Seizing central bank assets?

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Introduction

Motivation

The New York Times

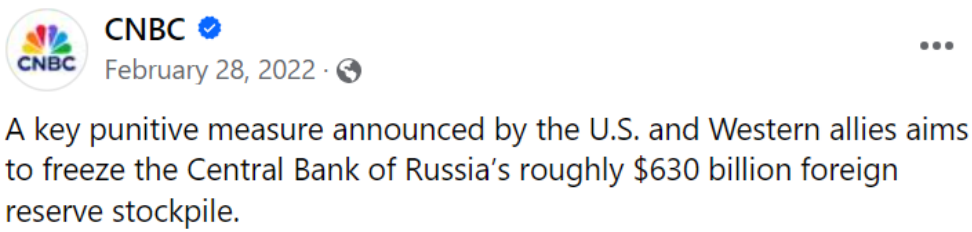
U.S. escalates sanctions with a freeze on Russian central bank assets.

The action is likely to fuel rapid inflation in Russia as it wages war in Ukraine.

Briefing | The economic weapon

Western sanctions on Russia are like none the world has seen

But they may weaken the system they are meant to defend



Motivation

Finance & economics | Seizing opportunities

Could seizing Russian assets help rebuild Ukraine?

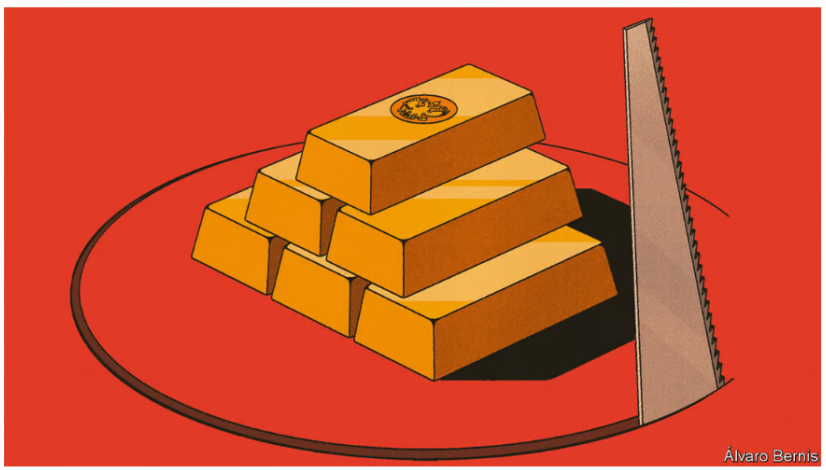
Both legal and practical hurdles stand in the way

Jun 6th 2022 Share

Finance and economics | Free exchange

What do you do with 191bn frozen euros owned by Russia?

The question that now confronts Western policymakers



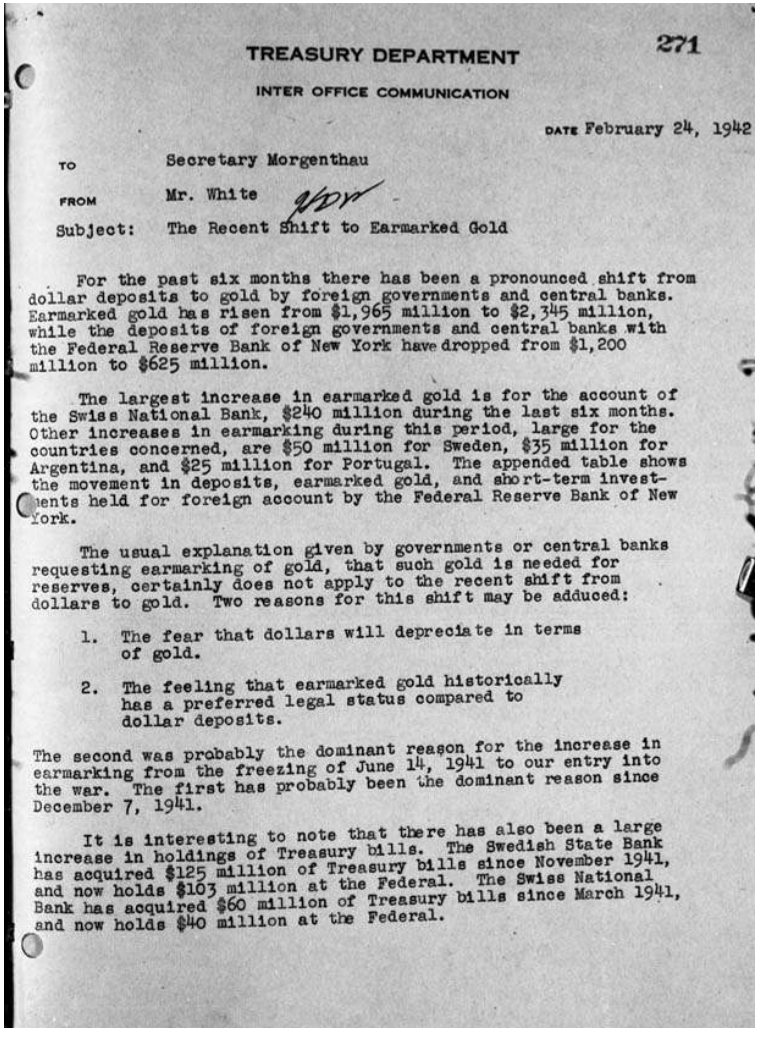
Feb 28th 2024 Share

Risks of sanctions have also been discussed in the past

"A unilateral vesting of blocked property could damage the reputation of the United States as a safe location for the investment of foreign capital, as many foreign investors would view the action as arbitrary, unjustified, and counter to standard international practice."

- Richard Newcomb (OFAC Director), 1989.

...including risks of shifts in foreign reserve portfolios



TREASURY DEPARTMENT 271

INTER OFFICE COMMUNICATION

DATE February 24, 1942

TO Secretary Morgenthau

FROM Mr. White

Subject: The Recent Shift to Earmarked Gold

For the past six months there has been a pronounced shift from dollar deposits to gold by foreign governments and central banks. Earmarked gold has risen from $1,965 million to $2,345 million, while the deposits of foreign governments and central banks with the Federal Reserve Bank of New York have dropped from $1,200 million to $625 million.

The largest increase in earmarked gold is for the account of the Swiss National Bank, $240 million during the last six months. Other increases in earmarking during this period, large for the countries concerned, are $50 million for Sweden, $35 million for Argentina, and $25 million for Portugal. The appended table shows the movement in deposits, earmarked gold, and short-term investments held for foreign account by the Federal Reserve Bank of New York.

The usual explanation given by governments or central banks requesting earmarking of gold, that such gold is needed for reserves, certainly does not apply to the recent shift from dollars to gold. Two reasons for this shift may be adduced:

1. The fear that dollars will depreciate in terms of gold.
2. The feeling that earmarked gold historically has a preferred legal status compared to dollar deposits.

The second was probably the dominant reason for the increase in earmarking from the freezing of June 14, 1941 to our entry into the war. The first has probably been the dominant reason since December 7, 1941.

It is interesting to note that there has also been a large increase in holdings of Treasury bills. The Swedish State Bank has acquired $125 million of Treasury bills since November 1941, and now holds $103 million at the Federal. The Swiss National Bank has acquired $60 million of Treasury bills since March 1941, and now holds $40 million at the Federal.

"For the past six months there has been a pronounced shift from dollar deposits to gold by foreign governments and central banks. [...] The usual explanation [...] that such gold is needed for reserves, certainly does not apply to the recent shift from dollars to gold. [...] The feeling that earmarked gold historically has a preferred legal status compared to dollar deposits [...] was probably the dominant reason for the increase in earmarking from the freezing of June 14, 1941."

- Harry Dexter White, Feb. 1942.

Our contributions

- ✓ Compile a new database on freezes and seizures of central bank assets spanning 1914–2024:
  - → Compare with discussions on today's Russia, show scale rarely seen in history and no precedent for seizure exists

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- ✓ Calibrate model simulations for today's Russia:
  - → Seizing Russia's immobilized sovereign assets could lead to increase in interest rates on U.S. government bonds of almost 60 basis points
  - → Potentially outweighing benefits of outright seizure

Related literature

- Features of (financial) sanction policies: Elliott and Hufbauer (1999), Hufbauer et al. (2009), Hufbauer et al. (2010), Clifton et al. (2014), Von Soest and Wahman (2015), Felbermayr et al. (2020), Eichengreen et al. (2023), **Mulder (2024)**

- Conceptual frameworks of how sanctions work: Kaempfer and Lowenberg (1988), Eaton and Engers (1992), Eaton and Engers (1999), Lorenzoni and Werning (2022), Itskhoki and Mukhin (2022, 2023), **Bianchi and Sosa-Padilla (2022, 2023)**, Clayton et al. (2023), **Chahrour and Valchev (2023)**, Ghironi et al. (2024)

- Empirical literature on international economic effects of sanctions: Haidar (2017), Besedeš et al. (2017), Crozet and Hinz (2020), Besedeš et al. (2021), Federle et al. (2022), Drott et al. (2022), Cipriani et al. (2023)

Data & Stylized Facts

Data construction

- Identification of sanctions on central bank assets and their features using primary, contemporary and secondary sources, including articles in contemporary newspapers and academic journals, and scholarly accounts

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- Identification of sanctions on central bank assets and their features using primary, contemporary and secondary sources, including articles in contemporary newspapers and academic journals, and scholarly accounts
- Focus on 1914 - 2024 and collect 117 cases of sanctions on central bank assets
- Features included in the database:
  - type of sanction
  - country targeted
  - country or coalition of countries imposing the sanctions
  - legal basis used to impose them
  - circumstances when they were adopted
  - beneficiary(ies)
  - duration of imposed sanctions

Example of documented case

Few cases of comparable magnitude in last century

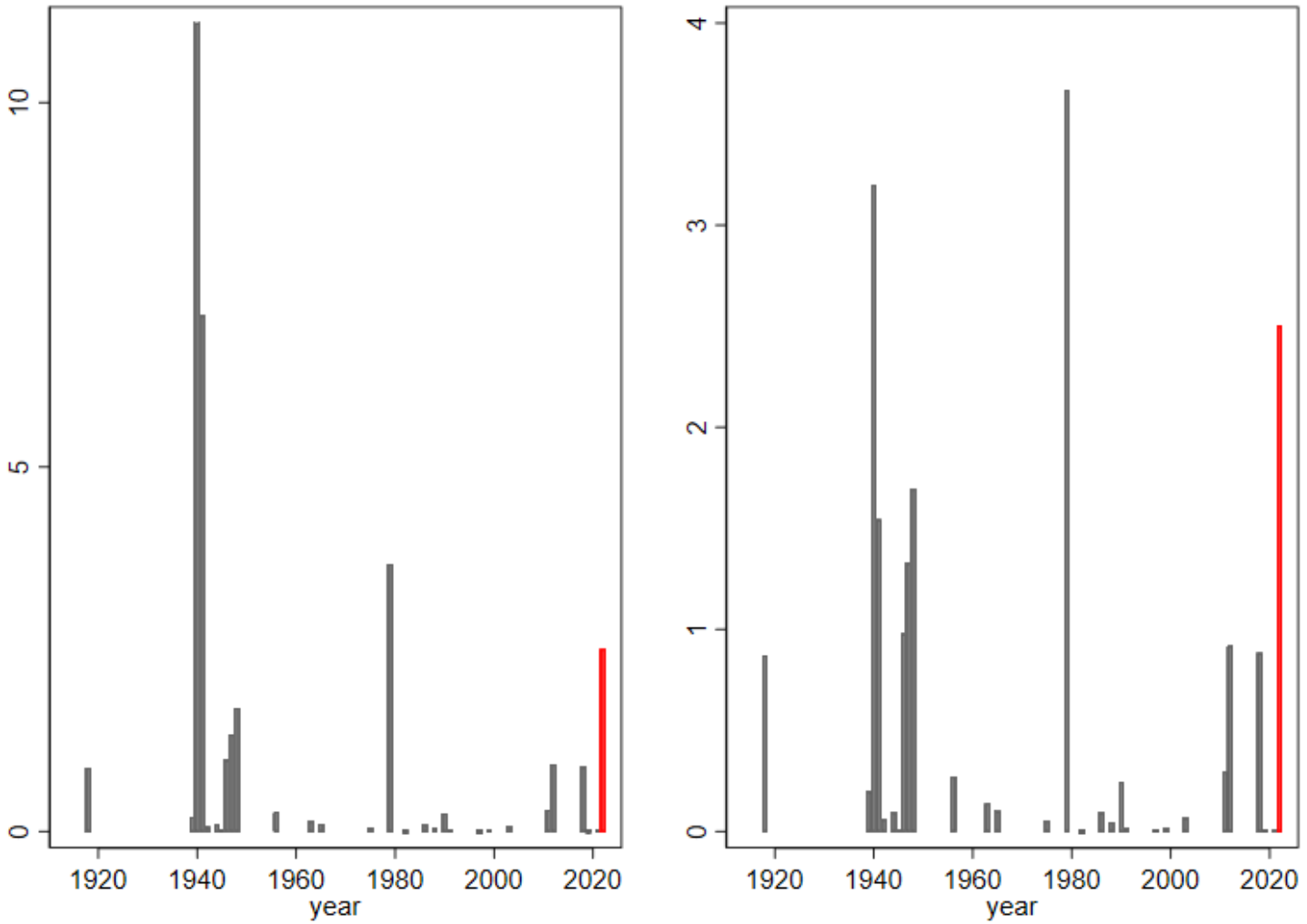


Figure: Share of global foreign reserve targeted: 1914-2022 (rhs: excluding precautionary measures).

No relevant historical precedents for today's Russia

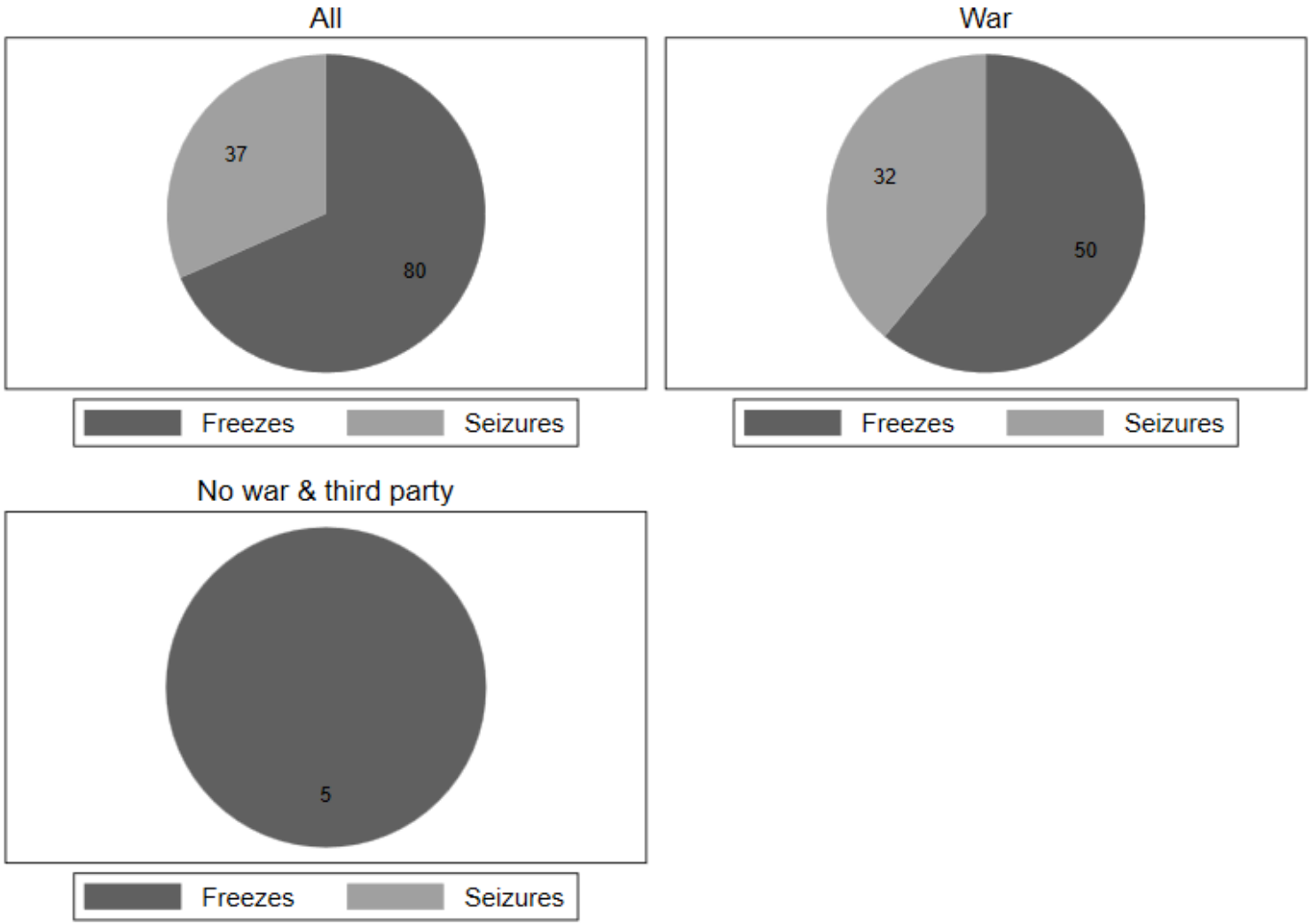


Figure: Breakdown of sanctions by type.

Model

Extend a 3-country model by:

→ Including a convenience yield from internationally-traded assets

HH derive utility from US bond holdings (i.e. reserves, transactions) as standard in convenience yield literature (Valchev, 2020 and Jiang et al., 2024)

Extend a 3-country model by:

→ Including a convenience yield from internationally-traded assets

→ Active management by central banks of their balance sheets

CBs **must** match money supply (M) with reserves (gold and assets)

$$\frac{M_{c,t}}{P_{c,t}} = \left[\underbrace{\psi_{c,b} \left(\frac{B^{CB}_{US,c,t}}{P_{US,t}} \frac{1}{RER_{US,c,t} r_{US,t}} \right)^{\gamma_{c,CB}}}_{\textit{Foreign bond holdings}} + \underbrace{\psi_{c,g} \left(\frac{P^{G}_{t} \mathcal{G}_{c,t}}{P_{US,t} RER_{US,c,t}} \right)^{\gamma_{c,CB}}}_{\textit{Gold}} + \underbrace{\psi_{c,d} \left(\frac{B^{CB}_{c,c,t}}{P_{c,t}} \frac{1}{r_{c,t}} \right)^{\gamma_{c,CB}}}_{\textit{Domestic bond holdings}} \right]^{\frac{1}{\gamma_{c,CB}}}$$

✓ subject to the equation above, reserve managers optimize the balance sheet.

✓ non-linear aggregator to proxy for alternative items on CB balance sheets and imperfect substitutability of the two.

FOCs

Extend a 3-country model by:

→ Including a convenience yield from internationally-traded assets

→ Active management by central banks of their balance sheets

→ Gold is in fixed supply

In each country, the stock of gold evolves according to:

$$\mathcal{G}_{c,t} = (1 - \delta_{c,g})\mathcal{G}_{c,t-1} + IG_{c,t}$$

New gold is fixed, so that the gold market clears as:

$$\mathcal{G}_{supply} = \sum_{c} n_c IG_{c,t}$$

Extend a 3-country model by:

- → Including a convenience yield from internationally-traded assets
- → Active management by central banks of their balance sheets
- → Gold is in fixed supply
- → Government follows a budget constraint & simple tax rule

Taxes stabilize debt to GDP, while the government's budget – which determines outstanding debt – is:

$$G_{c,t} + Debt_{c,t-1} = T_{c,t} + \frac{Debt_{c,t}}{R_{c,t}} + \Pi^{CB}_{c,t}$$

Extend a 3-country model by:

- → Including a convenience yield from internationally-traded assets
- → Active management by central banks of their balance sheets
- → Gold is in fixed supply
- → Government follows a budget constraint & simple tax rule
- → Sanctions modeled as an expropriation of some of assets held by the targeted central bank

$$\mathcal{G}_{c,t} = \boldsymbol{\xi_{g,t}}(1-\delta_{c,g})\mathcal{G}_{c,t-1} + IG_{c,t}$$

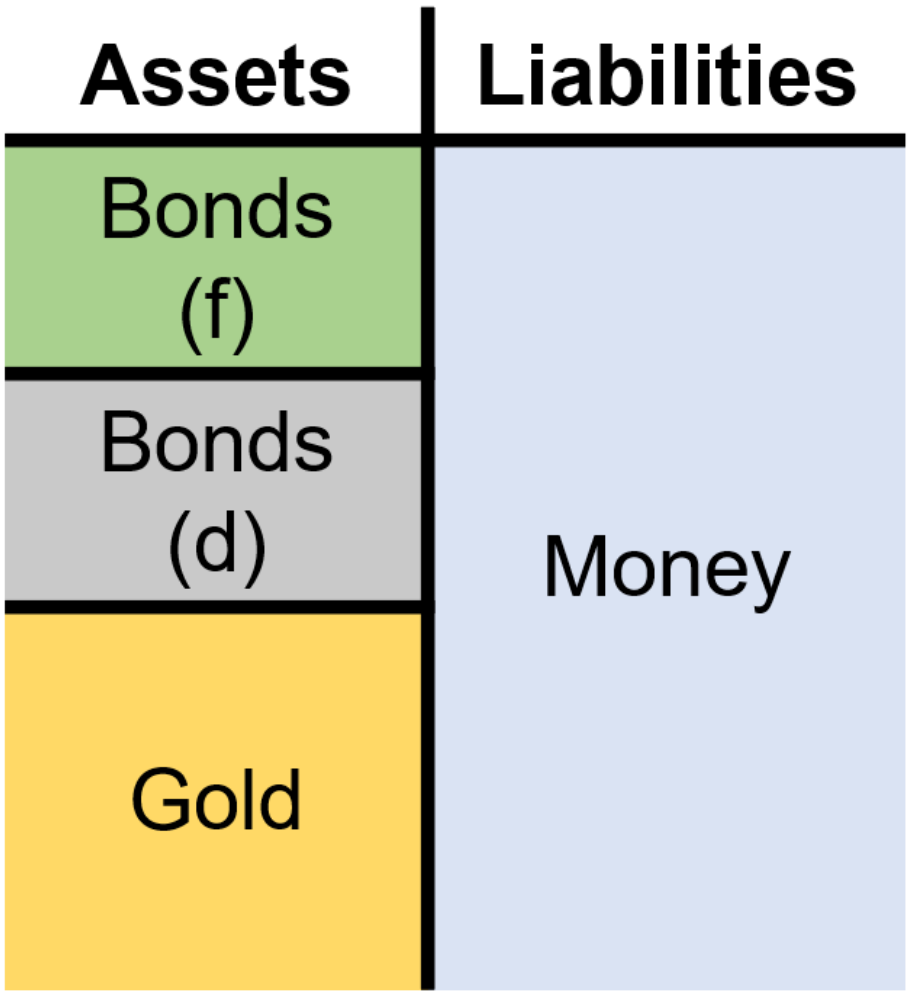
$$\frac{M_t}{P_{c,t}} = \left[\psi_{c,b}\left(\frac{\boldsymbol{\xi_b} B^{CB}_{US,c,t}}{P_{US,t} r_{US,t} RER_{US,c,t}}\right)^{\gamma_{c,CB}} + \psi_{c,g}\left(\frac{P^G_t \mathcal{G}_{c,t}}{P_{US,t} RER_{US,c,t}}\right)^{\gamma_{c,CB}} + \psi_{c,d}\left(\frac{B^{CB}_{c,c,t}}{P_{c,t} r_{c,t}}\right)^{\gamma_{c,CB}}\right]^{\frac{1}{\gamma_{c,CB}}}$$

seizure: loss is forever; **freeze**: the nominal value is returned (eventually).

Parameters; Solution algorithm

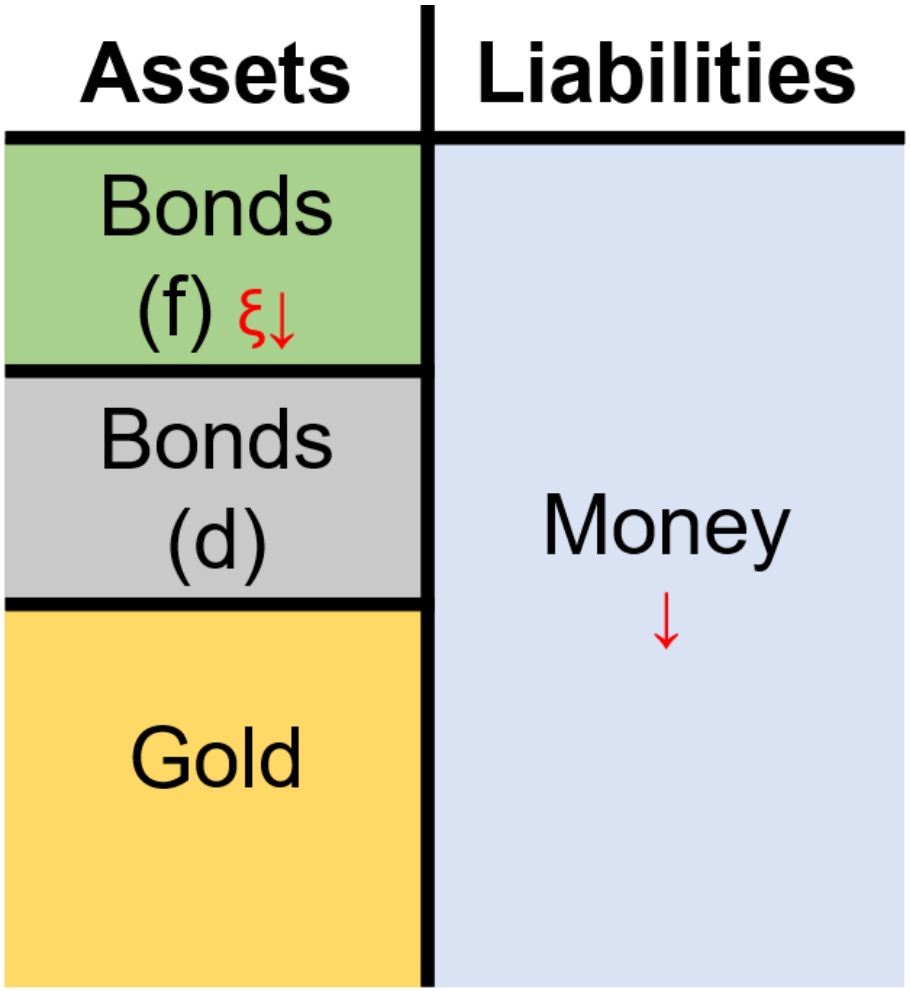
Intuition

In the model, the stylized central bank's balance sheet looks like...



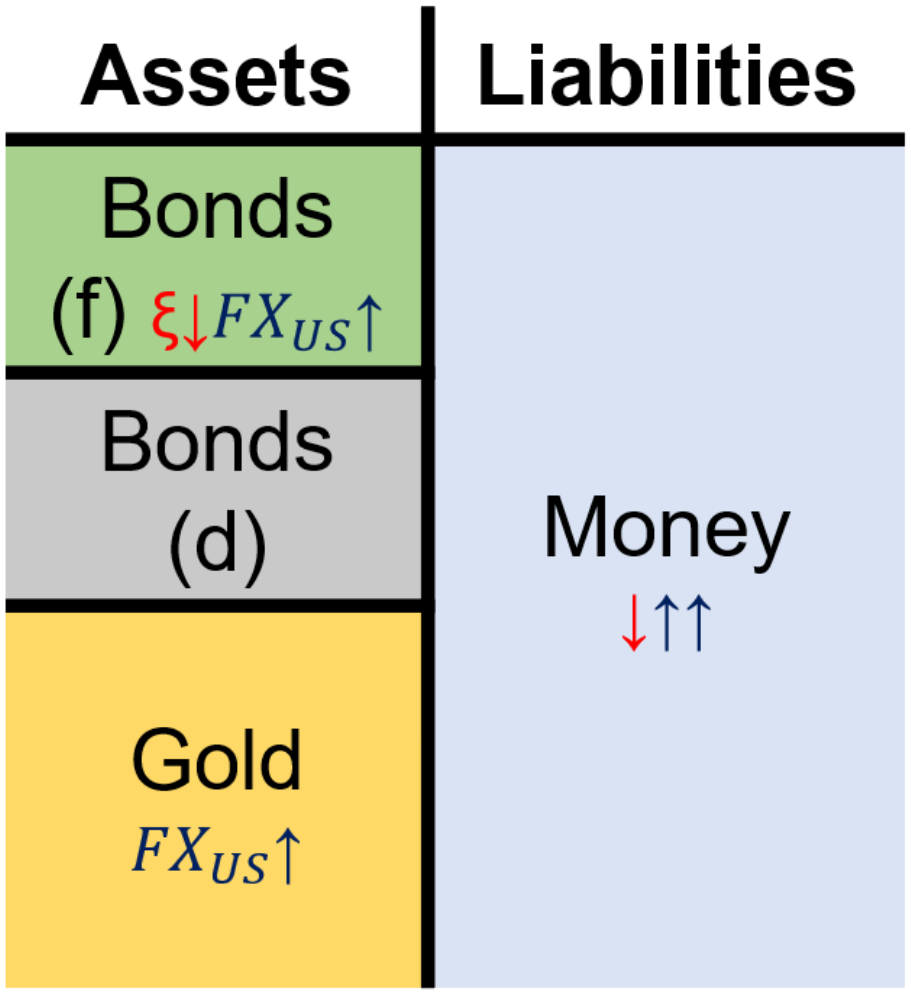
Intuition

... when sanctions hit, M should decrease starting a monetary tightening through HH Euler's condition



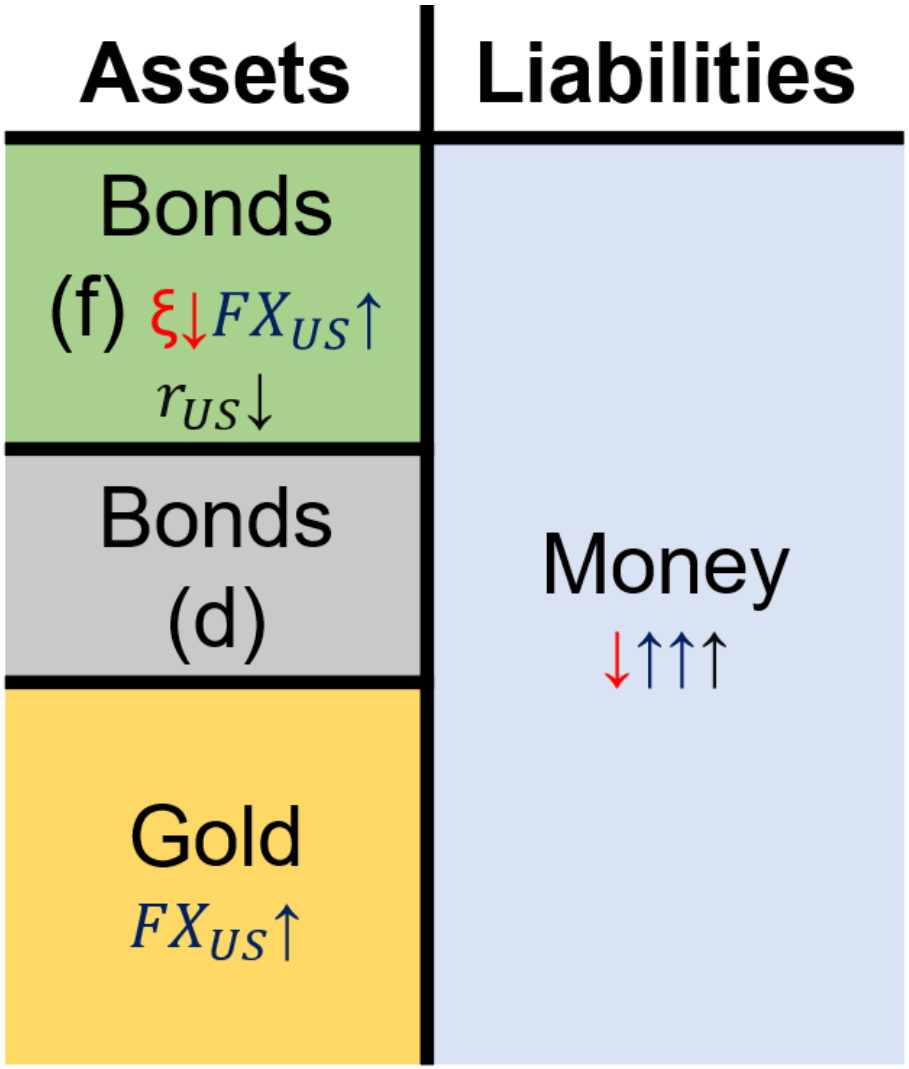
Intuition

but sanctions reduce the supply of dollar assets...

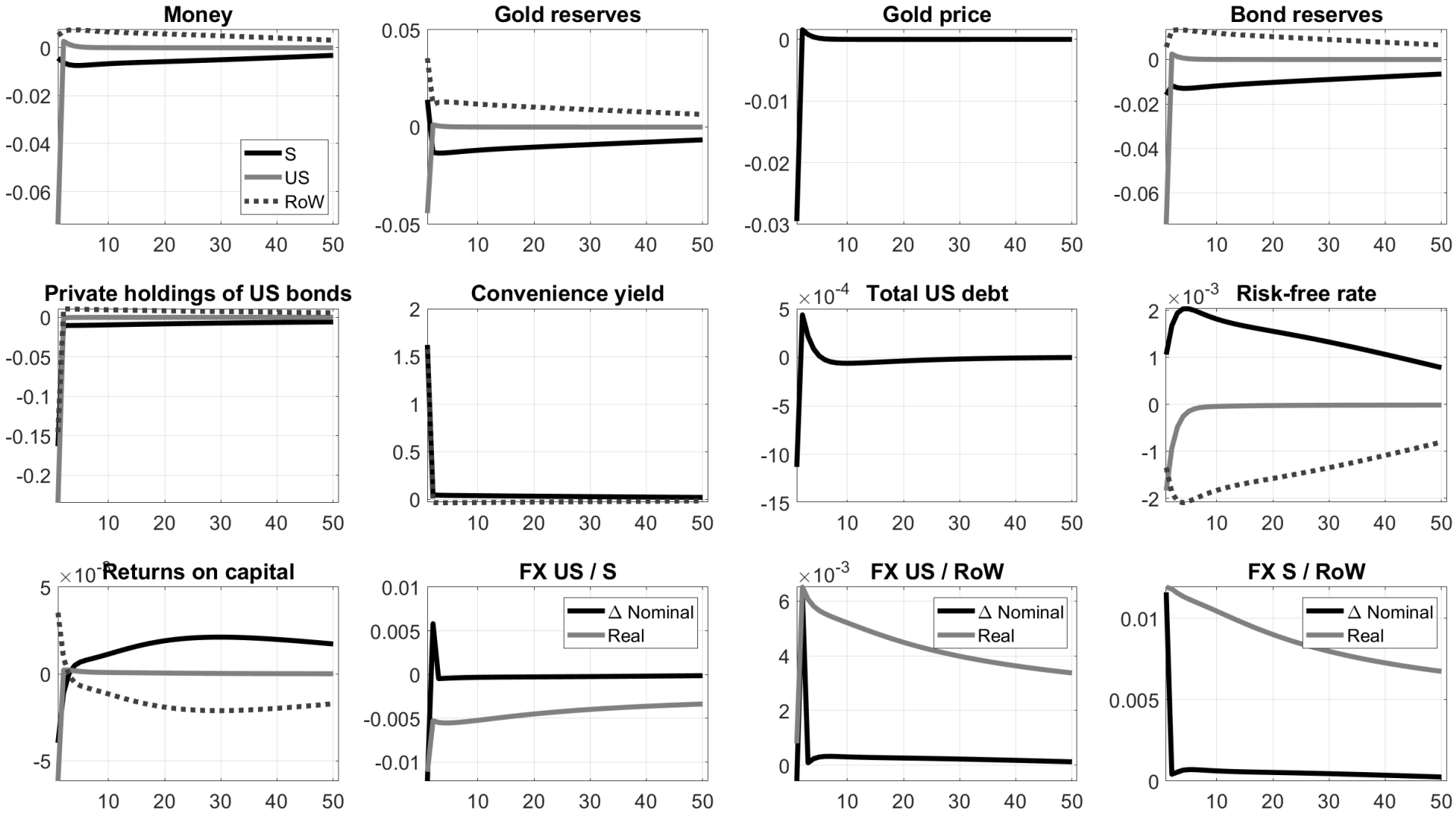


Intuition

What about yields on US bonds?

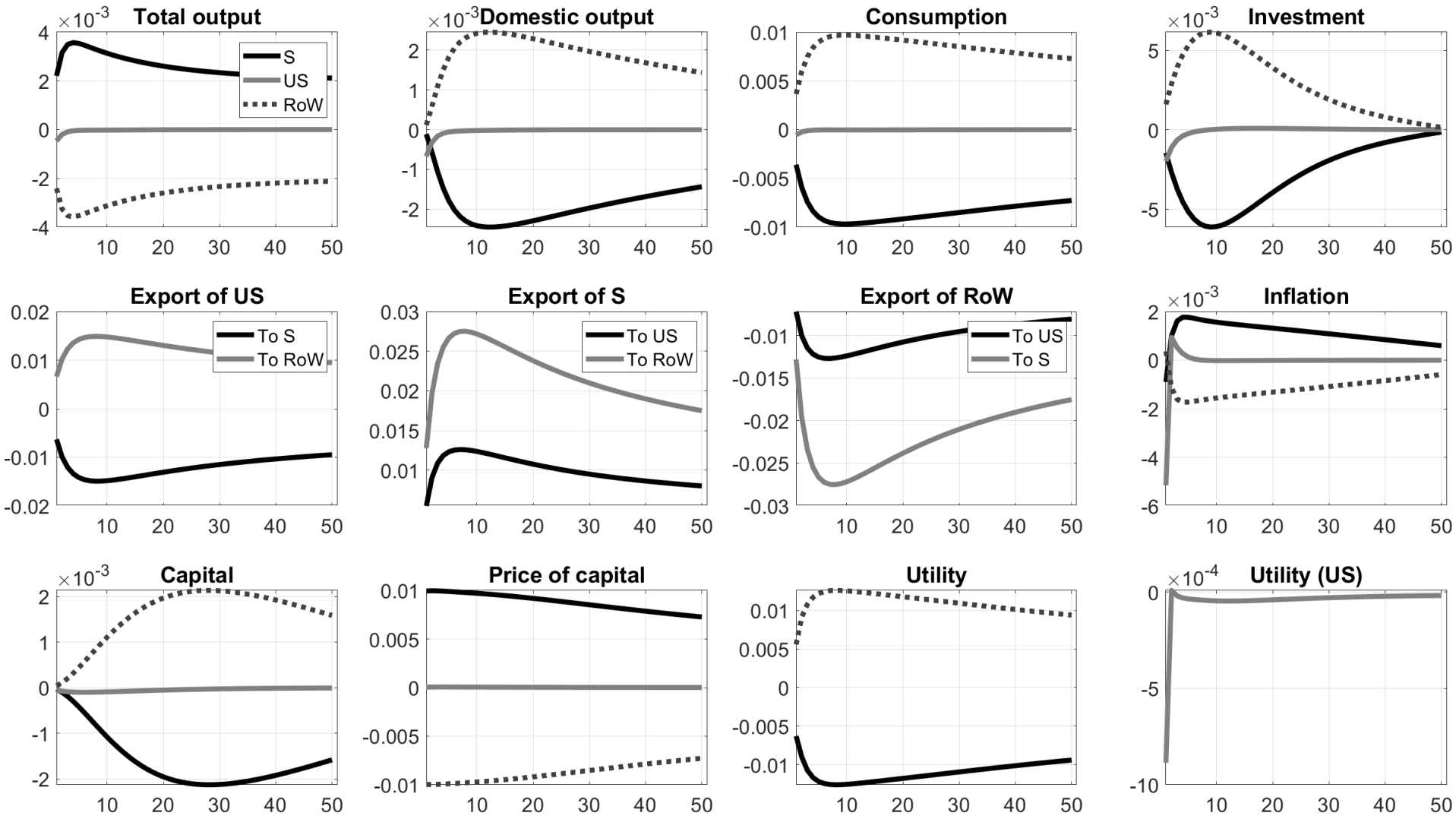


Seizure of U.S. bond reserves: **financial** variables



Notes: Impulse response for a 1% reduction in the U.S. bond reserve holdings of country S. All countries have equal weights; gold and bonds have equal weights in central bank reserves and γ_{CB}=2. The gold market is fully competitive. Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points.

Seizure of U.S. bond reserves: **real** variables



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Empirical framework

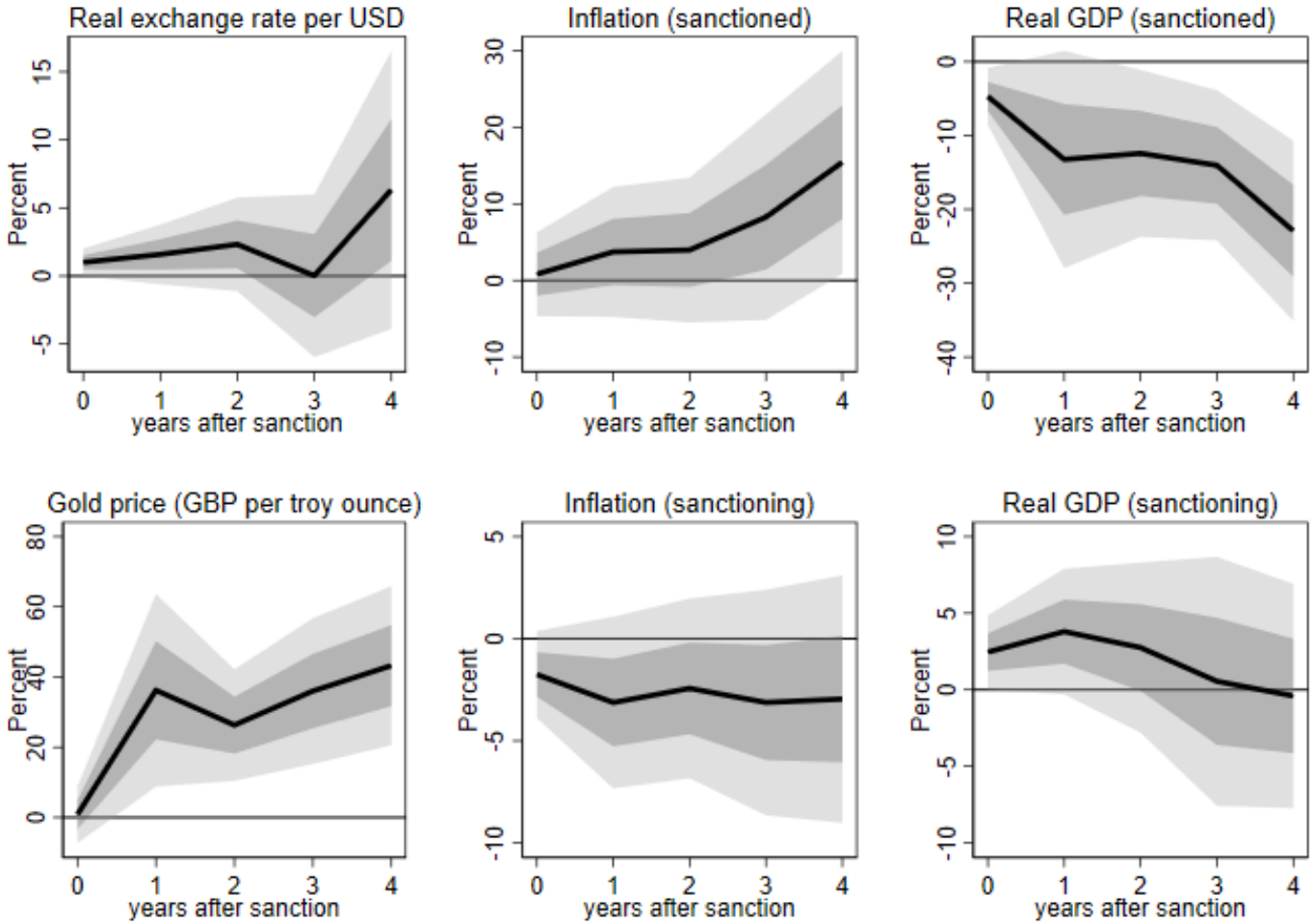
Estimate with panel local projections the reaction of key outcome variables to sanctions:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i + ED_{i,t} + \beta_k Sanction_{i,t} + \sum_{i=0,1} \delta_i GPR_{t-i} + \gamma Trade_{i,t} + \varepsilon_{i,t+k}$$

where:

- $\Rightarrow$ $y_{i,t+k}$: log of exchange rate per USD of country i in year t (or log of gold prices/ CPI index/ output in country i)
- $\Rightarrow$ GPR_t: geopolitical risk as control variable (Caldara and Iacoviello, 2022)
- $\Rightarrow$ α_i, $ED_{i,t}$: country fixed effect & external default dummy (Reinhart and Rogoff, 2009)
- $\Rightarrow$ Sanctions on central bank assets and trade in country i (or by country i): estimate Equation (1) for sanctioned and sanctioning countries separately and group together asset freezes and seizures

Estimated effects of sanctions on central bank assets



Notes: Responses of selected outcome variables (shown as a solid black line) in years 0–4 following the introduction of sanctions on central bank assets. The local projection estimates are obtained by OLS over the full sample (1914–2022); they control for country fixed effects and Caldara and Iacoviello (2022)'s index of geopolitical risk, the joint imposition of trade sanctions, Reinhart and Rogoff, (2009) external default. The shaded areas are 1.96 (1)-standard deviation confidence bands.

The Case of Today's Russia

Calibrate Model to Today's Russia

- ✓ Respective shares in global output: U.S. 15%, Russia 3%, RoW 82%

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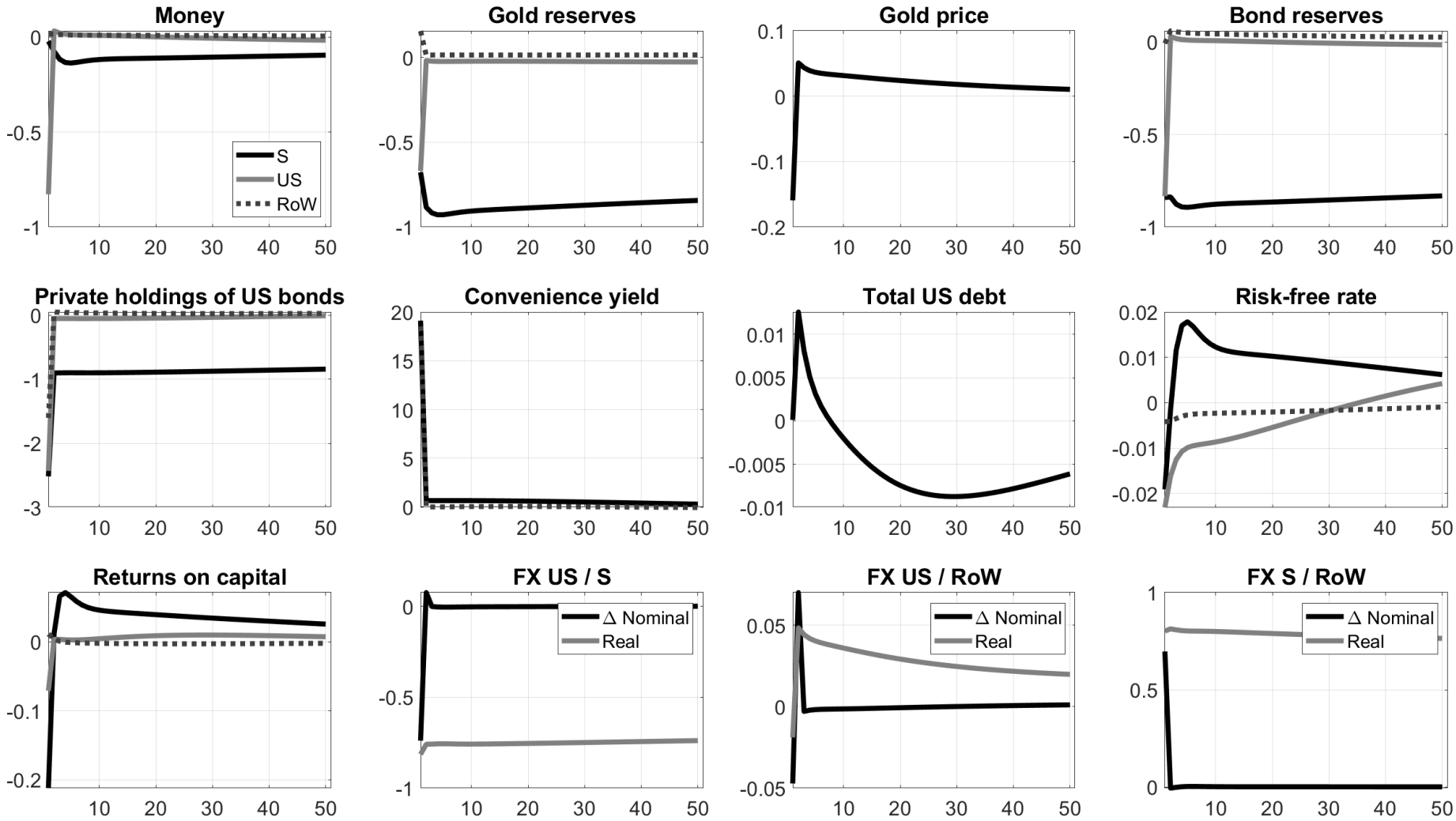
- ✓ Respective shares in global output: U.S. 15%, Russia 3%, RoW 82%
- ✓ Composition of Russia's foreign reserves: 20% gold , 80% U.S./G7 bonds
- ✓ Estimate 12 key structural parameters in the U.S. and Russia to match the volatility of consumption, GDP, inflation, money supply and interest rates (moment matching):
  - Taylor rule coefficients
  - price stickiness
  - elasticities of substitution across goods

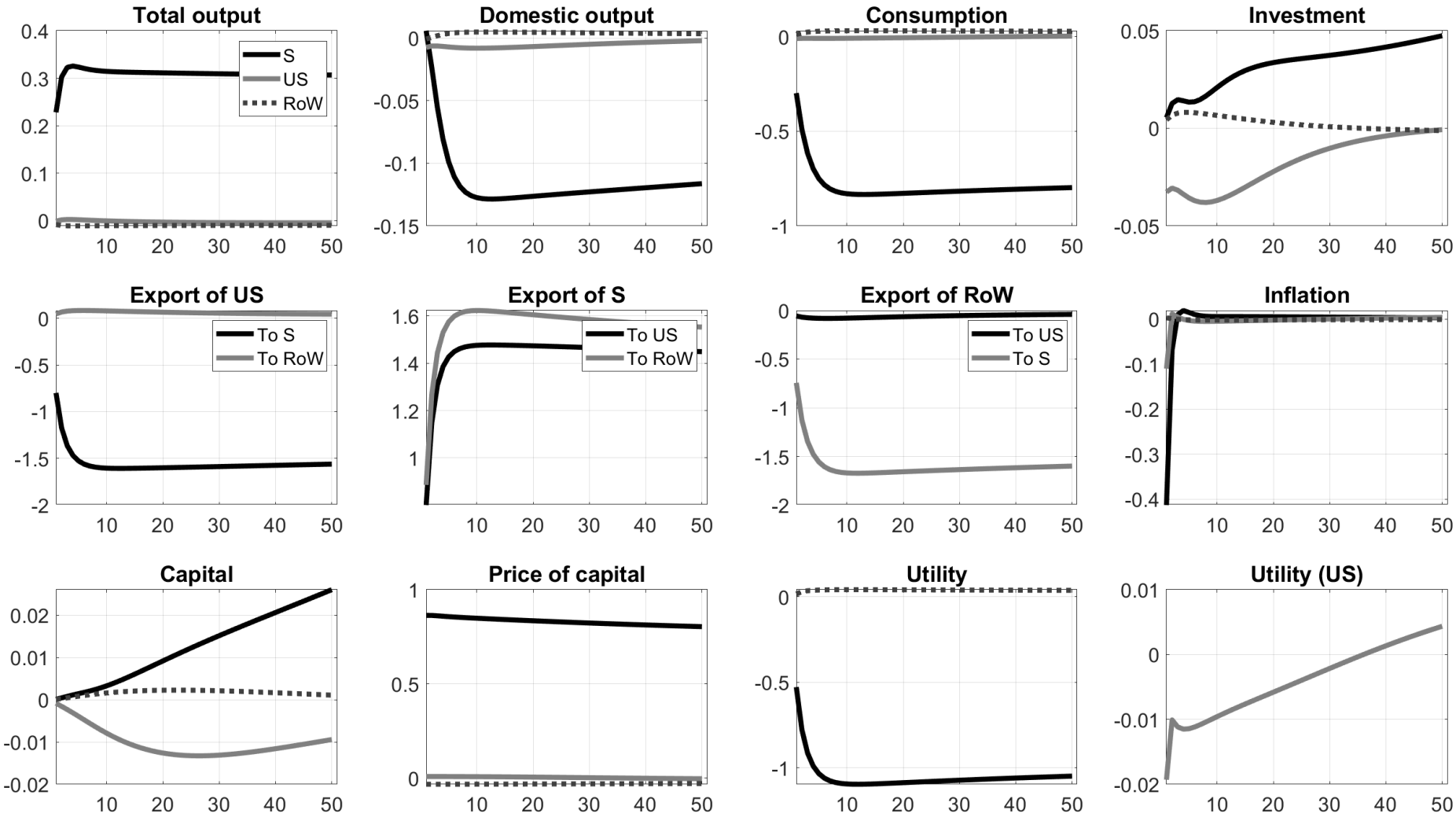
Estimated parameters.

Seizure of Russia's reserves: financial variables



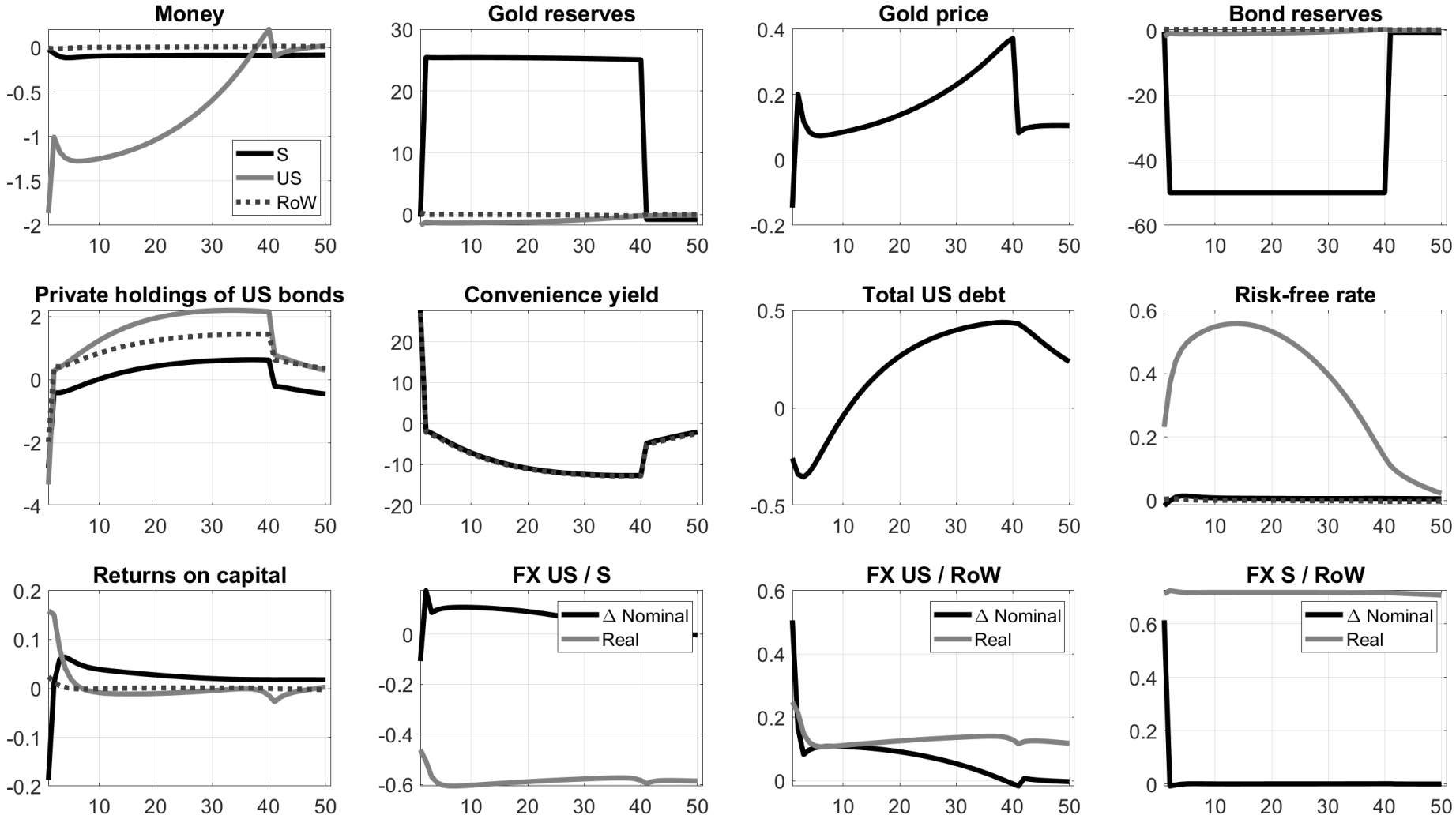
Notes: Impulse response for a 50% seizure of the U.S. bond reserve holdings of Russia (country S). The U.S. accounts for 15% of the global output against 3% for Russia, γ_{CB}=2. Russia's foreign reserves are composed of 20% gold and 80% U.S. bonds. The gold market is fully competitive. Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points.

Seizure of Russia's reserves: real variables



Notes: Impulse response for a 50% reduction in the U.S. bond reserve holdings of country S (Russia). The U.S. accounts for 15% of the world and Russia for 3%, γ_{CB}=2. Russia's foreign reserves are composed by gold for 20% and by assets for 80%. The gold market is fully competitive. Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points.

Seizure *plus* restricted access to U.S. bond markets



Notes: Impulse response for a 50% seizure of U.S. bond reserve holdings of Russia (country S). The U.S. accounts for 15% of the global output against 3% for Russia, γ_{CB}=2. Russia's foreign reserves are composed of 20% gold and 80% U.S. bonds. We further assume that Russia has no access to financial markets for 40 periods. Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points. Real variables

Conclusion

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- Model simulations demonstrate that seizing central bank assets have stronger effects than freezing and effects can partially backfire on the sanctioning country in general equilibrium
- Policy implications:
  - Seizing central bank assets not just an incremental step relative to freezing but may imply stronger economic effects and risks globally
  - For today's Russia increase in U.S. interest payments resulting from seizure could outweigh the amount of frozen assets already after two years (no free lunch)

Link to the paper

Appendix

What would be the effects of a seizure of central bank assets?

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What would be the effects of a seizure of central bank assets?

- So far, there is no comprehensive database of previous cases and a lack of a conceptual framework tailored to the understanding of the potential effects of such measures
- Put the current discussions in broader perspective and unearth the long – albeit hitherto forgotten – history of sanctions on central bank assets
- Need to analyze the global economic and financial impacts of sanctions through the lenses of an international macro-model

Countries' central bank assets targeted post-WWII

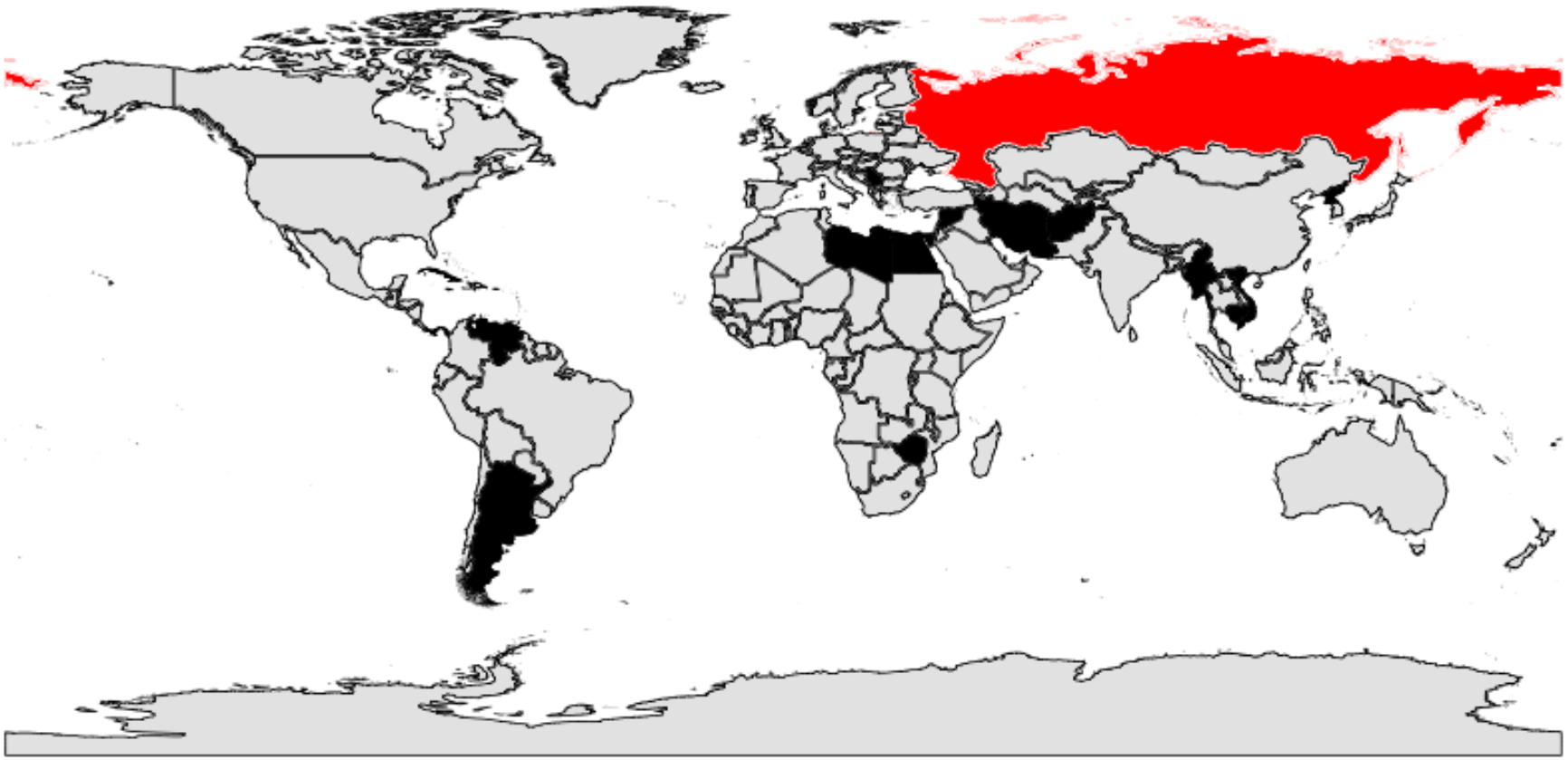


Figure: Countries targeted by sanctions on central bank assets since 1950

Countries' central bank assets targeted during WWII

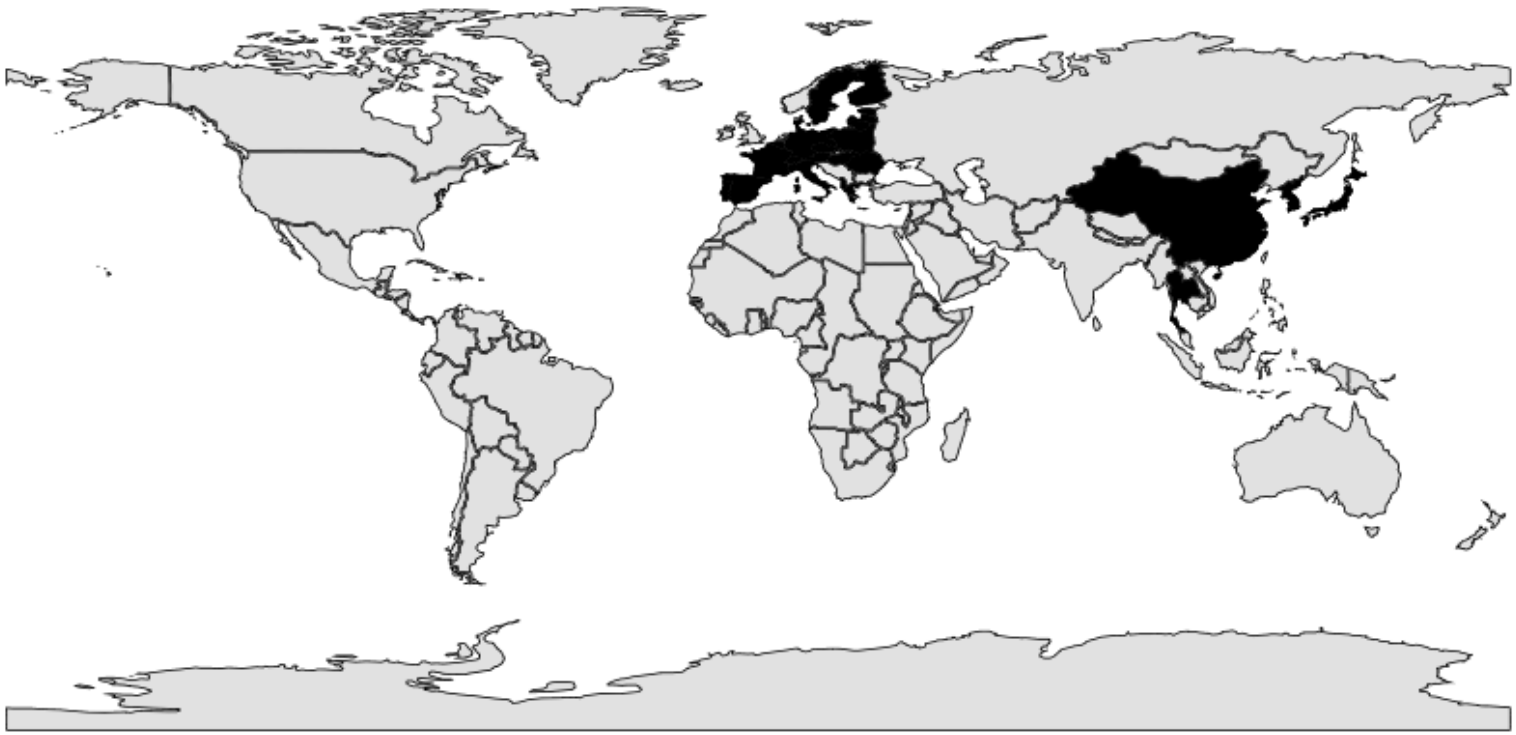


Figure: Countries targeted by sanctions on central bank assets during World War II

Scale of the freeze on CBR assets rarely seen in history

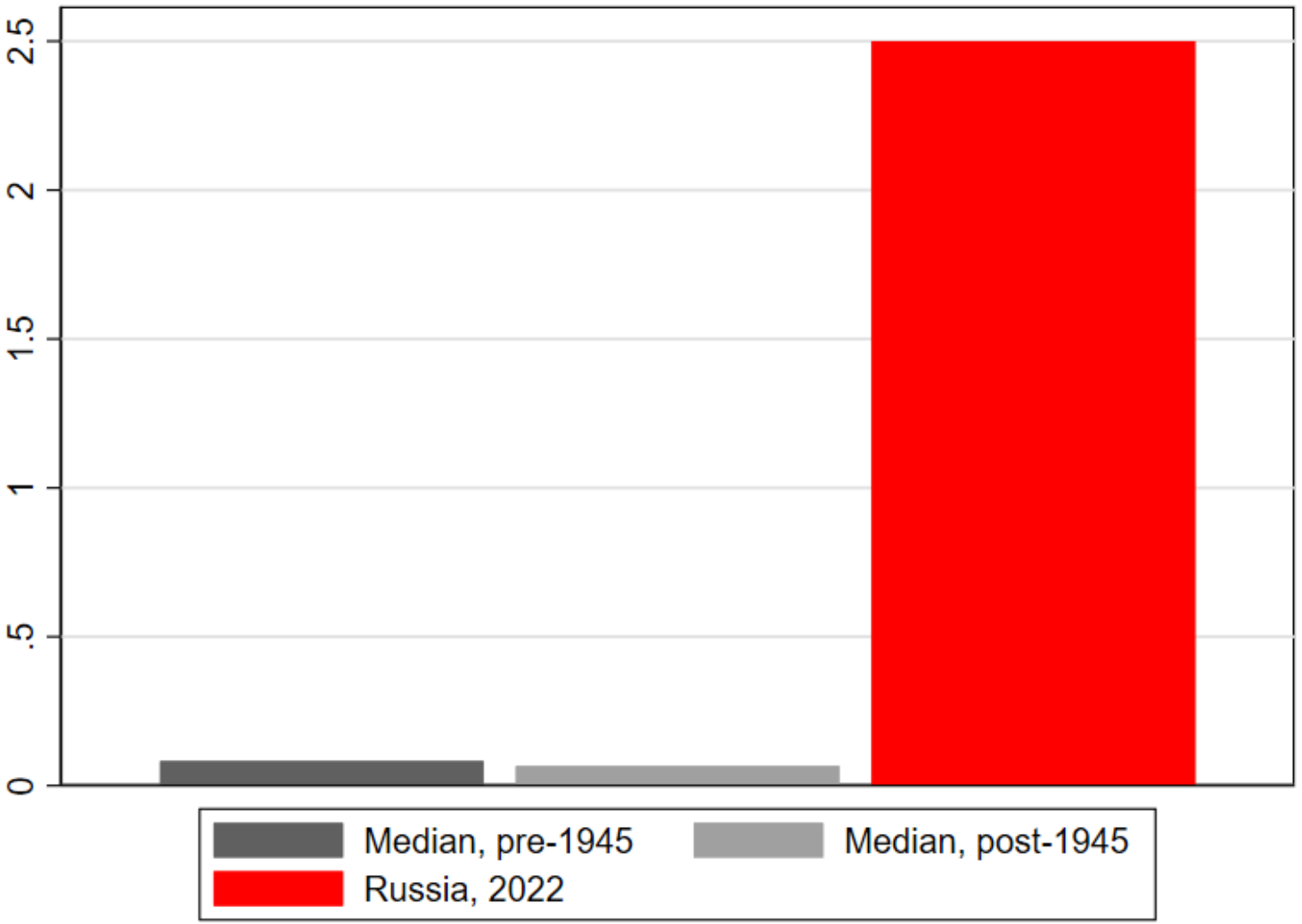
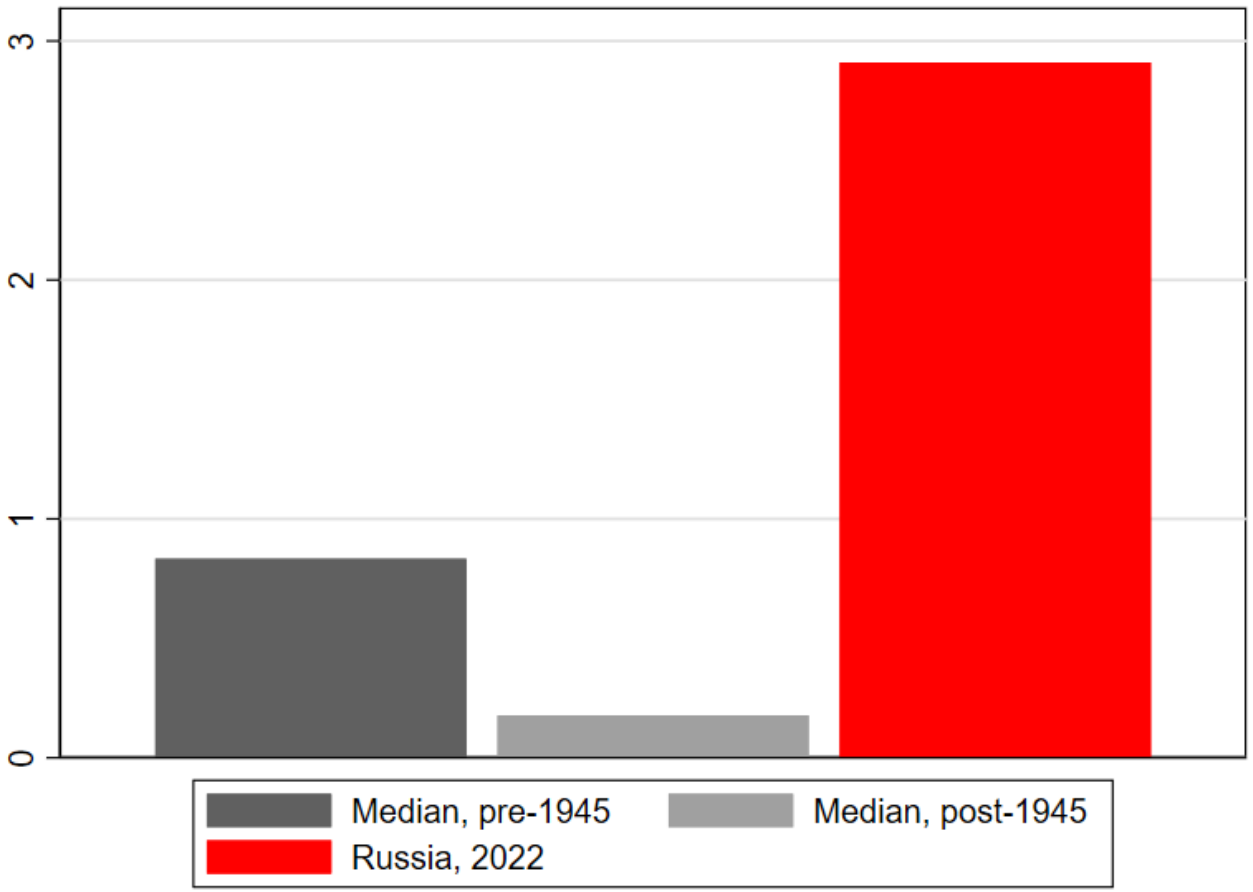
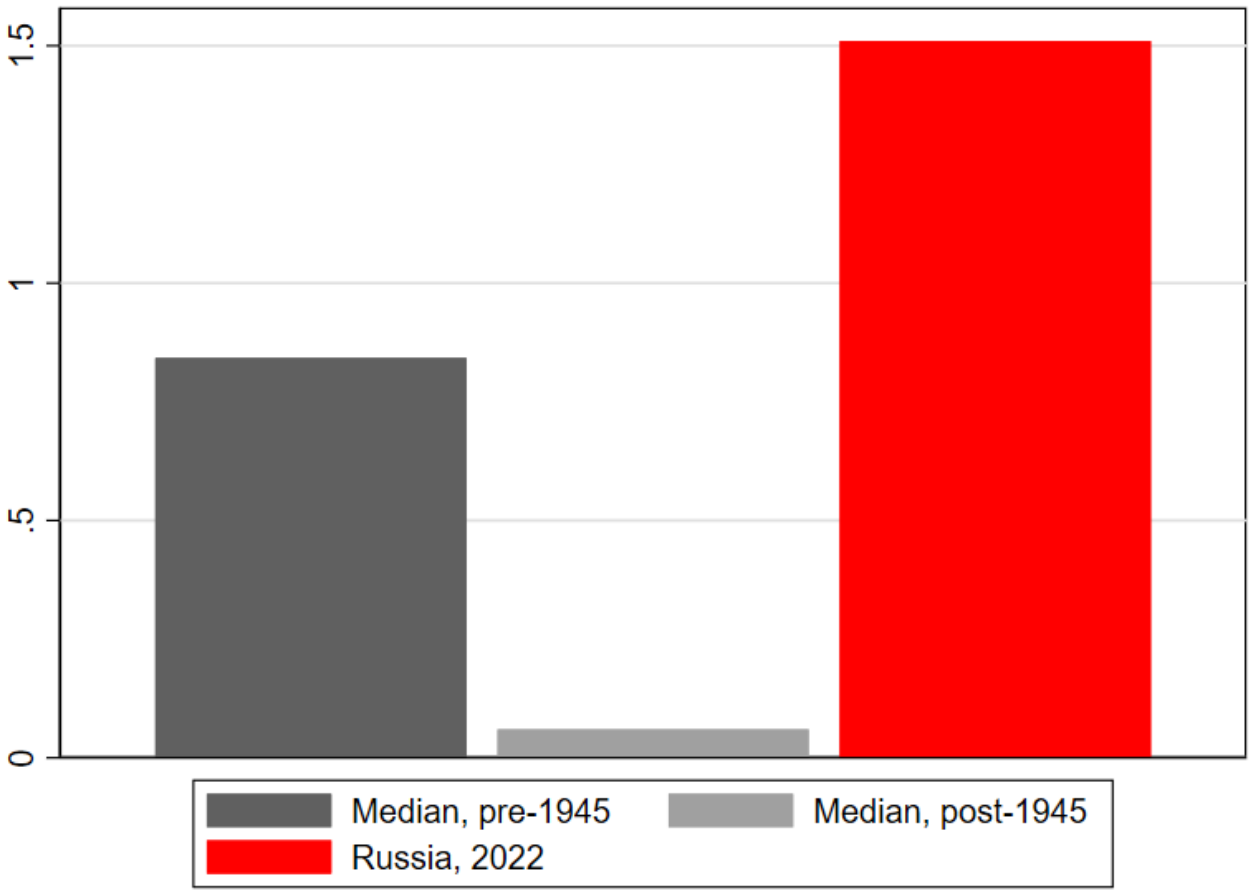


Figure: Median share of global foreign reserves held by targeted countries in selected periods.

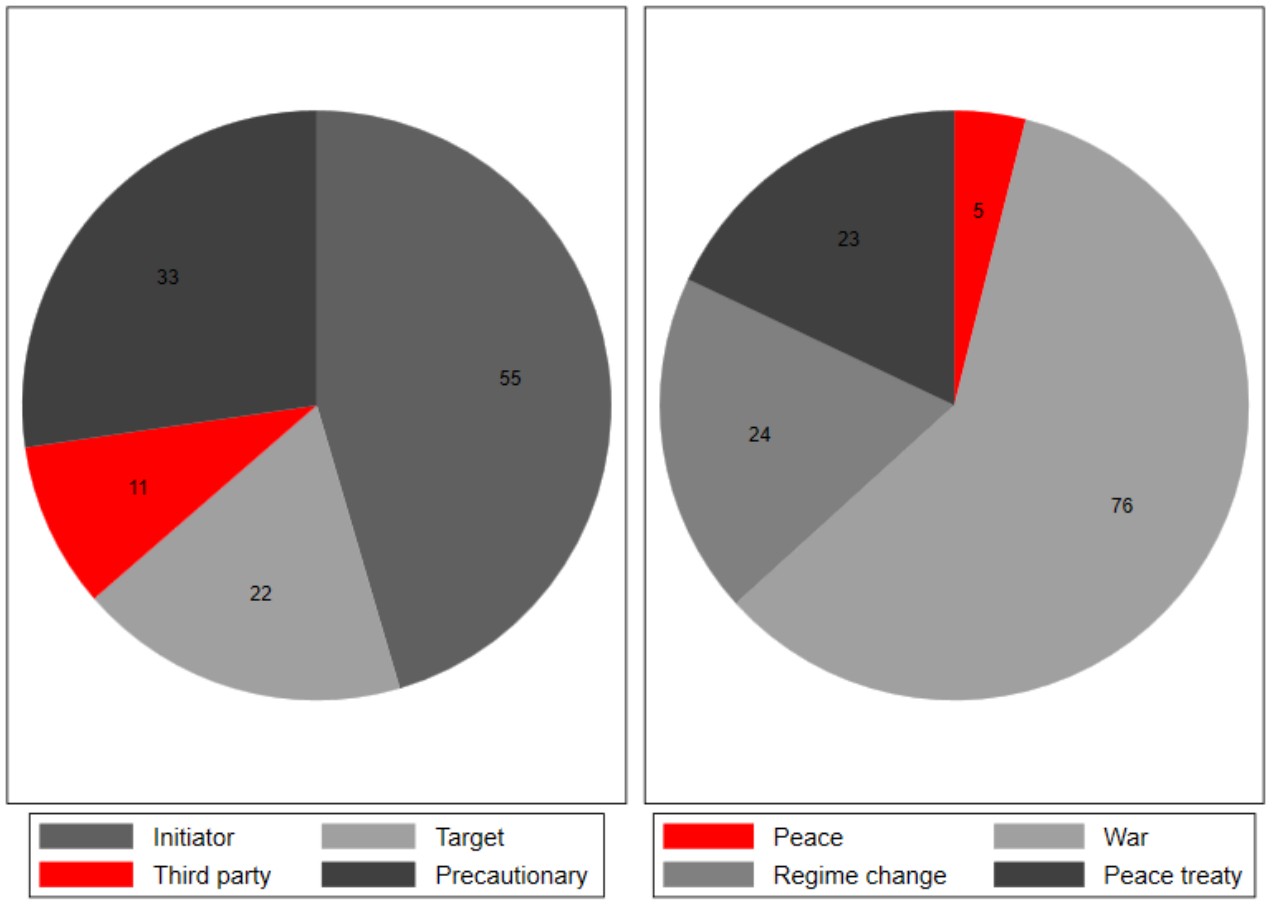
Median share of global GDP across targeted countries in selected periods



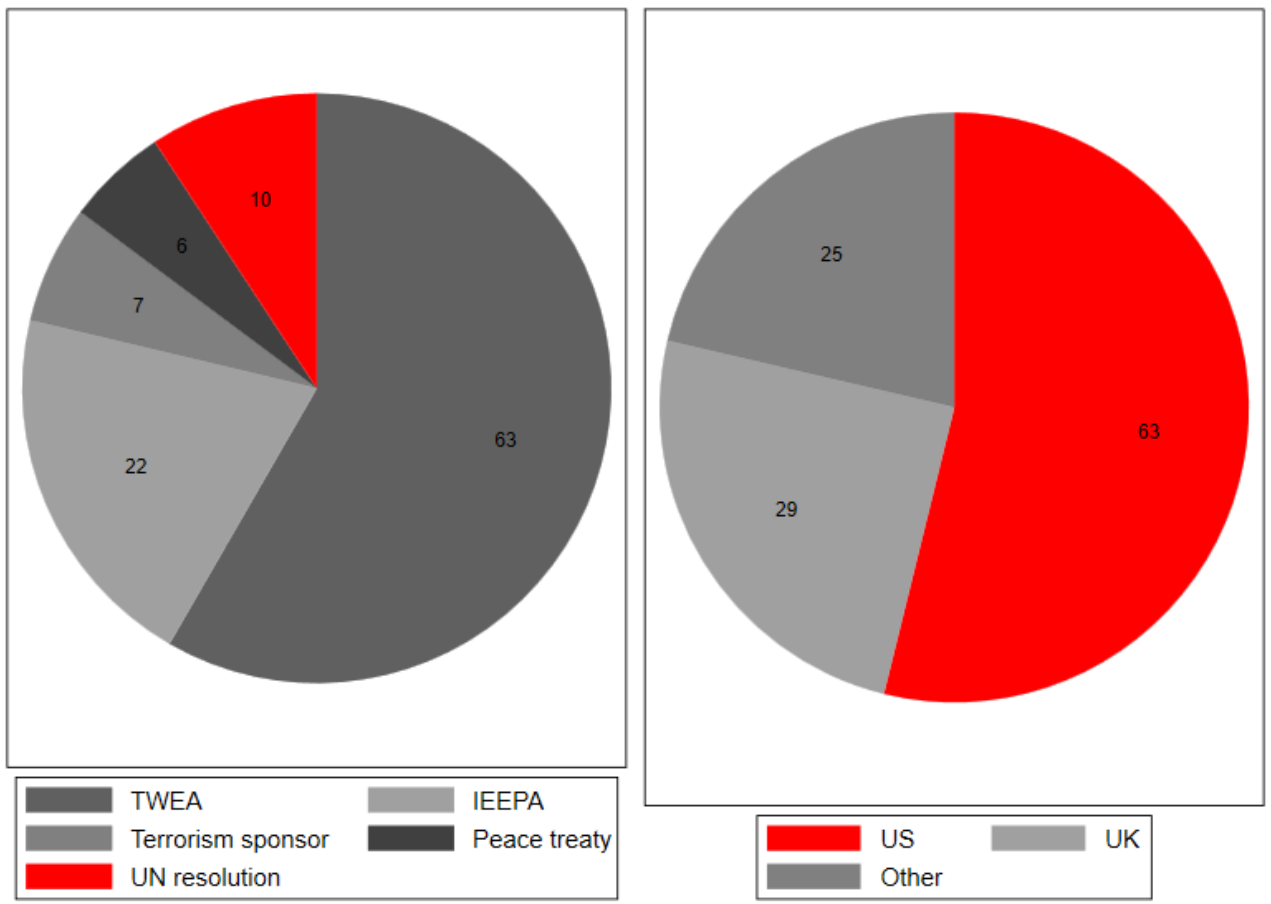
Median share of global trade across targeted countries in selected periods



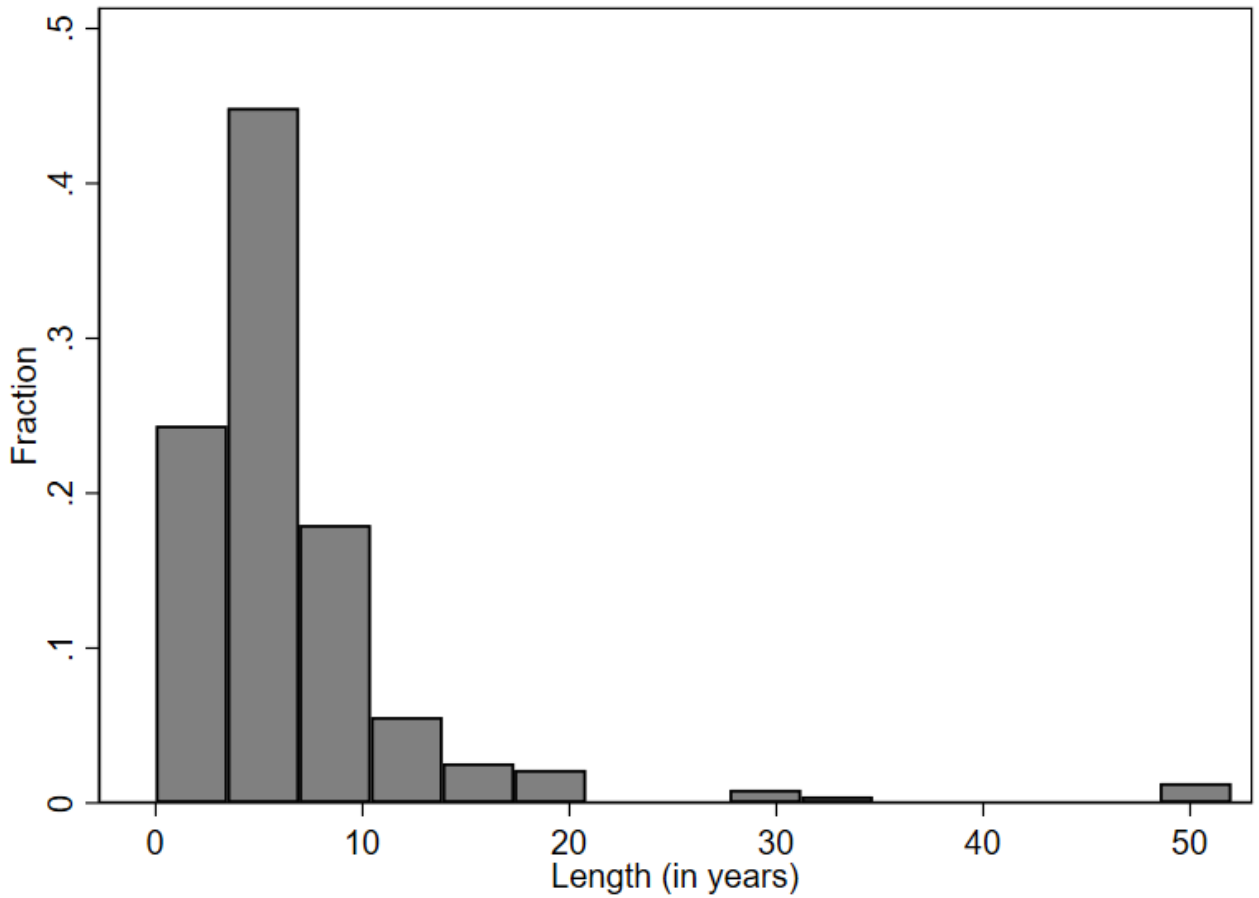
When and for who? Breakdown of sanctions by type: 1914-2024



Targeter and their legal basis? Breakdown of sanctions by type: 1914-2024



Length (in years) of sanctions on central bank assets: 1914-2022



Example of case study: Sudan

E.22 Sudan (1997-2017)

In August 1993, the U.S. placed Sudan on the State Department list of countries designated as supporters of international terrorism. After a series of events (including an attack on the Egyptian President Hosni Mubarak's limousine in Ethiopia), U.S. President Clinton invoked the IEEPA and issued Executive Order 13067 on November 3, 1997, which imposed unilateral sanctions on Sudan and froze all property of the Sudanese Government, including the assets of the Bank of Sudan. According to GAO (2004), the overall amount of frozen assets was estimated at about USD 28.4 million. After twenty years, the asset freeze measures were finally revoked on October 12, 2017, recognizing positive actions by the Government of Sudan. More recently, the situation in Sudan deteriorated significantly as reflected by the military's seizure of power in October 2021 and the outbreak of inter-service fighting in April 2023. In response to these developments, U.S. President Biden issued Executive Order 14098 on May 4, 2023, which imposed sanctions on "certain persons destabilizing Sudan and undermining the goal of a democratic transition" – including an asset freeze. However, the latter did not involve a broad-based freeze of all government assets but was rather targeted at certain individuals or entities (not including the central bank).

Sources: GAO (2004), Hufbauer et al. (2009), Executive Order 13067 Blocking Sudanese Government Property and Prohibiting Transactions With Sudan, November 3, 1997, https://www.govinfo.gov/link/cpd/executiveorder/13067, Executive Order 14098 Imposing Sanctions on Certain Persons Destabilizing Sudan and Undermining the Goal of a Democratic Transition, May 4, 2023, https://ofac.treasury.gov/media/931716/download?inline

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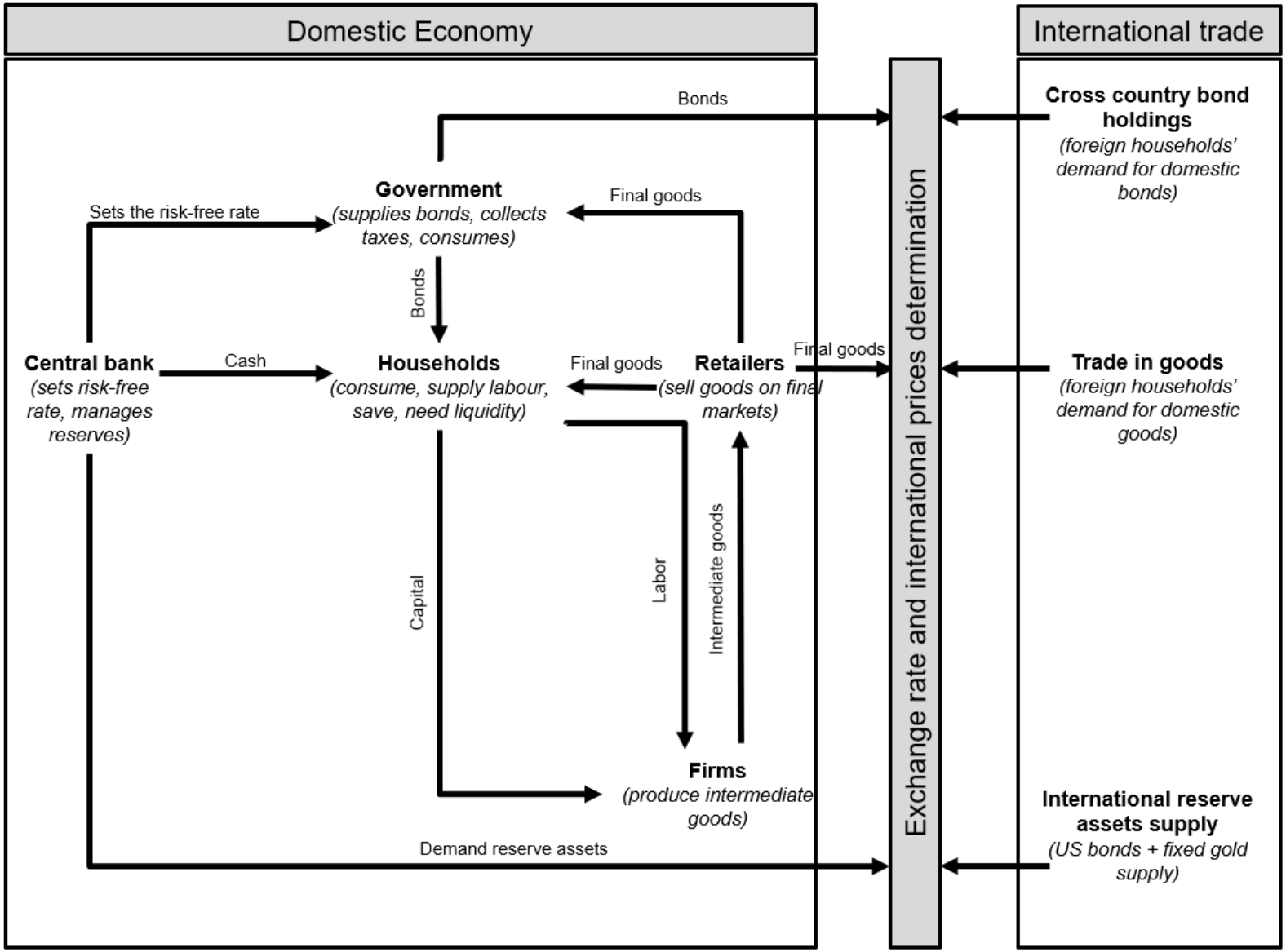
3-country model overview



The central bank problem

The CB problem is:

$$min_{\mathcal{IG},B^{CB}} \frac{P_t^G \mathcal{G}_{c,t}}{P_{US,t} RER_{US,c,t}} + \frac{B^{CB}_{US,c,t}}{r_{US,t} P_{US,t} RER_{US,c,t}} + + \frac{B^{CB}_{C,c,t}}{r_{C,t} P_{C,t}} \tag{1}$$

s.t. $\frac{M_{c,t}}{P_{c,t}} =$

$$\left[\psi_{c,b} \left(\frac{B^{CB}_{US,c,t}}{P_{US,t}} \frac{1}{RER_{US,c,t} r_{US,t}} \right)^{\gamma_{c,CB}} + \psi_{c,g} \left(\frac{P_t^G \mathcal{G}_{c,t}}{P_{US,t} RER_{US,c,t}} \right)^{\gamma_{c,CB}} + \psi_{c,d} \left(\frac{B^{CB}_{c,c,t}}{P_{c,t}} \frac{1}{r_{c,t}} \right)^{\gamma_{c,CB}} \right]^{\frac{1}{\gamma_{c,CB}}}$$

and $\mathcal{G}_{c,t} = (1 - \delta_{c,g}) \mathcal{G}_{c,t-1} + IG_{c,t}$

FOCs are:

$$1 = \psi_{c,b} \mathcal{M}_{c,t} \left(\frac{M_{c,t}}{P_{c,t}} \right)^{1-\gamma_{c,CB}} \left(\frac{B^{CB}_{US,c,t}}{r_{US,t} P_{US,t} RER_{US,c,t}} \right)^{\gamma_{c,CB}-1} \tag{2}$$

$$1 = \psi_{c,g} \mathcal{M}_{c,t} \left(\frac{M_{c,t}}{P_{c,t}} \right)^{1-\gamma_{c,CB}} \left(\frac{P_t^G \mathcal{G}_{c,t}}{P_{US,t} RER_{US,c,t}} \right)^{\gamma_{c,CB}-1} \tag{3}$$

$$1 = \psi_{c,d} \mathcal{M}_{c,t} \left(\frac{M_{c,t}}{P_{c,t}} \right)^{1-\gamma_{c,CB}} \left(\frac{B^{CB}_{c,c,t}}{r_{c,t} P_{c,t}} \right)^{\gamma_{c,CB}-1} \tag{4}$$

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Model calibration

Table: List of parameters

Parameter	Description	Value	Parameter	Description	Value
h_c	Habit formation	0.65	$\gamma_{c,r}$	Interest rate smoothing	0.75
ϕ_c	Inverse of Frish elasticity of labor	1	$\theta_{c,Y}$	Interest rate sensitivity to output	0.6
β_c	Discount factor	0.9926	$\theta_{c,\pi}$	Interest rate sensitivity to inflation	1.2
σ_c	Log-consumption	1	$\frac{G_{ss}}{Y_{ss}}$	Steady state gov. spending over output	0.2
$\sigma_{c,m}$	Elasticity of money	10.62	$\kappa_{c,T}$	Tax sensitivity to deficit	0.48
$\sigma_{c,b}$	Elasticity of bonds	10.62	$\varrho_{c,T}$	Persistency of taxation	0.5
$\chi_{c,m}$	Weight of money in utility	0.1	$\delta_{c,g}$	Depreciation rate of gold	0.0002
$\chi_{c,b}$	Weight of bonds in utility	0.1	$\psi_{c,b}$	Weight of bond in reserve aggregator	1
ϕ_c^B	Cross-country bond holding cost	0.001	$\psi_{c,g}$	Weight of gold in reserve aggregator	1
ϕ_c^K	Investment costs	1.728	γ_c, CB	Elasticity of reserves	2
$\omega_{c,c}$	Home bias	0.75	$\rho_{c,R}$	Persistency of monetary shocks	0
ϱ_c	Elasticity of substitution across goods	0.333333	$\rho_{c,A}$	Persistency of TFP shocks	0.5
δ_c	Capital depreciation rate	0.025	$\rho_{c,C}$	Persistency of preference shocks	0.5
$_c$	Prob. of price update	0.6	$\sigma_{c,r}$	Volatility of monetary shocks	0.01
ν_c	Demand elasticity	6	$\sigma_{c,A}$	Volatility of TFP shocks	0.01
α_c	Capital share in production	0.3	$\sigma_{c,C}$	Volatility of preference shocks	0.01

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Moment matching

Table: List of estimated parameters

Parameter	Description	Value	Parameter	Description	Value
ϱ_{US}	Elasticity of substitution across goods	0.31	ϱ_S	Elasticity of substitution across goods	0.32
ν_{US}	Demand elasticity	4.50	ν_S	Demand elasticity	4.4
$_{US}$	Prob. of price update	0.50	$_S$	Prob. of price update	0.50
$\gamma_{US,r}$	Interest rate smoothing	0.85	$\gamma_{S,r}$	Interest rate smoothing	0.84
$\theta_{US,\pi}$	Interest rate sensitivity to inflation	1.36	$\theta_{S,\pi}$	Interest rate sensitivity to inflation	1.8
$\theta_{US,Y}$	Interest rate sensitivity to output	0.61	$\theta_{S,Y}$	Interest rate sensitivity to output	0.73

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Solution algorithm

The non-linear system of equations in period τ is:

$$E_\tau \left[f\left(x_{\tau+1}, x_\tau, x_{\tau-1}, \eta_\tau \right) \right] = 0$$

with $f(\bullet)$ any non-linear function. Stack all the equilibrium conditions for periods $\tau \in [0, T]$ as:

$$\mathcal{F}\left(X \right) = 0$$

where $X = (x_0', x_1', ..., x_T')$ has $N \times T$ variables. This class of problems is solved numerically with a Newton-type algorithm as in Adjemian et al. (2022):

1. Start with an initial guess X^j and verify if the system is satisfied;
2. if not, try a new updated solution (X^{j+1}) from the *linearized* model $\mathcal{F}(X^j) + \mathcal{F}'(X^j)(X^{j+1} - X^j) = 0$ where $\mathcal{F}'(X^j)$ is the *Jacobian matrix* of $\mathcal{F}(\bullet)$ evaluated at X^j;
3. Iterate steps 1)-2) until convergence, i.e. $||\mathcal{F}(X^j)|| < \epsilon$.

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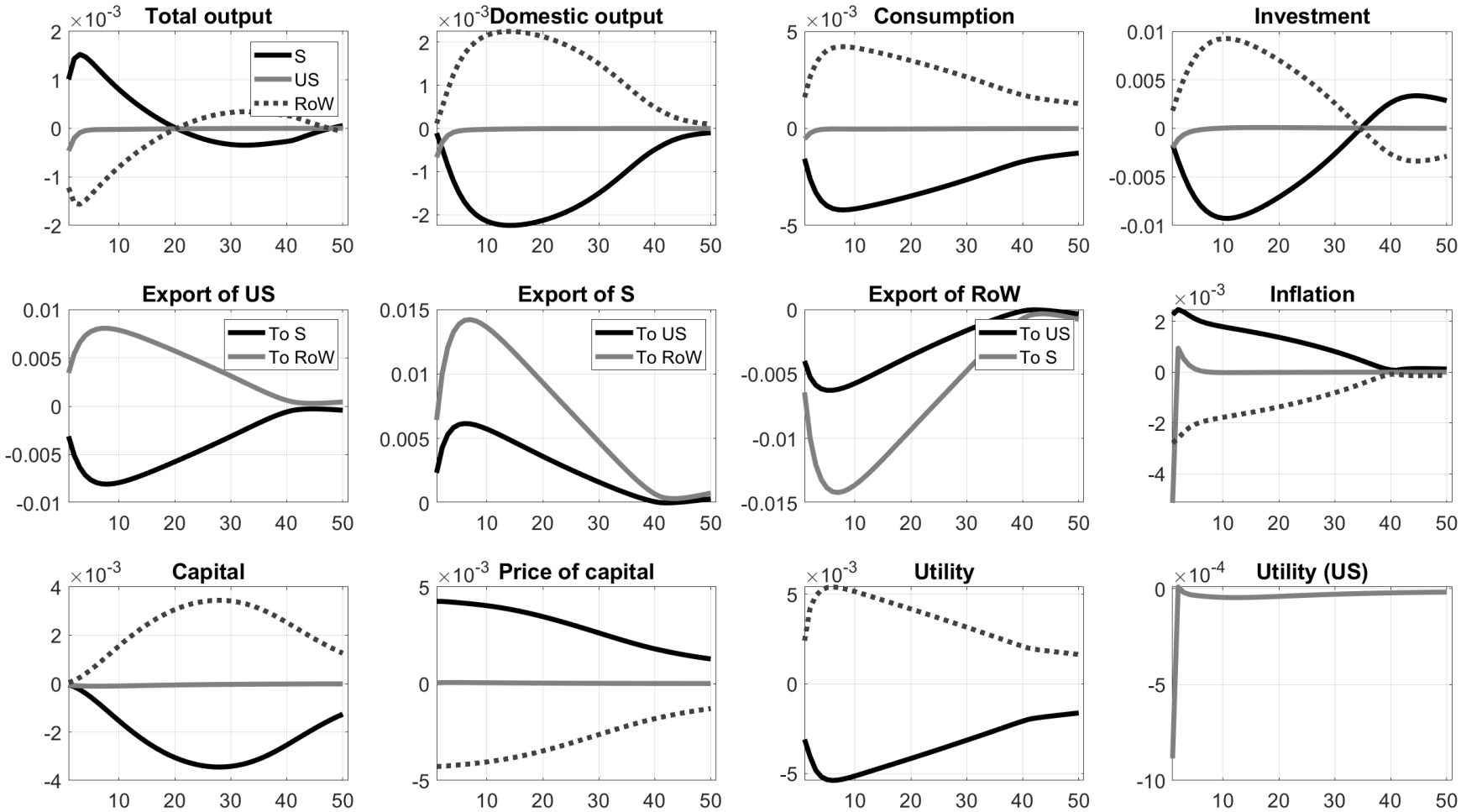
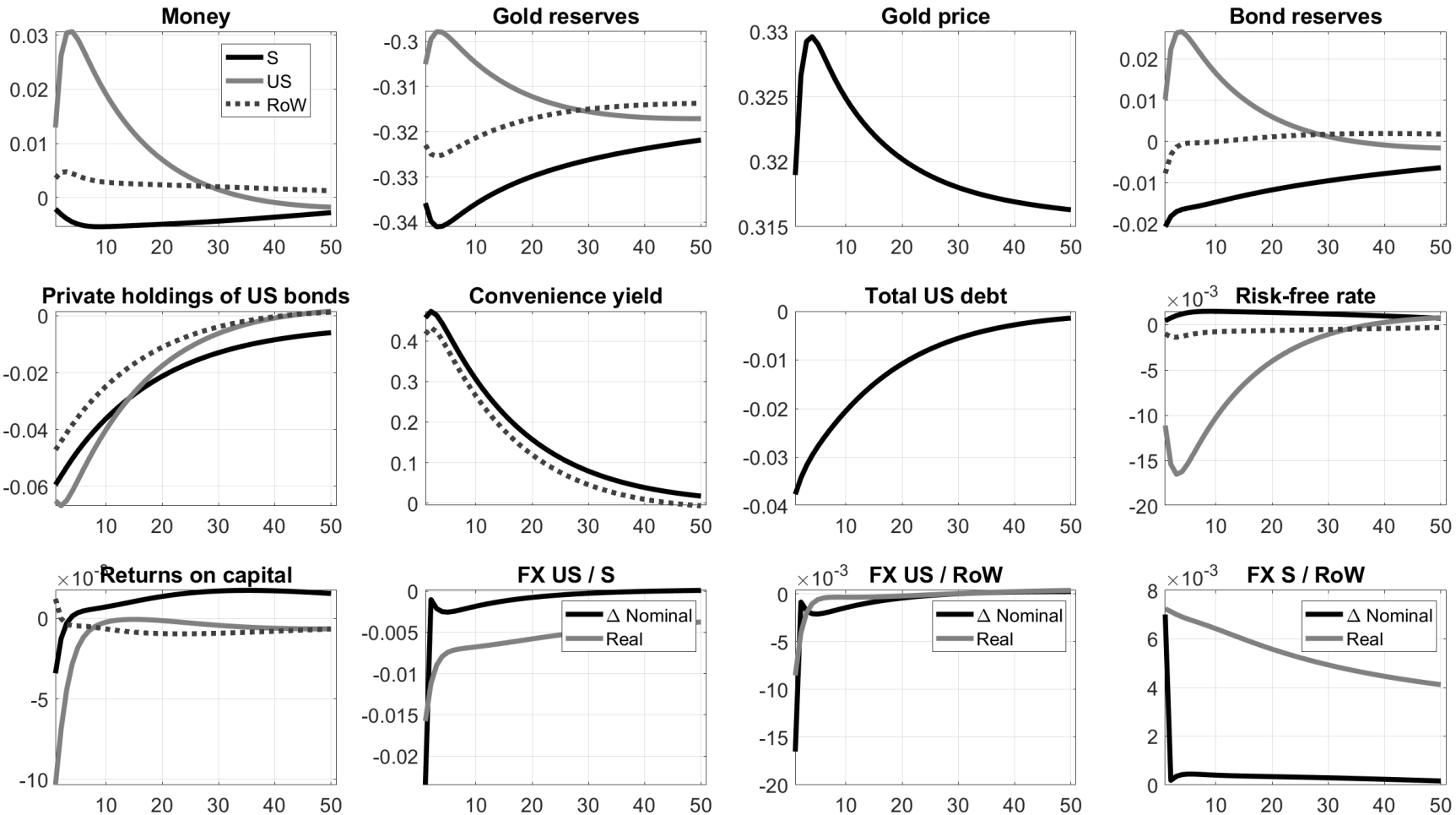
Freeze of U.S. bond reserves: muted response



Notes: Impulse response for a 1% reduction in the U.S. bond reserve holdings of country S. All countries have equal weights; gold and bonds have equal weights in central bank reserves and γ_{CB}=2. The gold market is fully competitive and U.S. bonds are returned after 10 years (40 periods). Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points.

Financial variables; Gold – financial variables; Gold – real variables

Seizure of gold reserves: financial variables



Notes: Impulse response for a 1% reduction in the gold reserve holdings of country S. All countries have equal weights, gold and bonds have equal weights in central bank reserves and γ_{CB}=2. The gold market is fully competitive. Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points.

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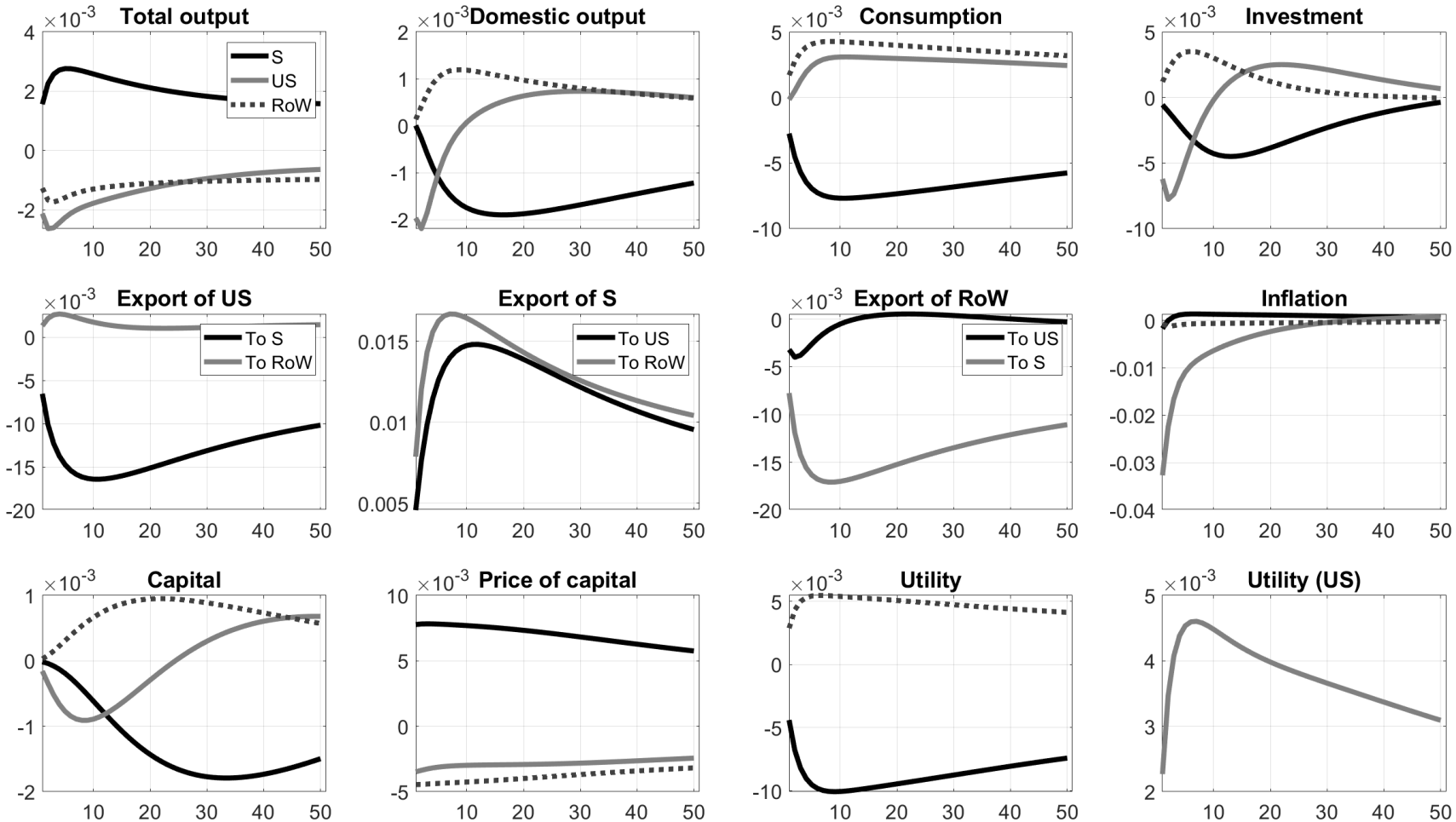
Seizure of gold reserves: real variables



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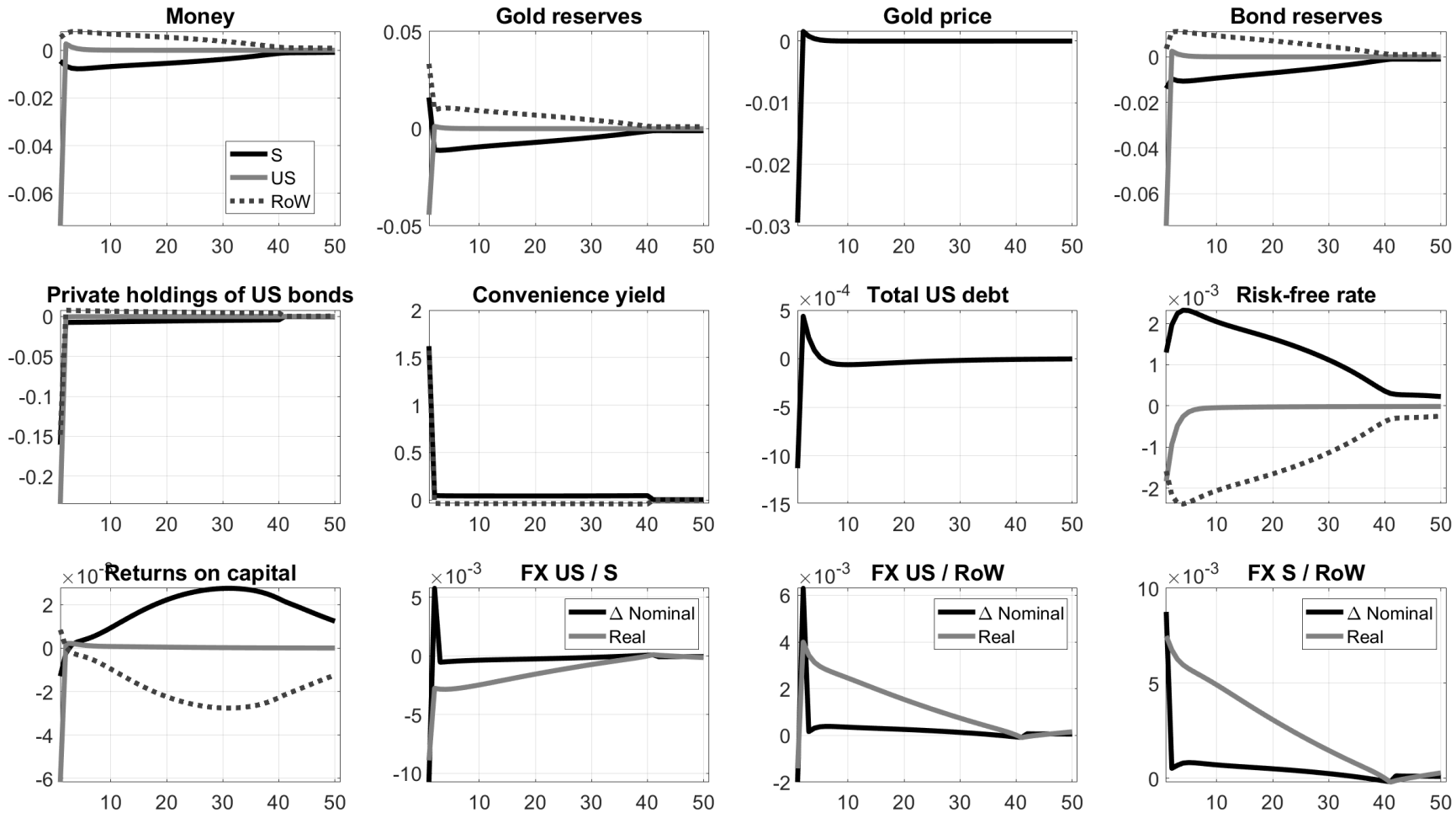
Freeze of U.S. bond reserves: financial variables



Notes: Impulse response for a 1% reduction in the U.S. bond reserve holdings of country S. All countries have equal weights; gold and bonds have equal weights in central bank reserves and γ_{CB}=2. The gold market is fully competitive and U.S. bonds are returned after 10 years (40 periods). Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points.

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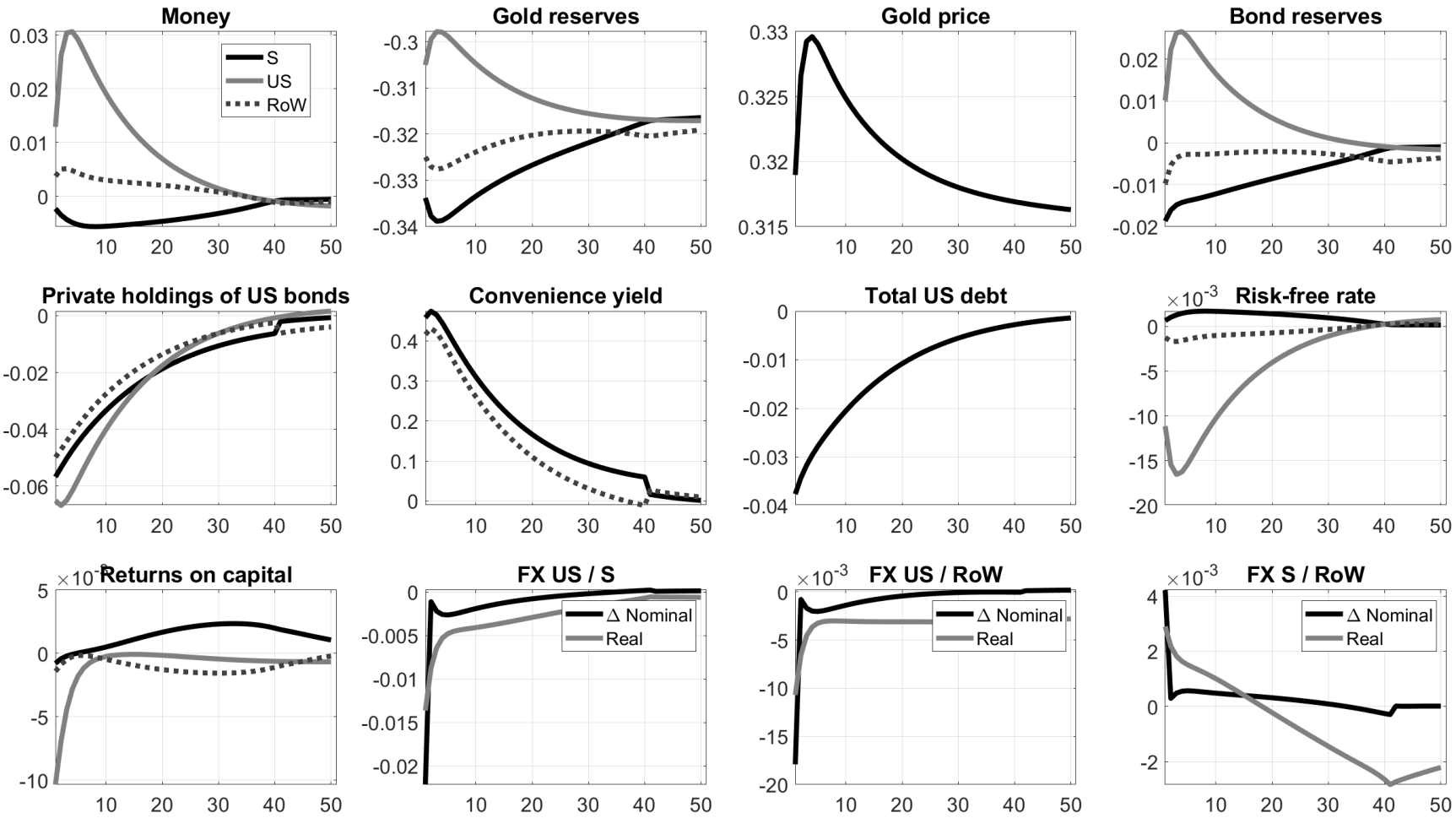
Freeze of gold reserves: financial variables



Notes: Impulse response for a 1% reduction in the gold reserve holdings of country S. All country have equal weights, gold and bonds have equal weights in central bank reserves and γ_{CB}=2. The gold market is fully competitive and gold is returned after 10 years (40 periods). Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points.

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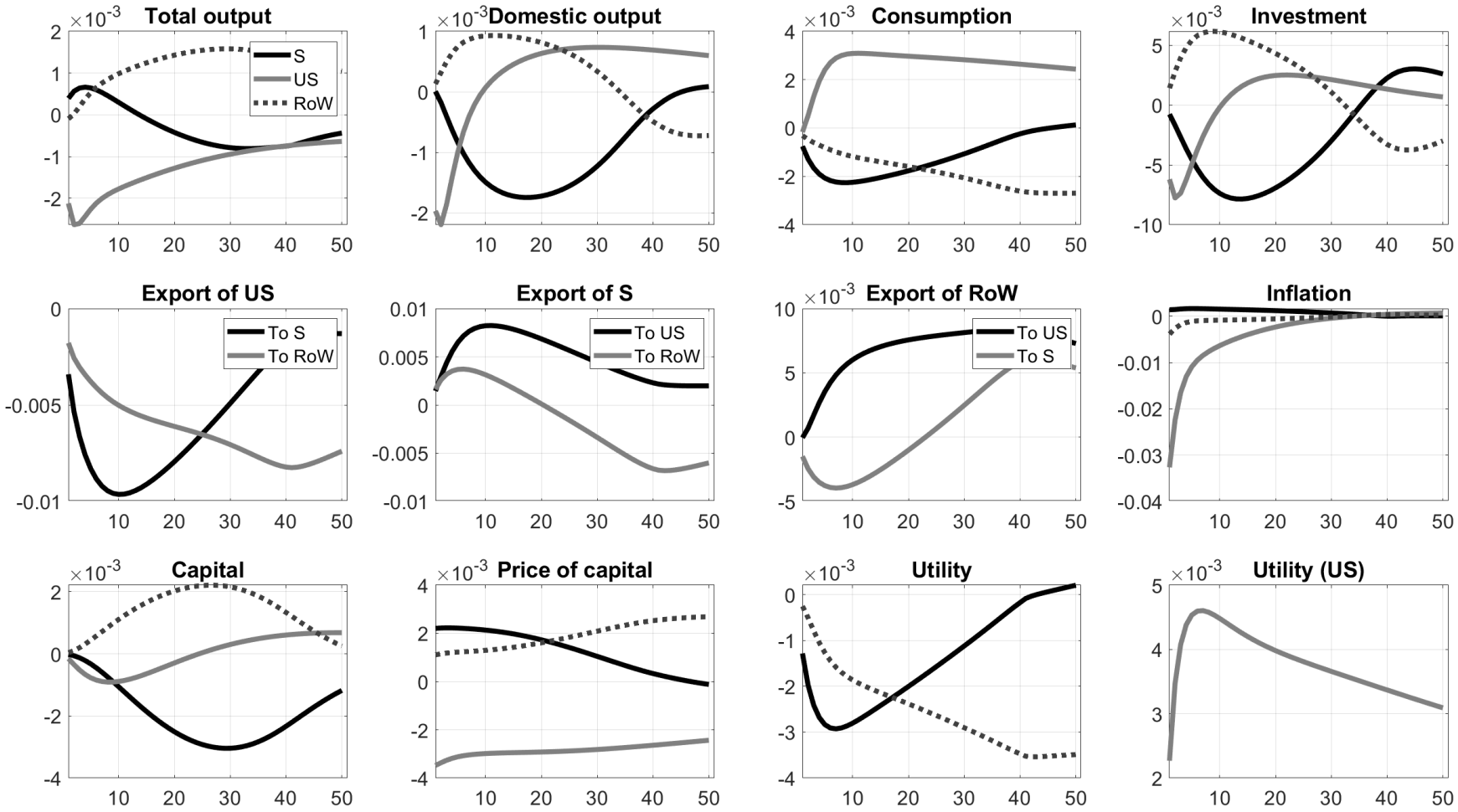
Freeze of gold reserves: real variables



Notes: Impulse response for a 1% reduction in the gold reserve holdings of country S. All country have equal weights, gold and bonds have equal weights in central bank reserves and γ_{CB}=2. The gold market is fully competitive and gold is returned after 10 years (40 periods). Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points.

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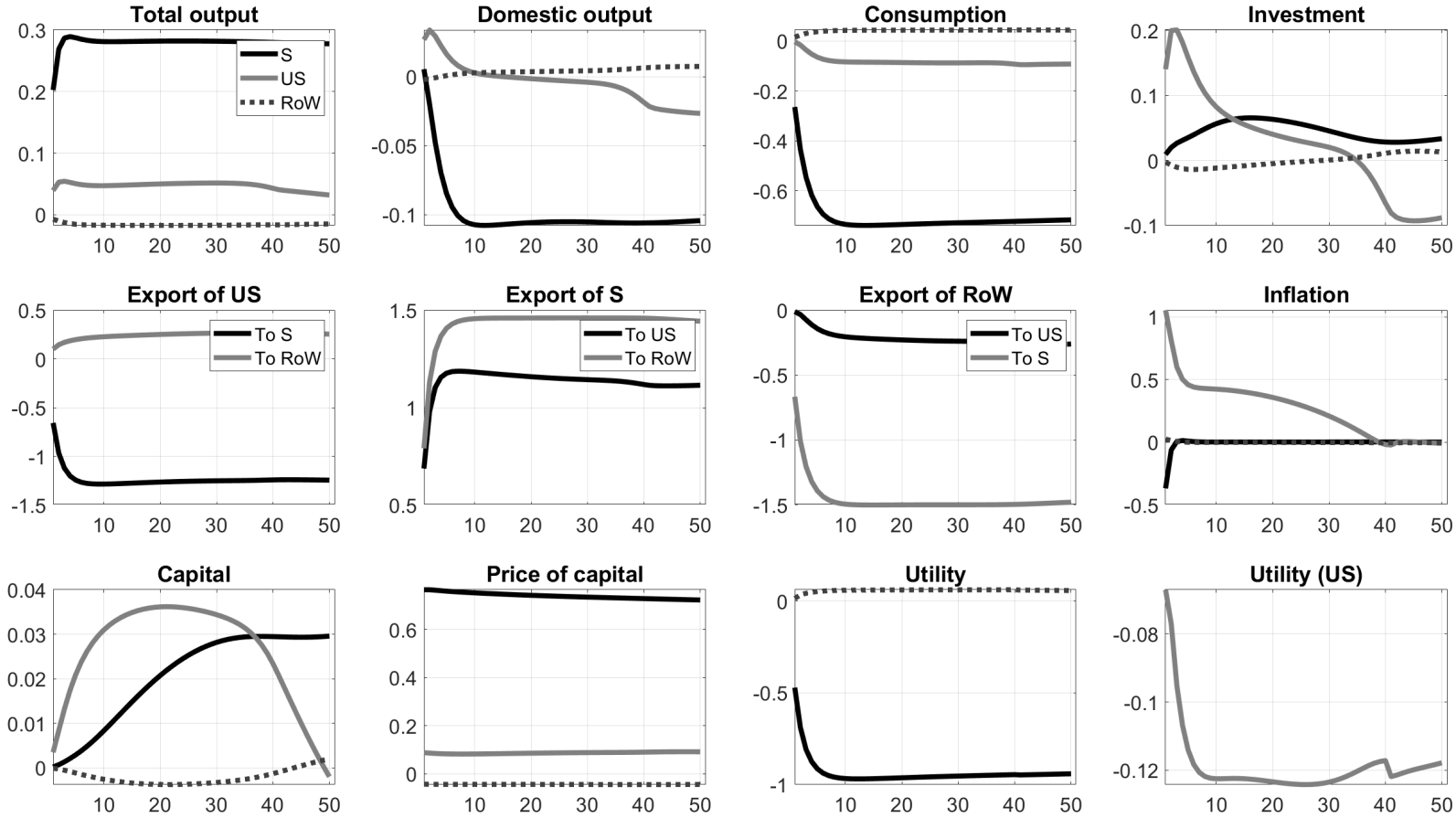
Seizure *plus* restricted access to U.S. bond markets: real variables



Notes: Impulse response for a 50% seizure of U.S. bond reserve holdings of Russia (country S). The U.S. accounts for 15% of the global output against 3% for Russia, γ_{CB}=2. Russia's foreign reserves are composed of 20% gold and 80% U.S. bonds. We further assume that Russia has no access to financial markets for 40 periods. Simulations are obtained with global methods. The responses are reported in percentage point deviation from the steady-state. Interest rate and inflation rates are reported in annualized percentage points.

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