Global Value Chains in a World of Uncertainty and Automation

Marius Faber, Swiss National Bank
Kemal Kilic, TU Munich
Gleb Kozliakov, TU Munich
Dalia Marin, TU Munich and CEPR

3rd Kiel-CEPR Conference on Geoeconomics
Berlin, October 2024

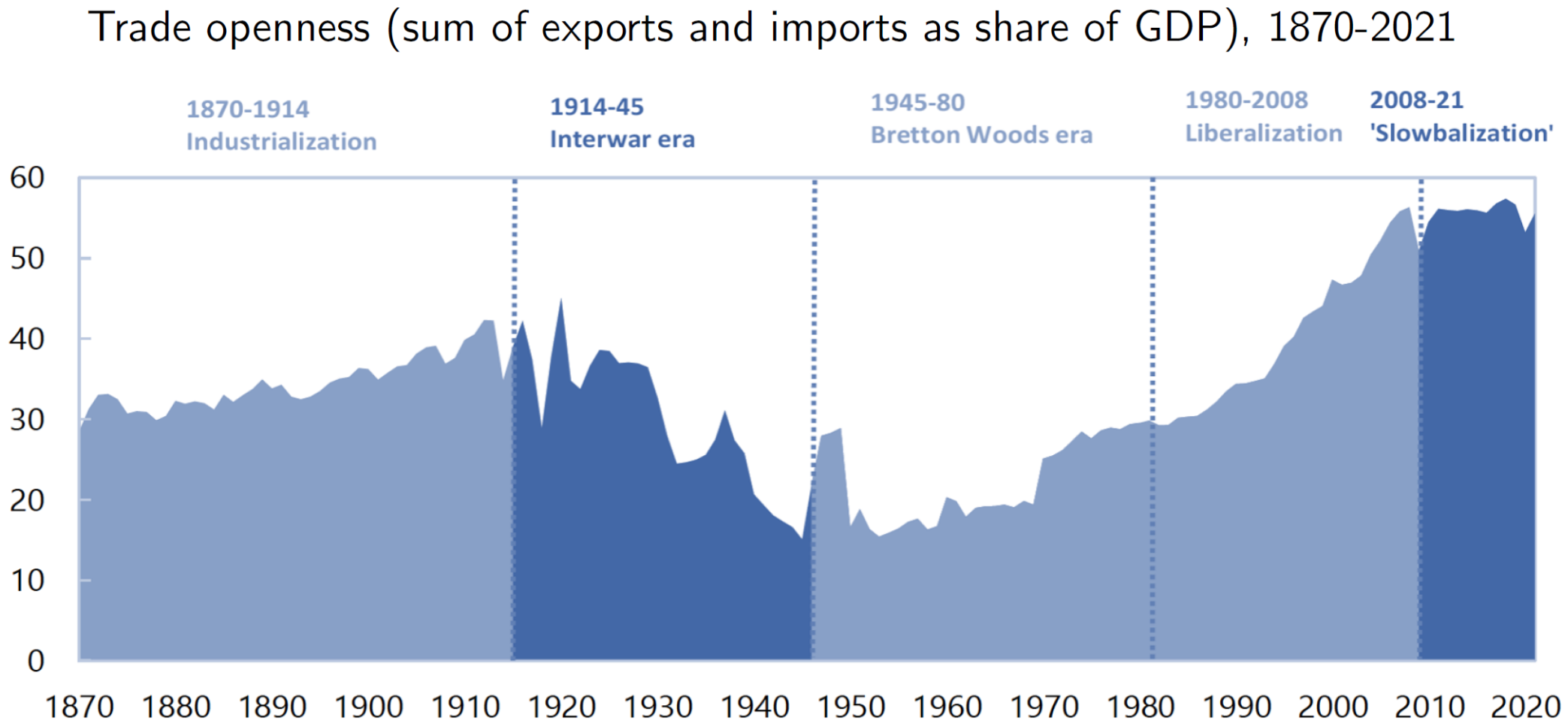
Question this Paper raises:

Can uncertainty together with automation

explain

the trend reversal in openess in the world economy?

Globalization is stagnating since the GFC



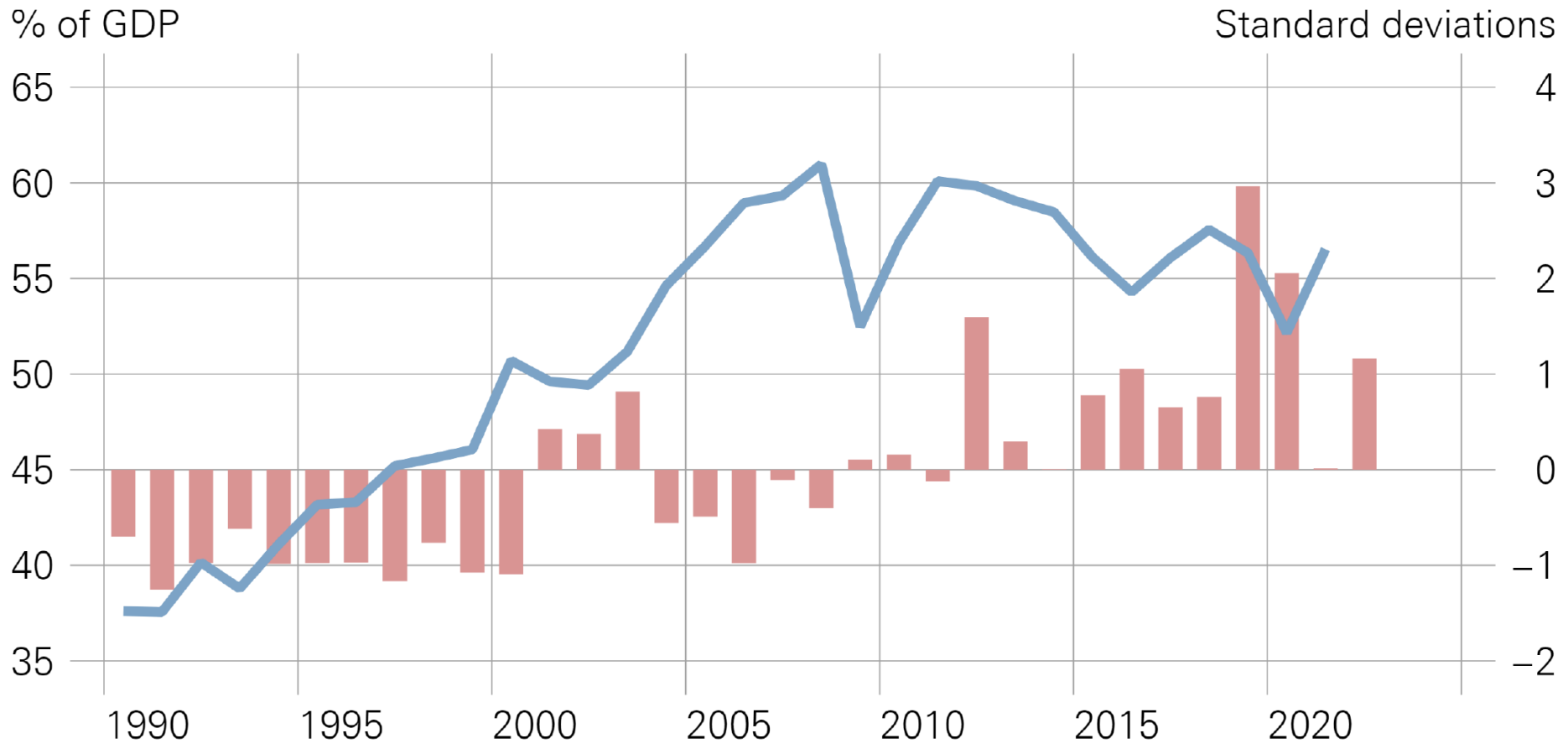
Measuring Uncertainty

World Uncertainty Index (WUI) by Ahir et al 2022

WUI counts the share of the word „uncertain“ (or ist variants) in the Economist Intelligence Unit country reports

Uncertainty has been unusually high since the GFC

Trade Openess and World Uncertainty Index 1990-2020



Higher uncertainty, greater risk of default

of an input good delivery,

firms are likely to start to reconsider their supplier relationships

Uncertainty shocks after GFC: European Debt Crisis 2011-2014, Brexit 2016, US-China trade war since 2018, Covid 2020, Russian attack on Ukraine 2022

Robots have become cheaper and more sophisticated

Automation technologies have made substantial advances, now they are able to perform tasks that have previously been offshored

Central banks have ensured low financing conditions after the GFC effectively lowering the cost of capital relative to labor.

Research Questions

Does uncertainty in developing countries cause reshoring of global supply chains to high income countries?

Does automation play a facilitating role?

Theoretical Ambiguities

Effect of uncertainty on GVC depends on

whether firms view the domestic or the foreign economy more prone to shocks,

if both are risky, they diversify

if home is less risky, they reshore (Grossman et al, 2023)

Effect of automation on GVC depends on whether robots substitute for foreign workers lowering GVC (displacement effect), robots increase productivity increasing GVC (productivity effect) (Acemoglu and Restrepo, 2020).

Related Literature

Uncertainty and International Trade:

Novy and Taylor (2020), Martin, Mejean, Parenti (2023), Handley and Limao (2015, 2017), Graziano et al (2021), Pierce and Schott (2016), Grossman, Helpman, Lhuillier (2023)

Robots and Offshoring:

Artuc et al (2020), Stapleton and Webb (2020), Faber (2020), Bonfiglioli (2022).

Testing for the Effect of Uncertainty and Robots on Reshoring

Data

GVC (World Input-Output Data Base): Internmediate input flows in 18 developed countries and 17 developing countries in 19 industries

Uncertainty (World Uncertainty Index, Ahir et al 2022)

Robot Replaceability (Graetz and Michaels, 2018), industry‘s share of occupations in the US in 1980 with skills that can be replaced by a robot

Controls

Empirical Strategy: Estimating quation (1/2)

$$\underbrace{\text{reshoring}_{ij,t}}_{\Delta \log\left(\frac{\text{inputs}^{home}_{ij,t}}{\text{inputs}^{dev}_{ij,t}}\right)} = \beta \underbrace{\Delta \begin{array}{c}\text{exposure to}\\ \text{developing countries'}\\ \text{uncertainty}_{ij,t}\end{array}}_{\sum_{k\in K} \alpha_{ijk,2000}\Delta\text{uncertainty}_{k,t}} + \eta_i + \theta_t + \boldsymbol{\kappa}\boldsymbol{X}_{ij,t} + \epsilon_{ij,t}$$

Shift share instrument

country-industry pair‘s exposure to uncertainty in developing countries

$$\Delta \begin{array}{c}\text{exposure to}\\ \text{developing}\\ \text{countries'}\\ \text{uncertainty}_{ij,t}\end{array} = \sum_{k \in K} \alpha_{ijk} \Delta \text{uncertainty}_{k,t} \tag{2}$$

where $\text{uncertainty}_{k,t}$ is developing country k's level of uncertainty in the World Uncertainty Index (Ahir et al., 2022), and $\alpha_{ijk} = \text{inputs}_{ijk,2000}/\text{inputs}_{ij,2000}$ is the share of developing country k's inputs of all inputs of (developed) country i in industry j in 2000[10]. Thus

Empirical Strategy: Estimating equation (2/2)

$$\text{reshoring}_{ij,t} = \beta\ \Delta\ \text{exposure to developing countries' uncertainty}_{ij,t} + \gamma\ \text{robot replaceability}_{j} + \delta\ \Delta\ \text{exposure to developing countries' uncertainty}_{ij,t} \times \text{robot replaceability}_{j}$$

$$+ \eta_i + \theta_t + \boldsymbol{\kappa}\boldsymbol{X}_{ij,t} + \epsilon_{ij,t} \qquad (2)$$

Main Results

The impact of uncertainty and robots on reshoring

	dep. variable: $\Delta \frac{\text{domestic inputs}}{\text{developing country inputs}}$			
	(1)	(2)	(3)	(4)$^{\pm}$
Δ exposure to developing countries' uncertainty	0.423	0.403	-0.547	-0.594
	(0.658)	(0.663)	(0.633)	(0.671)
1{robot replaceability}		-3.373*	-2.859	-3.457
		(1.810)	(1.761)	(2.654)
Δ exposure to developing countries' uncertainty $\times$1{robot replaceability}			7.527***	7.790***
			(2.162)	(2.366)
Period FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Observations	1710	1710	1710	1260
R^2	0.204	0.209	0.224	0.219
Joint hypothesis test $[H_0 : \beta + \delta = 0]$ p-value:	—	—	0.001	0.002

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; $^{\pm}$ manufacturing only

The impact of uncertainty and robots on reshoring

	dep. variable: $\Delta \frac{\text{domestic inputs}}{\text{developing country inputs}}$			
	(1)	(2)	(3)	(4)$^{\pm}$
Δ exposure to developing countries' uncertainty	0.423	0.403	-0.547	-0.594
	(0.658)	(0.663)	(0.633)	(0.671)
1{robot replaceability}		-3.373*	-2.859	-3.457
		(1.810)	(1.761)	(2.654)
Δ exposure to developing countries' uncertainty $\times$1{robot replaceability}			7.527***	7.790***
			(2.162)	(2.366)
Period FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Observations	1710	1710	1710	1260
R^2	0.204	0.209	0.224	0.219
Joint hypothesis test $[H_0 : \beta + \delta = 0]$ p-value:	—	—	0.001	0.002

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; $^{\pm}$ manufacturing only

Result: reshoring

Higher uncertainty in developing countries

increases

the relative use of domestic inputs,

but only in highly robotized industries

More reshoring, or less offshoring?

	$\Delta \frac{domestic}{developing}$	$\Delta \frac{domestic}{developing_{fix}}$	$\Delta \frac{domestic_{fix}}{developing}$	$\Delta \frac{domestic}{developed}$
	(1)	(2)	(3)	(4)
Δ exposure to developing countries' uncertainty	-0.594	2.292*	-1.472	-1.992**
	(0.671)	(1.267)	(0.904)	(0.978)
1{robot replaceability}	-3.457	-3.289*	1.466	2.607**
	(2.654)	(1.699)	(1.610)	(1.275)
Δ exposure to developing countries' uncertainty ×1{robot replaceability}	7.790***	-0.085	7.116***	4.244***
	(2.366)	(1.695)	(2.590)	(1.228)
Period FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Observations	1710	1710	1710	1260
R^2	0.170	0.166	0.166	0.170

More reshoring, or less offshoring?

	$\Delta \frac{domestic}{developing}$	$\Delta \frac{domestic}{developing_{fix}}$	$\Delta \frac{domestic_{fix}}{developing}$	$\Delta \frac{domestic}{developed}$
	(1)	(2)	(3)	(4)
Δ exposure to developing countries' uncertainty	-0.594	2.292*	-1.472	-1.992**
	(0.671)	(1.267)	(0.904)	(0.978)
1{robot replaceability}	-3.457	-3.289*	1.466	2.607**
	(2.654)	(1.699)	(1.610)	(1.275)
Δ exposure to developing countries' uncertainty ×1{robot replaceability}	7.790***	-0.085	7.116***	4.244***
	(2.366)	(1.695)	(2.590)	(1.228)
Period FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Observations	1710	1710	1710	1260
R^2	0.170	0.166	0.166	0.170

Result: fewer foreign inputs

Uncertainty shocks lead to fewer inputs from developing countries, not an increase in domestic inputs

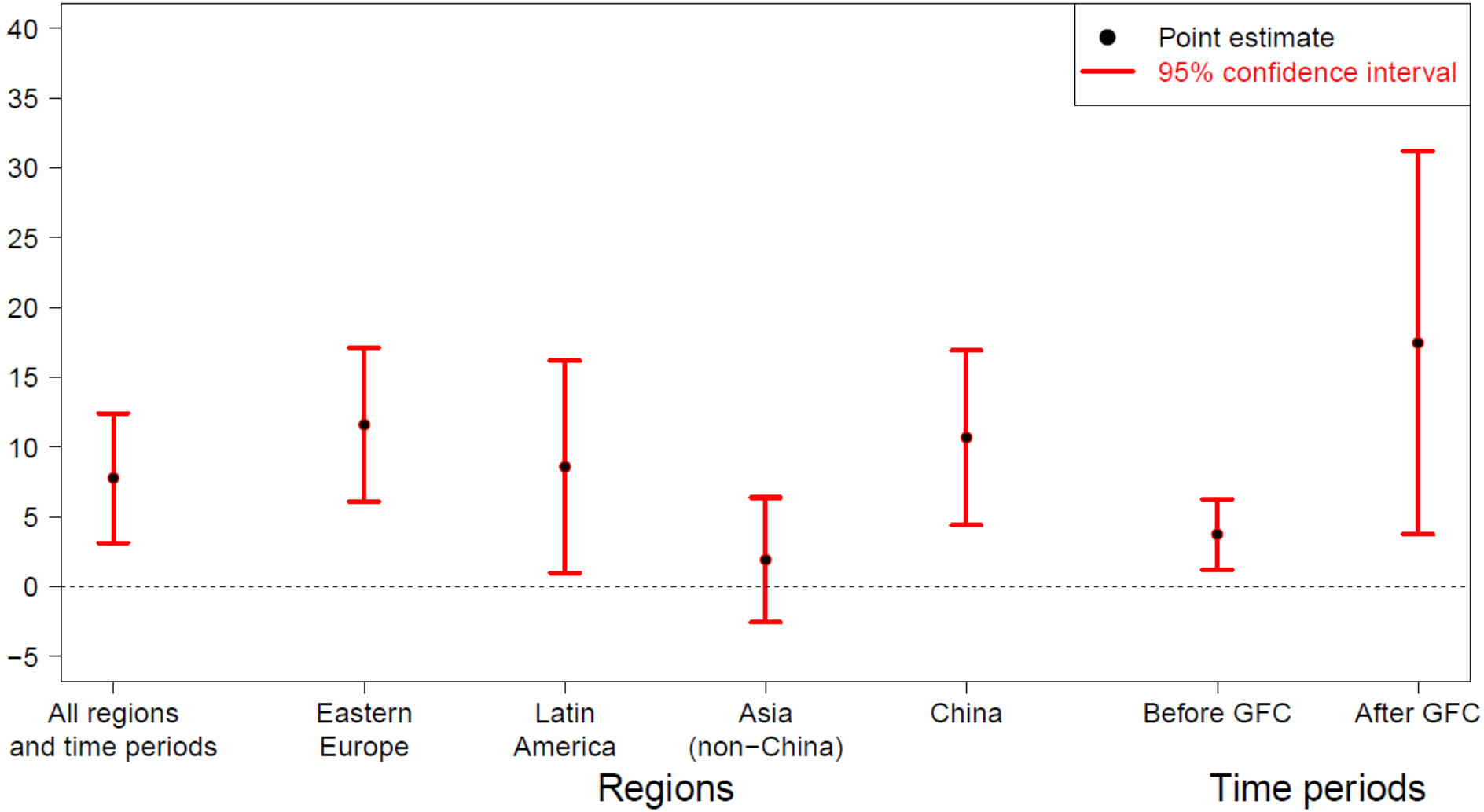
Result suggests that firms reorganize and move to produce the input in-house and they do not reshore to domestic input suppliers.

Possible reasons:

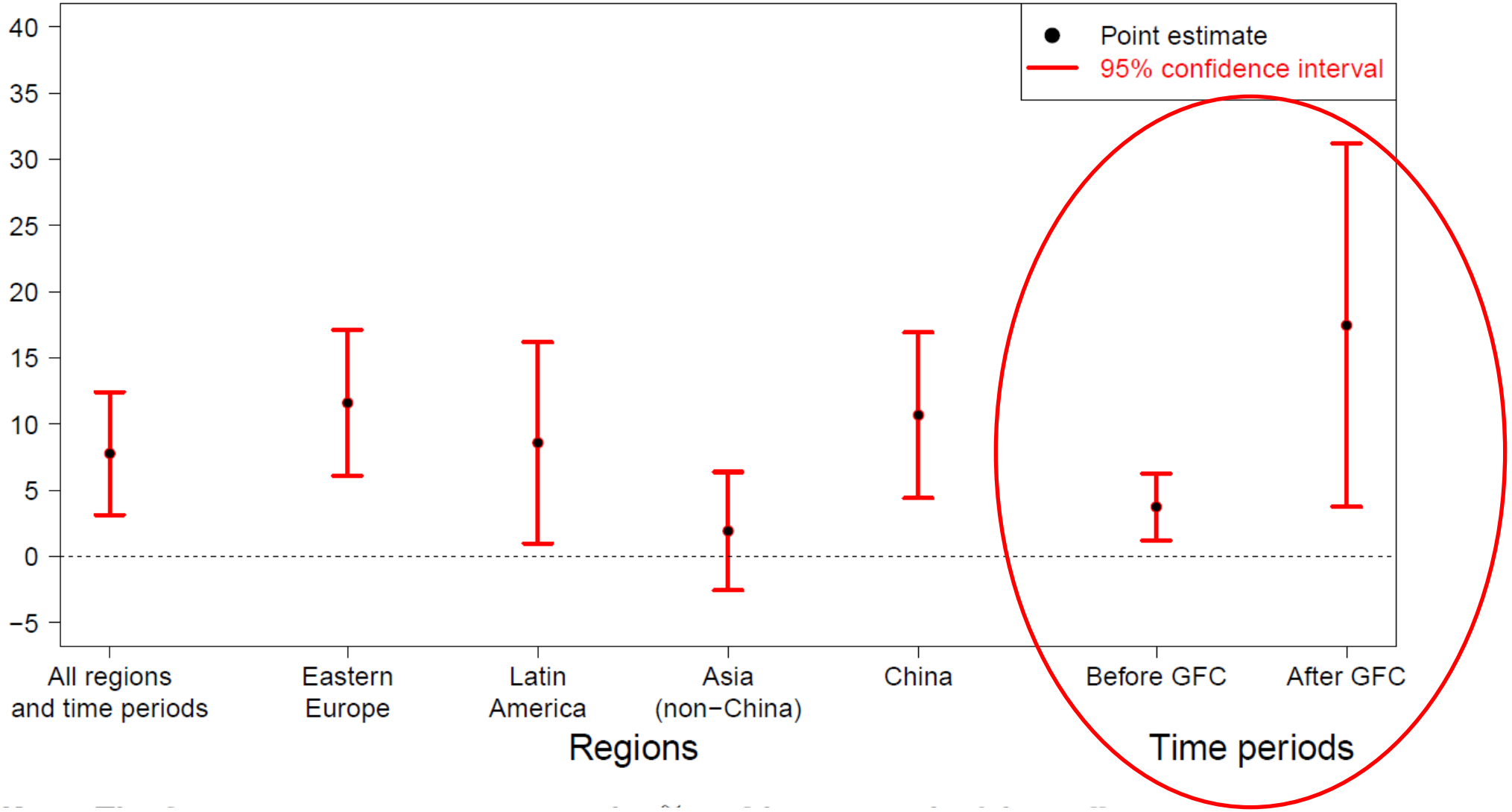
- Need for more control in uncertain times

- It is costly to find new suppliers when firms invest in a supplier relationship. Moving production in-house may be less costly alternative, Antras and Helpman 2008

Reshoring response to uncertainty more than triples after GFC



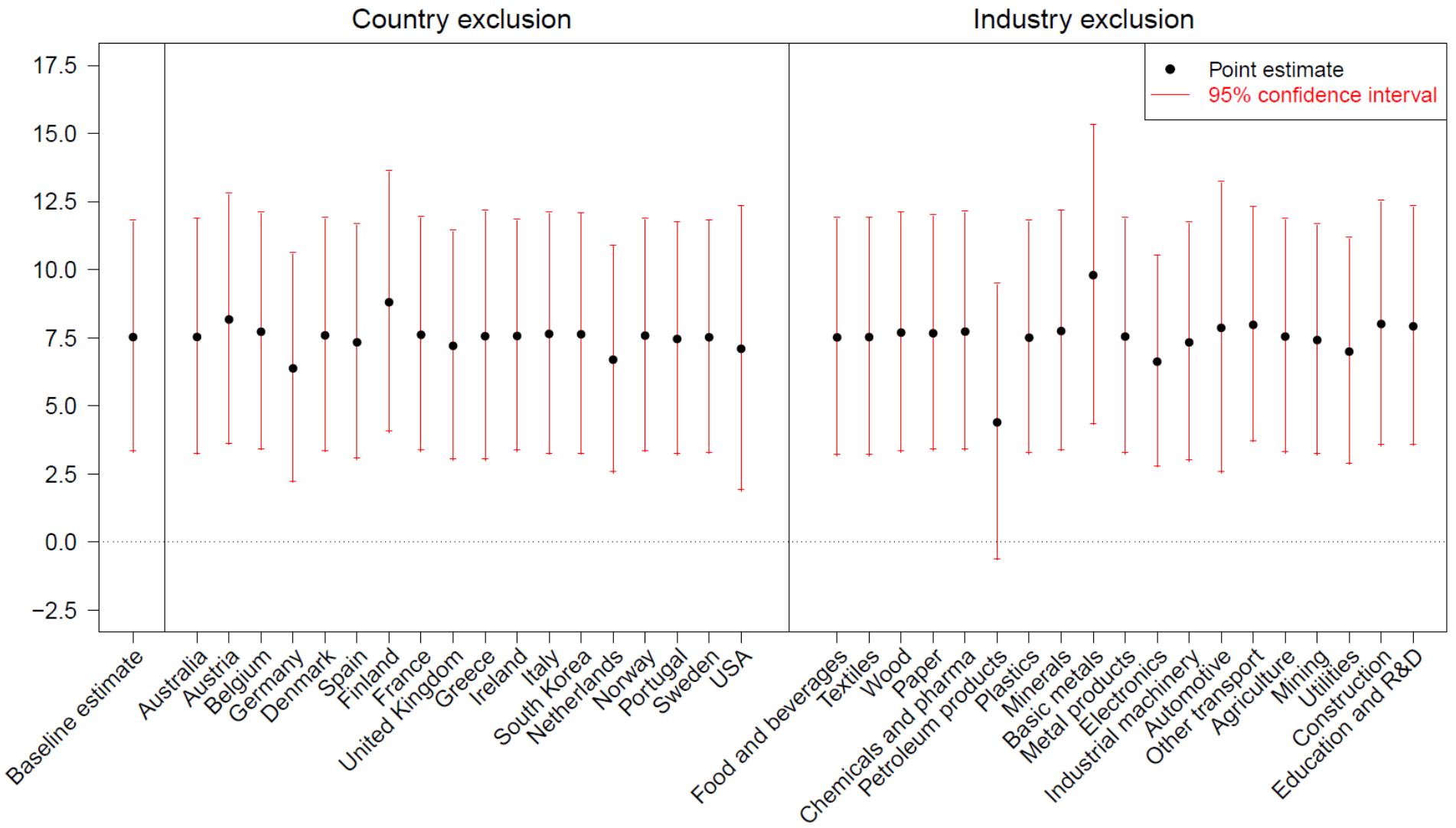
Reshoring response to uncertainty more than triples after GFC



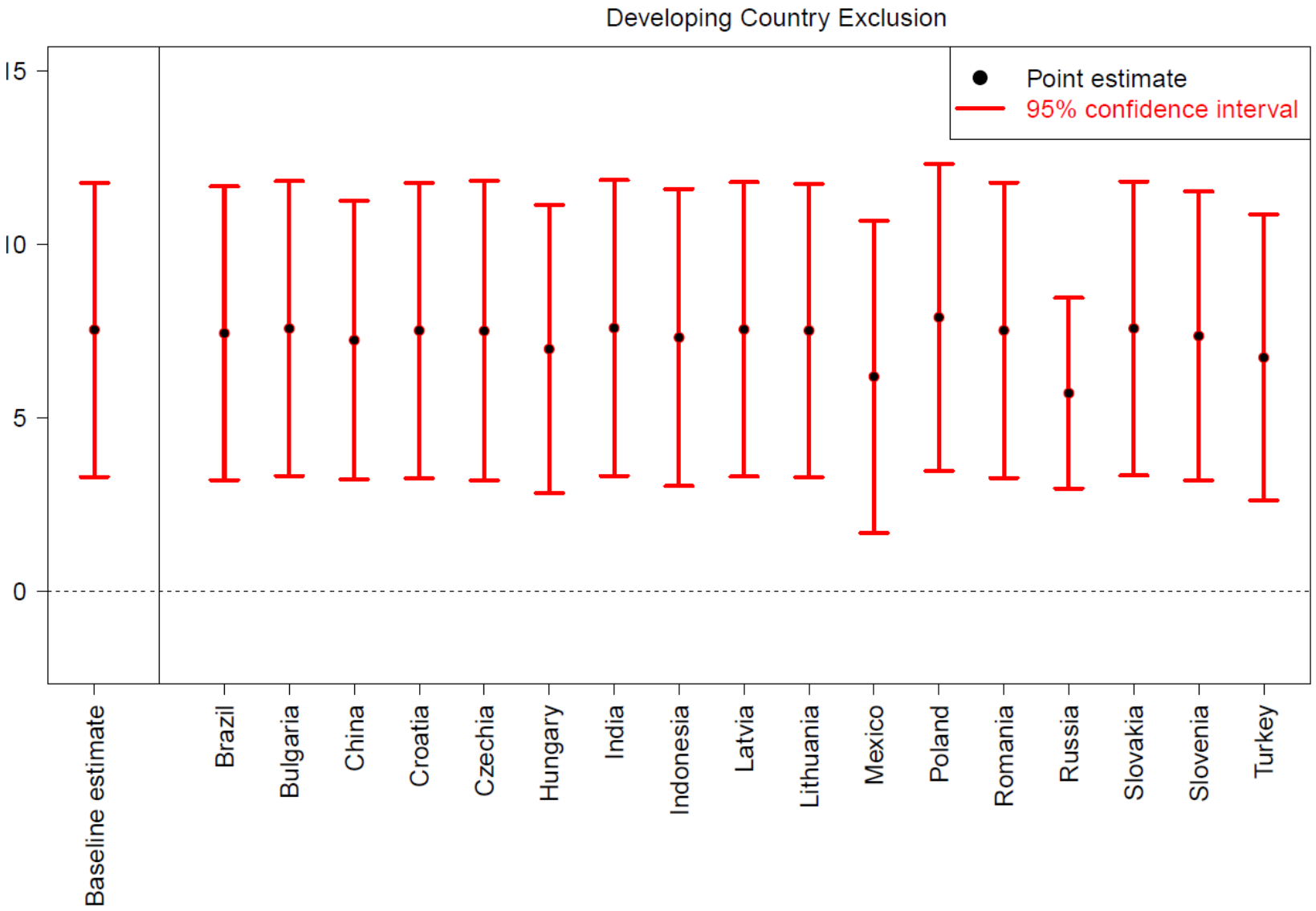
Possible Reasons

- Higher risk aversion folloing the traumatic experience after GFC
- Advances in automation making robots more efficient
- Low interest rate environment making investment in robots less costly

Results are not driven by single industries or countries



Results are not driven by single developing country



The impact of uncertainty and robots on nearshoring

	dep. variable: $\Delta \frac{\text{nearby developing}}{\text{faraway developing}}$			
	(1)	(2)	(3)	(4)$^{\pm}$
Δ exposure to developing countries' uncertainty	0.958	0.948	0.820	0.810
	(0.873)	(0.871)	(0.946)	(0.983)
1{robot replaceability}		-1.656	-1.586	-1.632
		(1.776)	(1.790)	(2.526)
Δ exposure to developing countries' uncertainty $\times$1{robot replaceability}			1.016	0.772
			(2.147)	(2.334)
Period FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Observations	1710	1710	1710	1260
R^2	0.164	0.166	0.166	0.170

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; $^{\pm}$ manufacturing only

Result: no nearshoring

No clear evidence of nearshoring (reshoring from far away to closeby developing countries)

The impact of uncertainty and robots on diversification

	dep. variable: Δ HHI			
	(1)	(2)	(3)	(4)±
Δ exposure to uncertainty in developing countries	0.022	0.024	0.032	0.037
	(0.041)	(0.040)	(0.041)	(0.044)
1{robot replaceability}		0.218**	0.214*	0.322**
		(0.107)	(0.110)	(0.141)
Δ exposure to uncertainty in developing countries × 1{robot replaceability}			-0.069	-0.084
			(0.138)	(0.129)
Period FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Observations	1710	1710	1710	1260
R^2	0.056	0.057	0.062	0.081

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; ± manufacturing only

Result: no diversification

Higher uncertainty in developing countries

does not reduce the concentration of input suppliers (no increase in the number of input suppliers) in developing countries in highly robotized industries

Suggests high costs of finding new suppliers

Major Threats to Identification

Reverse Causality

Reshoring may affect uncertainty in developing countries rather than the other way around

We use a ‚narrative approach‘ and a ‚small open economy approach‘ to show that uncertainty shocks in developing countries are unlikely to be caused by reshoring decisions in developed countries

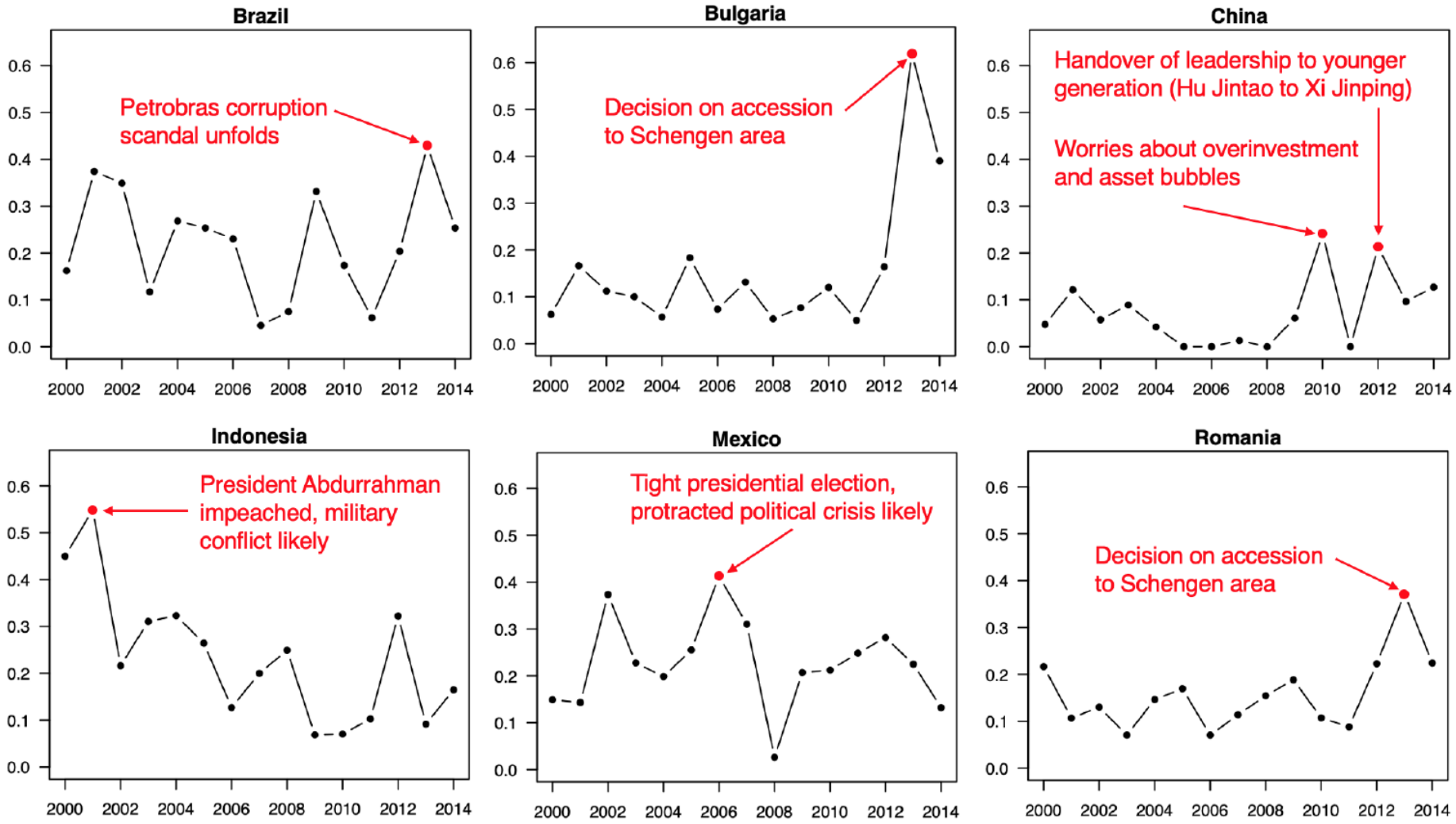
Narrative Approach

(Romer and Romer 1989)

We use only uncertainty spikes in developing countries for which the narrative around the events suggest that they are plausibly exogenous.

We take the narrative what caused the event from the country reports of the Economist Intelligence Unit

Examples of narratives of uncertainty spikes



The impact of uncertainty on reshoring (narrative approach)

dep. variable: $\Delta \log \frac{\text{domestic inputs}}{\text{developing country inputs}}$				
	(1)	(2)	(3)	(4)$^{\pm}$
Δ exposure to uncertainty in developing countries	0.452	0.456	-0.330	-0.378
	(1.123)	(1.127)	(1.030)	(1.073)
1{robot replaceability}		-3.388*	-3.615**	-4.267
		(1.806)	(1.837)	(2.744)
Δ exposure to uncertainty in developing countries $\times$ 1{robot replaceability}			7.693***	8.170***
			(1.797)	(2.045)
Period FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Observations	1710	1710	1710	1260
R^2	0.204	0.209	0.224	0.219
Joint hypothesis test $[H_0 : \beta + \delta = 0]$ p-value:	—	—	0.001	0.000

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Small Open Economy Approach

Small developed countries are less able to cause uncertainty in developing countries (they are price takers on world markets)

Exclude the 5 largest developed country destinations for developing countries‘ inputs (USA, Germany, South Korea, France, Italy), they account for almost 70% of all imported inputs from developing countries

The impact of uncertainty on reshoring (small open economy approach)

dep. variable: $\Delta \log \frac{\text{domestic inputs}}{\text{developing country inputs}}$	(1)	(2)	(3)	(4)$^{\pm}$
Δ exposure to uncertainty in developing countries	-0.684	-0.691	-1.010*	-0.921*
	(0.541)	(0.543)	(0.517)	(0.547)
1{robot replaceability}		-1.868	-1.634	-2.456
		(1.888)	(1.869)	(2.496)
Δ exposure to uncertainty in developing countries $\times$ 1{robot replaceability}			4.217**	4.785**
			(1.827)	(2.300)
Period FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Observations	1235	1235	1235	910
R^2	0.156	0.157	0.161	0.161
Joint hypothesis test $[H_0 : \beta + \delta = 0]$ p-value:	—	—	0.075	0.095

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Tests for
further threats to Identification in Shift-Share Designs

Shocks are as good as randomly assigned

(Borusyak and Hull, 2021)

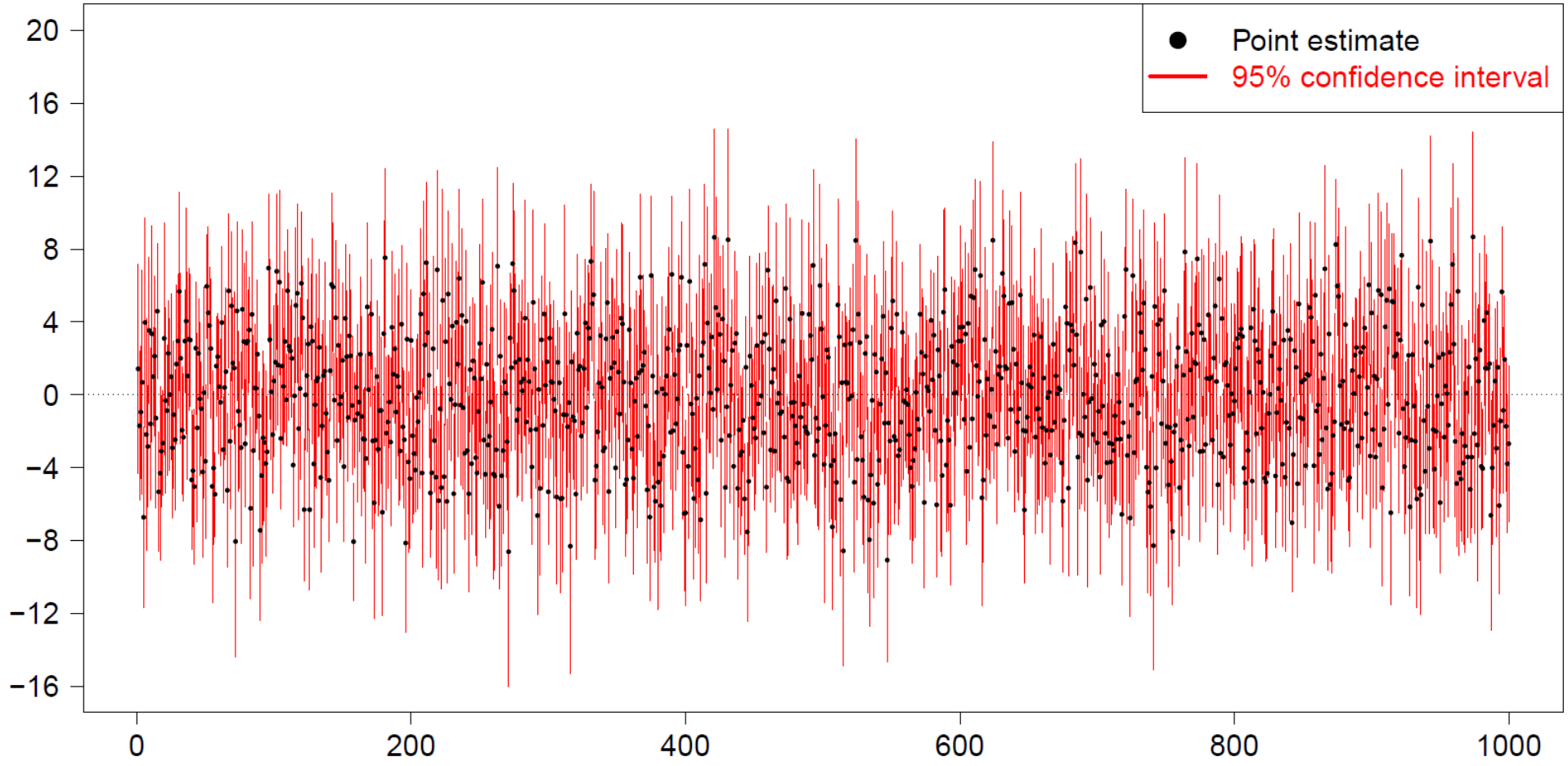
Non-random shock exposure

	dep. variable: $\Delta \frac{\textit{domestic inputs}}{\textit{developing country inputs}}$			
	(1)	(2)	(3)	(4)$^{\pm}$
Δ developing countries' uncertainty (adjusted)	0.410	0.386	-0.584	-0.630
	(0.661)	(0.667)	(0.636)	(0.676)
1{robot replaceability}		-3.372*	-2.871	-3.473
		(1.811)	(1.765)	(2.662)
Δ developing countries' uncertainty (adjusted) $\times$ 1{robot replaceability}			7.542***	7.821***
			(2.147)	(2.357)
Period FE	✓	✓	✓	✓
Country FE	✓	✓	✓	✓
Observations	1710	1710	1710	1260
R^2	0.204	0.209	0.224	0.219
Joint hypothesis test $\left[H_0 : \beta + \delta = 0\right]$ p-value:	—	—	0.001	0.002

Shocks are not driven by noise

(Adao et al 2019)

Testing that shocks are not driven by noise
Adao et al (2019)



% significant positive at 1% level = 5.9; % significant negative at 1% level = 5.6;
% significant positive at 5% level = 13.1; % significant negative at 5% level = 13.8.