

# Trade Wars with FDI Diversion

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# Motivation

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What are the impacts of trade policies on trade and welfare?

The logo for The Economist, featuring the words "The Economist" in white serif font on a red rectangular background.

Vietnam is emerging as a winner  
from the era of deglobalisation

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One important margin: the relocation of productive capital, as highlighted by the Trump Tariffs.

**The  
Economist**

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**ASIA**TIMES

Vietnam ready for next FDI wave out of China

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Vietnam ready for next FDI wave out of China

Accounting for the responses of **F**oreign **D**irect **I**nvestment & the patterns  
significantly change the quantitative implications of the Trump Tariffs.

# This Paper

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1. **Empirical evidence** connecting tariffs, trade and FDI;
2. A multi-country GE quantitative trade **model** incorporating FDI diversion;
  - FDI as producers choosing export-platform locations:  
*Aggregate welfare* effects of tariff changes: **terms-of-trade, profit-shifting, relocation effects**;  
*Distributional* effects (different income sources): **monopolistic-competition & profit repatriation**;
  - A tractable and flexible method to generate **heterogeneous bilateral FDI diversion elasticities**;  
Important for the *patterns* of FDI diversion, e.g., Vietnam;
3. **Calibrate** to world economy before the China-US trade war;  
**Quantitative** evaluations of the Trump Tariffs.

# Summary of Results

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- **Empirical** results:
  - Countries more exposed to trade diversion from the Trump Tariffs: higher inward FDI stocks;
  - Document **country characteristics** correlated with magnitude of bilateral FDI responsiveness;  
E.g., China and Vietnam;
- **Quantitative** results:
  - FDI diversion greatly changes welfare implications;  
E.g., China's losses tripled, the US flips from losses to gains;  
**Decomposition**: China's losses are borne by “consumers”, not “producers”;
  - FDI diversion leads to larger **tariff incentives**;
  - **Pattern of FDI diversion** especially important for certain cases, e.g. Chinese FDI in Vietnam.

# Literature

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- Trade Policies & Trade Diversion:

Waugh'19WP; Flaaen, Hortacsu & Tintelnot'20AER; Amiti, Redding & Weinstein'19JEP,'20AER; Amiti, Kong & Weinstein'20WP; Fajgelbaum, Goldberg, Kennedy, Khandelwal & Taglioni'21WP; McCaig, Pavcnik & Wong'22WP; IMF World Economic Outlook, 2023 Apr; Ma & Meng'23CanadianJE;  
Optimal Tariff: Dixit'85HB; Ossa'14AER; Caliendo & Parro'22HB; Ju, Ma, Wang & Zhu'24JME;

- Multinational Production & FDI:

Helpman'84JPE; Helpman, Melitz & Yeaple'04AER; Ramondo & Rodríguez-Clare'13JPE; Irarrazabal, Moxnes & Oromolla'13JPE; Tintelnot'17JPE; Arkolakis, Ramondo, Rodríguez-Clare & Yeaple'18AER;  
Heterogeneous Elasticity: Lind & Ramondo'23AER;

- International Capital Allocations:

Portes & Rey'05JIE; Eaton, Kortum, Neiman & Romalis'16AER; Alessandria, Choi, and Lu'17IMF; Reyes-Heroles'17WP; Ravikumar, Santacreu & Sposi'19JIE; Anderson, Larch & Yotov'19EER; Li, Nie & Wang'20JIMF; Kleinman, Liu, Redding & Yogo'22WP; Hu'23WP.

# Roadmap

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- 1. FDI Responses to the Trump Tariffs**
- 2. Model with FDI Diversion**
- 3. Calibration & Quantitative Evaluations**



# **FDI Responses to the Trump Tariffs**

# The Trump Tariffs: Who Gets Diverted Trade

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- Logic: Tariffs  $\rightarrow$  trade diversion  $\rightarrow$  production capacity adjustment: FDI;
- The US increased tariffs on China that covered about \$350b in trade flows over 2018-2019;
  - Shift: tariff increase across goods  $\nu$ ,  $\Delta\tau_{US,CN}(\nu)$ ;
  - Share: country  $i$ 's and China's 2017 trade shares;

Construct a country's **exposure to trade diversion** from the Trump Tariffs;

# The Trump Tariffs: Who Gets Diverted Trade

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Construct a country's **exposure to trade diversion** from the Trump Tariffs;

- When does a big  $\Delta\tau_{US,CN}(\nu)$  create large trade diversion “opportunities” for country  $i$ ?
  - China accounts for a large fraction of US imports on  $\nu$ ;
  - $i$  specializes in  $\nu$ ;
  - The US is a large market for  $i$  on  $\nu$ ;

$$\text{Trade Diversion Index: } DI_i = \sum_{\nu} \underbrace{r_i(\nu)}_{\text{i's revenue share for good } \nu} \cdot \underbrace{r_{US,i}(\nu)}_{\text{i's revenue share from US for good } \nu} \cdot \underbrace{\pi_{US,CN}(\nu)}_{\text{US's import share from China for good } \nu} \cdot \Delta\tau_{US,CN}(\nu).$$

# Event Study Design: Treat the 2018-2019 Trade War as an Event

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- Denote the inward FDI stocks as **FDK**;
- **Country** level regression:

$$\ln \text{FDK}_{it} = \text{FE}_i + \text{FE}_t + \sum_{t'=2013, t' \neq 2017}^{2021} \vartheta_{t'} \mathbb{1}_{\{t'\}} \times \text{DI}_i + u_{it};$$

Data: OECD Int'l direct investment database + IMF Coordinated Direct Investment Survey;

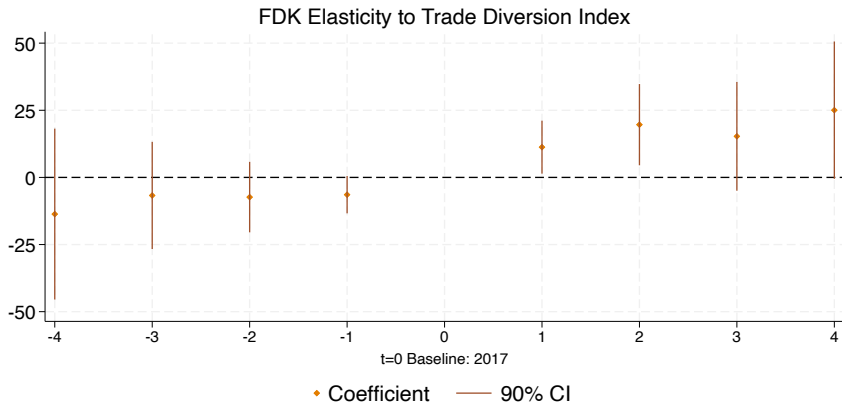
- **Sector** (NAICS 3-digit) level:

$$\ln J_{sit} = \text{FE}_{it} + \text{FE}_{st} + \text{FE}_{si} + \sum_{t'=2013, t' \neq 2017}^{2021} \vartheta_{t'} \mathbb{1}_{\{t'\}} \times \text{DI}_{si} + u_{sit},$$

where  $J_{sit}$  is the cumulative estimated jobs created from FDI;

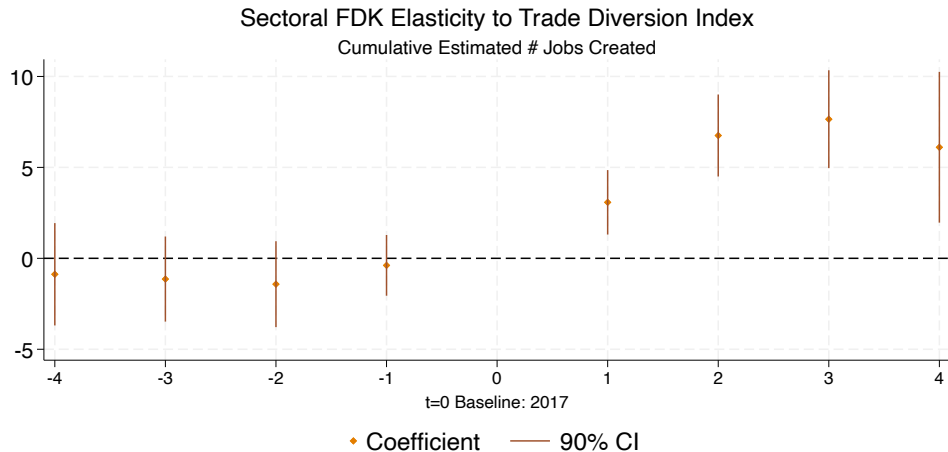
Data: fDi Markets – project-level database since 2003, with source country, receiver, sector.

# Country Level Result



Point estimate  $\approx 20$ , 95th percentile DI  $\approx 0.004$  (which is Vietnam)  $\Rightarrow$  8% relative growth.

# Sector Level Result: Cumulative Estimated Jobs Created



## **Model with FDI Diversion**

# Model Overview

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- Static;
- $N$  countries: exogenous efficiency units of labor  $\{L_j\}$  and aggregate firm productivity  $\{z_j\}$ ;
- $S$  sectors;
- Representative **household**: consume aggregate goods;
- A fixed unit mass of **producers** indexed by  $\omega$  in each **source country  $j$**  and sector  $s$ ;
  - Each  $\omega$  produces a differentiated tradable variety with monopolistic competition;
  - Simplifying assumption: Each  $\omega$  operates in one **production country  $i$**  as an export platform;
- Key model mechanisms:
  - Producer's location choice  $\rightarrow$  Trade shocks lead to trade and FDI diversion;
  - "FDI with Correlation"  $\rightarrow$  Heterogeneous FDI diversion elasticities.



# Decomposition: Welfare Change Induced by Tariff Changes

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$$d \ln C_j \approx \frac{w_j L_j}{X_j} d \ln w_j + \sum_i \sum_s \frac{D_{ij}^s}{X_j} d \ln w_i - \sum_i \sum_s \frac{\mathcal{T}_{ji}^s}{X_j} d \ln w_i$$

Terms-of-trade

where  $\mathcal{T}_{ji}^s \equiv \frac{\pi_{ji}^s}{\tau_{ji}^s} X_j^s$  is the factual trade value exported from  $i$  to  $j$  in sector  $s$ , and

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 &+ \sum_i \sum_s \frac{D_{ij}^s}{X_j} (d \ln D_{ij}^s - d \ln w_i) && \text{Profit-shifting} \\
 &+ \sum_i \sum_s \frac{1}{\epsilon^s - 1} \frac{\tau_{ji}^s \mathcal{T}_{ji}^s}{X_j} \sum_{j'} \omega_{ij'}^s d \ln \tilde{M}_{ij'}^s && \text{Relocation}
 \end{aligned}$$

where  $\mathcal{T}_{ji}^s \equiv \frac{\pi_{ji}^s}{\tau_{ji}^s} X_j^s$  is the factual trade value exported from  $i$  to  $j$  in sector  $s$ , and  $\omega_{ij}^s \equiv \frac{D_{ij}^s}{\sum_{j'} D_{ij'}^s}$  is the share of FDI stocks in  $i$  and sector  $s$  owned by producers from  $j$ .

# Decomposition: Welfare Change Induced by Tariff Changes

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 & + \underbrace{\sum_i \sum_s \frac{(\tau_{ji}^s - 1) \mathcal{T}_{ji}^s}{X_j} (d \ln \mathcal{T}_{ji}^s - d \ln w_i)}_{\text{Tariff Revenues}} - \underbrace{\frac{\Gamma_j}{X_j} d \ln \Gamma_j}_{\text{Value of Transfers}},
 \end{aligned}$$

where  $\mathcal{T}_{ji}^s \equiv \frac{\pi_{ji}^s}{\tau_{ji}^s} X_j^s$  is the factual trade value exported from  $i$  to  $j$  in sector  $s$ , and

$\omega_{ij}^s \equiv \frac{D_{ij}^s}{\sum_{j'} D_{ij'}^s}$  is the share of FDI stocks in  $i$  and sector  $s$  owned by producers from  $j$ .

# **Calibration & Quantitative Evaluations**

# Calibration to the World Economy in 2017

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- 13 economies + World Rest;
- 3 sectors: Agriculture and mining, Manufacturing, Service;
- 3 sets of parameters:
  1. Direct measurement;
    - $\{L_i\}_{i=1}^N$ : product of employees and human capital index (PWT);
    - $\{\phi_h^s\}_{h=1,s=1}^{N,S}$ : 2017 Inter-Country Input-Output (ICIO) Tables sectoral expenditure;
    - $\{\tau_{ij}^s\}_{i \neq j,s=1}^{N,N,S}$ : MFNAVE from WITS TRAINS + BACI;
  2. Fundamentals recovered by solving the model;
    - $\{z_j\}_{j=1}^N$  chosen to match expenditure  $\{X_j\}_{j=1}^N$  (ICIO);
    - $\{d_{ij}^s\}_{i \neq j,s=1}^{N,N,S}$  chosen to match trade shares  $\{\pi_{ij}^s\}_{i \neq j,s=1}^{N,N,S}$  (ICIO);
    - $\{\kappa_{ij}^s\}_{i \neq j,s=1}^{N,N,S}$  chosen to match FDI positions:  $\{K_{ij}^s\}_{i \neq j,s=1}^{N,N,S}$  (OECD + CDIS + fDi Markets);
  3. Parameters that govern trade and FDI elasticities.

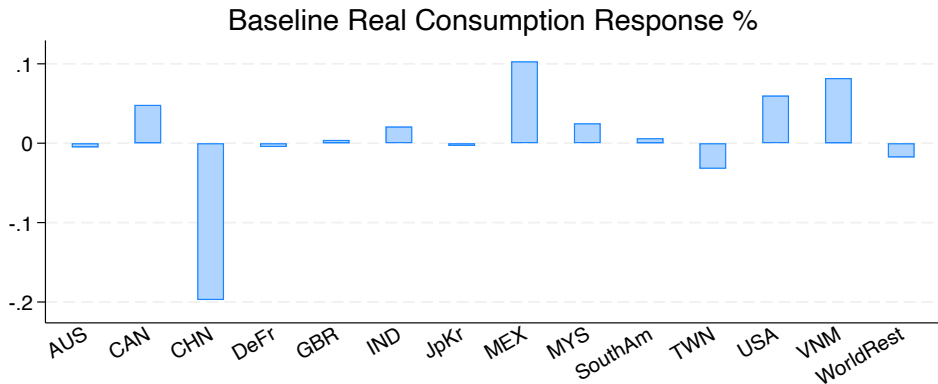
# Quantitative Evaluations: The Trump Tariffs

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- The Trump Tariffs:
  - 16.3% for the agriculture and mining sector, and
  - 19.7% for the manufacturing sector;
- The importance of FDI diversion for welfare:
  - Compare the Baseline with an “Fixed FDI” exercise where producers’ locations are held fixed;
  - Decomposition;
  - Numerical “optimal tariff” for the US;
- Baseline model implications:
  1. FDI’s contributions in driving export value responses;
  2. FDI diversion patterns: heterogeneity and its effects;
  3. Distributional implications.

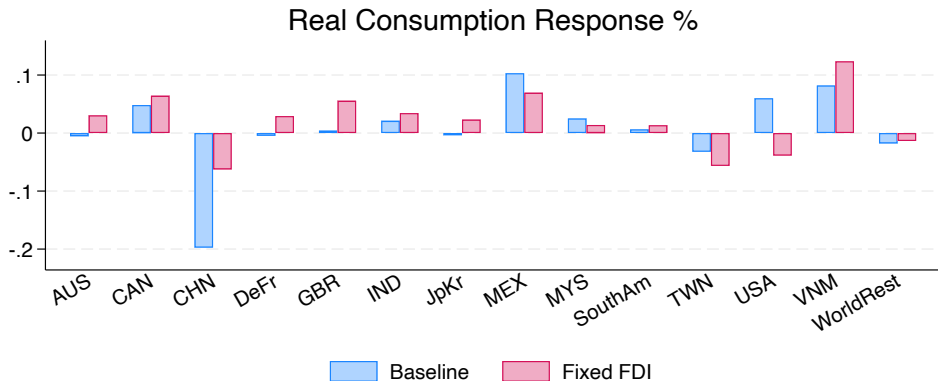
# FDI Diversion on Aggregate Welfare

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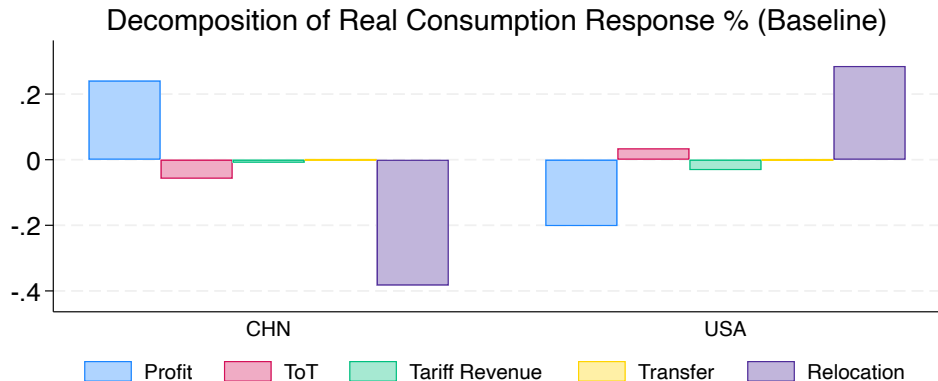




# FDI Diversion on Aggregate Welfare

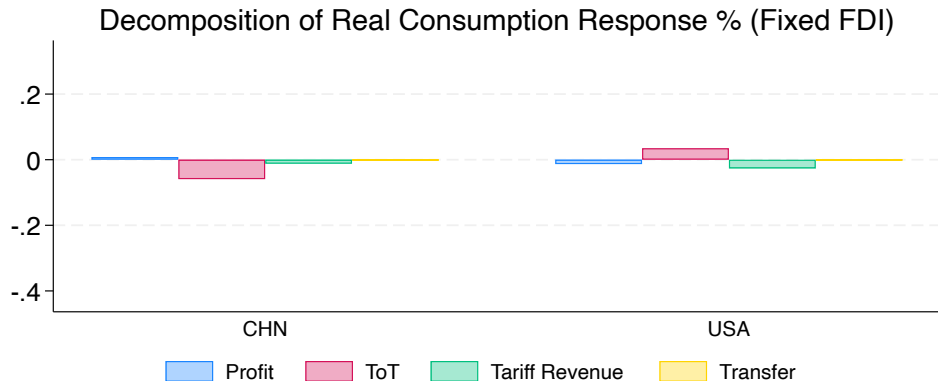


# Welfare Response Decomposition: Baseline

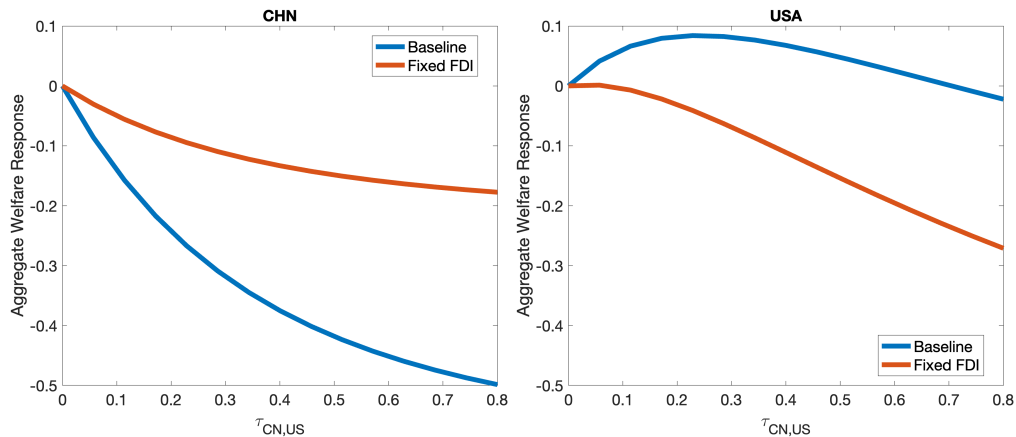


# Welfare Response Decomposition: Fixed FDI

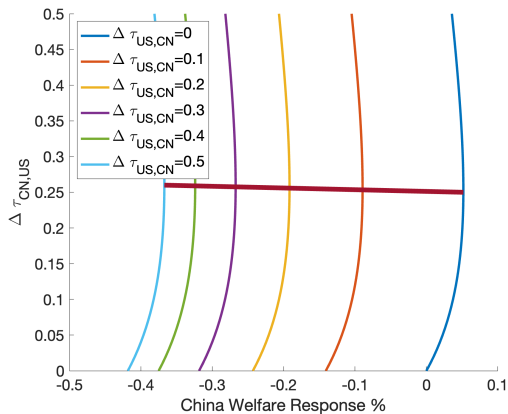
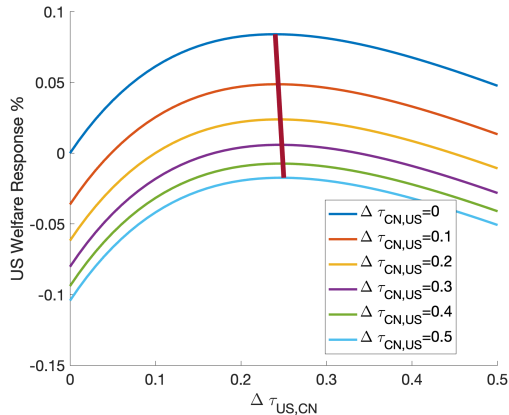
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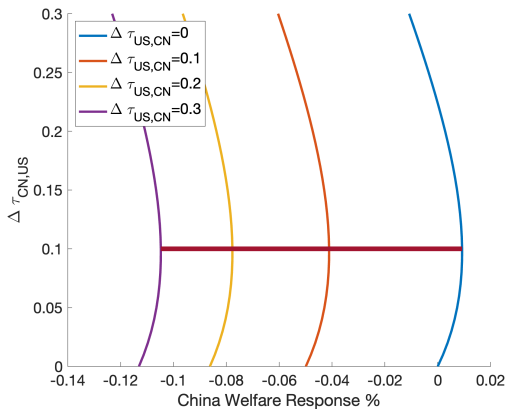
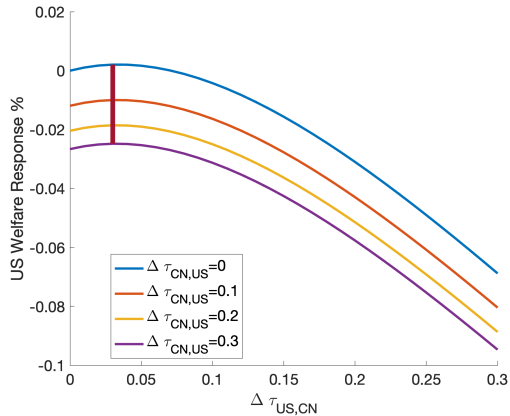
# Numerical “Optimal Tariff” (Uniform and Unilateral)



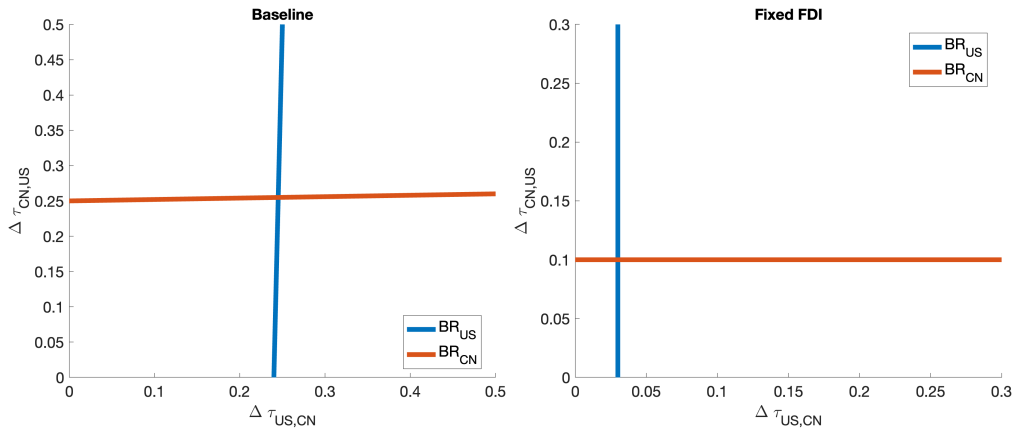
# “Optimal Tariff”: Nash (Baseline)



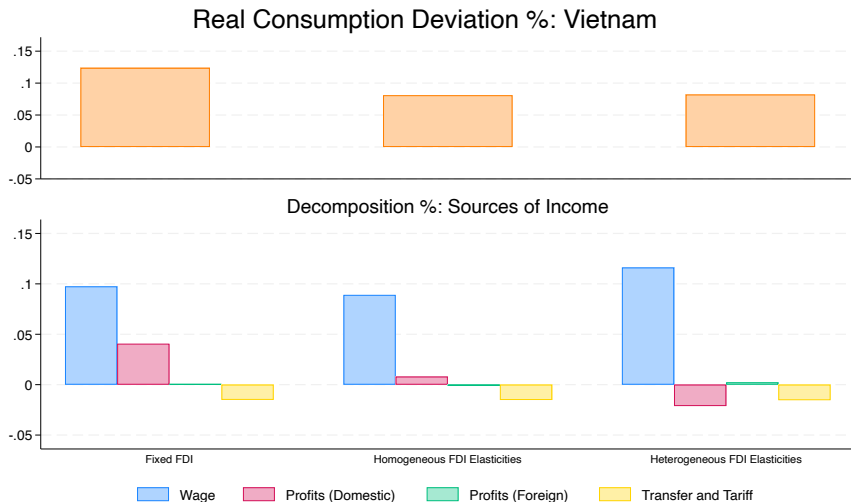
# “Optimal Tariff”: Nash (Fixed FDI)



# “Optimal Tariff”: Nash Equilibrium Tariffs



# Heterogeneous FDI Elasticities on Vietnam Welfare Implications





# Conclusion

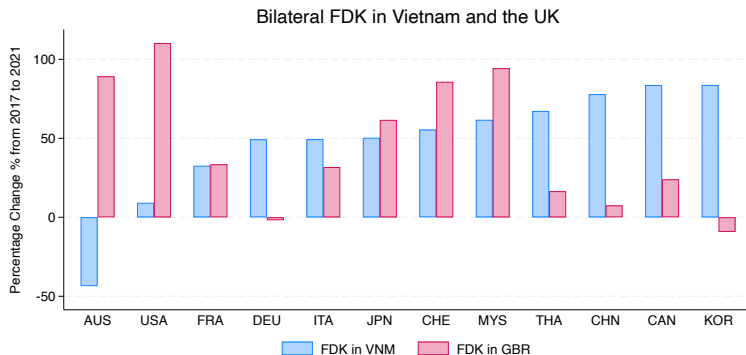
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- Should not ignore FDI when studying trade policies: numbers, mechanisms, distributions;
  - Recent case: the China-US trade war;
- Heterogeneous FDI elasticities important for FDI diversion patterns and implications;
  - Underlying mechanisms and policies?

# Appendix

# Heterogeneous Bilateral FDK Responsiveness

- Bilateral FDK with a gravity structure:  $d \ln FDK_{ij} = \underbrace{d \ln FE_i}_{\text{Receiver}} + \underbrace{d \ln FE_j}_{\text{Source}} + \underbrace{d \ln \kappa_{ij}}_{\text{E.g., FDI efficiency cost}} ;$



- Are such deviations purely due to bilateral idiosyncratic shocks?

# Systematic Factors for Responsiveness Heterogeneity

- $\mathbf{Z}_{ij}$ : Bilateral country characteristics;

- $$d \ln \text{FDK}_{ij} = \text{FE}_i + \text{FE}_j + \mathbf{Z}_{ij} \tilde{\psi} + \underbrace{\left( d \ln \text{FDK}_i \cdot \mathbf{Z}_{ij} \right)}_{\text{Proxy for change of receiver's overall FDI attractiveness;}} \psi + u_{ij}$$

Proxy for change of receiver's overall FDI attractiveness;

$\psi$	
$d \ln \text{FDK}_i \times \ln (\text{Dist}_{ij})$	-0.284** (0.122)
$d \ln \text{FDK}_i \times \ln (\text{GDPpc}_j)$	0.156** (0.065)
$d \ln \text{FDK}_i \times \text{ComparaAdv}_{ij}$	0.599** (0.283)
$R^2$	0.105
# of Obs.	2735

- Geographic distance;
- Source country GDP per capita;
- Comparative advantage similarity (correlation of two countries' export portfolio over sectors): e.g. China & Vietnam.

Notes: The dependent variable is the bilateral FDI growth from 2017 to 2019. The sample includes 34 source countries and 199 receiver countries. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

# CES Demand

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- For each **importing country h** and sector s:
  - Sectoral non-tradable composite goods aggregated by purchasing all varieties, supplied at cost:

$$Q_h^s = \left( \sum_{j=1}^N \sum_{i=1}^N \int_{M_{ij}^s} (q_{hij}^s(\omega))^{\frac{\epsilon^s-1}{\epsilon^s}} d\omega \right)^{\frac{\epsilon^s}{\epsilon^s-1}};$$

- $M_{ij}^s$ : the endogenous set of varieties by producers from source country **j** produced in **i** in sector s;
  - Two frictions between **i** and **h**: iceberg trade costs  $\{d_{hi}^s\}$ , and one plus ad-valorem tariffs  $\{\tau_{hi}^s\}$ ;
- Sectoral composites aggregate into final goods for consumption:

$$Q_h = \prod_{s=1}^S (Q_h^s)^{\phi_h^s}, \text{ s.t. } \sum_s \phi_h^s = 1.$$

# Household Consumption

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- The household consumes the final good, and the expenditure  $X_h \equiv P_h C_h$  equals

$$w_h L_h + D_h + T_h - \Gamma_h;$$

- Total **income**:
  - labor wage income  $w_h L_h$ ;
  - the aggregate rebated profits from domestic producers  $D_h$ ;
  - the rebated tariff revenues from the government  $T_h$ ;
  - an exogenous transfer term  $\Gamma_h$ .

# Production

- Each  $\omega$  draws a random vector of productivities across production locations  $i$ :  $\mathbf{a}_j^s = \left\{ a_{ij}^s \right\}_{i=1}^N$ , which follows a max-stable Fréchet with shape  $\theta$ , scale  $z_j$  and a correlation function  $G^j$ :

$$\mathbb{F}_{ij}^s(\mathbf{a}_j^s) \equiv \mathbb{P} \left( a_{1j}^s \leq a_1, a_{2j}^s \leq a_2, \dots, a_{Nj}^s \leq a_N \right) = e^{-z_j G^j(a_1^{-\theta}, a_2^{-\theta}, \dots, a_N^{-\theta})};$$

- Given location choice  $i$ , and productivity  $a$ ,  $\omega$  from  $j$  in sector  $s$ :
  - Hires labor in  $i$ , produces output:

$$q_{ij}^s(a) = \frac{a^{\frac{1}{\sigma^s-1}}}{\kappa_{ij}^s} l_{ij}^s(a),$$

where  $\kappa_{ij}^s$  is the bilateral foreign operation friction (normalized to one when  $i = j$ );

- Sets prices  $p_{hij}^s$  for sales to each country  $h$ , subject to

$$q_{hij}^s = \left( \frac{p_{hij}^s}{p_h^s} \right)^{-\epsilon^s} Q_h^s, \forall h, \quad \sum_{h=1}^N \tau_{hi}^s q_{hij}^s = q_{ij}^s.$$

# Equilibrium

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An equilibrium is

- a set of prices (good prices, wages) and allocations (consumptions, producer allocations)
- given a set of fundamentals (productivities, labor endowments, trade costs, tariffs, foreign operation frictions, idiosyncratic productivity draw distributions)

such that producers optimize, the distributions are consistent with these decisions, and

- goods markets clear:  $Y_i = \sum_h \sum_s \frac{\pi_{hi}^s}{\tau_{hi}^s} X_h^s$ , and
- country budget constraints hold:  $\text{Current Account}_j + \text{Capital Account}_j + \text{Transfer}_j = 0$ .



# Solution to the Producer's Problem

1. Given the choice of production location  $i$ , optimal prices & profits:

$$p_{hij}^s(a) = \frac{\epsilon^s}{\epsilon^s - 1} \frac{d_{hi}^s \tau_{hi}^s w_i}{a^{\frac{1}{\epsilon^s - 1}} / \kappa_{ij}^s} \quad \& \quad v_{ij}^s(a) \equiv \frac{1}{\epsilon^s - 1} \overbrace{A_i^s w_i^{1 - \epsilon^s}}^{\equiv \tilde{A}_i^s} \frac{a}{\kappa_{ij}^s \epsilon^s - 1};$$

where  $A_i^s$  captures the market access of country  $i$  as a production location for sector  $s$ ;

2. Denote  $\tilde{v}_{ij}^s = v_{ij}^s(1)$ , the probability that the location  $i$  is chosen:

$$\mathbb{P} \left( v_{ij}^s(a_{ij}^s) = \max_{i'} v_{i'j}^s(a_{i'j}^s) \right) = \frac{\tilde{v}_{ij}^{s\theta} G_i^j(\tilde{v}_{1j}^{s\theta}, \tilde{v}_{2j}^{s\theta}, \dots, \tilde{v}_{Nj}^{s\theta})}{G^j(\tilde{v}_{1j}^{s\theta}, \tilde{v}_{2j}^{s\theta}, \dots, \tilde{v}_{Nj}^{s\theta})}, \text{ where } G_i^j \equiv \frac{\partial G^j(x_1, x_2, \dots, x_N)}{\partial x_i};$$

$$\text{Denote } \tilde{M}_{ij}^s \equiv \left( (\tilde{v}_{ij}^s)^\theta G_i^j / G^j \right)^{\frac{\theta-1}{\theta}} (G_i^j)^{\frac{1}{\theta}},$$

which captures the mass of producers, adjusted for the producers productivity distributions.

# FDI Diversion & Elasticity

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- Model counterpart of FDK:  $D_{ij}^s$ ;
- The aggregate profits that producers from  $j$  in sector  $s$  get from operating in  $i$

$$D_{ij}^s = \frac{\left(\tilde{v}_{ij}^s\right)^\theta G_i^j}{G^j} D_j^s;$$

- The magnitude and heterogeneity of the elasticities of  $D_{ij}^s$  w.r.t.  $\tilde{v}_{ij}^s$ :
  1. Independence of draws across locations;
  2. Uniform correlation to productivity draws across locations;
  3. Bilateral correlations.

## Example 1: No Correlation

- Suppressing  $s$ , suppose  $G^j \left( a_1^{-\theta}, a_2^{-\theta}, \dots, a_N^{-\theta} \right) \equiv \sum_{i=1}^N a_i^{-\theta}$  (i.i.d. Fréchet):

$$\mathbb{P} \left( a_{1j} \leq a_1, a_{2j} \leq a_2, \dots, a_{Nj} \leq a_N \right) = e^{-z_j \sum_{i=1}^N a_i^{-\theta}};$$

- FDI gravity, and bilateral FDI responses across equilibria:

$$D_{ij} = \frac{(\tilde{v}_{ij})^\theta}{\sum_{i'} (\tilde{v}_{i'j})^\theta} D_j \quad \Rightarrow \quad d \ln D_{ij} = \theta \left[ d \ln \tilde{A}_i - (\epsilon - 1) d \ln \kappa_{ij} \right] + \underbrace{d \ln \frac{D_j}{\sum_{i'} (\tilde{v}_{i'j})^\theta}}_{FE_j};$$

- Suppose  $d \ln \tilde{A}_i > 0$  due to tariff shocks;
  - Larger  $\theta$ : smaller draw dispersion, and larger elasticity;
  - Conditional on  $FE_j$ , elasticity  $d \ln D_{ij} / d \ln \tilde{A}_i = \theta$  is the same across country pairs.

## Example 2: Uniform Correlation

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- Suppose  $G^j(a_1^{-\theta}, a_2^{-\theta}, \dots, a_N^{-\theta}) = \left( \sum_{i=1}^N a_i^{-\frac{\theta}{1-\rho}} \right)^{1-\rho}$  with  $0 < \rho < 1$ :

$$\mathbb{P}(a_{1j} \leq a_1, a_{2j} \leq a_2, \dots, a_{Nj} \leq a_N) = e^{-z_j \left( \sum_{i=1}^N a_i^{-\frac{\theta}{1-\rho}} \right)^{1-\rho}} ;$$

- The corresponding bilateral FDI deviation across equilibria:

$$d \ln D_{ij} = \frac{\theta}{1-\rho} \left[ d \ln \tilde{A}_i - (\epsilon - 1) d \ln \kappa_{ij} \right] + d \ln \frac{D_j}{\left( G^j \right)^{\frac{\rho}{1-\rho}}} ;$$

- As if dispersion is smaller and FDI elasticity is larger, but still the same across country pairs.

## Example 3: Bilateral Correlations

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- A cross-nested CES correlation function  $G^j$  (from Lind and Ramondo, 2023):

$$G^j \left( a_1^{-\theta}, a_2^{-\theta}, \dots, a_N^{-\theta} \right) = \underbrace{\sum_{i=1}^N (1 - \eta_{ij}) a_i^{-\theta}}_{\text{First nest i.i.d. across } i} + \underbrace{\left( \sum_{i=1}^N \left( \eta_{ij} a_i^{-\theta} \right)^{\frac{1}{1-\rho}} \right)^{1-\rho}}_{\text{Second nest with correlation } \rho > 0} ;$$

- Interpretation: two *latent technology types* for operation;
- Building in the idea of the “fit” of technologies to locations:
  - Nest 1: no *predictability* in terms how good  $a_{ij}^s$  is tells how good  $\{a_{i'j}^s\}_{i' \neq i}$  are;
  - Nest 2: operation using some technologies have such correlation and predictability;
- Certain  $Z_{ij}$  informative of *the relative importance* of the two nests for  $i$  and  $j$ :  $\eta_{ij}$ ;

## Example 3: Bilateral Correlations, Cont.

---

- When fundamentals change, larger responsiveness if the second type more important:
  - $\lambda_{ij}^{W*}$ : within-type profit shares from  $i$  for  $j$  for the second technology type;
  - The corresponding bilateral FDK responses across equilibria:

$$d \ln D_{ij} = \theta \left( 1 + \frac{\rho}{1 - \rho} \frac{\eta_{ij} \left( \lambda_{ij}^{W*} \right)^{\rho}}{(1 - \eta_{ij}) + \eta_{ij} \left( \lambda_{ij}^{W*} \right)^{\rho}} \right) \left[ d \ln \tilde{A}_i - (\epsilon - 1) d \ln \kappa_{ij} \right] + u_{ij};$$

- A change for  $\tilde{A}_i$  leads to heterogeneous responses of FDK for different source countries  $j$ .

## Trade Elasticity $\epsilon^s$

---

- Trade gravity:  $\frac{X_{hi}^s}{X_{hh}^s} = \frac{\Phi_i^s (d_{hi}^s)^{1-\epsilon^s} (\tau_{hi}^s)^{-\epsilon^s}}{\Phi_h^s}$ ;
- For  $s = \text{Agriculture, Manufacturing}$ , gravity regression with fixed effects and tariff shifters:

$$\ln EX_{hit}^s = FE_{ht}^s + FE_{it}^s - \epsilon^s \ln \tau_{hit}^s + u_{hit}^s;$$

- Not applicable to the service sector; Instead, use real exchange rate (RER) as cost shifters:

$$\ln EX_{hit}^3 = FE_h^3 + FE_i^3 + FE_t - \epsilon_{\text{RER}}^3 \ln \text{RER}_{hit} + u_{hit}^3;$$

- Trade elasticities inferred from RER are much lower than those inferred from tariff shifters:

$$\hat{\epsilon}^3 = \hat{\epsilon}_{\text{RER}}^3 \times \frac{\hat{\epsilon}^2}{\hat{\epsilon}_{\text{RER}}^2},$$

assuming the same pass-throughs difference between RER and tariff shifters across sectors;  
 $\Rightarrow \hat{\epsilon}^1 = 5.34, \hat{\epsilon}^2 = 3.29, \hat{\epsilon}^3 = 2.84.$

# FDI Elasticities $\theta, \rho$ and $\{\eta_{ij}\}_{i \neq j}^{N,N}$ : Indirect Inference

---

- FDI diversion elasticities:

- Magnitude:  $\theta, \rho$ ;
- Heterogeneity:  $\eta_{ij}$ ;

Parametrize  $\eta_{ij}$  to be systematically correlated with observable bilateral variables  $\mathbf{Z}_{ij}$ :

$$\eta_{ij} = \frac{e^{\mathbf{Z}_{ij}\boldsymbol{\zeta}}}{1 + e^{\mathbf{Z}_{ij}\boldsymbol{\zeta}}}, \text{ where } \mathbf{Z}_{ij}\boldsymbol{\zeta} = \zeta_0 + \zeta_1 \ln(\text{Dist}_{ij}) + \zeta_2 \ln(\text{GDPpc}_j) + \zeta_3 \text{CA}_{ij};$$

Set  $\eta_{ij} = 1$  when  $i = j$ ;

- Pick  $\theta, \rho, \boldsymbol{\zeta}$  to match empirical and model regression coefficients  $\vartheta, \boldsymbol{\psi}$ :

$$d \ln K_i = \vartheta \text{DI}_i + u_i,$$

$$d \ln K_{ij} = \text{FE}_i + \text{FE}_j + \mathbf{Z}_{ij} \tilde{\boldsymbol{\psi}} + (d \ln K_i \cdot \mathbf{Z}_{ij}) \boldsymbol{\psi} + u_{ij},$$

where  $K_i, K_{ij}$  are replaced by corresponding profits in the model.



# FDI Elasticities $\theta, \rho$ and $\{\eta_{ij}\}_{i \neq j}^{N,N}$ : Indirect Inference, Cont.

- $u_{ij}$  is correlated with regressors; Need to specify the shock process from 2017 to 2019;
  - Shocks to  $L_j, z_j, \phi_h^s, d_{ij}^s, \tau_{ij}^s, \kappa_{ij}^s$ : directly measured or recovered by matching 2019;
  - Decompose  $d \ln \kappa_{ij}^s = d \ln \kappa_i^{s,in} + d \ln \kappa_j^{s,out} + d \ln \tilde{\kappa}_{ij}^s$ ;
  - Simulate  $d \ln \tilde{\kappa}_{ij}^s$ , assuming i.i.d.  $\sim$  recovered distribution, while other shocks are deterministic;

	Outcome: $d \ln K_i$		Calibration	
	Data	Model	Parameter	Value
$DI_i$	18.67 ** (7.83)	18.29 (7.60)	$\rho$ $\theta$	0.82 5.79
$R^2$ # of Obs.	0.471 117			

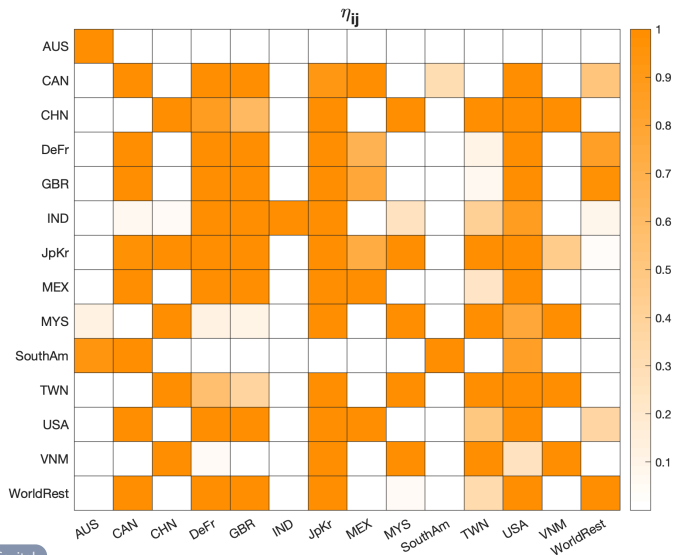
Notes: The first column reports empirical regression coefficient for  $\vartheta$ . I constrain the sample to include the largest FDI receivers, while excluding those typically considered tax havens, which results in 117 receiver countries. The second column reports the median and standard error of regression coefficients from 10 model simulation runs. Finally, the last column reports the corresponding parameter values. Standard errors in parentheses, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

# FDI Elasticities $\theta, \rho$ and $\{\eta_{ij}\}_{i \neq j}^{N,N}$ : Indirect Inference, Cont.

	Outcome: $d \ln K_{ij}$		Calibration	
	Data	Model	Parameter	Value
$d \ln K_i \times \ln (\text{Dist}_{ij})$	-0.169* (0.090)	-0.176	$\zeta_1$	-7
$d \ln K_i \times \ln (\text{GDP}_{pcj})$	0.117** (0.059)	0.116	$\zeta_2$	5
$d \ln K_i \times \text{ComparaAdv}_{ij}$	0.576*** (0.219)	0.521	$\zeta_3$	19
			$\zeta_0$	-9.5
$R^2$	0.111			
# of Obs.	2621			

Notes: The first column reports empirical regression estimates of the interaction coefficients  $\psi$ . I constrain the sample to include investors with sufficient large number of receivers, while excluding those typically considered tax havens, which results in 36 investor and 193 receiver countries. The second column reports the median of regression coefficients from 10 model simulation runs. Finally, the last column reports the corresponding parameter values. Standard errors in parentheses, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

# Calibrated $\{\eta_{ij}\}_{i \neq j}^{N,N}$

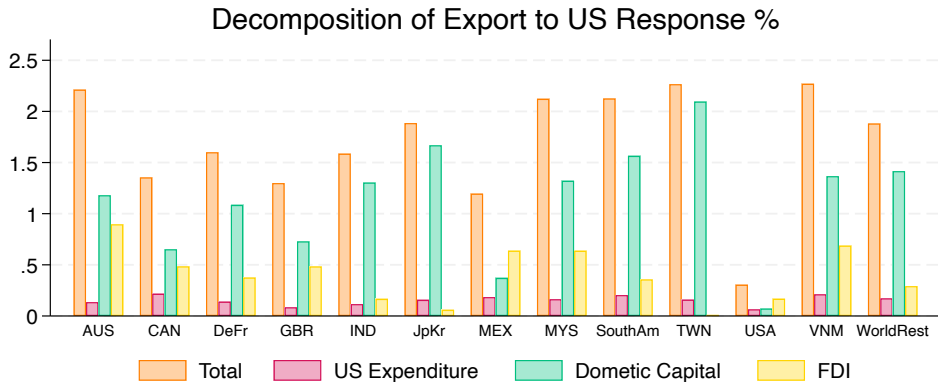


# Export Value Responses

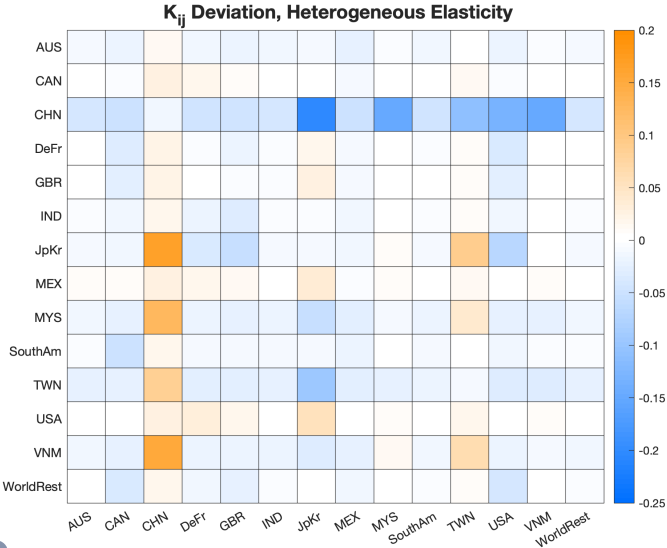
$$d \ln \frac{X_{hi}^s}{\tau_{hi}^s} = \underbrace{d \ln \frac{X_h^s}{\tau_{hi}^s} \frac{1}{(P_h^s)^{1-\epsilon^s}}}_{\text{Importer's sectoral expenditure}} + \underbrace{(1 - \omega_h^s) d \ln \tilde{M}_{ii}^s (P_{hii}^s)^{1-\epsilon^s}}_{\text{Domestic capital}} + \underbrace{\omega_h^s d \ln \sum_{j \neq i} \tilde{M}_{ij}^s (P_{hij}^s)^{1-\epsilon^s}}_{\text{FDI}}.$$

- $\tilde{M}_{ij}^s$ : the mass of producers, adjusted for the productivity distribution;
- $\omega_h^s \equiv \frac{\sum_{j \neq i} \tilde{M}_{ij}^s (P_{hij}^s)^{1-\epsilon^s}}{\sum_j \tilde{M}_{ij}^s (P_{hij}^s)^{1-\epsilon^s}}$ : the share of foreign production capacity in country  $i$  for sector  $s$ .

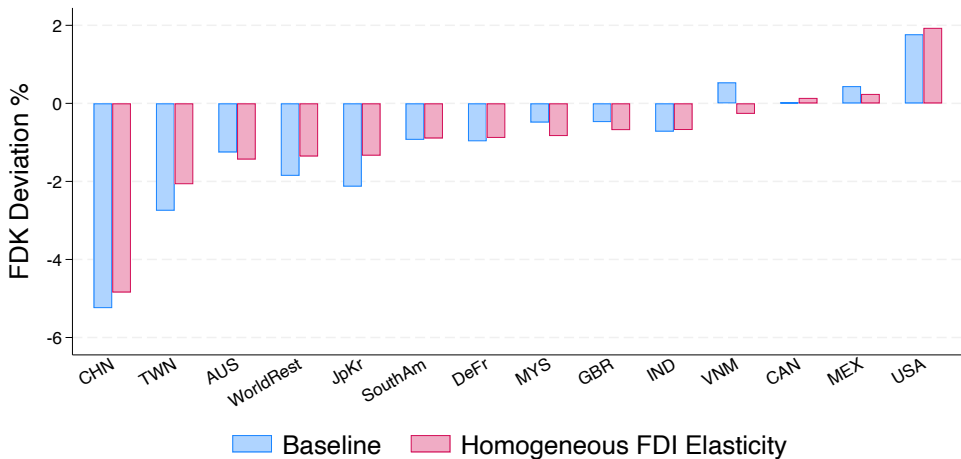
# Export Value Responses



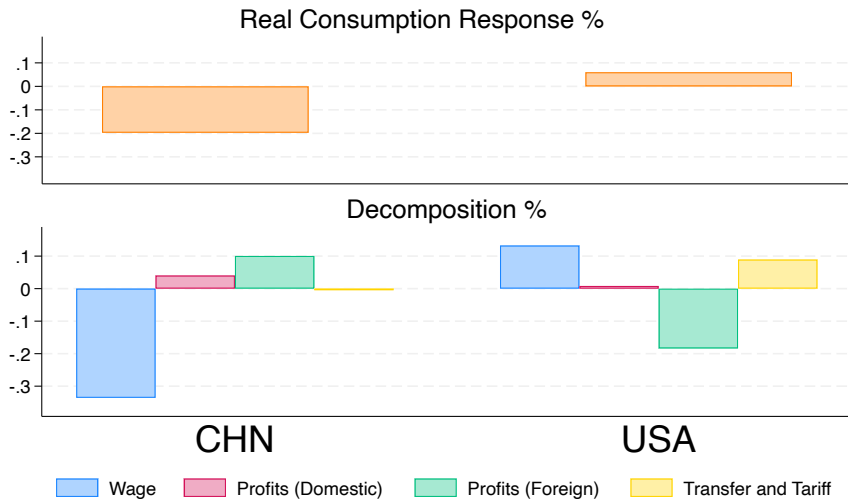
# FDI Diversion: Bilateral



# FDI Diversion: FDK, Homogeneous vs. Heterogeneous Elasticities

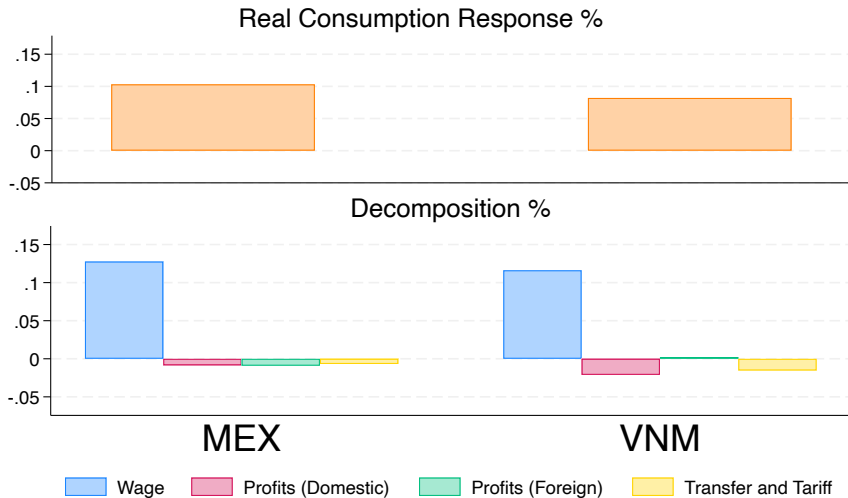


# Distributional Implications: China and the US

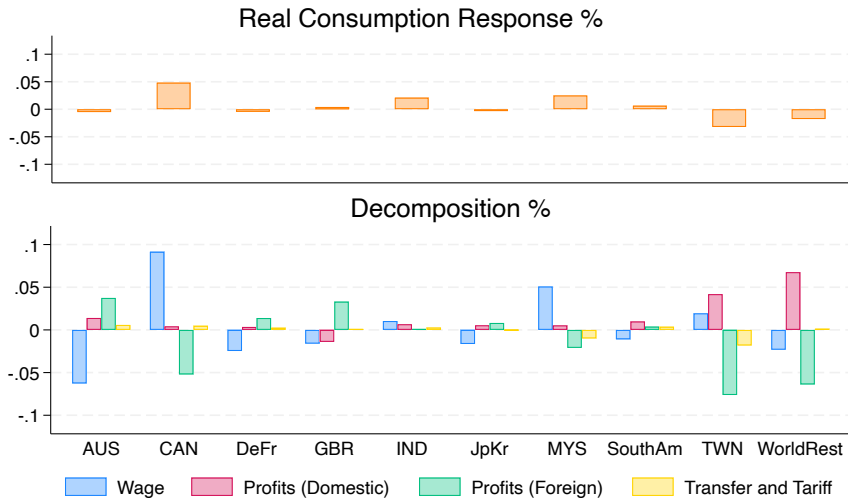




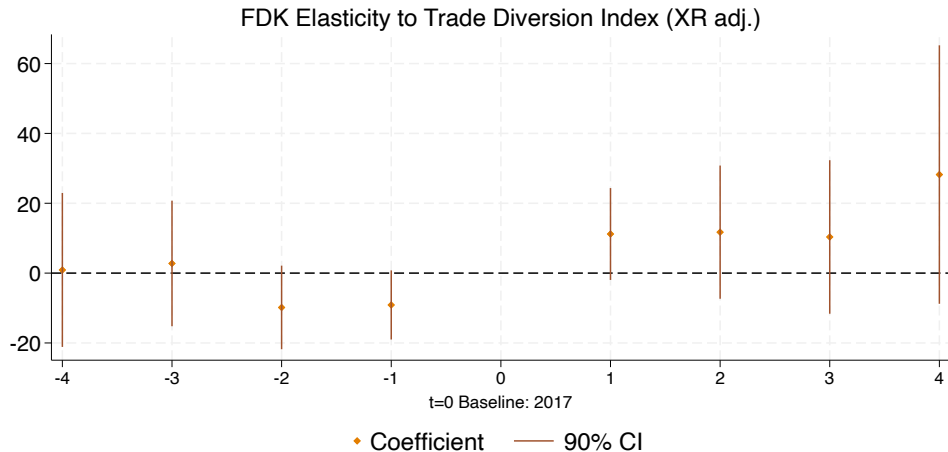
# Distributional Implications: Mexico and Vietnam



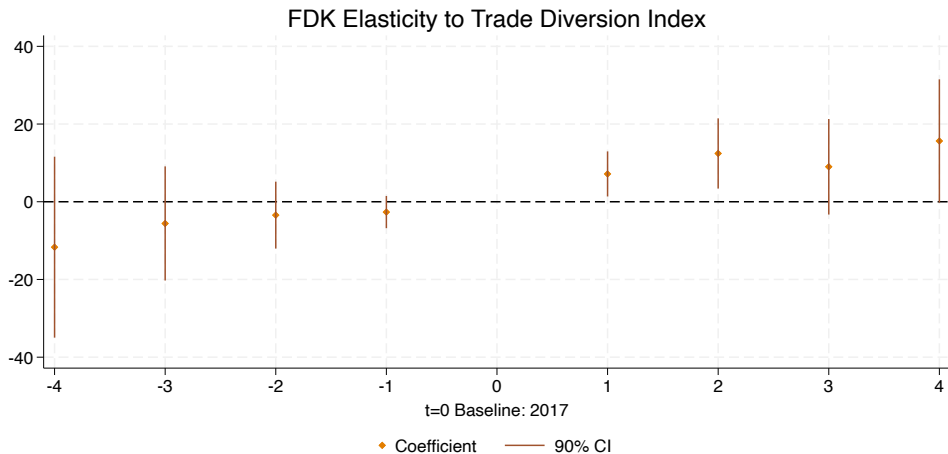
# Distributional Implications: Others



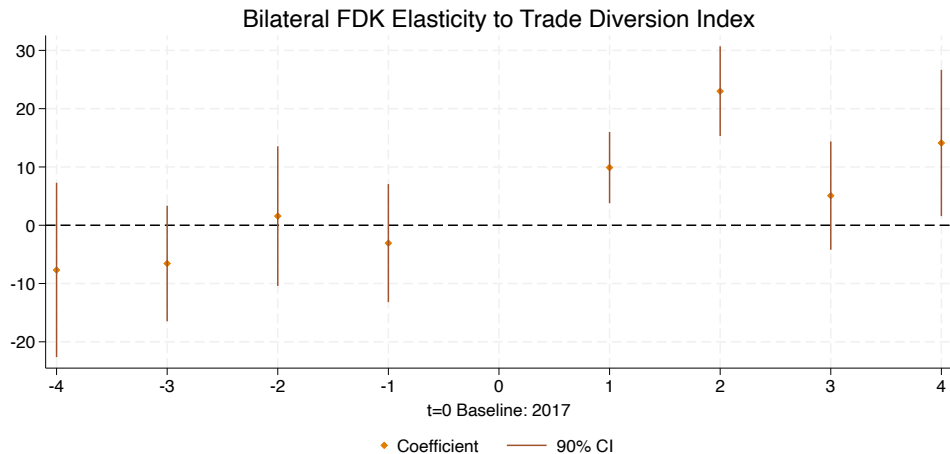
# Country Level Result: Exchange Rate Adjusted



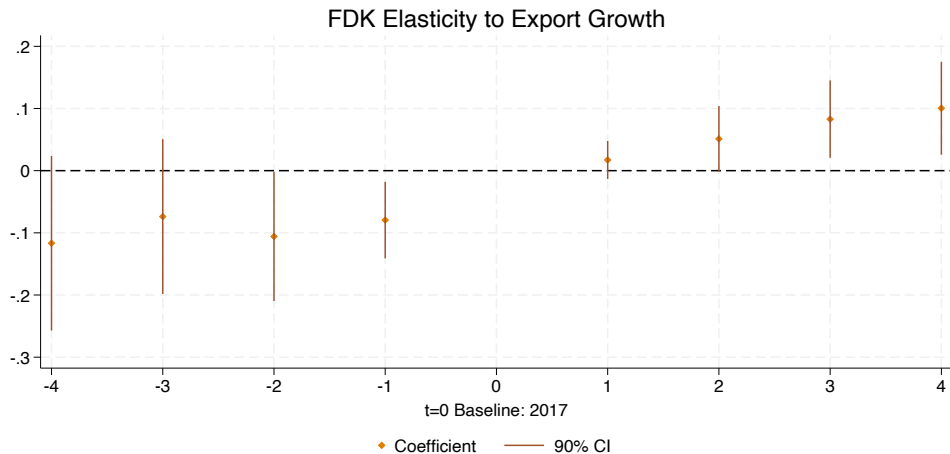
## Country Level Result: Use ISIC 2-digit Tariffs



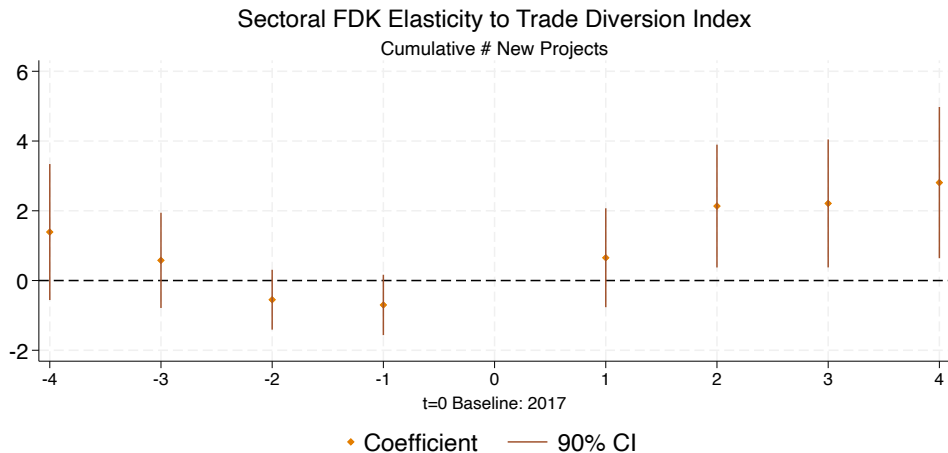
# Country Level Result: Bilateral FDI Stocks



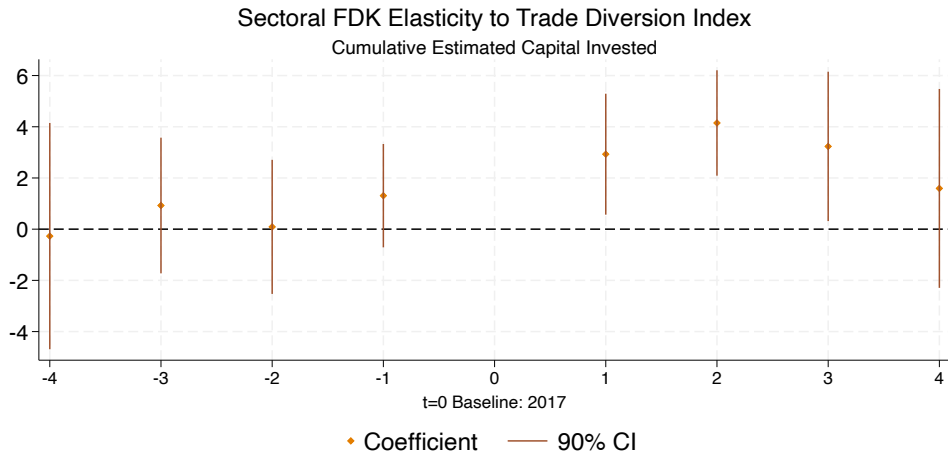
# Using Export Directly: Export Growth as Independent Variable



# Sector Level Result: Cumulative # Projects

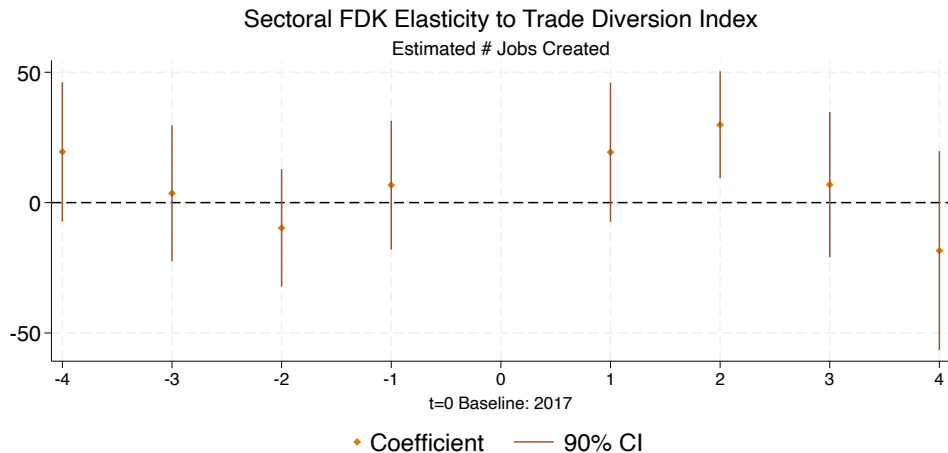


# Sector Level Result: Cumulative Estimated Capital Invested

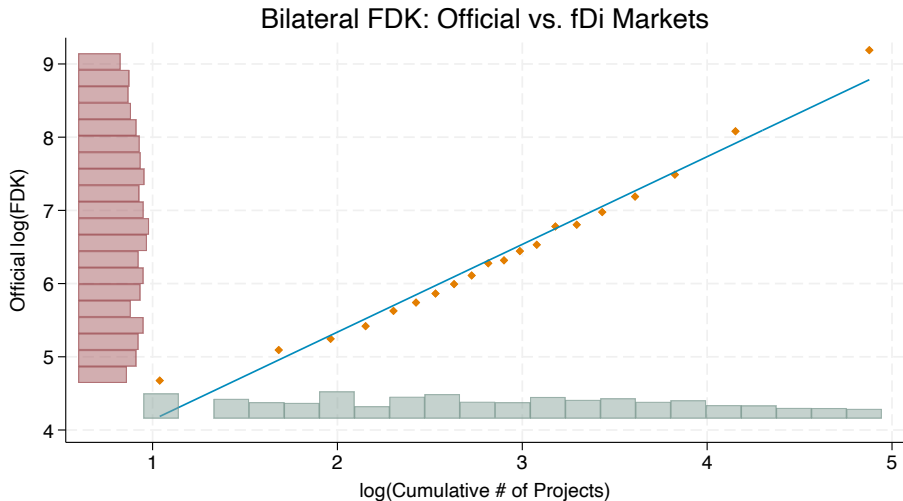




# Sector Level Result: Estimated Jobs Created

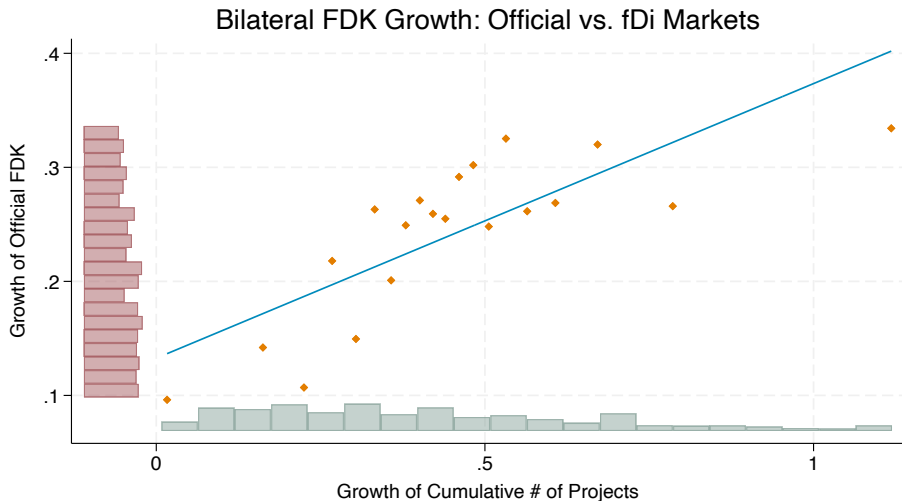


# FDI Data: Official vs. fDi Markets



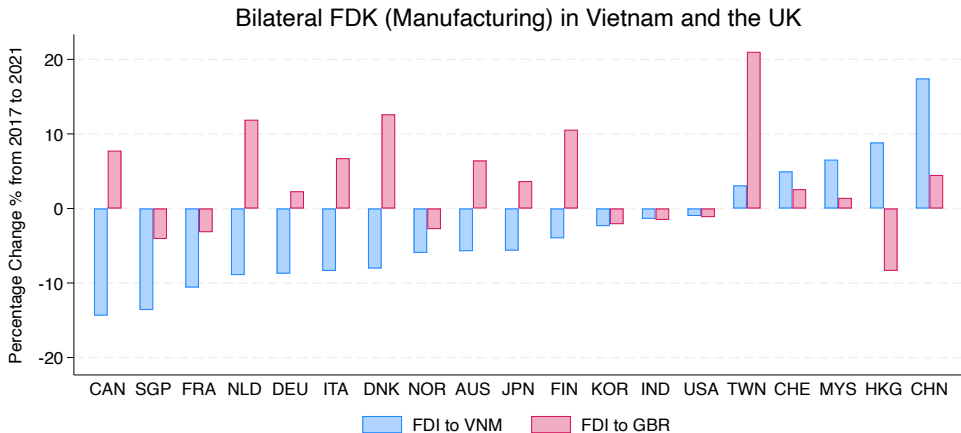
Controlled for Receiver, Source, Year FE.

# FDI Data: Official vs. fDi Markets



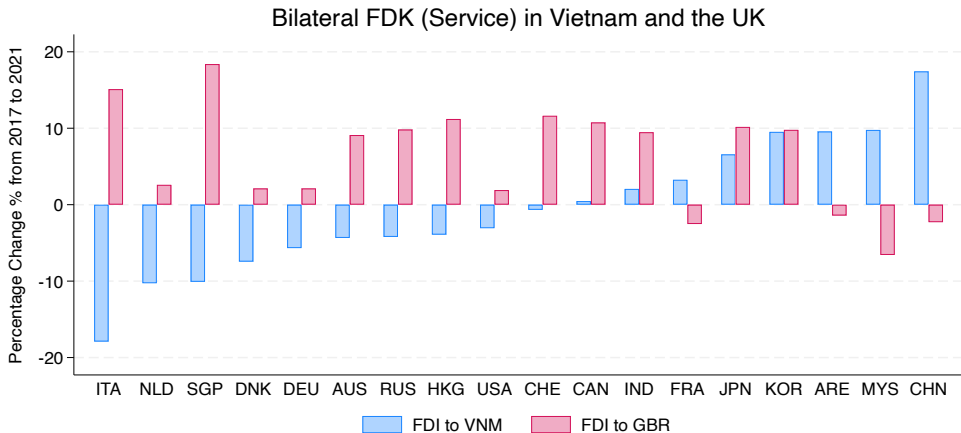
Accumulative growth from 2013; Controlled for Receiver, Source, Year FE.

# Heterogeneous Bilateral FDK Responsiveness (Manufacturing)



FDK measured using Cumulative # of FDI projects from fDi Markets, residualized by investor FE.

# Heterogeneous Bilateral FDK Responsiveness (Service)



FDK measured using Cumulative # of FDI projects from fDi Markets, residualized by investor FE.

# Share of FDK Investment

- $\omega_{ij} = \frac{FDK_{ij}}{\sum_{j' \neq i} FDK_{ij'}};$

	(1)	(2)
d ln FDK <sub>i</sub> × ln (Dist <sub>ij</sub> )	-0.284** (0.122)	-0.204* (0.121)
d ln FDK <sub>i</sub> × ln (GDPpc <sub>j</sub> )	0.156** (0.065)	0.115* (0.065)
d ln FDK <sub>i</sub> × ComparaAdv <sub>ij</sub>	0.599** (0.283)	0.580** (0.280)
d ln FDK <sub>i</sub> × ω <sub>ij</sub>		1.342*** (0.240)
R <sup>2</sup> adj.	.005	.03
# of Obs.	2735	2735

Notes: The dependent variable is the bilateral FDI growth from 2017 to 2019. The sample includes 34 source countries and 199 receiver countries.

\* p < 0.1, \*\* p < 0.05, \*\*\* p < 0.01.

## Within Sector: NAICS 2-digit (fDi Markets)

- Outcome:  $d \ln N_{ij,t} = \ln(N_{ij,t+1}/N_{ij,t})$ ,  $t = 2017, \dots, 2020$ ;

$N_{i,t}$ : Cumulative # of Projects;

FE: Investor-year-sector & Receiver-year-sector;

	(1)	(2)	(3)
$d \ln N_{i,t} \times \omega_{ij,t}$	0.429*** (0.011)		0.413*** (0.011)
$d \ln N_{i,t} \times \ln(\text{Dist}_{ij})$		-0.048*** (0.006)	-0.046*** (0.006)
$d \ln N_{i,t} \times \text{GDP}_{pcj}$		0.060*** (0.006)	0.044*** (0.006)
$R^2$ adj.	.087	.086	.108
# of Obs.	24211	24211	24211

Notes: The dependent variable is the next-year bilateral FDI growth measured by the number of projects from fDi Markets at the NAICS 2-digit sector level, for years from 2017 to 2020. The dependent variable is winsorized at the 90<sup>th</sup> percentile. The sample includes 30 source countries, 92 receiver countries, and 14 sectors. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

# From Trade Policy to FDI Diversion: Details

- Trade policy change (i.e.  $\tau_{hi}^s$ )  $\Rightarrow$  a new steady state;
- Without capital adjustment: Prices & Trade diversion;
- For production location  $i$  of sector  $s$ , producers from  $j$ , the following also change:

**Market access**  $A_i^s = \text{constant} \cdot \sum_h (d_{hi}^s)^{-\epsilon^s} (\tau_{hi}^s)^{1-\epsilon^s} \overbrace{(P_h^s)^{\epsilon^s} Q_t^s}^{\text{h market size}} ;$

**Optimal capital value**  $P_i k_{ij}^{s*}(a) = \underbrace{\Lambda_i^s}_{\text{constant}} \frac{\tilde{A}_i^s}{\kappa_{ij}^s \epsilon^s - 1}, \text{ where } \tilde{A}_i^s \equiv P_i^{-(\epsilon^s-1)\alpha_i^s} \left( \frac{w_i}{1-\alpha_i^s} \right)^{-(\epsilon^s-1)(1-\alpha_i^s)} A_i^s ;$

**Value of operation**  $\tilde{v}_{ij}^s = \underbrace{\tilde{\Lambda}_i^s}_{\text{constant}} \frac{\tilde{A}_i^s}{\kappa_{ij}^s \epsilon^s - 1} ;$

$\Rightarrow$  FDI diversion: intensive ( $k_{ij}^{s*}(a)$ ) and extensive ( $\tilde{\mathbb{F}}_{ij}^s(a)$ ).



# Binscatter: $EX \sim DI + FDI$

	To All (ex. CN)		To US	
	(1)	(2)	(3)	(4)
Diversion Index	26.692 (19.479)	14.536 (19.445)	88.429** (41.371)	74.273* (39.604)
FDK Growth		0.591*** (0.185)		0.791** (0.383)
Controls	✓	✓	✓	✓
R2 adj.	.02	.06	.07	.09
# of Obs.	140	140	141	141

*Notes:* Data uses official inward FDI stocks from OECD, IMF CDIS, and UNCTAD, export value from BACI. The export growth is from 2017 to 2020, while FDI growth is from 2017 to 2019. The diversion index is constructed using equation (??), with  $\nu$  at HS 6-digit level, and trade value from BACI for year 2017, Trump tariff increase from 2017 to 2020, all at at HS 6-digit level. I constraint the country to be those with the largest inward FDI stocks in 2017, and excluding those that are usually regarded as tax heavens, which results in about 140 countries. All regressions control for the log export, inward FDI stock, and GDP per capita levels in 2017. Standard errors in parentheses, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

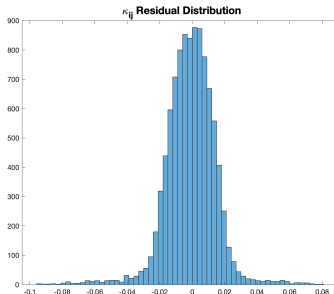
# Country List

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Code	Name	Economies
AUS	Australia	Australia
CAN	Canada	Canada
CHN	China	China
DeFr	Germany & France	Germany, France
GBR	United Kingdom	United Kingdom
JpKr	Japan & Korea	Japan, Korea
MEX	Mexico	Mexico
MYS	Malaysia	Malaysia
SouthAm	South America	
TWN	Taiwan	Taiwan
USA	United States of America	United States of America
VNM	Viet Nam	Viet Nam
WorldRest	Rest of the World	

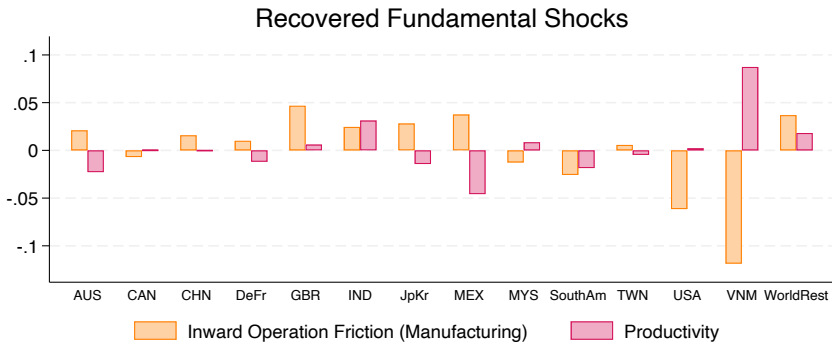
# Back Out Shocks

- Shocks in the model:
  - $d \ln L_j, d \ln \phi_h^s, d \ln \tau_{ij}^s$  directly measured;
  - $d \ln z_j, d \ln d_{ij}^s$  account for deviation in total expenditure and trade shares;
  - $d \ln \kappa_{ij}^s = d \ln \kappa_j^{s,out} + d \ln \kappa_i^{s,in} + d \ln \tilde{\kappa}_{ij}^s$  account for deviation in bilateral FDI positions;
- Recover shocks by matching 2019 data; get distribution for  $d \ln \tilde{\kappa}_{ij}^s$ ; Data is one realization;  
In principle, can add i.i.d. shocks to all other fundamentals;



# Back Out Shocks

- Recovered  $d \ln \kappa_i^{2,\text{in}}$  and  $d \ln z_i^{1/\epsilon^2}$



## Indirect Inference: Given $\theta = 14$

---

	Outcome: $d \ln K_i$		Calibration	
	Data	Model	Parameter	Value
$DI_i$	18.67 ** (7.83)	18.90 (7.02)	$\rho$ $\theta$	0.84 14
$R^2$	0.471			
# of Obs.	117			

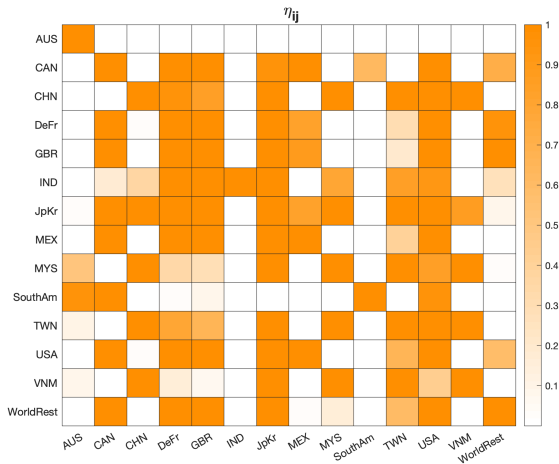
*Notes:* The first column reports empirical regression coefficient for  $\vartheta$ . I constrain the sample to include the largest FDI receivers, while excluding those typically considered tax havens, which results in 117 receiver countries. The second column reports the median and standard error of regression coefficients from 10 model simulation runs. Finally, the last column reports the corresponding parameter values. Standard errors in parentheses, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

## Indirect Inference: Given $\theta = 14$ , Cont.

	Outcome: $d \ln K_{ij}$		Calibration	
	Data	Model	Parameter	Value
$d \ln K_i \times \ln (\text{Dist}_{ij})$	-0.169* (0.090)	-0.181	$\zeta_1$	-7
$d \ln K_i \times \ln (\text{GDPpc}_j)$	0.117** (0.059)	0.122	$\zeta_2$	4.5
$d \ln K_i \times \text{ComparaAdv}_{ij}$	0.576*** (0.219)	0.634	$\zeta_3$	16.5
			$\zeta_0$	-7
$R^2$	0.111			
# of Obs.	2621			

*Notes:* The first column reports empirical regression estimates of the interaction coefficients  $\psi$ . I constrain the sample to include investors with sufficient large number of receivers, while excluding those typically considered tax havens, which results in 36 investor and 193 receiver countries. The second column reports the median of regression coefficients from 10 model simulation runs. Finally, the last column reports the corresponding parameter values. Standard errors in parentheses, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Calibrated  $\{\eta_{ij}\}_{i \neq j}^{N,N}$ : Given  $\theta = 14$



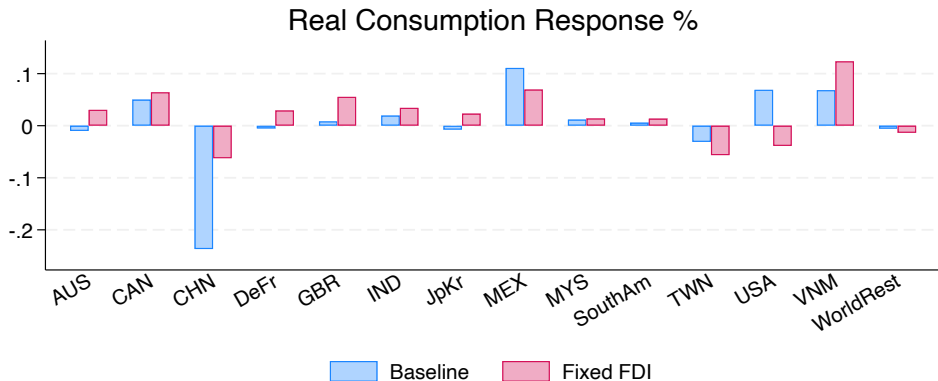
## Untargeted Moments: Domestic Capital $\sim$ DI

	FDK		Domestic Capital	
	Data	Model	Data	Model
	(1)	(2)	(3)	(4)
DI	18.281** (8.180)	18.291** (7.600)	-5.621 (3.766)	-4.279 (4.469)
R2 adj.	.04		.01	
# of Obs.	100		96	

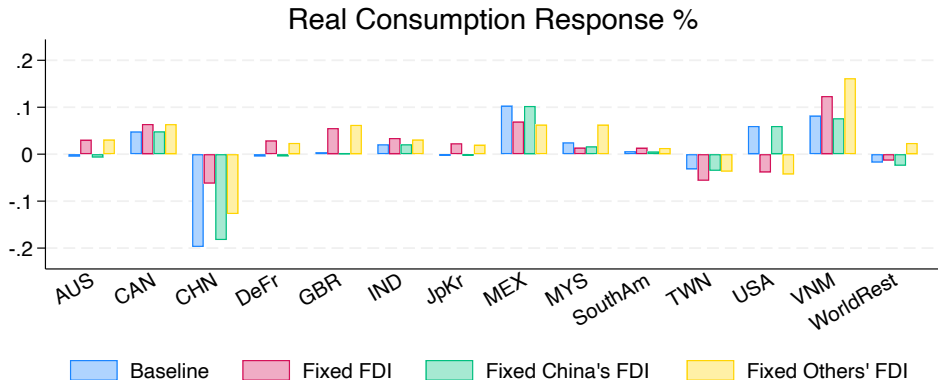
*Notes:* Columns (1) and (3) reports empirical regression estimates of the coefficients on the Trade Diversion Index. I constrain the sample to include investors with sufficient large number of receivers, while excluding those typically considered tax havens. The data for domestic capital use IMF domestic capital from 2017, and GDP growth to infer the 2019 value. Columns (2) and (4) report the median of regression coefficients from 10 model simulation runs. Standard errors in parentheses, \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .



## FDI Diversion on Aggregate Welfare: Given $\theta = 14$

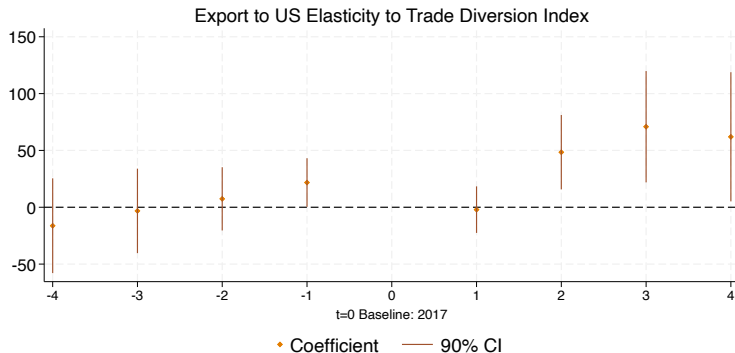


# Chinese and Others' FDI Diversion



# Contribution of FDI Diversion to Relative Export Growth

- $DI_i$  also predicts relative export growth to the US:



- Production capacity responses: Domestic capital + FDI; How large is FDI's contribution?

# Contribution of FDI Diversion to Relative Export Growth

- Assume identical contributions to export of per unit increase in domestic capital and FDK;
- The elasticities of FDK / domestic capital to the trade diversion index:

	FDK	Domestic Capital
DI	26.029** (11.536)	19.567* (11.265)
R2 adj.	.04	.02
# of Obs.	99	94

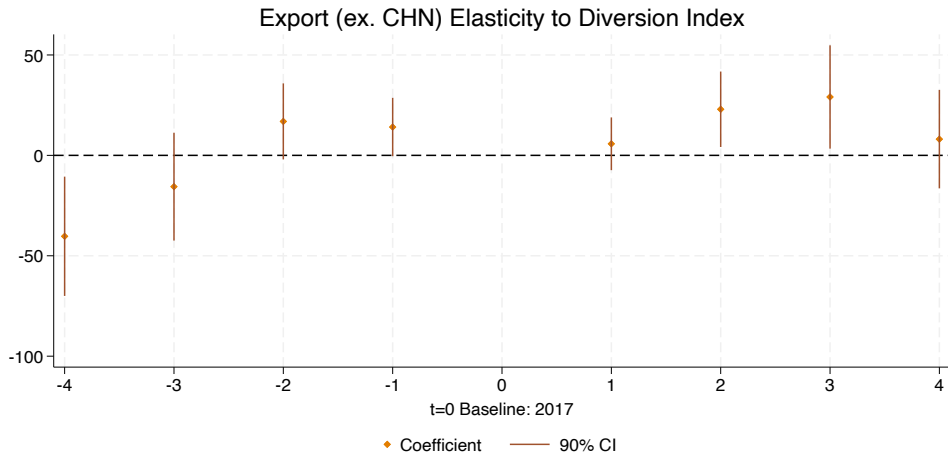
Notes: The dependent variables are FDK growth and domestic capital stocks growth from 2017 to 2019 at the country level. I drop countries with measured FDK larger than the domestic capital stocks. I further winsorize the growth of domestic capitals at the 2.5th and 97.5th percentiles and drop Mexico and Canada. I exclude Mexico and Canada because they have the largest trade diversion indexes. If I include these two countries, the estimates and standard errors for both columns become 17.96 (8.13) and 8.95 (7.92). \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

- Average FDK share: 23.6%;

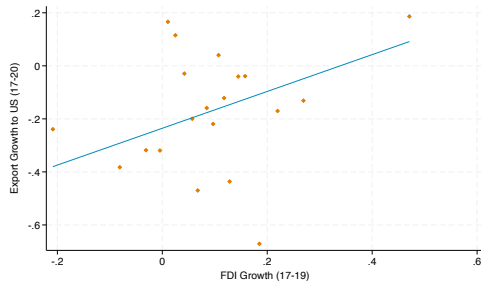
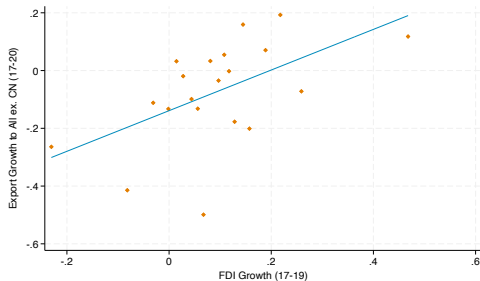
- Relative export growth to the US for a given country associated with FDI diversion:

$$\frac{26.03 \times 23.6\%}{26.03 \times 23.6\% + 19.57 \times (1 - 23.6\%)} \approx 29.1\%.$$

# Total Export Growth (ex CN)



# Bin-scatters: $EX \sim FDI$



# Contribution of FDI Diversion to Export Growth: Example

- Consider two countries, where country 1 is more exposed, e.g., 1 vs. 0;
- Before the Trump Tariffs:

	FDK	Domestic Capital	Export
Country 1	50	100	150
Country 2	50	100	150

- After the Trump Tariffs:

	FDK	Domestic Capital	Export
Country 1	70	130	200
Country 2	60	120	180

- Contribution of FDK is

$$\frac{(40 - 20)\% \times 1/3}{(40 - 20)\% \times 1/3 + (30 - 20)\% \times 2/3} = 50\%.$$

## Contribution of FDI Diversion to Export Growth: Example 2

- Consider two countries, where country 1 is more exposed, e.g., 1 vs. 0;
- Before the Trump Tariffs:

	FDK	Domestic Capital	Export
Country 1	10	20	30
Country 2	50	100	150

- After the Trump Tariffs:

	FDK	Domestic Capital	Export
Country 1	15	21	36
Country 2	55	110	165

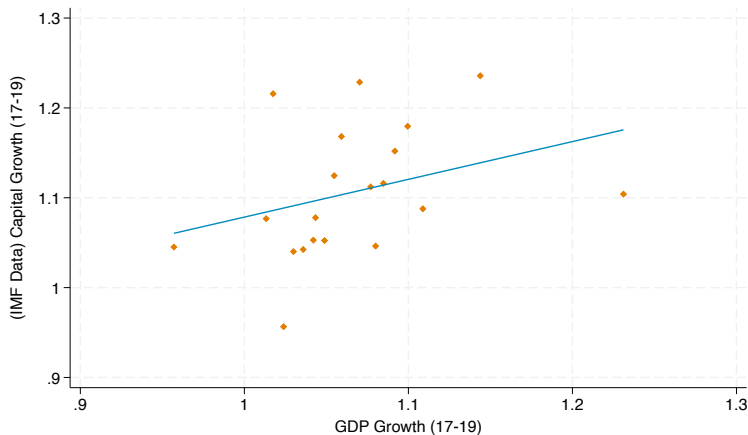
- Contribution of FDK is

$$\frac{(50 - 10)\% \times 1/3}{(50 - 10)\% \times 1/3 + (55 - 15)\% \times 2/3} = 133\%.$$



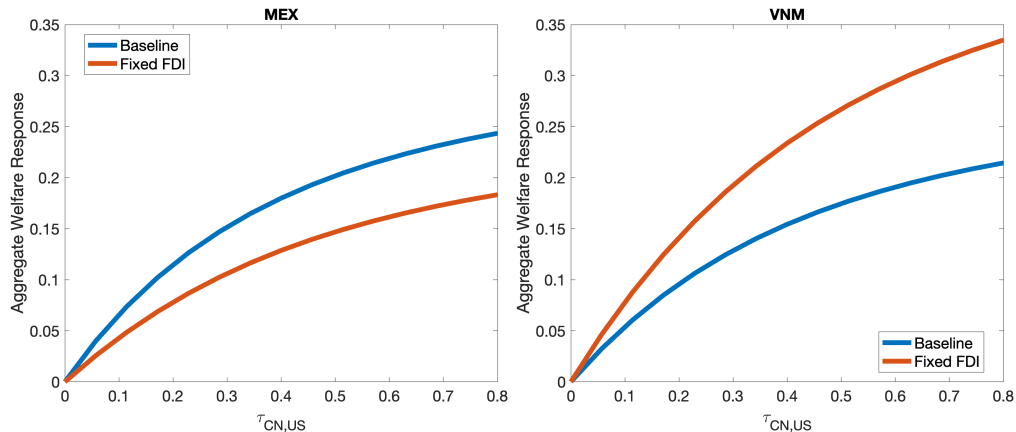
# Data: FDI Growth

- Current results use IMF domestic capital measure: not very realistic across years (2017-2019);

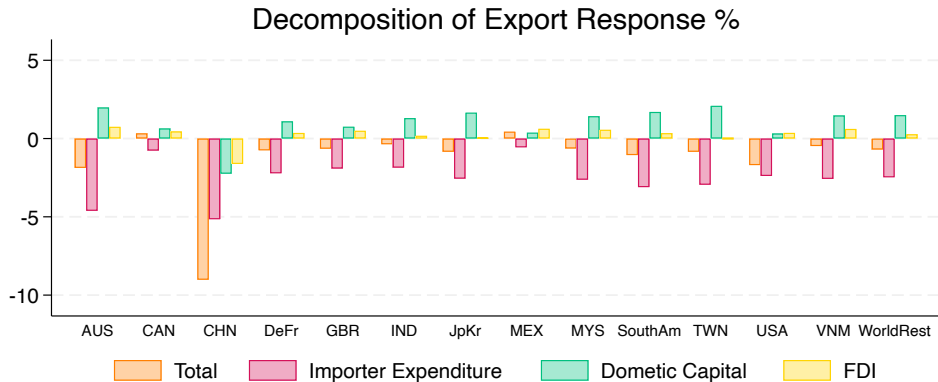


- Calibration uses GDP growth implied total capital growth from 17 to 19;

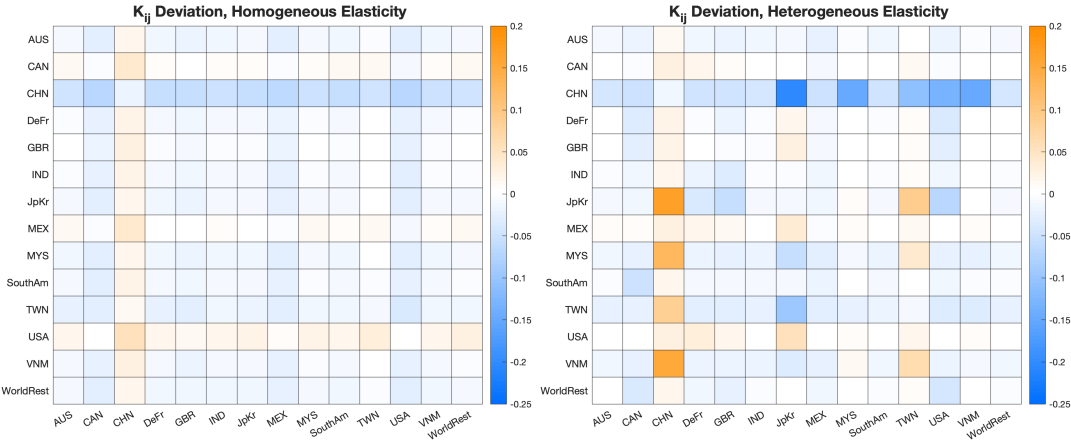
# Numerical “Optimal Tariff”: MEX, VNM



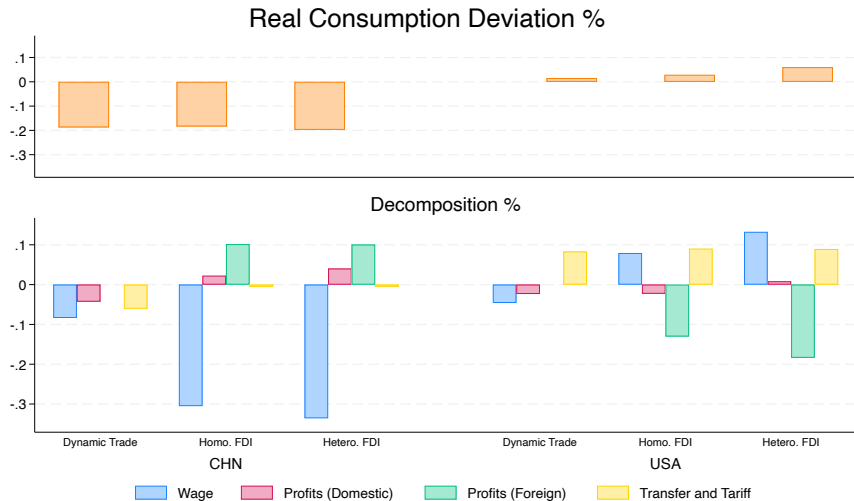
# Total Export Value Responses



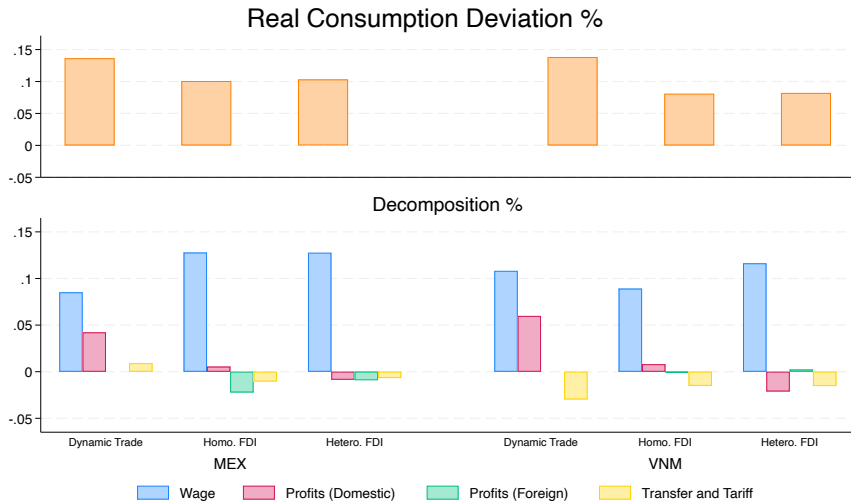
# Bilateral FDI Diversion: Homogeneous vs. Heterogeneous Elasticity



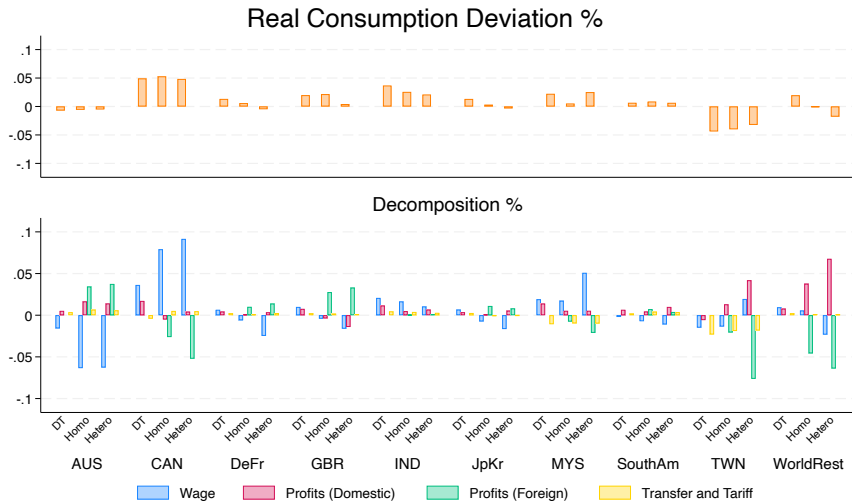
# Model Comparison for China and the US



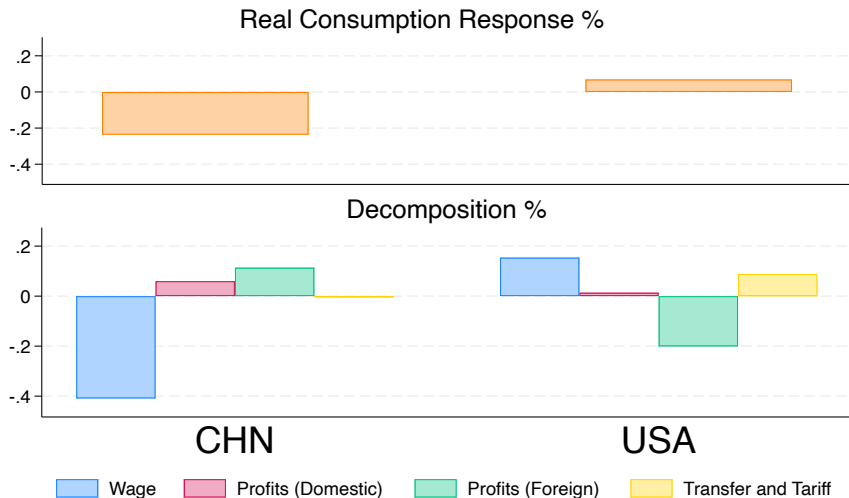
# Model Comparison for Mexico and Vietnam



# Model Comparison for Others

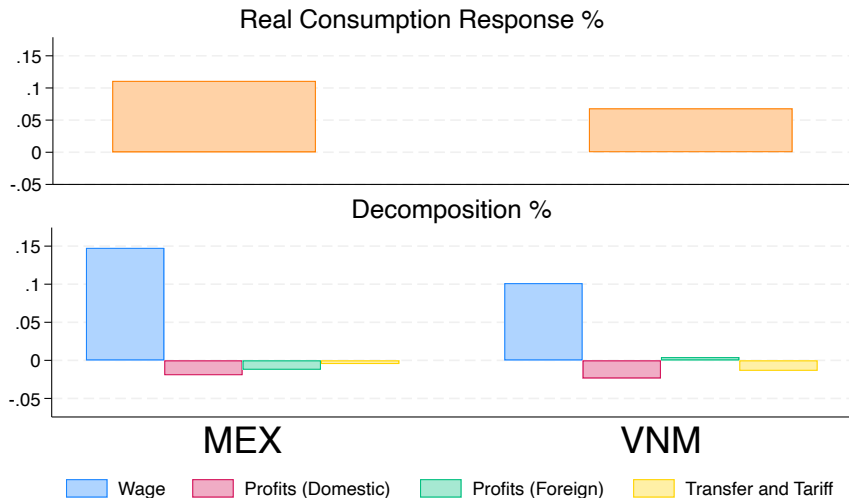


## Sensitivity Quantitative Results: $\theta = 14$





## Sensitivity Quantitative Results: $\theta = 14$ , Cont.



## Sensitivity Quantitative Results: $\theta = 14$ , Cont.

