Sanctions and the Exchange Rate

Oleg Itkhoki
UCLA

23. June 2022
Webinars on Sanctions

- Sergei Guriev *Russian Economy*
- Jim Hamilton *Oil*
- David Bacaas *German Economy* /Ben Moll
- Elina Ribakova *Details*
- Oleg Itskhoki *Exchange Rate*
Ruble-US$ exchange rate
Trade Sanctions vs. Financial Sanctions
Poll

1. End of the year ruble per US$ exchange rate (was initially 75, depreciating to 125 and then to 55)
   a. Stronger: < 65: stronger rubles per USD;
   b. Similar: 65-80;
   c. Weaker; > 80.

2. The West concentrated sanctions on Russian imports rather than exports. This made it ___ for Russia to fund the war
   a. easier;
   b. equally effective;
   c. Didn’t matter as it is independent of short-run fiscal deficit.

3. Three statements: The West does
   a. not have sufficient economic leverage against Russia, and should not use sanctions.
   b. not have sufficient economic leverage against Russia, and nonetheless should use sanctions.
   c. have sufficient economic leverage against Russia, but should not use it
Sanctions and the Exchange Rate

23. June 2022
Markus Brunnermeier
Sanctions and the Exchange Rate

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Princeton, June 2022
Rouble-USD Exchange Rate
This Paper

• Positive and normative questions:
  1. why did Ruble depreciate initially and appreciate thereafter?
  2. are sanctions “not working”?
  3. is the exchange rate irrelevant under financial constraints?
  4. what implications for government revenues?
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• Build on our earlier equilibrium exchange rate model
  — small open economy version streamlined to focus on exchange rate, real cost of living, government revenues
  — augmented with a rich set of sanctions and policy instruments
This Paper

• Positive and normative questions:
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• Build on our earlier equilibrium exchange rate model
  — small open economy version streamlined to focus on exchange rate, real cost of living, government revenues
  — augmented with a rich set of sanctions and policy instruments

• Dual role of foreign currency:
  1. goods market (exports and imports)
  2. asset market (official reserves and private savings)
MODEL
Model

• Endowment Small Open Economy with tradables and non-tradables and demand for foreign currency savings

• Households:

\[
\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[ u(C_{Ht}, C_{Ft}) + \nu \left( \frac{B^*_{t+1}}{P^*_{t+1}} ; \psi_t \right) \right]
\]

s.t. \( P_tC_{Ht} + \mathcal{E}_t P^*_{t} C_{Ft} + \frac{B_{t+1}}{R_t} + \frac{\mathcal{E}_t B^*_{t+1}}{R^*_{Ht}} \leq B_t + \mathcal{E}_t B^*_{t} + W_t \),

\( u(C_{H}, C_{F}) = (1 - \gamma)^{1/\theta} C^{\theta - 1/\theta}_{H} + \gamma^{1/\theta} C^{1/\theta}_{F} \), \( \nu(b, \psi) = -\frac{\kappa}{2} \cdot (b - \psi)^2 \)

— precautionary savings (Diamond ’65, Aiyagari ’94, CFG ’08)
Model

- Endowment Small Open Economy with tradables and non-tradables and demand for foreign currency savings

- **Households:**

  \[
  \max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[ u(C_{Ht}, C_{Ft}) + v \left( \frac{B^*_t}{P^*_{t+1}} ; \psi_t \right) \right] \\
  \text{s.t.} \quad P_tC_{Ht} + \mathcal{E}_tP^*_t C_{Ft} + \frac{B_{t+1}}{R_t} + \frac{\mathcal{E}_tB^*_t}{R^*_{Ht}} \leq B_t + \mathcal{E}_tB^*_t + W_t,
  \]

  \[
  u(C_H, C_F) = (1 - \gamma)^{1/\theta} C_H^{\theta-1} + \gamma^{1/\theta} C_F^{\theta-1}, \quad v(b; \psi) = -\frac{\kappa}{2} \cdot (b - \psi)^2
  \]

  -- precautionary savings (Diamond ’65, Aiyagari ’94, CFG ’08)

- **Government, Firms & Financial sector**

  \[
  \mathcal{E}_t \left( \frac{F^*_{t+1}}{R^*_t} - F^*_t \right) - \mathcal{E}_t \left( \frac{B^*_{t+1}}{R^*_t} - B^*_t \right) = \mathcal{E}_t Y^*_t + P_t Y_t - W_t,
  \]

  -- NFA $F^*_t$; FX deposits $B^*_t$; official FX reserves $F^*_t - B^*_t$
Equilibrium

- Market clearing: \( C_{Ht} = Y_t \) and \( B_{t+1} = 0 \)

Import demand (expenditure switching):

\[
\frac{C_{Ft}}{C_{Ht}} = \frac{\gamma}{1 - \gamma} \left( \frac{E_t P^*_t}{P_t} \right)^{-\theta}
\]
Equilibrium

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\]

2. Country budget constraint in foreign currency:

\[
\frac{F_{t+1}^*}{R_t^*} - F_t^* = NX_t^* = Y_t^* - P_t^* C_{Ft}
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Equilibrium

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\]

3. Demand for foreign currency savings (Euler equation):

\[
\beta R_{Ht}^* E_t \left\{ \frac{P_t^*}{P_{t+1}^*} \left[ \left( \frac{C_{Ft}}{C_{Ft+1}} \right)^{1/\theta} + \tilde{\kappa} C_{Ft}^{1/\theta} \left( \psi_t - \frac{B_{t+1}^*}{P_{t+1}^*} \right) \right] \right\} = 1
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\]

— Equil. system in \( \{ C_{Ft}, E_t, B_{t+1}^* \} \) given policy \( \{ P_t, R_{Ht}^*, F_{t+1}^* - B_{t+1}^* \} \)
Sanctions and Policies

1. Export sanctions: $Y_t^* \downarrow$

2. Import sanctions: ration $C_{Ft}$ or increase $P_t^*$

3. Exit of foreign MNC/withdrawal of intermediates: $Y_t \downarrow$

4. Foreign asset freeze: $F_0^* \downarrow$

5. Exclusion from international financial market:

$$F_{t+1}^* - F_t^* = NX_t^*, \quad F_{t+1}^* \geq 0, \quad B_{t+1}^* \leq F_{t+1}^*.$$  

6. Household precautionary demand for foreign currency: $\psi_t \uparrow$

---

1. transfers $W_t$

2. monetary policy $P_t$ (via choice of $R_t$)

3. FX reserves $F_{t+1}^* - B_{t+1}^*$

4. financial repression $R_{Ht}^* < R_t^*$
TRADE SANCTIONS
Stationary Equilibrium

- Assume $\beta R_t^* = 1$, $\psi_t = 0$, $\theta = 1$ and $\delta$ imports are rationed

- Steady state equilibrium system: import demand and country budget constraint

$$C_F = \frac{\gamma PY}{1 - \gamma E \hat{P}^*}, \quad \hat{P}^* = \frac{\gamma}{\gamma - \delta} P^*$$

$$P^* C_F = Y^* + (1 - \beta)F^*$$
Stationary Equilibrium

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• Equilibrium exchange rate:

$$\mathcal{E} = \frac{\gamma}{1 - \gamma} \frac{P \cdot Y}{Y^* + (1 - \beta) F^*} \cdot \frac{P^*}{\hat{P}^*}$$
Stationary Equilibrium

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- Equilibrium exchange rate:
  \[
  \hat{E} = \frac{\gamma P \cdot Y}{1 - \gamma \frac{P \cdot Y}{Y^* + (1 - \beta) F^*} \cdot \hat{P}^*}
  \]

- Wage commitment of the government (fiscal balance):
  \[
  W \leq (1 - \beta)(F^* - B^*) + \hat{E} Y^* + P Y
  \]
Stationary Equilibrium

- Assume $\beta R_t^* = 1$, $\psi_t = 0$, $\theta = 1$ and $\delta$ imports are rationed

- Steady state equilibrium system: import demand and country budget constraint

\[ C_F = \frac{\gamma P Y}{1 - \gamma E \hat{P}^*}, \quad \hat{P}^* = \frac{\gamma}{\gamma - \delta} P^* \]

\[ P^* C_F = Y^* + (1 - \beta) F^* \]

- Equilibrium exchange rate:

\[ E = \frac{\gamma P \cdot Y}{1 - \gamma Y^* + (1 - \beta) F^* \cdot \hat{P}^*} \]

- Wage commitment of the government (fiscal balance):

\[ P \geq \left[ 1 + \gamma - \delta \frac{Y^*}{1 - \gamma Y^* + (1 - \beta) F^*} \right]^{-1} \cdot \frac{W - (1 - \beta)(F^* - B^*)}{Y} \]
Consider the foreign reserves freeze $F^* \downarrow$ or sanctions on exports $Y^* \downarrow$. This depreciates the exchange rate, $E \uparrow$, and results in a reduction in imports, $C_F \downarrow$. 

Sanctions that limit domestic non-tradable output $Y \downarrow$ appreciate the exchange rate $E \downarrow$. 

- no effect on quantity of imports $C_F$ and foreign-currency value of net exports $NX^* = Y^* - P^* C_F$

Sanction on imports in the form of rationing of $C_F$ appreciate the exchange rate, $E \downarrow$. 

- currency market: excess supply of FX when imports are curbed
- goods market: shift out demand for available imports (LW'22)
Consider the foreign reserves freeze $F^* \downarrow$ or sanctions on exports $Y^* \downarrow$. This depreciates the exchange rate, $\mathcal{E} \uparrow$, and results in a reduction in imports, $C_F \downarrow$.

Sanctions that limit domestic non-tradable output $Y \downarrow$ appreciate the exchange rate $\mathcal{E} \downarrow$.

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Results I

Comparative statics

1. Consider the foreign reserves freeze $F^* \downarrow$ or sanctions on exports $Y^* \downarrow$. This depreciates the exchange rate, $E \uparrow$, and results in a reduction in imports, $C_F \downarrow$.

2. Sanctions that limit domestic non-tradable output $Y \downarrow$ appreciate the exchange rate $E \downarrow$.
   - no effect on quantity of imports $C_F$ and foreign-currency value of net exports $NX^* = Y^* - P^* C_F$

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   - currency market: excess supply of FX when imports are curbed
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Consider the foreign reserves freeze \( F^* \downarrow \) or sanctions on exports \( Y^* \downarrow \). This depreciates the exchange rate, \( E \uparrow \), and results in a reduction in imports, \( C_F \downarrow \).

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Sanction on imports in the form of rationing of \( C_F \) appreciate the exchange rate, \( E \downarrow \).

- currency market: excess supply of FX when imports are curbed
- goods market: shift out demand for available imports (LW’22)

- sanctions generally tighten the gov’t fiscal constraint and may trigger inflation \( P \uparrow \) and monetary devaluation \( E \uparrow \)
GENERAL EQUIVALENCE
Import Sanctions = Export Sanctions

- General Lerner (1936) symmetry result (FGI 2004)
  - import tariff = export tax (via relative wage or ER adjust.)
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- Proposition
  i) export sanctions \( \{Y_t^* \downarrow\} \) with partial NFA freeze \( F_0^* \downarrow \)
  ii) import sanctions \( \{P_t^* \uparrow\} \)
Import Sanctions $\Rightarrow$ Export Sanctions

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  - import tariff = export tax (via relative wage or ER adjust.)

- Proposition
  i) export sanctions $\{Y^*_t \downarrow\}$ with partial NFA freeze $F^*_0 \downarrow$
  ii) import sanctions $\{P^*_t \uparrow\}$ result in

1. same allocation and welfare, including reduced imports $\{C_{Ft}\} \downarrow$

$$\frac{F^*_{t+1}/P^*_t}{R^*_t} - F^*_t/P^*_t = \frac{Y^*_t}{P^*_t} - C_{Ft}$$
Import Sanctions=Export Sanctions

- General Lerner (1936) symmetry result (FGI 2004)
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- Proposition
  i) export sanctions \( \{ Y^*_t \downarrow \} \) with partial NFA freeze \( F^*_0 \downarrow \)
  ii) import sanctions \( \{ P^*_t \uparrow \} \) result in
  1 same allocation and welfare, including reduced imports \( \{ C_{Ft} \} \downarrow \)
    \[
    \frac{F^*_{t+1}/P^*_t}{R^*_t} - \frac{F^*_t}{P^*_t} = \frac{Y^*_t}{P^*_t} - C_{Ft}
    \]
  2 opposite changes in the exchange rate
    \[
    \mathcal{E}_t = \frac{P_t}{P^*_t} \left( \frac{\gamma}{1 - \gamma} \frac{Y_t}{C_{Ft}} \right)^{\frac{1}{\delta}}
    \]
    - export sanctions \( Y^*_t \downarrow \Rightarrow C_{Ft} \downarrow \Rightarrow \text{depreciation } \mathcal{E}_t \uparrow \)
    - import sanctions \( P^*_t \uparrow \Rightarrow C_{Ft} \downarrow \Rightarrow \text{appreciation } \mathcal{E}_t \downarrow \)
• **Corollary**: The import and export sanctions of $x\%$ have identical effects on gov’t revenues and cost of living:

\[
d\log TR = -\frac{XR}{TR} \cdot \frac{\theta - 1}{\theta} \cdot x\%, \quad d\log CPI = \frac{\text{Import}}{GDP} \cdot \frac{1}{\theta} \cdot x\%,
\]

— TR are fiscal revenues and XR are fiscal revenues from exports
Government Revenues I

• **Corollary**: The import and export sanctions of \( x\% \) have **identical** effects on gov’t revenues and cost of living:

\[
\frac{d \log TR}{TR} = -\frac{XR}{\theta} \cdot \frac{\theta - 1}{\theta} \cdot x\%
\]
\[
\frac{d \log CPI}{\theta} = \frac{\text{Import}}{\text{GDP}} \cdot \frac{1}{\theta} \cdot x\%
\]

— TR are fiscal revenues and XR are fiscal revenues from exports

• Effect of \( Y_t^* \) on gov’t revenues \( \sim \frac{XR}{TR} \), effect of \( P_t^* \) on CPI \( \sim \frac{\text{Import}}{\text{GDP}} \)
Government Revenues I

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--- TR are fiscal revenues and XR are fiscal revenues from exports

- Effect of $Y_t^*$ on gov’t revenues $\sim \frac{XR}{TR}$, effect of $P_t^*$ on CPI $\sim \frac{\text{Import}}{GDP}$

- Lerner symmetry for revenues (BFGI 2019):

  1. **export sanctions**

$$Y_t^* \downarrow \Rightarrow E_t^* \uparrow \Rightarrow d \log (E_t Y_t^*) = \left(1 - \frac{1}{\theta}\right) d \log Y_t^*$$
Government Revenues I

• **Corollary**: The import and export sanctions of \( x\% \) have **identical**
effects on gov’t revenues and cost of living:

\[
\begin{align*}
\frac{d \log TR}{d \log CPI} &= - \frac{XR}{TR} \cdot \frac{\theta - 1}{\theta} \cdot x\% \\
\frac{d \log CPI}{d \log TR} &= \frac{\text{Import GDP}}{1} \cdot \frac{1}{\theta} \cdot x\%,
\end{align*}
\]

— \( TR \) are fiscal revenues and \( XR \) are fiscal revenues from exports

• Effect of \( Y^*_t \) on gov’t revenues \( \sim \frac{XR}{TR} \), effect of \( P^*_t \) on CPI \( \sim \frac{\text{Import GDP}}{1} \)

• Lerner symmetry for revenues (BFGI 2019):

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\[
Y^*_t \downarrow \Rightarrow E^*_t \uparrow \Rightarrow \frac{d \log (E_t Y^*_t)}{d \log Y^*_t} = \left( 1 - \frac{1}{\theta} \right) d \log Y^*_t
\]

2. **import sanctions**

\[
P^*_t \uparrow \Rightarrow E^*_t \downarrow \Rightarrow \frac{d \log (E_t Y^*_t)}{d \log P^*_t} = - \left( 1 - \frac{1}{\theta} \right) d \log P^*_t
\]
FINANCIAL SHOCK
Currency Market

- Two competing foreign currency uses:
  - imports $P_t^* C_{F_t}$ and savings $B_{t+1}^*$

- Two source of foreign currency:
  - exports $Y_t^*$ and foreign reserves $F_t^*$

- Exchange rate balances the two
  - depreciates when currency is scarce
  - appreciates when currency is abundant

- Conventional models vs segmented markets
  (or “convenience yield”)


Exchange Rate Policy

• **Proposition**: Consider an increase in private FX demand $\psi_t \uparrow$

1. Passive gov’t ($F_t^* = B_t^*$, $R_H^* = R_t^*$): imports fall $C_{Ft} \downarrow$, exchange rate depreciates $\mathcal{E}_t \uparrow$, both gradually mean reverts

  \[
  \beta R_H^* \mathcal{E}_t \left\{ P_t^* P_{t+1}^* \left( \frac{C_{Ft}}{C_{Ft+1}} \right)^{1/\theta} + \tilde{\kappa} C_{Ft} \left( \frac{\psi_t - B_{t+1}^* P_{t+1}^*}{P_t^*} \right) \right\} = 1
  \]

  — (weakly) relaxes the gov’t budget constraint
  — applies under financial autarky as well
  — implicit repression: risk of expropriation, limits on withdrawals
  — explicit repression: tax on purchasing FC

Financial repression: a tax on FX purchases $R_H^* < R_t^*$, which leaves the path \{ $B_{t+1}^*$, $F_{t+1}^*$, $C_{Ft}$, $\mathcal{E}_t$ \} unchanged
**Exchange Rate Policy**

- **Proposition**: Consider an increase in private FX demand $\psi_t \uparrow$
  
  1. Passive gov’t ($F_t^* = B_t^*, R_{Ht}^* = R_t^*$): imports fall $C_{Ft} \downarrow$, exchange rate depreciates $E_t \uparrow$, both gradually mean reverts

(a) Net foreign assets, $\frac{B_t^*}{P_t^*Y_t^*}$

(b) Exchange rate, log $E_t$

![Graphs showing net foreign assets and exchange rate behavior](image)
Exchange Rate Policy

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  1. **Passive gov't** ($F_t^* = B_t^*, R_{Ht}^* = R_t^*$): imports fall $C_{Ft} \downarrow$, exchange rate depreciates $E_t \uparrow$, both gradually mean revert.

  2. **FX policy**: full accommodation by selling reserves $F_0^* - B_0^* \downarrow$ leaves unchanged the path of imports and ER $\{C_{Ft}, E_t\}$

  - **Financial repression**: a tax on FX purchases $R_{Ht}^* < R_t^*$, which leaves the path $\{B_{t+1}^*, F_{t+1}^*, C_{Ft}, E_t\}$ unchanged.

  - **Implicit repression**: risk of expropriation, limits on withdrawals.

  - **Explicit repression**: tax on purchasing FC.
Exchange Rate Policy

**Proposition**: Consider an increase in private FX demand $\psi_t \uparrow$

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2. **FX policy**: full accommodation by selling reserves $F^*_0 - B^*_0 \downarrow$
   - leaves unchanged the path of imports and ER $\{C_{Ft}, E_t\}$
   - synthetic FC deposits if reserves are not available

$$
\frac{F^*_{t+1}}{R^*_t} - F^*_t = Y^*_t + \frac{Y_t - W_t/P_t}{E_t/P_t} + \left(\frac{B^*_{t+1}}{R^*_Ht} - B^*_t\right)
$$
Exchange Rate Policy

- **Proposition**: Consider an increase in private FX demand $\psi_t \uparrow$

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$$\beta R_{Ht}^* \mathbb{E}_t \left\{ \frac{P_t^*}{P_{t+1}^*} \left[ \left( \frac{C_{Ft}}{C_{Ft+1}} \right)^{1/\theta} + \tilde{\kappa} C_{Ft}^{1/\theta} \left( \psi_t - \frac{B_{t+1}^*}{P_{t+1}^*} \right) \right] \right\} = 1$$
Exchange Rate Policy

• **Proposition:** Consider an increase in private FX demand \( \psi_t \uparrow \)

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Heterogeneous Agents

- **Representative agent**: Financial repression reduces welfare
Heterogeneous Agents

- Representative agent: Financial repression reduces welfare

- Representative agent: consider extension with 2 types
  1. **Hand-to-mouth**: income $\alpha P_t Y_t$, no access to savings
  2. **Ricardian agents**: income $(1 - \alpha) P_t Y_t + \mathcal{E}_t Y_t^*$, can hold foreign currency and subject to $\psi_t$ shocks

Coaxing: Assume $\theta = 1$. Then

1. aggregate dynamics does not depend on $\alpha$ (Werning'15, ARSS'21)
2. financial repression reduces welfare in a rep.-agent economy
3. financial repression redistributes from RA to HtM (FS'21)

$R^*_{Ht} < R^*_t \Rightarrow B^*_t + 1 \downarrow, E_t \downarrow \Rightarrow C_{HtM} t \uparrow$
Heterogeneous Agents

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\[
R_{Ht}^* < R_t^* \implies B_{t+1}^* \downarrow, \mathcal{E}_t \downarrow \implies C_t^{HtM} \uparrow
\]
Heterogeneous Agents

- **Representative agent**: Financial repression reduces welfare

- **Representative agent**: consider extension with 2 types
  1. **Hand-to-mouth**: income $\alpha P_t Y_t$, no access to savings
  2. **Ricardian agents**: income $(1 - \alpha)P_t Y_t + \varepsilon_t Y_t^*$, can hold foreign currency and subject to $\psi_t$ shocks

- **Corollary**: Assume $\theta = 1$. Then
  1. aggregate dynamics does not depend on $\alpha$ (Werning’15, ARSS’21)
  2. financial repression reduces welfare in a rep.-agent economy
  3. financial repression redistributes from RA to HtM (FS’21)

\[
R_{Ht}^* < R_t^* \implies B_{t+1}^* \downarrow, \varepsilon_t \downarrow \implies C_t^{HtM} \uparrow
\]

- **Other motive**: anchoring inflation expectations
Government Revenues II

• Can ER depreciation rebalance gov’t budget without inflation?

• FX interventions \( F_t^* - B_t^* \uparrow: \)

\[
B_t^* \downarrow \Rightarrow \varepsilon_t \uparrow \Rightarrow C_{Ft} \downarrow \Rightarrow F_t^* \uparrow
\]

• Gov’t budget:

\[
\left( \frac{F_{t+1}^*}{R_t^*} - F_t^* \right) - \left( \frac{B_{t+1}^*}{R_{Ht}^*} - B_t^* \right) = Y_t^* - \frac{W_t/P_t - Y_t}{\varepsilon_t/P_t}
\]

• Policy changes in Russia:
  — FX sold by exporters \( \downarrow \) from 80% to 50%
  — allowed monthly transfers abroad \( \uparrow \) from $5k to $150k
CONCLUSION
Conclusion

• Why did the ruble depreciate initially?
  — overnight freeze of gov’t reserves + threat of blocking exports
  — high home demand for foreign currency as a store of value

• Why did the exchange rate reverse in mid-March?
  — tougher sanctions on imports than exports ⇒ supply of FX↑
  — capital controls + financial repression ⇒ demand for FX↓

• Are sanctions “not working”?  
  — effectiveness cannot be inferred from ER dynamics alone
  — equivalence of M & X sanctions for welfare & gov’t revenues

• Is the exchange rate irrelevant?
  — affects imports and gov’t revenues
  — financial repression benefits consumers at the expense of savers
APPENDIX
Model of Rationing

- Continuum varieties of imported goods $[0, \gamma]$
- Varieties $[0, \delta]$ are banned under import sanctions ($\delta < \gamma$)
Model of Rationing

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- Varieties $[0, \delta]$ are banned under import sanctions ($\delta < \gamma$)
- Cobb-Douglas: $u_t = (1 - \gamma) \log C_{Ht} + \int_0^\gamma \log c_{it}^* \, di$, $p_{it}^* = P_t^*$

\[
c_{it}^* = \frac{1}{1 - \gamma} \frac{P_t C_{Ht}}{E_t p_{it}^*}
\]
Model of Rationing

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$$c_{it}^* = \frac{1}{1 - \gamma} \frac{P_t C_{Ht}}{E_t p_{it}^*}$$

- Without rationing:

$$P_t^* C_{Ft} = \int_0^\gamma p_{it}^* c_{it}^* di = \frac{\gamma}{1 - \gamma} \frac{P_t C_{Ht}}{E_t}$$ and $C_{Ft} = \gamma c_{it}^*$
Model of Rationing

- Continuum varieties of imported goods \([0, \gamma]\)
- Varieties \([0, \delta]\) are banned under import sanctions \((\delta < \gamma)\)

Cobb-Douglas: \( u_t = (1 - \gamma) \log C_{Ht} + \int_0^{\gamma} \log c_{it}^* \, di \), \( p_{it}^* = P_t^* \)

\[
c_{it}^* = \frac{1}{1 - \gamma} \frac{P_t C_{Ht}}{\mathcal{E}_t p_{it}^*}
\]

- With rationing:

\[
P_t^* C_{Ft} = \int_0^{\gamma} p_{it}^* c_{it}^* \, di = \frac{\gamma - \delta}{1 - \gamma} \frac{P_t C_{Ht}}{\mathcal{E}_t}
\]

and \( C_{Ft} = (\gamma - \delta) c_{it}^* \)
Model of Rationing

- Continuum varieties of imported goods $[0, \gamma]$
- Varieties $[0, \delta]$ are banned under import sanctions ($\delta < \gamma$)
- Cobb-Douglas:
  \[ u_t = (1 - \gamma) \log C_{Ht} + \int_0^\gamma \log c_{it}^* d_i, \quad p_{it}^* = P_t^* \]
  \[ c_{it}^* = \frac{1}{1 - \gamma} \frac{P_t C_{Ht}}{E_t p_{it}^*} \]

- With rationing:
  \[ P_t^* C_{Ft} = \int_\delta^\gamma p_{it}^* c_{it}^* d_i = \frac{\gamma - \delta}{1 - \gamma} \frac{P_t C_{Ht}}{E_t} \quad \text{and} \quad C_{Ft} = (\gamma - \delta)c_{it}^* \]

- Finite shadow price $\hat{P}_t^*$ (ideal price is $\infty$):
  \[ C_{Ft} = \frac{\gamma - \delta}{1 - \gamma} \frac{P_t C_{Ht}}{E_t p_{it}^*} = \frac{\gamma}{1 - \gamma} \frac{P_t C_{Ht}}{E_t \hat{P}_t^*}, \quad \hat{P}_t^* = \frac{\gamma}{1 - \gamma} P_t^* \]
• CES case:

\[ u_t = (1 - \gamma)^{1/\theta} C_H^{\theta-1} + \gamma^{1/\theta} \int_0^1 c_{it}^{\theta-1} \frac{\theta-1}{\theta} \, di, \quad C_{Ft} = \left[ \left( \int_0^1 c_{it}^{\theta-1} \frac{\theta-1}{\theta} \, di \right)^{\theta} \right]^{\theta-1} \]
Model of Rationing

• CES case:

\[ u_t = (1 - \gamma)^{1/\theta} C_H^{\theta-1/\theta} + \gamma^{1/\theta} \int_0^1 c_{it}^{1/\theta} \frac{c_{it}^{\theta-1}}{\theta} \, di + \int_0^1 c_{it}^{\theta-1} \frac{c_{it}^{\theta-1}}{\theta} \, di, \quad C_{Ft} = \left[ \int_0^1 c_{it}^{\theta-1} \frac{c_{it}^{\theta-1}}{\theta} \, di \right]^{\theta} \]

• Ration fraction \( \hat{\delta} = \delta / \gamma \in [0, 1) \) of import varieties:

\[ P_t^* = \left[ \int_{\hat{\delta}}^1 p_{it}^{1-\theta} \, di \right]^{1/(1-\theta)} = (1 - \hat{\delta})^{1/(1-\theta)} p_{it}^* = \left( \frac{\gamma}{\gamma - \delta} \right)^{1/\theta-1} p_{it}^* \]

— import expenditure \( P_t^* C_{Ft} \) and demand \( \frac{C_{Ft}}{C_{Ht}} = \frac{\gamma}{1-\gamma} \left( \frac{E_t P_t^*}{P_t} \right)^{-\theta} \)
Model of Rationing

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— import expenditure \( P_t^* C_{Ft} \) and demand \( \frac{C_{Ft}}{C_{Ht}} = \frac{\gamma}{1-\gamma} \left( \frac{E_t P_t^*}{P_t} \right)^{-\theta} \)

• Equivalent to a tax \( \tau > 0 \) on every import variety:

\[ 1 + \tau = (1 - \hat{\delta})^{1/(1-\theta)} = \left( \frac{\gamma}{\gamma - \delta} \right)^{1/(\theta-1)} \]
Multiple Foreign Currencies

- March 4–April 11: 12% tax on USD, euros, GBP in Russia
  - overvalued Swiss franc relative to foreign exchanges
  - larger purchases of Swiss franc as a safe asset
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  - larger purchases of Swiss franc as a safe asset

**Figure:** Swiss franc vs U.S. dollar

(a) Exchange rates

(b) Relative turnover

Note: (a) exchange rate at the Moscow Exchange relative to its international value, (b) Swiss franc turnover relative to the dollar at the Moscow Exchange.