

International Trade of Essential Goods During a Pandemic

Fernando Leibovici
Federal Reserve Bank of St. Louis

Ana Maria Santacreu
Federal Reserve Bank of St. Louis

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International Trade of Essential Medical Goods

Some goods have proved **critical** to combat **COVID-19**:

- **Personal protective equipment (PPE)**: Gloves, medical masks, face shields, ...
- **Medical equipment**: Respirators, equipment for ICU units, ...
- **COVID-19 tests**

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Key role of trade to consume these goods **in normal times**

- Production of these goods is highly concentrated in a few locations
 - ▶ Only 20% of countries are net exporters of these goods
- Some countries are highly dependent on imports
 - ▶ e.g., US: $\approx 36\%$ of total absorption of these goods is imported

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Yet, in a global pandemic:

- Increasing unease about relying so much on other countries for these goods
- If trade breaks down, importers may end up with very limited access to them

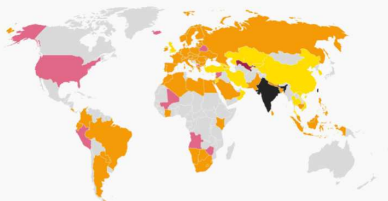
⇒ **To what extent does trade of these goods affect impact of a pandemic?**

Trade Policy on Essential Medical Goods During COVID-19

Widespread trade policy changes during COVID-19:

Exports of medical supplies & medicines: 91 jurisdictions are reported executing a total of 191 export controls since the beginning of 2020

Updated on 17 July 2020

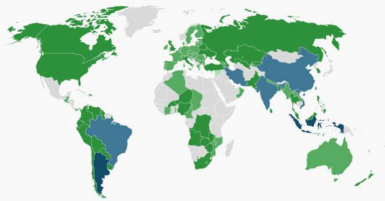


Source: Information collected by the Global Trade Alert team as part of a joint project with the European University Institute and the World Bank. Policy changes identified from official decrees, regulations, and announcements and from media reports. Some policy measures are announced to the press before implementing regulations are published. Information based on media reports is updated when an official state act is located. Date of first relevant policy information by a jurisdiction was used to prepare this map. The information collection methodology as well as the worksheet of information on policy change used to construct the latest version of this map can be downloaded from <https://www.globaltradealert.org/reports/54> (Please copy & paste this URL into your browser).



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Higher export controls

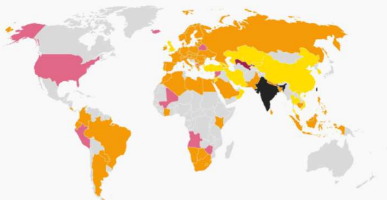
Lower import barriers

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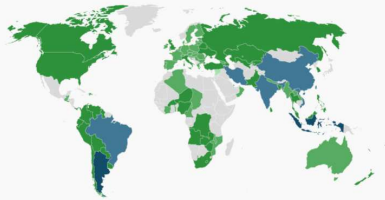


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Higher export controls

Lower import barriers

⇒ Trade policy as important lever to address pandemic?

⇒ Key role of international trade of essential medical goods during a pandemic?

Two weeks ago...



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THE BIDEN PLAN TO REBUILD U.S. SUPPLY CHAINS AND ENSURE THE U.S. DOES NOT FACE FUTURE SHORTAGES OF CRITICAL EQUIPMENT

Joe Biden will work to ensure that the U.S. does not face shortages of the critical products America needs in times of crisis and to protect our national security. To combat the COVID-19 pandemic, Biden will immediately marshal all of the tools of the Federal government to secure sufficient supplies, treatments, and, as soon as possible, a vaccine to combat the pandemic. At the same time, he will implement fundamental reforms that shift production of a range of critical products back to U.S. soil, creating new jobs and protecting U.S. supply chains against national security threats.

This Paper

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How we answer these questions:

- Quantitative dynamic trade model with **essential goods**
 - ▶ **Non-homothetic preferences** for essential goods
 - ▶ **Sectoral trade imbalances** driven by comparative advantage
 - ▶ **Sectoral adjustment costs** on capital and labor
- Study impact of a pandemic across countries + international trade policy
- Contrast with evidence from trade policy changes during COVID-19

This Paper: Preview of the Results

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3. Trade openness at the onset of the pandemic

- **Net importers:** Better off with higher initial trade barriers
- **Net exporters:** Better off with lower initial trade barriers

This Paper: Implications

Important implications beyond COVID-19 and essential medical goods. . .

1. Broader range of essential goods subject to trade disruptions

- Food and agriculture, defense and steel, key production inputs, . . .

2. Connects with theoretical literature on trade policy under uncertainty

- National defense argument for trade protection: Mayer (1977)
- Trade protection as insurance: Eaton and Grossman (1985)
- Broader literature on trade under uncertainty: Helpman and Razin (1978)

⇒ **This paper: Novel mechanism + Quantification + Evidence**

3. Trade policy in dynamic models of international trade

(Ravikumar, Santacreu, Sposi 2019; Kohn, Leibovici, Tretvoll 2020; among many others)

Model

- Two countries: Home, foreign
 - ▶ Present model for home, foreign is symmetric except for parameters
- Two sectors: Essential (e), non-essential (c)
 - ▶ Each country produces a domestic variety of each
- In each country:
 - ▶ Household
 - ▶ Producer of a **domestic variety** in each sector
 - ▶ Producer of **bundles of domestic and imported varieties** in each sector
 - ▶ Essential and non-essential bundles are used for consumption and investment
- International trade
 - ▶ Goods: Essential and non-essential varieties
 - ▶ Financial assets: 1-period bond

Household: Preferences

Preferences

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\log c_t - \gamma \left(\frac{\bar{e}_t}{e_t} \right)^\eta \right]$$

where. . .

- c_t : non-essential goods
- e_t : essential goods
- \bar{e}_t : “reference level” of essential good consumption (exogenous)
- η : Sensitivity to deviations from reference level ($\eta > 0$)

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Idea

- Akin to Stone-Geary: $\ln c_t + \gamma \ln (e_t - \bar{e}_t)$
- Consumption of essential goods is high or low **relative to some reference level**
- e.g. Food consumption compared to physical needs
- e.g. Health services compared to medical needs

Household: Preferences

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Implications

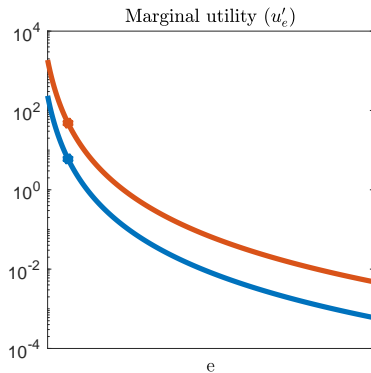
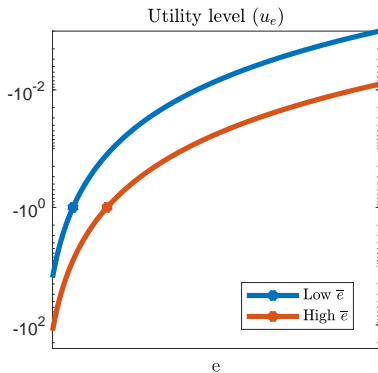
- 1 Demand for essential goods is less elastic than for non-essential goods
- 2 Tight mapping between \bar{e}/e and data used to discipline pandemic shock
- 3 CRRA on essential goods: Risk aversion is $1 + \eta$

Household: Preferences (cont.)

Preferences

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\log c_t - \gamma \left(\frac{\bar{e}_t}{e_t} \right)^\eta \right]$$

To illustrate. . .



Household: Income, Financial Markets, and Household's Problem

Income

- One unit of labor supplied inelastically at wage w_t
- Own domestic producers of essential and non-essential varieties, earn $\pi_{c,t}$ and $\pi_{e,t}$

Financial markets

- Can save or borrow with 1-period bond at interest r
- Bond-holding cost: Penalizes deviations from steady-state holdings

Household's problem:

$$\max_{\{c_t, e_t, b_{t+1}\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\log c_t - \gamma \left(\frac{\bar{e}_t}{e_t} \right)^{\eta} \right]$$

subject to

$$p_{c,t}c_t + p_{e,t}e_t + b_t + p_{c,t}\frac{\Omega_b}{2} (b_{t+1} - \bar{b})^2 = w_t + \pi_{c,t} + \pi_{e,t} + \frac{b_{t+1}}{1+r} \quad \forall t = 0, \dots, \infty$$

Producers of Domestic Varieties in Sector $j \in \{c, e\}$

Technologies

- 1 Produce varieties: $Y_{j,t} = A_j N_{j,t}^\alpha K_{j,t}^{1-\alpha}$
- 2 Accumulate capital: $K_{j,t+1} = (1 - \delta)K_{j,t} + I_{j,t}$

Sectoral adjustment costs

- Capital: $\phi_k(K_{j,t+1}, K_{j,t}) = \frac{\Omega_k}{2} \left(\frac{K_{j,t+1}}{K_{j,t}} - 1 \right)^2$
- Labor: $\phi_n(N_{j,t}, N_{j,t-1}) = \frac{\Omega_n}{2} \left(\frac{N_{j,t}}{N_{j,t-1}} - 1 \right)^2$
- Denominated in units of non-essential goods

Firms are myopic:

- They discount profits with β , not with household's SDF
- Essential good producers don't internalize value of production during pandemic
 \Rightarrow Captures use of Defense Production Act in U.S. during COVID-19

Producers of Domestic Varieties in Sector $j \in \{c, e\}$ (cont.)

Producers' problem:

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [q_{j,t} Y_{j,t} - w_t N_{j,t} - p_{c,t} l_{j,t} - p_{c,t} \phi_k(K_{j,t+1}, K_{j,t}) - p_{c,t} \phi_n(N_{j,t}, N_{j,t-1})]$$

subject to

$$K_{j,t+1} = (1 - \delta)K_{j,t} + I_{j,t} \quad \forall t = 0, \dots, \infty$$

$$Y_{j,t} = A_j N_{j,t}^{\alpha} K_{j,t}^{1-\alpha} \quad \forall t = 0, \dots, \infty.$$

where...

- control variables: $\{N_{j,t}, I_{j,t}, K_{j,t+1}, Y_{j,t}\}_{t=0}^{\infty}$

and...

- $q_{j,t}$: price of domestic variety j
- $p_{j,t}$: price of bundle of domestic and imported varieties from sector j

Producers of Composite Good $j \in \{c, e\}$

Technology

$$Q_{j,t} = \left[\omega_j Q_{j,h,t}^{\frac{\sigma-1}{\sigma}} + (1 - \omega_j) Q_{j,f,t}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

where...

- $Q_{j,h,t}$: Domestic variety
- $Q_{j,f,t}$: Imported variety
- $\omega_j \in (0, 1)$: Weight across varieties

International trade

- Imported varieties subject to sector-specific iceberg trade cost τ_j

Uses of composite goods

- Non-essential goods: Consumption, investment, adj. costs
- Essential goods: Consumption

Competitive Equilibrium

Home country:

- 1 Given prices, allocations solve the household's problem
- 2 Given prices, allocations solve problem of domestic producers
- 3 Given prices, allocations solve problem of composite good producers
- 4 Labor market clears: $N_{c,t} + N_{e,t} = 1 \forall t$
- 5 Essential variety market clearing: $Q_{e,h,t} + \tau_e^* Q_{e,h,t}^* = Y_{e,t} \forall t$
- 6 Non-essential variety market clearing: $Q_{c,h,t} + \tau_c^* Q_{c,h,t}^* = Y_{c,t} \forall t$
- 7 Essential composite market clearing: $e_t = Q_{e,t} \forall t$
- 8 Non-essential composite market clearing:

$$c_t + \sum_{j \in \{c,e\}} \left[l_{j,t} + \frac{\Omega_k}{2} \left(\frac{K_{j,t+1}}{K_{j,t}} - 1 \right)^2 + \frac{\Omega_n}{2} \left(\frac{N_{j,t}}{N_{j,t-1}} - 1 \right)^2 + \frac{\Omega_b}{2} (b_{t+1} - \bar{b})^2 \right] = Q_{c,t} \forall t$$

- 9 Financial market clearing: $b_{t+1} + b_{t+1}^* = 0$

⇒ Foreign country is symmetric except for some parameters

A Pandemic in Our Model

We model **a pandemic** as . . .

- **An increase in \bar{e}_t** (the reference level of essential goods)

Goal is to capture:

- Increased need for essential medical goods (e.g., PPE, COVID-19 tests, etc.)
- Utility is lower if these increased needs are not satisfied (e.g., disease, death, etc.)

Does not capture other important features of a pandemic:

- Lockdown policies and their economic consequences
- Endogeneity between increased needs and the level of economic activity

⇒ **We take increased needs as exogenous, study role the of international trade**

What is the Impact of a Pandemic in Our Model?

1. **Sharp increase in demand for essential medical goods**

What is the Impact of a Pandemic in Our Model?

1. Sharp increase in demand for essential medical goods
2. Hard to adjust production in short-run, forced to rely on international trade

Inelastic demand for essential goods \Rightarrow Prices increase sharply

$$\frac{p_e}{p_c} = \gamma \frac{c}{e} \times \underbrace{\eta \left(\frac{\bar{e}}{e} \right)^\eta}_{\text{Extra term relative to log-log preferences}}$$

Extra term relative
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3. Net importers of essential medical goods are worse off, net exporters better off

(Kohn, Leibovici, Tretvoll 2020)

$$\text{Real Absorption}_t = \frac{\text{PPI}_t}{\text{CPI}_t} \times \text{Real Output}_t$$

- Net importers: \Downarrow $\text{PPI}_t/\text{CPI}_t$ during pandemic, \Downarrow Real Absorption
- Net exporters: \Uparrow $\text{PPI}_t/\text{CPI}_t$ during pandemic, \Uparrow Real Absorption

Quantitative Analysis

We now ask:

- ① What is the quantitative impact of a pandemic across countries?
- ② Do countries prefer to decrease trade barriers once the pandemic hits?
- ③ Do they prefer to be hit with pandemic in world with lower initial trade barriers?

Quantitative Analysis

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To do so, parametrize model:

- One period = One month
- Two countries: Home is U.S., foreign is the rest of the world
- **Both countries are identical except for the sectoral productivities**
 - ▶ Home: $A_c > A_e$
 - ▶ Foreign: $A_e^* > A_c^*$
 - ▶ Symmetry and normalization: $A_c = A_e^*$, $A_e = A_c^* = 1$
- Estimate parameters to get home country match U.S. moments
- Essential goods \equiv PPE and other medical goods, non-essential \equiv all other goods

Parametrization: Steady-State

Predetermined parameters

Parameter	Value	Description
β	0.9967	Discount factor (\approx 4% annual interest rate)
σ	4	Elasticity of substitution
α	0.66	Labor share
δ	0.01	Capital depreciation rate (\approx 11% annual depreciation)
$\omega_e = \omega_c$	0.50	Weight on home goods

Estimated parameters

Parameter	Value	Description
$A_c = A_e^*$	1.10	Sectoral productivities
γ	0.018	Utility weight on essential goods
τ_e	1.52	Trade costs on essential goods
τ_c	1.44	Trade costs on non-essential goods
\bar{e}	0.062	Reference level of essential goods
η	3	Sensitivity of essential goods to reference level

Moment	<i>Targeted</i>		<i>Untargeted</i>
	Home country S.S.		Foreign country S.S.
	Target value	Model	Model
NX_e / GDP_e	-0.25	-0.25	0.18
GDP_e / GDP	0.03	0.03	0.05
$M_e / p_e e$	0.36	0.36	0.17
$M_c / p_c c$	0.21	0.21	0.24
e / \bar{e}	1.00	1.00	0.99
e price elasticity	-0.02 (Ellis et al. 2017)	-0.02	-0.02

COVID-19 Pandemic + Remaining Parameters

1. Shock to \bar{e}

- Focus on needs (\bar{e}) vs. availability (e) of N95 masks, Jan to May 2020
- White House COVID-19 Supply Chain Task Force: $\Delta \ln(\bar{e}/e) \approx 1.22$

2. Sectoral adjustment costs $\Omega_n = \Omega_k = 100$

- Target domestic production increase of N95 masks, Jan to May 2020
- 3M (major producer): 59% increase, from 22m to 35m per month

3. Bond-holding costs $\Omega_b = 0.10$

- Target change in agg. NX/GDP in US ≈ 0.01 , Jan to May 2020

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The experiment

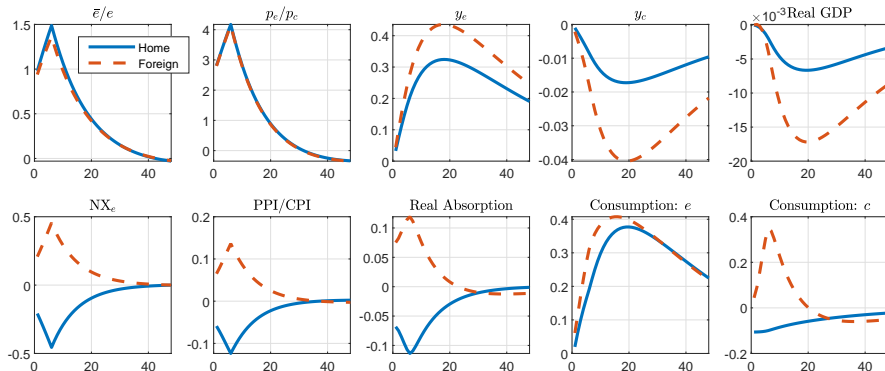
- Economy is in steady-state before shock hits
- Study impact of unexpected transitory shock to \bar{e}
 - ▶ Gradual increase of \bar{e}/e as in the data, peaks after a few months
 - ▶ Autoregressive with persistence 0.95

Dynamics Following a Pandemic

Q1: What is the cross-country impact of a pandemic?

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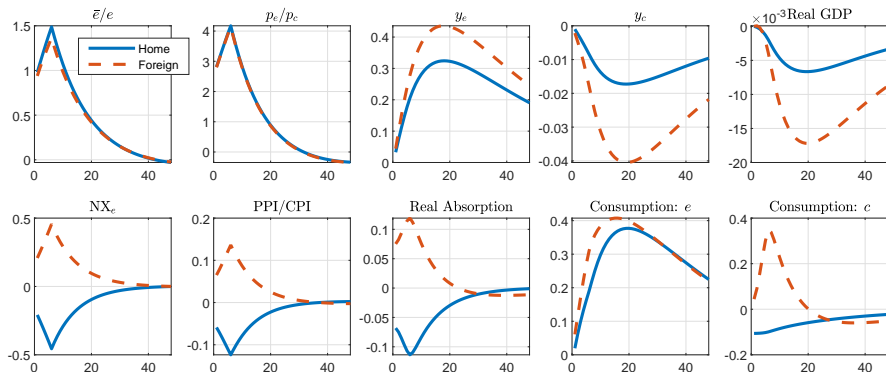


1/3 — Recall:

- Countries are identical except for sectoral productivities
 - ▶ $A_c > A_e \Rightarrow$ Home is a net importer of essential goods
 - ▶ $A_e^* > A_c^* \Rightarrow$ Foreign is a net exporter of essential goods

Dynamics Following a Pandemic

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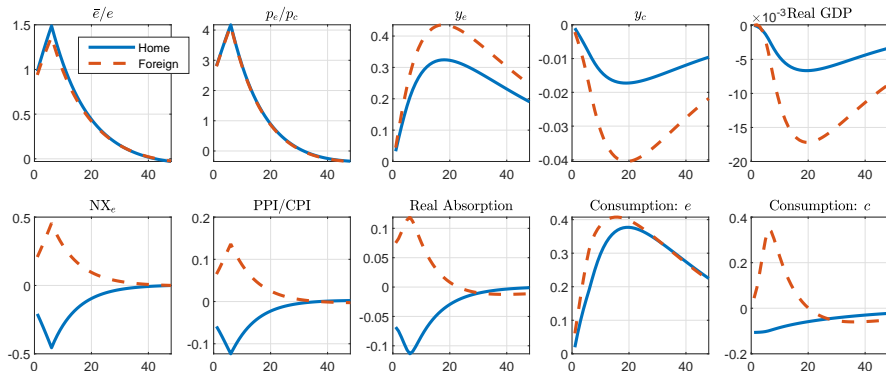


2/3 — We find:

- Higher \bar{e} , higher demand for essential goods
- Limits to short-run adjustment: Gradual increase of y_e leads to $\uparrow p_e/p_c$
- Sectoral imbalances exacerbated given inelastic demand and slow output adjustment

Dynamics Following a Pandemic

Q1: What is the cross-country impact of a pandemic?



3/3 — Impact on consumption across countries:

- Net importers relatively worse-off than net exporters
- Slower increase of essential good consumption, decline of non-essential consumption
- Sharp differences in absorption

Trade Policy Changes During the Pandemic

Q2: Do countries prefer to decrease trade barriers once the pandemic hits?

How we answer this question:

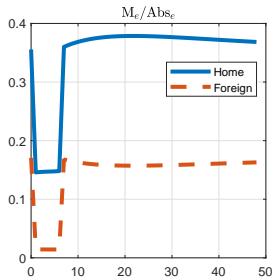
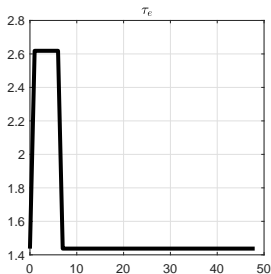
- Consider global increase of trade barriers during pandemic
 - ▶ τ_e increases by 0.60 log points for 6 months
- For each country, contrast vs. baseline
 - ▶ IRFs
 - ▶ Welfare gains (or losses) from trade policy change

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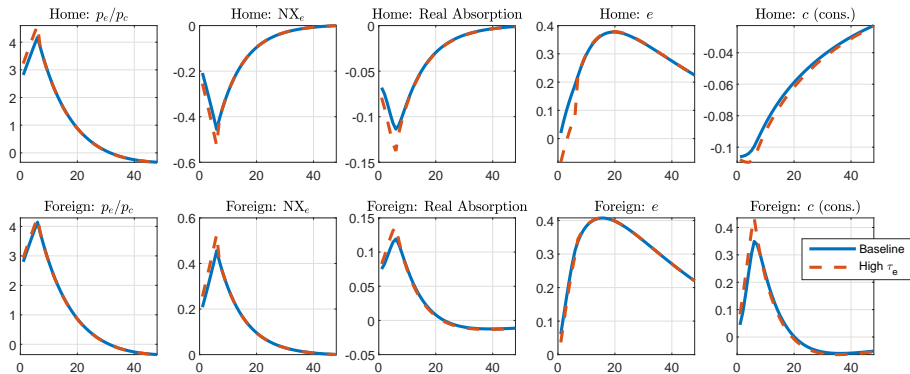
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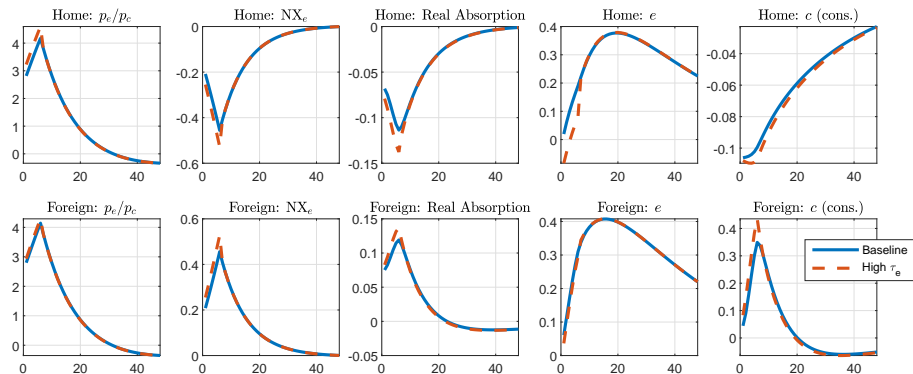
Trade Policy Changes During the Pandemic (cont.)



1/3 — We find:

- Trade policy change leads to higher p_e/p_c
- Inelastic demand + gradual increase of $y_e \Rightarrow$ Sectoral imbalances widen even more

Trade Policy Changes During the Pandemic (cont.)

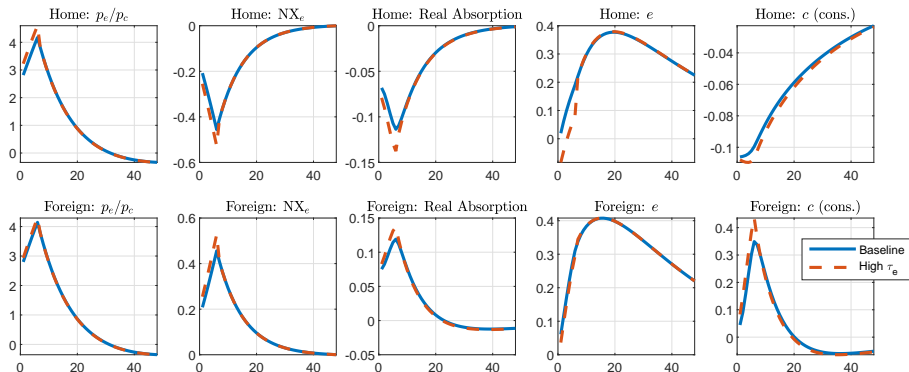


2/3 — Net importer of essential goods:

- Small production scale + Harder to import \Rightarrow Slower increase of e
- Larger decline of terms of trade \Rightarrow Lower profits, lower c and agg. absorption

\Rightarrow **Worse off with higher trade barriers during pandemic**

Trade Policy Changes During the Pandemic (cont.)



3/3 — Net exporter of essential goods:

- High production scale + Harder to export \Rightarrow Reallocate exports to domestic sales
- Thus, e increases as in baseline despite lower access to imports
- Higher increase of terms of trade \Rightarrow Higher profits, higher c and agg. absorption
 \Rightarrow **Better off with higher trade barriers during pandemic**

Trade Policy Changes During the Pandemic: Welfare

What is the welfare impact of raising trade barriers?

- Consider first $T \in \{12, 24\}$ periods after the pandemic hits
- Contrast living first T periods after pandemic in either:
 - ① No change in trade barriers
 - ② Global increase in trade barriers on essential goods

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Consumption-equivalent units of non-essential goods:

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We find. . .

Welfare gains from raising trade barriers (+ if prefer higher trade barriers)

	Home	Foreign
12 months	-2.8%	1.8%
24 months	-1.6%	0.4%

Trade Policy Changes During the Pandemic: Evidence

Q3: Are these findings consistent with trade policy changes during COVID-19?

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How we answer this question:

- Contrast trade policy changes across countries, by trade imbalances pre-COVID-19
- **Goods:** Medical goods essential to combat COVID-19 (Peterson Institute)
- **Trade policy changes:** Global Trade Alert up to mid-April 2020
 - ▶ Export curbs
 - ▶ Import liberalization
- **Sectoral trade imbalances:** COMTRADE 2018

Trade Policy Changes During the Pandemic: Evidence

Q3: Are these findings consistent with trade policy changes during COVID-19?

We find:

Share of countries by change in trade policy		
	Net importers	Net exporters
Import liberalization	28.7%	18.2%
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Consistent with the model. . .

⇒ Net importers more likely to lower import barriers than net exporters

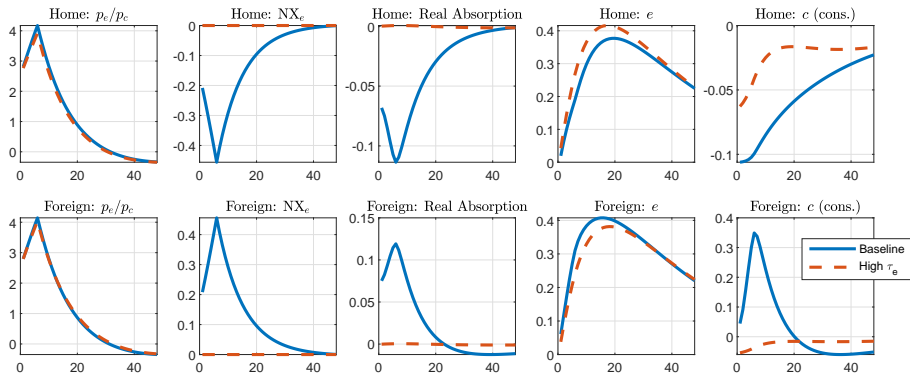
⇒ Net exporters more likely to introduce export curbs than net importers

Q4: Do countries prefer to be hit with pandemic under low initial trade barriers?

How we answer this question:

- Examine pandemic in world with **no trade of essential goods**
- For each country, contrast vs. baseline
 - ▶ IRFs
 - ▶ Welfare gains (or losses) from pandemic without trade of essential goods

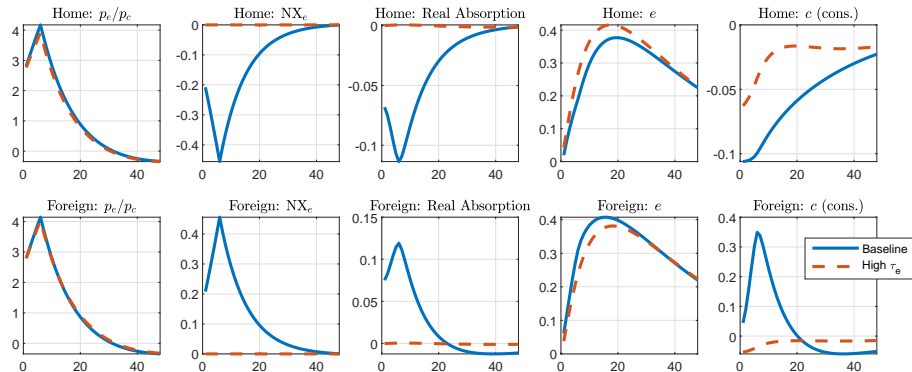
Trade Policy at the Onset of the Pandemic (cont.)



1/3 — We find:

- No trade of essential goods \Rightarrow No sectoral imbalances
- Changes in p_e/p_c do not lead to changes in terms of trade

Trade Policy at the Onset of the Pandemic (cont.)

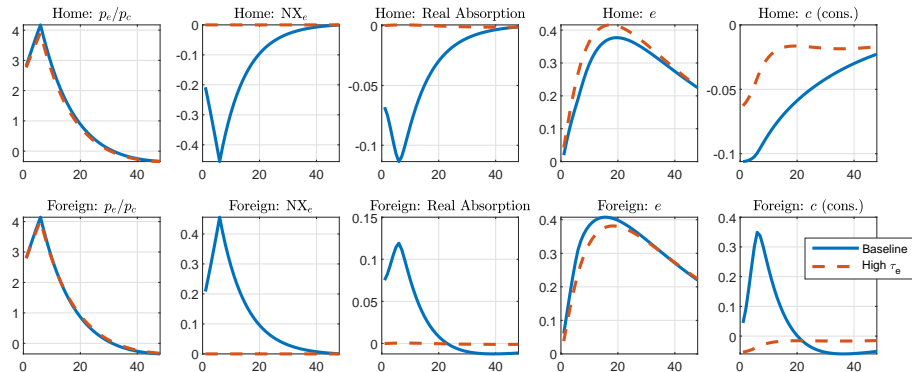


2/3 — Net importer of essential goods:

- Self-sufficient: p_e/p_c changes affect similarly income and expenditures
- Faster increase of output due to higher initial scale
- Much lower decline in absorption and non-essential good consumption

⇒ **Better off if hit with pandemic without trade of essential goods**

Trade Policy at the Onset of the Pandemic (cont.)



3/3 — Net exporter of essential goods:

- Cannot benefit from terms of trade increase
- Lower initial scale, slower output increase of essential goods
- Much lower increase in absorption, decline in non-essentials

⇒ **Worse off if hit with pandemic without trade of essential goods**

Trade Policy at the Onset of the Pandemic: Welfare

What are the welfare implications of pandemic without trade of essentials?

- Consider first $T \in \{12, 24\}$ periods after the pandemic hits
- Contrast living first T periods after pandemic in either:
 - ① Baseline
 - ② No trade of essential goods

Consumption-equivalent units of non-essential goods:

- Q: What % change of non-essential consumption every period $t = 1, \dots, T$ in the baseline would make HHs indifferent to economy without trade of essential goods?

We find. . .

Welfare implications of essential good trade (+ if prefer no trade of essentials)

	Home	Foreign
12 months	3.5%	-24.4%
24 months	3.6%	-15.8%

Role of Model Ingredients on Our Findings

Which channels/ingredients are most important for our findings?

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Which channels/ingredients are most important for our findings?

In the paper, we show that:

① Sectoral adjustment costs: Important

- ▶ If lower, can increase output faster, reducing impact on imbalances
- ▶ Domestic production can rapidly offset trade specialization patterns

② Non-homothetic preferences on essential goods: Important

- ▶ Given shock, lower price and income elasticities amplify impact of price and TOT Δ s
- ▶ Otherwise, household could mitigate impact by reducing exposure to these goods

③ Myopic firms: Important

- ▶ Firms don't internalize large marginal utility from increasing y_e
- ▶ Net importers less worse off if firms assign more weight to profits during pandemic
- ▶ Trade policy implications: Different incentives of planner vs. individual firms for producing essential goods despite being less productive than trade partners

Concluding Remarks

Q: What is the role of intl. trade of essential medical goods during a pandemic?

We find:

- Net trade position key for whether trade amplifies or mitigates pandemic
- Net importers better off lowering trade barriers during pandemic
- Net exporters better off raising trade barriers during pandemic
- Trade policy changes during COVID-19 consistent with these implications

Additional motives for trade policy in the long-run?

- Specialization based on comparative advantage vs. resilience to trade disruption
- Protectionism might be optimal as self-insurance against global shocks?
- Much broader than medical: e.g., food, defense, key production inputs, etc.