H,t}(j) = P_{F,t}^*(j) \qquad \text{and} \qquad P_{F,t}(j) = P_{H,t}^*(j) \tag{2.6}$$

Incomplete International Financial Markets

Households can trade a complete set of one-period state-contingent claims only within their own country. **Households in country H can purchase one-period bonds issued by both countries' governments**, while **households in country F can only purchase one-period bonds issued by their own country's government**.

From the no-arbitrage condition on bonds for households in country H:

$$\frac{1}{(1+i_t^*)(1-\delta_t)} = \frac{1}{1+i_t} = E_t\{\mathcal{Q}_{t,t+1}\} = \beta E_t\left\{\frac{\xi_{t+1}}{\xi_t}\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\frac{1}{\Pi_{t+1}}\right\} \quad (2.7)$$

which shows **there is no full international risk-sharing**.

The interest rate paid on government bonds issued by country F is then given by:

$$1+i_t^* = \frac{1+i_t}{1-\delta_t} \quad (2.8)$$

and is increasing in the transaction cost δ_t, or in the government bond spread $(1+i_t^*)\delta_t$, other than increasing in the interest rate set by the central bank and paid on government bonds issued by country H, i_t.

Firms

In country H there is a continuum of Firms indexed by $j \in [0, h)$, each producing a differentiated good with the same technology represented by the following **production function**:

$$Y_t(j) = A_t N_t(j) \tag{2.9}$$

where A_t represents the country-specific **level of technology**.

Firm j's **period t profits net of taxes** in country H are given by:

$$\Gamma_t(j) = (1 - \tau_t^s) P_{H,t}(j) Y_t(j) - W_t N_t(j) \tag{2.10}$$

where τ_t^s is the marginal **tax rate on firm sales**.

- Following Calvo (1983), **each firm may reset its price with probability** $1-\theta$ **in any given period**.
- The **average duration of a price** is given by $(1-\theta)^{-1}$
- θ can be seen as a natural **index of price stickiness** for country H.
- The index of **price stickiness in the two countries can differ**: $\theta \neq \theta^*$

More Details

Central Bank and Monetary Policy

Monetary policy follows an **Inflation Targeting regime** of the kind:

$$\beta(1+i_t) = \left(\frac{\Pi_t^U}{\Pi^U}\right)^{\phi_\pi(1-\rho_i)} [\beta(1+i_{t-1})]^{\rho_i} \qquad \Pi_t^U \equiv (\Pi_t)^h (\Pi_t^*)^{1-h} \tag{2.11}$$

where ϕ_π represents the **responsiveness of the interest rate to inflation** and ρ_i is a measure of the persistence of the interest rate.

We also consider **the case of the Zero Lower Bound constraint**:

$$i_t = \max\{\tilde{i}_t, 0\} \quad \beta(1+\tilde{i}_t) = \left(\frac{\Pi_t^U}{\Pi^U}\right)^{\phi_\pi(1-\rho_i)} \left[\beta(1+\tilde{i}_{t-1})\right]^{\rho_i} \tag{2.12}$$

where $\tilde{i}_t$ is the shadow interest rate, which is the unconstrained level of the nominal interest rate.

Government and Fiscal Policy

In country H **the government finances a stream of public consumption G_t and transfers $\tilde{T}_t$ subject to the following sequence of budget constraints**:

$$G_t + \tilde{T}_t + i_{t-1}\frac{\tilde{B}^G_{t-1}}{\Pi_{H,t}} = \tau^s_t Y_t + \tau^w_t MC_t d_t Y_t + \tilde{B}^G_t - \frac{\tilde{B}^G_{t-1}}{\Pi_{H,t}} \qquad (2.13)$$

- $\tilde{B}^G_t$ is overall **real government debt** in country H
- **the left hand side represents current government expenditure and interest payments on outstanding debt**.
- **the right hand side represents government financing of that expenditure** through taxes and the possible variation of government debt.

Government consumption is characterized by complete home bias.

Pure Currency Union - Distortionary Tax Scenario

Fiscal policy **chooses government consumption to stabilize the output gap countercyclically**:

$$\frac{G_t^*}{G^*} = \left(\frac{Y_t^*}{Y^*}\right)^{-\psi_y^*(1-\rho_g^*)} \left(\frac{G_{t-1}^*}{G^*}\right)^{\rho_g^*} e^{\varepsilon_t} \tag{2.14}$$

while keeping real transfers constant and **varying equally the tax rates on labour income and firm sales to deleverage its government debt and to finance the remaining government expenditure**:

$$\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}_t^{*G} = \gamma_t^* \left(\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}^{*G}\right) \qquad \tilde{T}_t^* = \tilde{T}^* \tag{2.15}$$

$$\tau_t^{*w} - \tau^{*w} = \tau_t^{*s} - \tau^{*s} \tag{2.16}$$

where $\psi_y^* \geq 0$ represents the **responsiveness of government consumption to variations of the output gap** and $\gamma_t^* \in [0,1]$ is the **desired share of reduction per period of the excess real government debt with respect to steady state**.

Pure Currency Union - Transfer Scenario

Fiscal policy **chooses government consumption to stabilize the output gap countercyclically**:

$$\frac{G_t^*}{G^*} = \left(\frac{Y_t^*}{Y^*}\right)^{-\psi_y^*(1-\rho_g^*)} \left(\frac{G_{t-1}^*}{G^*}\right)^{\rho_g^*} e^{\varepsilon_t} \tag{2.17}$$

while **using real transfers $\tilde{T}_t^*$ to deleverage its government debt**:

$$\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}_t^{*G} = \gamma_t^* \left(\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}^{*G}\right) \tag{2.18}$$

and **varying equally the tax rates on labour income and firm sales to finance the remaining government expenditure**:

$$\tau_t^{*w} - \tau^{*w} = \tau_t^{*s} - \tau^{*s} \qquad (\tau_t^{*s} + \tau_t^{*w} MC_t^* d_t^*) Y_t^* - (\tau^{*s} + \tau^{*w} MC^*) Y^* = G_t^* - G^* \tag{2.19}$$

Consumption Scenario

Coordinated Currency Union - Transfer Scenario

Fiscal policy **chooses government consumption to stabilize its real net exports gap procyclically**:

$$\frac{G_t^*}{G^*} = \left(\frac{\widetilde{NX}_t^*}{\widetilde{NX}^*}\right)^{\psi_{nx}^*(1-\rho_g^*)} \left(\frac{G_{t-1}^*}{G^*}\right)^{\rho_g^*} e^{\varepsilon_t} \tag{2.20}$$

while **using real transfers $\tilde{T}_t^*$ to deleverage its government debt**:

$$\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}_t^{*G} = \gamma_t^* \left(\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}^{*G}\right) \tag{2.21}$$

and **varying equally the tax rates on labour income and firm sales to finance the remaining government expenditure**:

$$\tau_t^{*w} - \tau^{*w} = \tau_t^{*s} - \tau^{*s} \qquad (\tau_t^{*s} + \tau_t^{*w} MC_t^* d_t^*) Y_t^* - (\tau^{*s} + \tau^{*w} MC^*) Y^* = G_t^* - G^* \tag{2.22}$$

where $\psi_{nx}^* \geq 0$ represents the **responsiveness of government consumption to variations of the output gap** and $\gamma_t^* \in [0, 1]$ is the **desired share of reduction per period of the excess real government debt with respect to steady state**.

Consumption and Distortionary Tax Scenario

Full Fiscal Union

A Full Fiscal Union **uses local government spending to manage fiscal policy at the union level with a consolidated budget constraint**:

$$P_{H,t}G_t + P^*_{H,t}G^*_t + T_t + T^*_t + B^G_{t-1}(1+i_{t-1}) + B^{*G}_{t-1}\frac{1+i_{t-1}}{1-\delta_{t-1}} =$$
$$B^G_t + B^{*G}_t + \tau^s_t P_{H,t}Y_t + \tau^{*s}_t P^*_{H,t}Y^*_t + \tau^w_t W_t N_t + \tau^{*w}_t W^*_t N^*_t \quad (2.23)$$

In this case government debt will be aggregated across countries and both countries will contribute to the deleveraging of government debt. Nonetheless, **given that financial markets are still incomplete, there continue to be two separate government bonds for the two countries, which pay different interest rates and so have different bond yields**.

Full Fiscal Union - Transfer Scenario

Union-wide fiscal policy **chooses government consumption in each country to stabilize its real net exports gap procyclically**:

$$\frac{G_t^*}{G^*} = \left(\frac{\widetilde{NX}_t^*}{\widetilde{NX}^*}\right)^{\psi_{nx}^*(1-\rho_g^*)} \left(\frac{G_{t-1}^*}{G^*}\right)^{\rho_g^*} e^{\varepsilon_t} \tag{2.24}$$

while **using real transfers equally in both countries to deleverage the government debt of country F**, while country H maintains its government debt constant:

$$\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}_t^{*G} = \gamma_t^* \left(\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}^{*G}\right) \qquad \tilde{B}_t^G = \frac{\tilde{B}_{t-1}^G}{\Pi_{H,t}} \qquad \tilde{T}_t - \tilde{T} = \tilde{T}_t^* - \tilde{T}^* \tag{2.25}$$

and **varying equally across countries the tax rates on labour income and firm sales to finance the remaining government expenditure**:

$$\tau_t^w - \tau^w = \tau_t^s - \tau^s \qquad \tau_t^{*w} - \tau^{*w} = \tau_t^w - \tau^w \qquad \tau_t^{*s} - \tau^{*s} = \tau_t^s - \tau^s \tag{2.26}$$

$$(\tau_t^s + \tau_t^w MC_t d_t) Y_t + (\tau_t^{*s} + \tau_t^{*w} MC_t^* d_t^*) S_t Y_t^* - (\tau^s + \tau^w MC) Y - (\tau^{*s} + \tau^{*w} MC^*) Y^* = G_t + G_t^* - G - G^* \tag{2.27}$$

Consumption and Distortionary Tax Scenario

Outline

Calibration - Structure

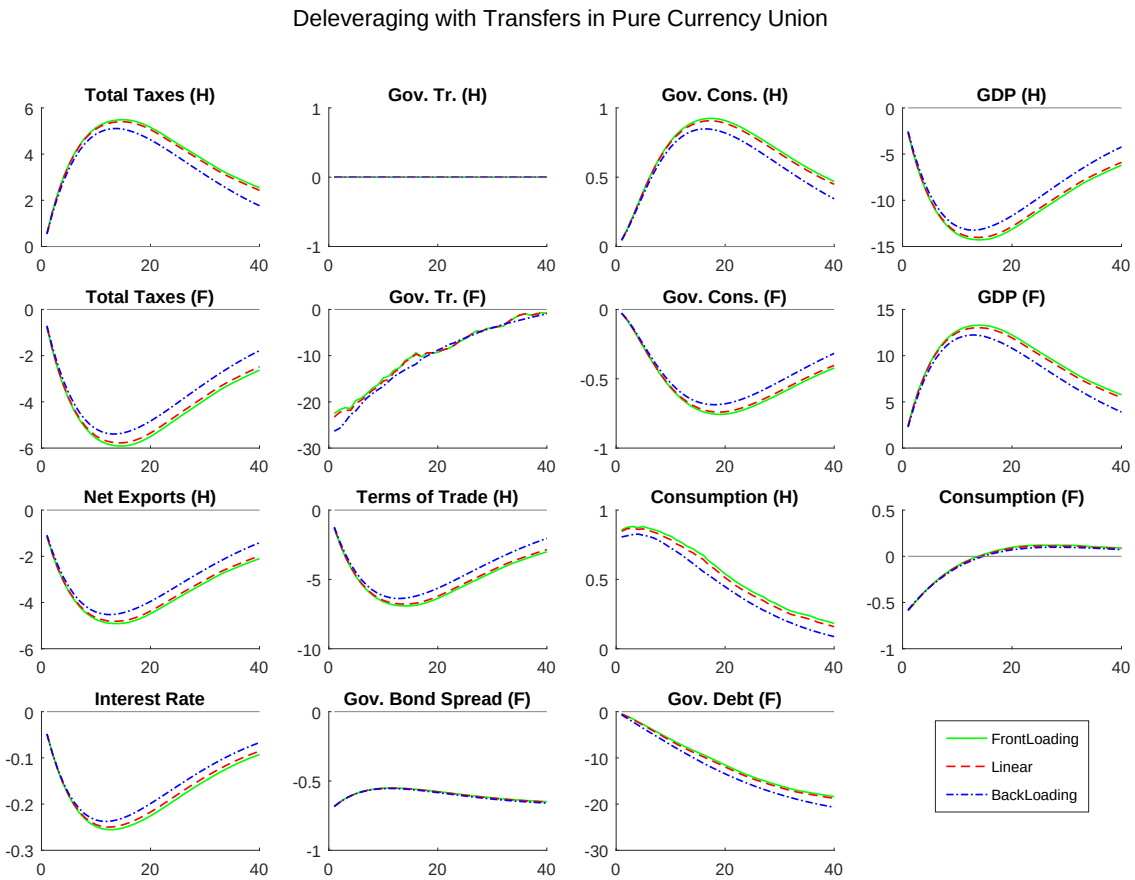
Following Ferrero (2009), **we consider the top 5 Eurozone countries, which account for more than 80% of Eurozone GDP** and we divide them into:

1. **Country F**, the periphery (namely **France, Italy, Spain and The Netherlands**)
2. **Country H**, the core (namely **Germany**)

- **The annualized steady state value of government debt-to-GDP in both countries is set to roughly 60%**, as stated in the Maastricht Treaty.
- In the simulations, **country F starts with a higher level of government debt-to-GDP, equal to roughly 80%**, in line with the average level of government debt-to-GDP for France, Italy, Spain and The Netherlands.
- **For every ten percentage points increase in government debt-to-GDP the government bond spread increases by 9 percentage points**, according to which we set $\delta^B = 0.009$.
- **The desired fraction of reduction of excess government debt is set** to $\gamma_t^* = 0.05$ for country F, **corresponding to a 5% yearly reduction**, to comply with the Debt Brake Rule in the Fiscal Compact, and to $\gamma_t = 0$ for country H, as **only country F needs to deleverage**.

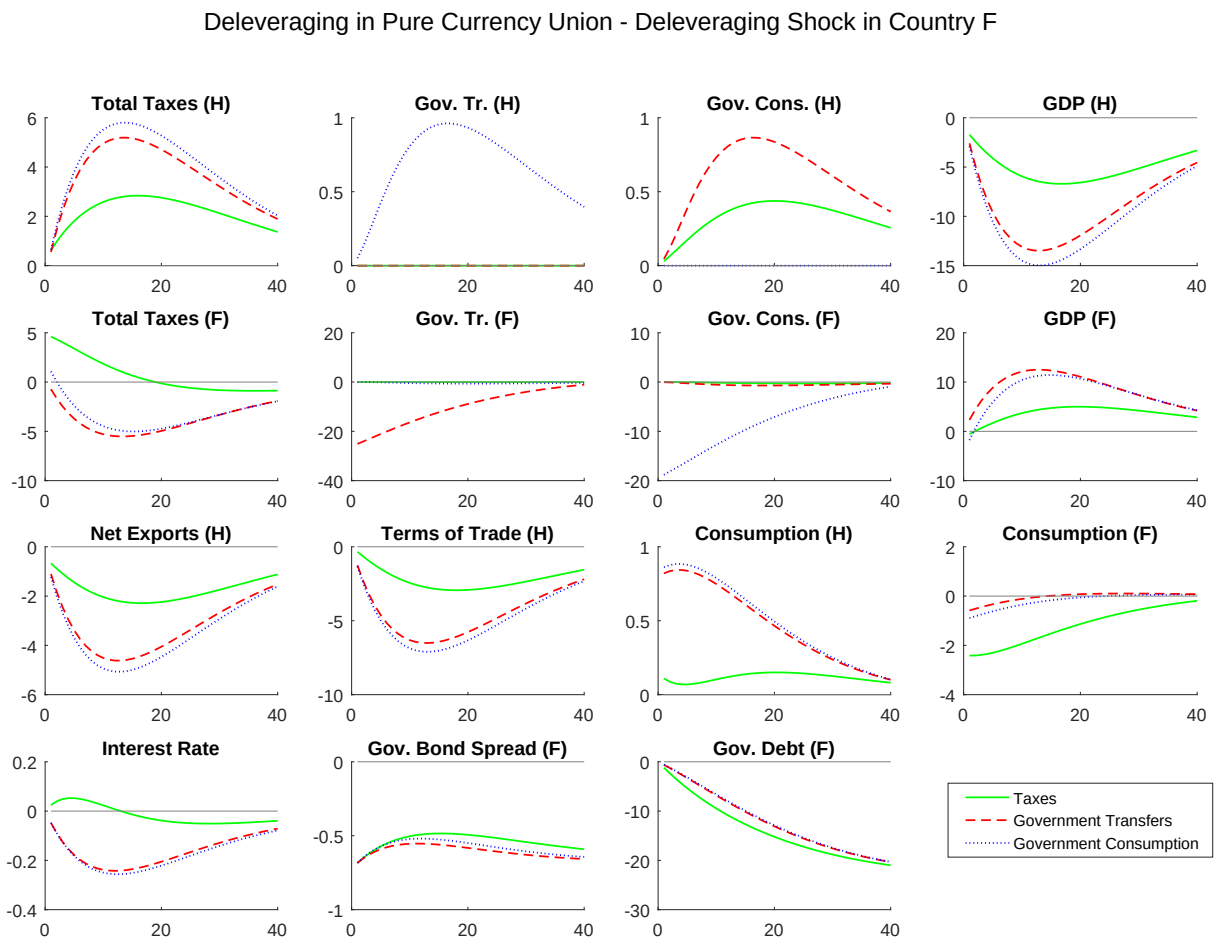
Outline

Deleveraging Schemes - Pure Currency Union



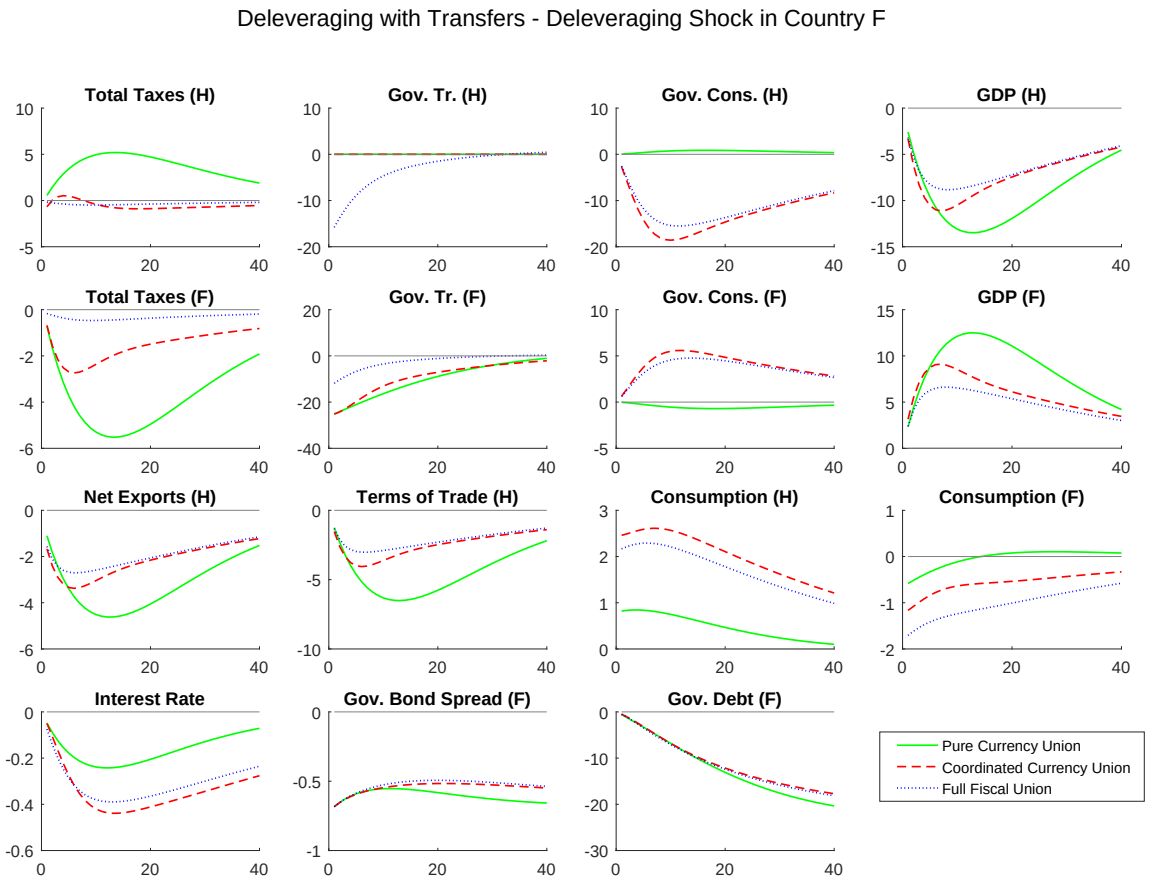
Here we compare: Frontloading (γ_t from 13% to 0.1% in 10 years), Backloading (γ_t from 1% to 10% in 10 years) and Linear (γ_t constant at 5%). More Details

Instruments for Deleveraging - Pure Currency Union



Here we compare different fiscal instruments: taxes, government consumption and government transfers. Full Fiscal Union

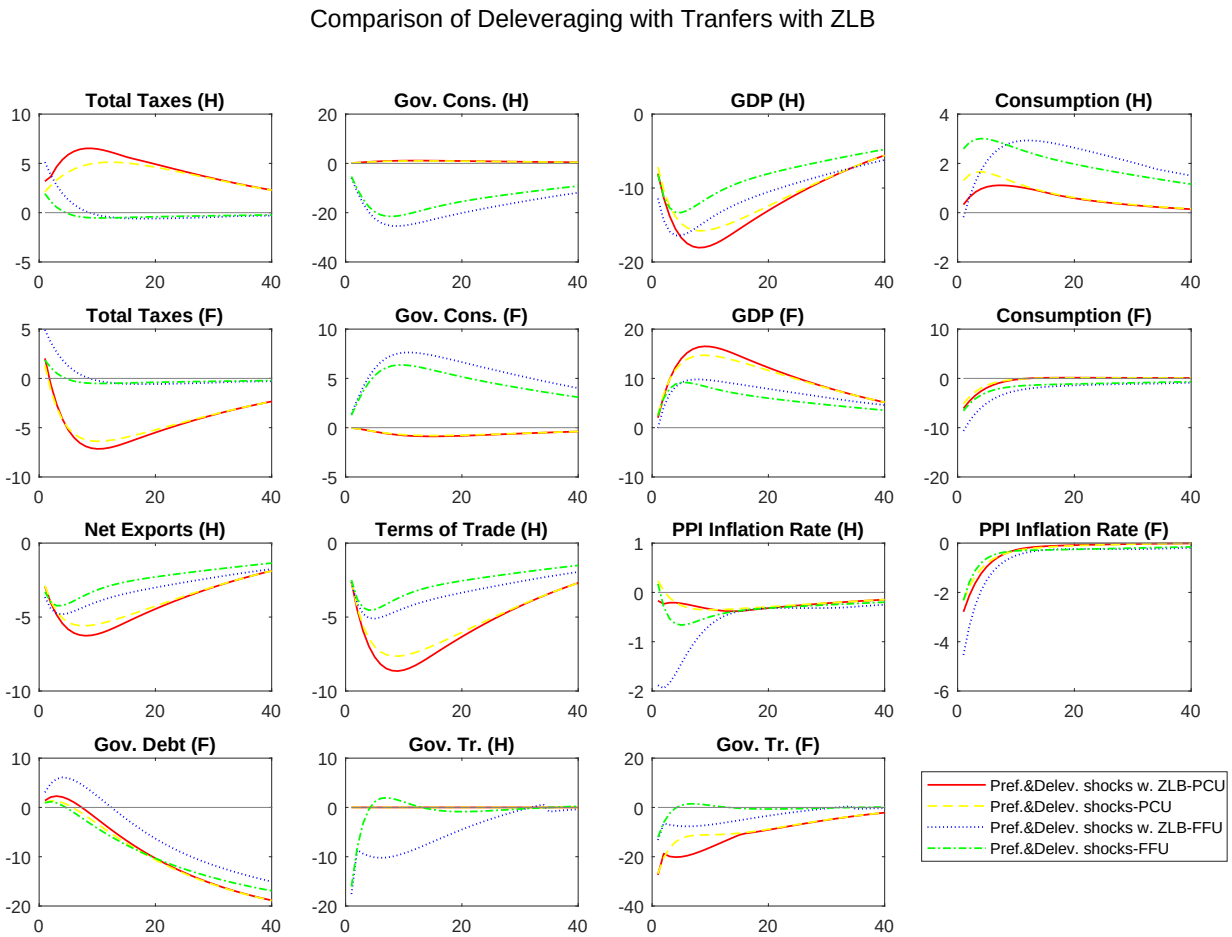
Coordination of Deleveraging with Government Transfers



Here we compare different degrees of coordination: Pure Currency Union, Coordinated Currency Union, and Full Fiscal Union.

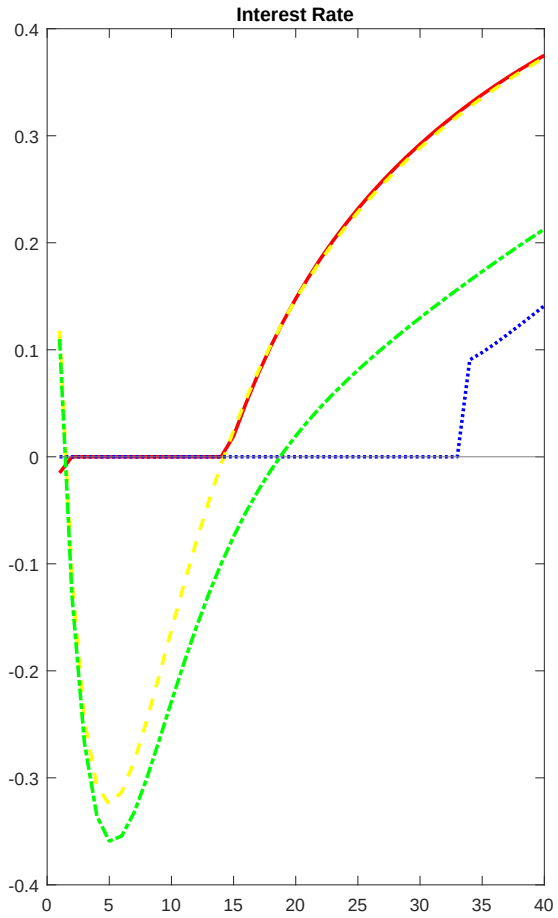
Deleveraging with Taxes

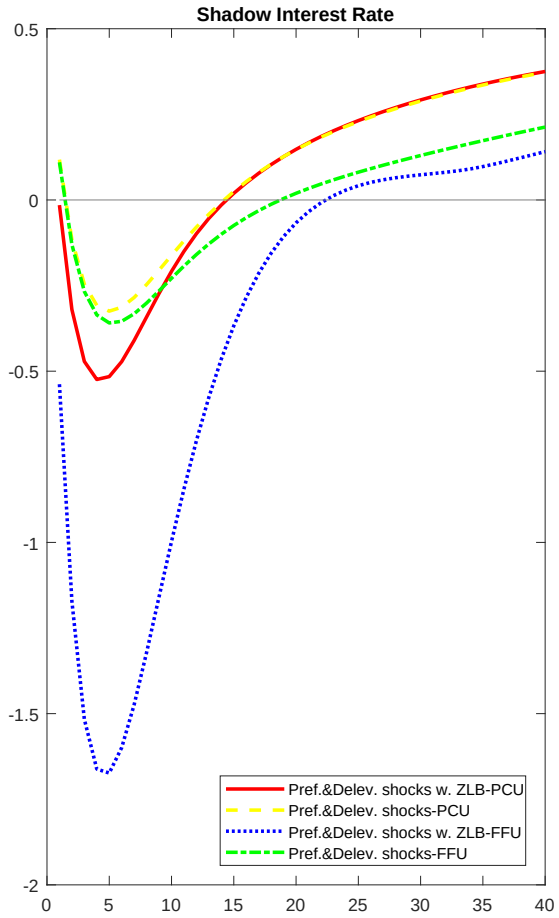
Coordination of Deleveraging at the ZLB



Here we compare Pure Currency Union and Full Fiscal Union with and without the ZLB constraint.

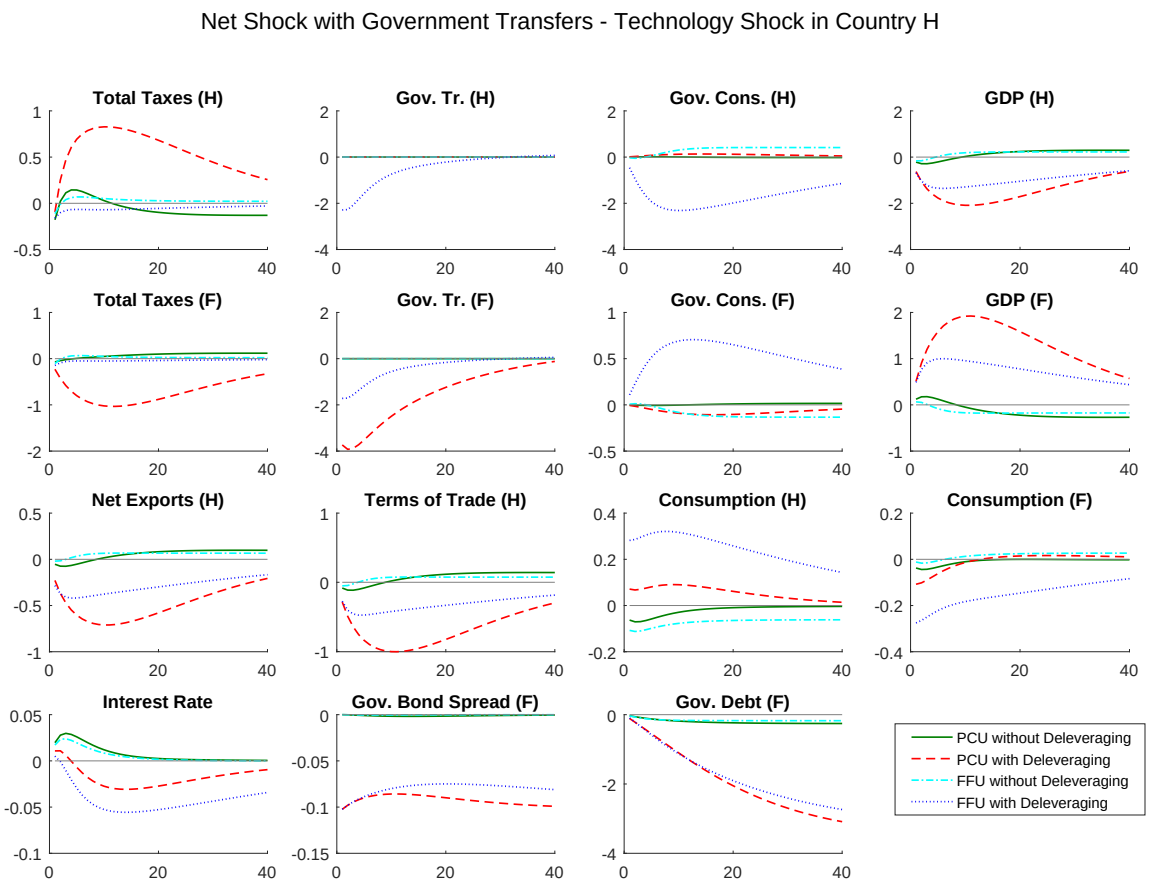
Duration of the Liquidity Trap





Here we show the nominal interest rate and the shadow interest rate from which one can see the duration of the liquidity trap.

Net Shocks from Deleveraging with Government Transfers



Here we compare the response to a negative technology shock in country H when country F is deleveraging and when it is not (net shocks).

Outline

Welfare Costs of Deleveraging Scenarios by Instrument

We compare the stabilization properties of the fiscal policy scenarios and of the deleveraging instruments **by means of an ad hoc Loss Function**. **Here we compare the welfare costs for the three scenarios for fiscal policy coordination.**

Table: Welfare Costs: Comparison of Fiscal Scenarios by Instrument

Welfare Costs based on ad hoc loss function			
Fiscal Instrument: Government Consumption			
	Country H	Country F	Average
PCU	216.3%	160.7%	188.1%
CCU	9.33%	9.38%	9.36%
FFU *	0%	0%	0%
Fiscal Instrument: Government Transfers			
	Country H	Country F	Average
PCU	93.55%	196.9%	140.7%
CCU	22.99%	49.51%	35.09%
FFU*	0%	0%	0%
Fiscal Instrument: Taxes on Sales and Wages			
	Country H	Country F	Average
PCU	25.02%	82.64%	45.19%
CCU *	0%	0%	0%
FFU	50.20%	62.72%	54.58%

Welfare Costs are computed as $\frac{Loss_a - Loss_b}{Loss_b}$, with b the scenario featuring the lowest loss for the selected fiscal instrument (indicated with *)

Welfare Costs of Deleveraging Instruments by Scenario

Here we compare the welfare costs of using a specific fiscal instrument for deleveraging in each of the three scenarios for fiscal policy coordination.

Table: Welfare Costs: Comparison of Fiscal Instruments by Scenario

Welfare Costs based on ad hoc loss function			
Fiscal Scenario: Pure Currency Union			
	Country H	Country F	Average
Gov. Cons.	292.3%	323.3%	305.9%
Gov. Tr.	211.0%	409.1%	298.2%
Taxes*	0%	0%	0%
Fiscal Scenario: Coordinated Currency Union			
	Country H	Country F	Average
Gov. Cons.	69.53%	224.3%	123.7%
Gov. Tr.	147.1%	368.2%	224.5%
Taxes*	0%	0%	0%
Fiscal Scenario: Full Fiscal Union			
	Country H	Country F	Average
Gov. Cons.	3.23%	82.20%	32.33%
Gov. Tr.	33.75%	92.46%	55.38%
Taxes*	0%	0%	0%

Welfare Costs are computed as $\frac{Loss_a - Loss_b}{Loss_b}$, with b the instrument featuring the lowest loss for the selected fiscal scenario (indicated with *)

Outline

Conclusions and Possible Extensions

- **Coordinating on the net exports gap** and (to a minor extent) consolidating budget constraints when deleveraging provides more stabilization.
- **Taxes are a better instrument for deleveraging** compared to government consumption or transfers.
- By **backloading the deleveraging process** one can achieve greater stabilization over time: timing of deleveraging matters!
- **Deleveraging government debt amplifies negative technology shocks**.
- In presence of the ZLB deflationary pressures are stronger and **when deleveraging the liquidity trap lasts longer**.

Possible Extensions:

- Different coordination strategies for national fiscal policies can be imagined.
- A more complex structure of international financial markets might change the amount of private risk-sharing across countries and the international transmission of shocks.
- Distributional consequences of fiscal consolidations may matter, with government transfers used to reduce inequalities.

The End

Thank you for your attention!

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Outline

Financial Intermediaries

The financial intermediaries, owned by the households in country H, **earn profits on all the internationally traded bonds** $B^i_{F,t-1}$ **by collecting savings from households in country H at the interest rate set by the central bank** i_{t-1} **and lending to the government in country F at the interest rate paid on its government bonds** i^*_{t-1}. The aggregate profits of these financial intermediaries are given by:

$$\mathcal{I}_t \equiv B_{F,t-1}\left[(1+i^*_{t-1}) - (1+i^*_{t-1})(1-\delta_{t-1})\right] = B_{F,t-1}(1+i^*_{t-1})\delta_{t-1} \quad (8.1)$$

where $B_{F,t-1} \equiv \int_0^h B^i_{F,t-1}\, di$ are aggregate bonds issued by the government in country F and purchased by households in country H and where **the government bond spread for country F, on which financial intermediaries make profits, is given by** $(1+i^*_{t-1})\delta_{t-1}$.

Net Exports and the Balance of Payments

Net Exports for country H are given by:

$$NX_t \equiv P_{H,t} Y_t - P_t C_t - P_{H,t} G_t \tag{8.2}$$

Net Foreign Assets for country H are given by:

$$NFA_t \equiv D_t + B_t - B_t^G \tag{8.3}$$

The **Balance of Payments** for country H is given by:

$$BP_t \equiv NX_t + i_{t-1} NFA_{t-1} \tag{8.4}$$

so that **Net Foreign Assets for country H evolve according to**:

$$NFA_t = (1 + i_{t-1}) NFA_{t-1} + NX_t = NFA_{t-1} + BP_t \tag{8.5}$$

Back to International Assumptions

Firms

A firm in country H re-optimizing in period t will **choose the price $\bar{P}_{H,t}$ that maximizes the current market value of the profits generated while that price remains effective**, formally solving the problem:

$$\max_{\bar{P}_{H,t}} \sum_{k=0}^{\infty} \theta^k E_t \left\{ \mathcal{Q}_{t,t+k} Y_{t+k|t}(j) \left[(1 - \tau^s_{t+k}) \bar{P}_{H,t} - MC^n_{t+k} \right] \right\} \tag{8.6}$$

where $\mathcal{Q}_{t,t+k}$ is the **household's stochastic discount factor**.

One can then express the **optimal price chosen by firms** in country H as a function of only aggregate variables:

$$\bar{P}_{H,t} = \frac{\varepsilon}{\varepsilon - 1} \frac{\sum_{k=0}^{\infty} (\beta\theta)^k E_t \left\{ \frac{\xi_{t+k} (C_{t+k})^{-\sigma}}{P_{t+k}} \frac{Y_{t+k}}{(P_{H,t+k})^{-\varepsilon}} MC^n_{t+k} \right\}}{\sum_{k=0}^{\infty} (\beta\theta)^k E_t \left\{ \frac{\xi_{t+k} (C_{t+k})^{-\sigma}}{P_{t+k}} \frac{Y_{t+k}}{(P_{H,t+k})^{-\varepsilon}} (1 - \tau^s_{t+k}) \right\}} \tag{8.7}$$

Back to Firms

Pure Currency Union - Consumption Scenario

Fiscal policy **chooses real transfers to stabilize the output gap countercyclically**, while following in part an exogenous process:

$$\frac{\tilde{T}_t^*}{\tilde{T}^*} = \left(\frac{Y_t^*}{Y^*}\right)^{-\psi_y^*(1-\rho_t^*)} \left(\frac{\tilde{T}_{t-1}^*}{\tilde{T}^*}\right)^{\rho_t^*} e^{\varepsilon_t} \tag{8.8}$$

while **using government consumption G_t^* to deleverage its government debt**:

$$\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}_t^{*G} = \gamma_t^* \left(\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}^{*G}\right) \tag{8.9}$$

and **varying equally the tax rates on labour income and firm sales to finance the remaining government expenditure**:

$$\tau_t^{*w} - \tau^{*w} = \tau_t^{*s} - \tau^{*s} \qquad (\tau_t^{*s} + \tau_t^{*w} MC_t^* d_t^*) Y_t^* - (\tau^{*s} + \tau^{*w} MC^*) Y^* = \tilde{T}_t^* - \tilde{T}^* \tag{8.10}$$

Back to Pure Currency Union - Transfer Scenario

Coordinated Currency Union - Consumption Scenario

Fiscal policy **chooses real transfers to stabilize its real net exports gap pro-cyclically**, while following in part an exogenous process:

$$\frac{\tilde{T}_t^*}{\tilde{T}^*} = \left(\frac{\widetilde{NX}_t^*}{\widetilde{NX}^*} \right)^{\psi_{nx}^*(1-\rho_t^*)} \left(\frac{\tilde{T}_{t-1}^*}{\tilde{T}^*} \right)^{\rho_t^*} e^{\varepsilon_t} \tag{8.11}$$

while **using government consumption G_t^* to deleverage its government debt**:

$$\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}_t^{*G} = \gamma_t^* \left(\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}^{*G} \right) \tag{8.12}$$

and **varying equally the tax rates on labour income and firm sales to finance the remaining government expenditure**:

$$\tau_t^{*w} - \tau^{*w} = \tau_t^{*s} - \tau^{*s} \qquad (\tau_t^{*s} + \tau_t^{*w} MC_t^* d_t^*) Y_t^* - (\tau^{*s} + \tau^{*w} MC^*) Y^* = \tilde{T}_t^* - \tilde{T}^* \tag{8.13}$$

where $\psi_{nx}^* \geq 0$ represents the **responsiveness of government consumption to variations of the output gap** and $\gamma_t^* \in [0, 1]$ is the **desired share of reduction per period of the excess real government debt with respect to steady state**.

Coordinated Currency Union - Distortionary Tax Scenario

Fiscal policy **chooses government consumption to stabilize its real net exports gap procyclically**:

$$\frac{G_t^*}{G^*} = \left(\frac{\widetilde{NX}_t^*}{\widetilde{NX}^*} \right)^{\psi_{nx}^*(1-\rho_g^*)} \left(\frac{G_{t-1}^*}{G^*} \right)^{\rho_g^*} e^{\varepsilon_t} \tag{8.14}$$

while keeping real transfers constant and **varying equally the tax rates on labour income and firm sales to deleverage its government debt and to finance the remaining government expenditure**:

$$\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}_t^{*G} = \gamma_t^* \left(\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}^{*G} \right) \qquad \tilde{T}_t^* = \tilde{T}^* \tag{8.15}$$

$$\tau_t^{*w} - \tau^{*w} = \tau_t^{*s} - \tau^{*s} \tag{8.16}$$

where $\psi_{nx}^* \geq 0$ represents the **responsiveness of government consumption to variations of the output gap** and $\gamma_t^* \in [0,1]$ is the **desired share of reduction per period of the excess real government debt with respect to steady state**.

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Full Fiscal Union - Consumption Scenario

Union-wide fiscal policy **chooses real transfers in each country to stabilize its real net exports gap procyclically**, while following in part an exogenous process:

$$\frac{\tilde{T}_t^*}{\tilde{T}^*} = \left(\frac{\widetilde{NX}_t^*}{\widetilde{NX}^*} \right)^{\psi_{nx}^*(1-\rho_t^*)} \left(\frac{\tilde{T}_{t-1}^*}{\tilde{T}^*} \right)^{\rho_t^*} e^{\varepsilon_t} \tag{8.17}$$

while **using government consumption equally in both countries to deleverage the government debt of country F**, while country H maintains its government debt constant:

$$\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}_t^{*G} = \gamma_t^* \left(\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}^{*G} \right) \qquad \tilde{B}_t^G = \frac{\tilde{B}_{t-1}^G}{\Pi_{H,t}} \qquad G_t - G = G_t^* - G^* \tag{8.18}$$

and **varying equally across countries the tax rates on labour income and firm sales to finance the remaining government expenditure**:

$$\tau_t^w - \tau^w = \tau_t^s - \tau^s \qquad \tau_t^{*w} - \tau^{*w} = \tau_t^w - \tau^w \qquad \tau_t^{*s} - \tau^{*s} = \tau_t^s - \tau^s \tag{8.19}$$

$$(\tau_t^s + \tau_t^w MC_t d_t) Y_t + (\tau_t^{*s} + \tau_t^{*w} MC_t^* d_t^*) S_t Y_t^* - (\tau^s + \tau^w MC) Y - (\tau^{*s} + \tau^{*w} MC^*) Y^* = \tilde{T}_t + \tilde{T}_t^* - \tilde{T} - \tilde{T}^* \tag{8.20}$$

Full Fiscal Union - Distortionary Tax Scenario

Union-wide fiscal policy **chooses government consumption in each country to stabilize its real net exports gap procyclically**:

$$\frac{G_t^*}{G^*} = \left(\frac{\widetilde{NX}_t^*}{\widetilde{NX}^*}\right)^{\psi_{nx}^*(1-\rho_g^*)} \left(\frac{G_{t-1}^*}{G^*}\right)^{\rho_g^*} e^{\varepsilon_t} \tag{8.21}$$

while keeping real transfers constant and **varying equally the tax rates on labour income and firm sales to deleverage the government debt of country F**, while country H maintains its government debt constant:

$$\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}_t^{*G} = \gamma_t^* \left(\frac{\tilde{B}_{t-1}^{*G}}{\Pi_{H,t}^*} - \tilde{B}^{*G}\right) \qquad \tilde{B}_t^G = \frac{\tilde{B}_{t-1}^G}{\Pi_{H,t}} \qquad \tilde{T}_t - \tilde{T} = \tilde{T}_t^* - \tilde{T}^* \tag{8.22}$$

and also **varying equally across countries the tax rates on labour income and firm sales to finance the remaining government expenditure**:

$$\tau_t^w - \tau^w = \tau_t^s - \tau^s \qquad \tau_t^{*w} - \tau^{*w} = \tau_t^w - \tau^w \qquad \tau_t^{*s} - \tau^{*s} = \tau_t^s - \tau^s \tag{8.23}$$

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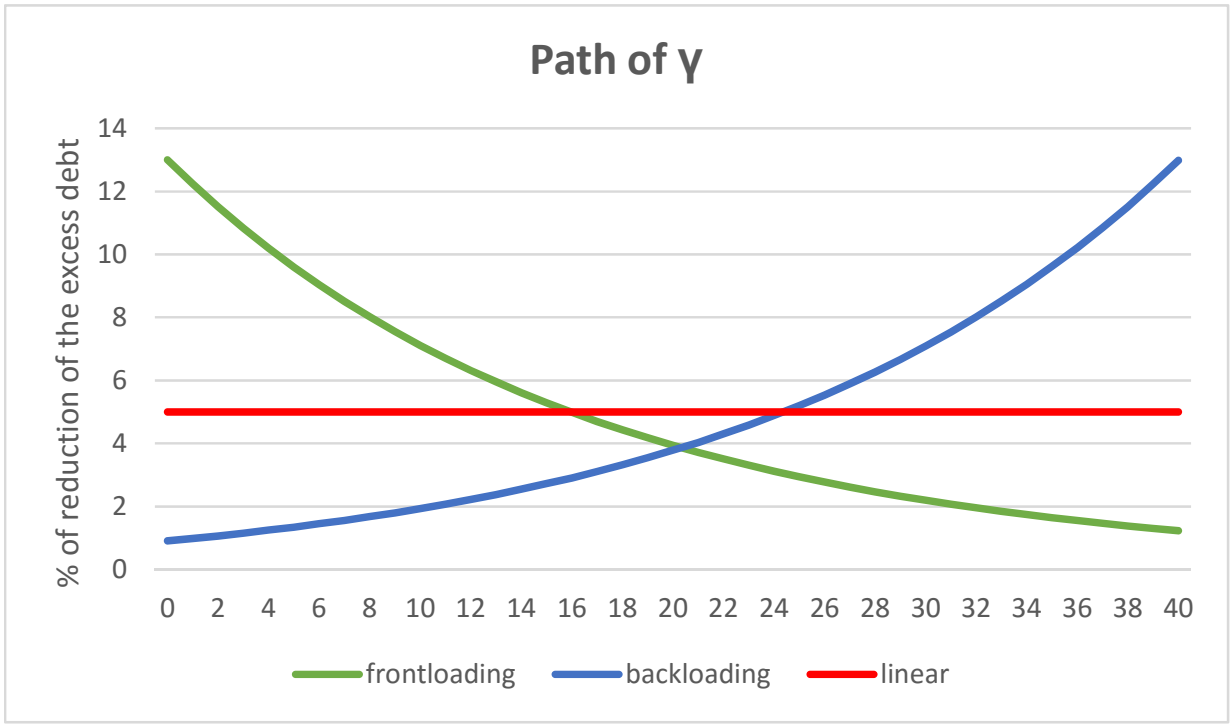
Deleveraging Paths

The three deleveraging paths over time are shown in terms of the percent reduction of excess government debt:



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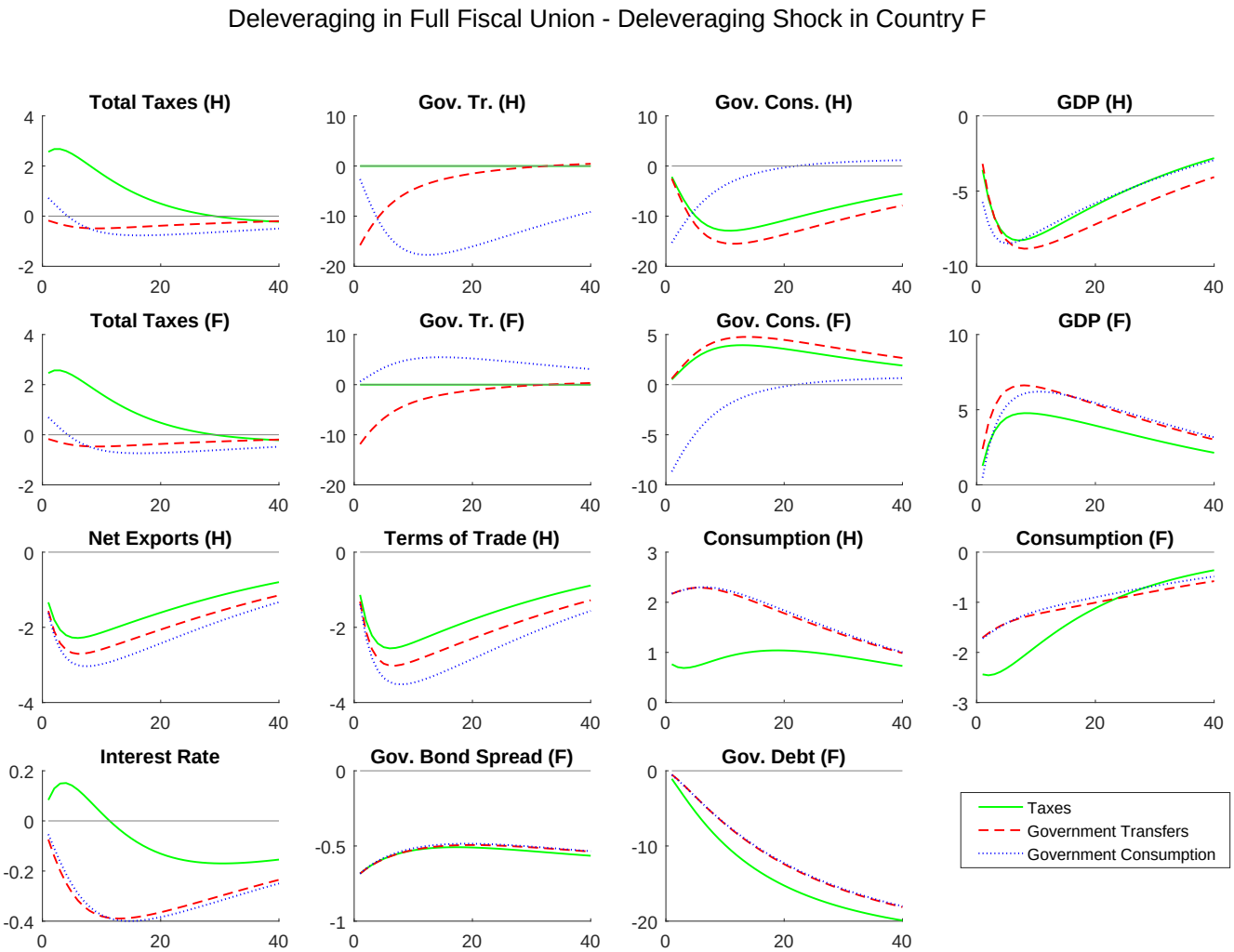
Instruments for Deleveraging - Full Fiscal Union



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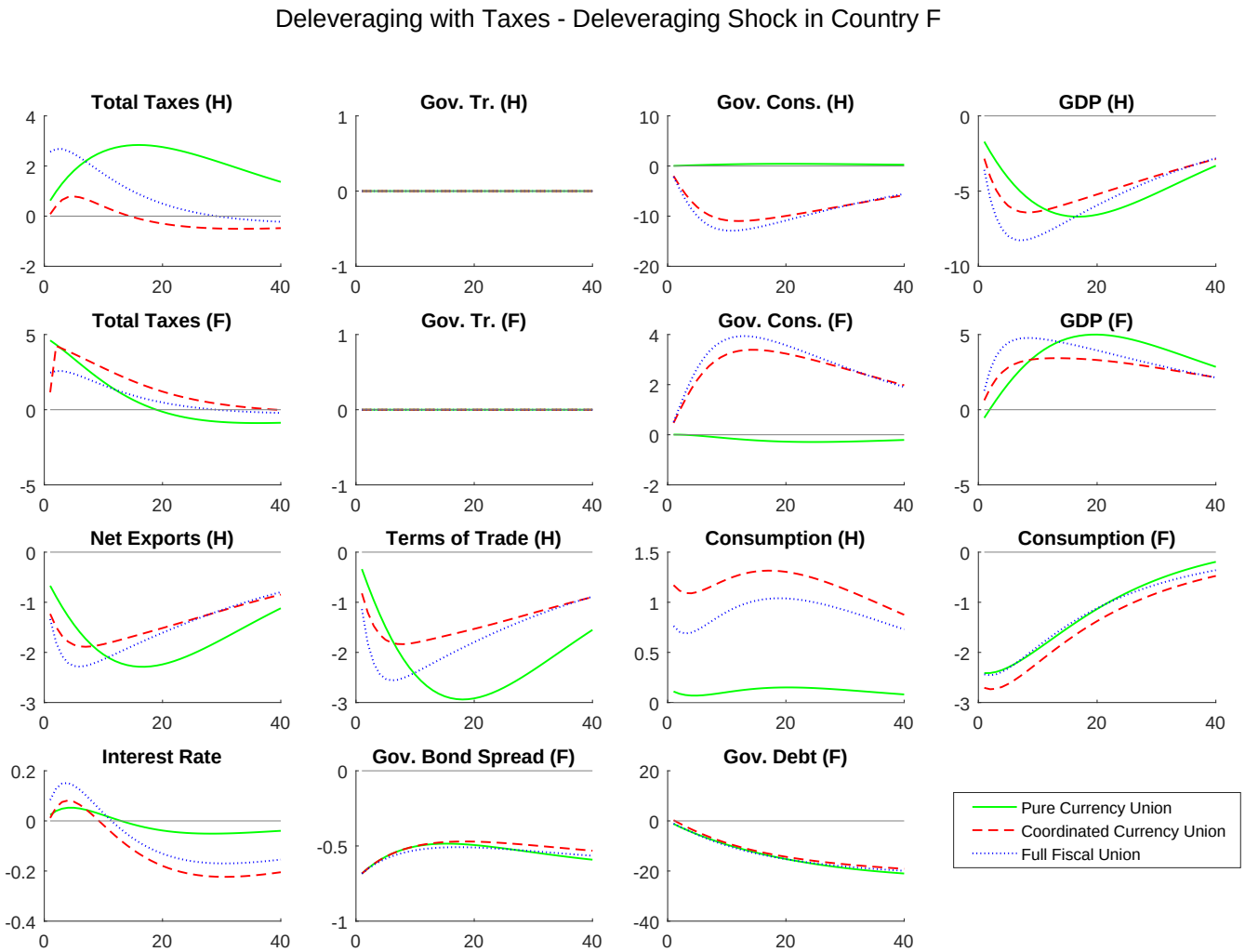
Coordination of Deleveraging with Taxes



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