

More Trade, Less Diffusion: **Technology Transfers and the Dynamic Effects of Import Liberalization**

Gustavo de Souza, Ruben Gaetani, and Marti Mestieri

The ideas presented here do not represent those of the Federal Reserve System or the Federal Reserve Bank of Chicago.

Motivation: Trade and Diffusion

- **Canonical View:** More trade, More diffusion

- Firms learn from exporters or international suppliers

Eaton and Kortum (1999); Buera and Oberfield (2020); Santacreu (2015, 2022); Cai, Li and Santacreu (2020); Lind and Ramondo (2019, 2023); among many others

- Implication: larger gains from trade in the long-run

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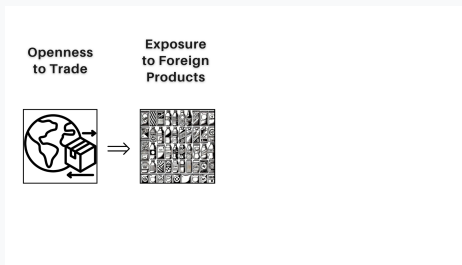
Openness
to Trade



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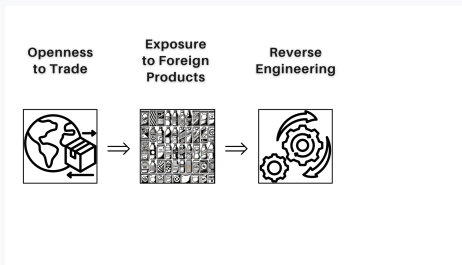
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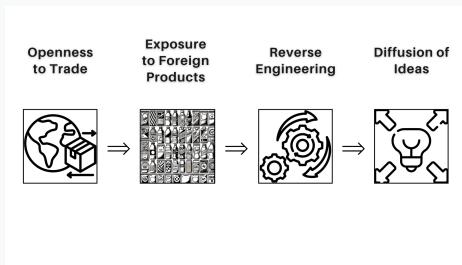
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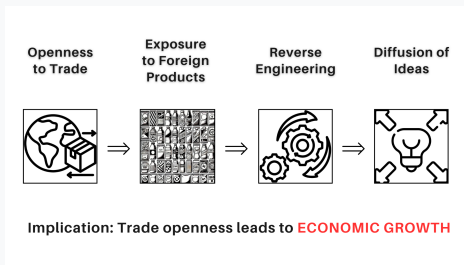
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- **Weak Empirical Evidence to the Canonical View:**

- Correlation between openness to trade and technology adoption

Comin and Hobijn (2004, 2010); Comin et al. (2013); Comin and Mestieri (2018)

- Trade increases firm-level TFP

Pavcnik (2002), Harrison and Rodríguez-Clare (2010)

This Paper: Effect of Tariffs on the Diffusion of Technology

- **Question:**

- How does trade policy affect the diffusion of technologies across countries?

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- **Policy Variation:**

- Brazilian trade liberalization: in the 90s, tariffs went from 30% to 10% (Dix-Carneiro and Kovak (2017))

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- **Policy Variation:**

- Brazilian trade liberalization: in the 90s, tariffs went from 30% to 10% (Dix-Carneiro and Kovak (2017))

- **Measures of diffusion:**

1. Technology transfers from foreign firms to Brazil
e.g., patent transfers, technical consulting, R&D support, and others
2. Patent citations by Brazilian firms to foreign firms

Result: More Trade, Less Diffusion

1. Tariffs increase technology transfers from foreign firms to Brazilian firms
2. Tariffs increase citations
 - to firms transferring technology
 - by firms in the same zip code of those receiving technology

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3. **Importance:**
 - more trade, less diffusion
 - knowledge diffusion is linked to technology transfers

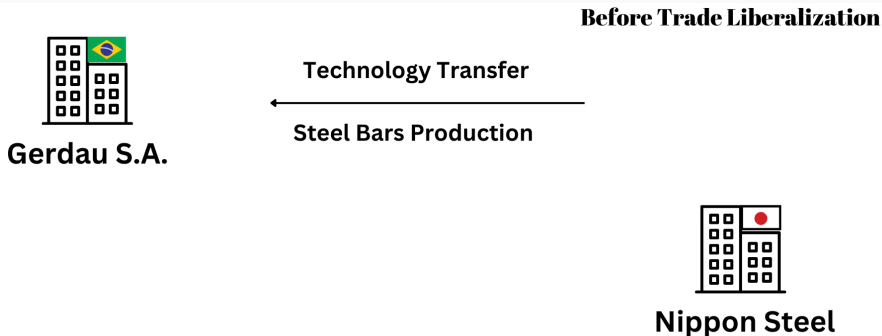
Example: Nippon Steel technology transfer before the liberalization

Before Trade Liberalization

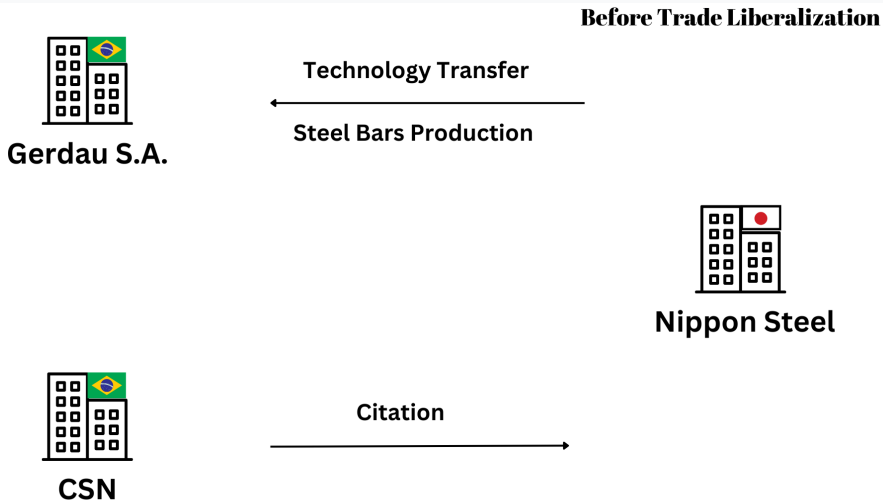


Nippon Steel

Example: Nippon Steel technology transfer before the liberalization



Example: Diffusion to local firms



Trade-off: Technology transfer $\times$ export to Brazil

- **Model:** adding technology transfers to Buera and Oberfield (2020)
 - *Trade-off:* technology transfer $\times$ export to Brazil

Firms Transfer Technology if Tariffs are **High**

High Import Tariffs



Nippon Steel

Foreign Firms:

- Profit of Transferring technology > Profit Exporting
- Technology Transfer to Brazil ↑

Low Import Tariffs

Firms Transfer Technology if Tariffs are **High**

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Gerdau S.A.



CSN

Brazilian Firms:

- Learn and build on foreign technology
- Foreign technology diffuses
- Citation to foreign patents ↑

Firms Export if Tariffs are **Low**

High Import Tariffs



Nippon Steel

Foreign Firms:

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- Technology Transfer to Brazil ↑



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Low Import Tariffs



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- Don't learn from foreign firms
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Optimal Policy: Trade Liberalization + Subsidy to Tech. Transfer

DATA

Data: Universe of Technology Transfers

- Since the 1970s, the Patent office and the Central Bank record all international royalty payments associated to improvement in production
- Types of Technology Transfers
 1. Patent or trademark transfer
 2. Know-How transfer, e.g., technical consulting, R&D support, trade secrets, and others

EMPIRICS

Empirics: Gravity of Citations and Tech. Transfers

- **Empirical Model:**

$$y_{o,s,t} = \beta \tau_{o,s,t} + \eta_{o,s} + \eta_{s,t} + \eta_{o,t} + X'_{o,s,t} \mathbf{\kappa} + \epsilon_{o,s,t}$$

where

- $y_{o,s,t}$: outcome of origin country o , sector s , in year t
- technology transfers in next 3 years from country o to sector s
- citations in next 3 years to country o by sector s

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where

- $\tau_{o,s,t}$: import tariff in Brazil against country o , sector s , in year t

Empirics: Fixed Effects Isolate Diffusion

- **Empirical Model:**

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where

- $\eta_{s,t}$: identification and isolating channel
- Identification
 - productivity shock, industrial policy, technological progress
- Isolating diffusion:
 - removes effect of tariff on competition, firm exit, and other margins unrelated to diffusion

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where

- $\eta_{o,t}$: captures intellectual property agreements and country shocks

Empirics: Fixed Effects Isolate Diffusion

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where

- β : effect of tariff on diffusion from a particular country-sector pair
- **Canonical View:** $\tau_{o,s,t} \uparrow \implies \text{imports} \downarrow \implies \text{learning from foreigners} \downarrow \implies \beta < 0$
(Eaton and Kortum (1999); Buera and Oberfield (2020); Santacreu (2015, 2022); Cai, Li and Santacreu (2020); Lind and Ramondo (2019, 2023), Ramondo and Rodríguez-Clare (2010), among many others)

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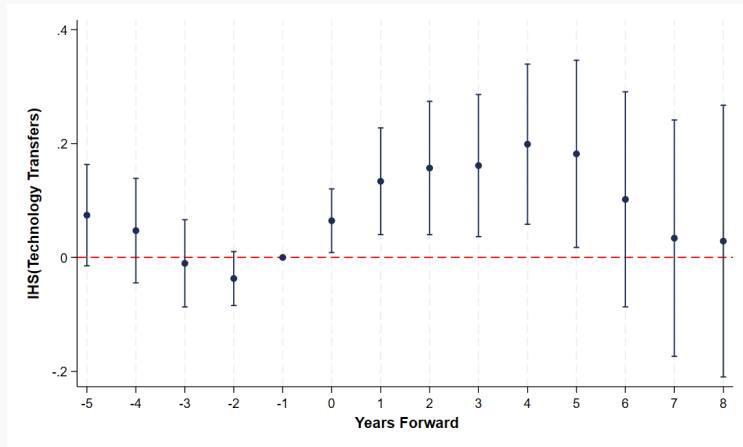
- Identification: instrument by Boehm, Levchenko, and Pandalai-Nayar (2023)

EMPIRICAL RESULTS

Tariffs Increase Technology Transfers

	(1) <i>IHS N. Tech.</i>	(2) <i>IHS N.Unique Licensees</i>	(3) <i>IHS N. Unique Licensors</i>
Tariff	0.157** (0.0712)	0.131** (0.0643)	0.154** (0.0707)
N	1,229,689	1,229,689	1,229,689

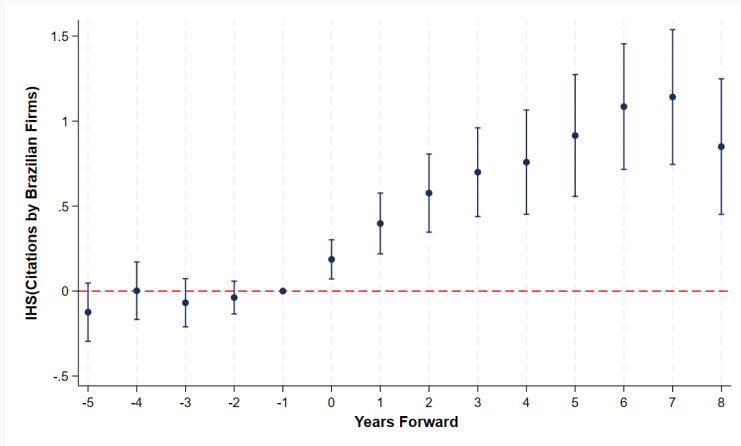
Impulse Response of Technology Transfers to Tariffs



Tariffs Increase Citation to Foreign Firms

	(1) <i>IHS Citations</i>	(2) <i>At Least One Cit.</i>
Tariff	0.577*** (0.140)	0.411*** (0.0825)
N	1,229,689	1,229,689

Impulse Response of Citations to Tariffs



Empirical Results

- Tariffs increase:
 - international technology transfers
 - citations to foreign patents

⇒ **More Trade, Less Diffusion**

Citations are Directed to Firms Transferring Technologies

	(1) <i>IHS. Cit. to Licensor</i>	(2) <i>IHS Cit. to Non-Licensor</i>
Tariff	0.565*** (0.132)	0.206 (0.126)
N	1,229,689	1,229,689

Technology Transfers Diffuse Locally

	(1)	(2)	(3)	(4)
	<i>IHS. Cit.</i>	<i>IHS. Cit.</i>	<i>IHS Cit.</i>	<i>IHS Cit.</i>
	<i>Same Zip</i>	<i>Diff. Zip</i>	<i>Same City</i>	<i>Diff. City</i>
Tariff	0.312*** (0.120)	0.206* (0.121)	0.351*** (0.122)	0.136 (0.120)
N	1,229,689	1,229,689	1,229,689	1,229,689

Citations are Made by Firms without Connection to Foreign Markets

	(1) <i>IHS Cit. by Tech. Licensees</i>	(2) <i>IHS Cit. by Non-Tech. Licensees</i>	(3) <i>IHS Cit. by Importers</i>	(4) <i>IHS Cit. by Non- Importers</i>	(5) <i>IHS Cit. by Exporters</i>	(6) <i>IHS Cit. by Non- Exporters</i>
Tariff	0.164 (0.106)	0.452*** (0.133)	0.179 (0.110)	0.461*** (0.133)	0.173 (0.110)	0.460*** (0.133)
N	1,229,689	1,229,689	1,229,689	1,229,689	1,229,689	1,229,689

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Are Markets that Send More Technology Receiving More Citations?

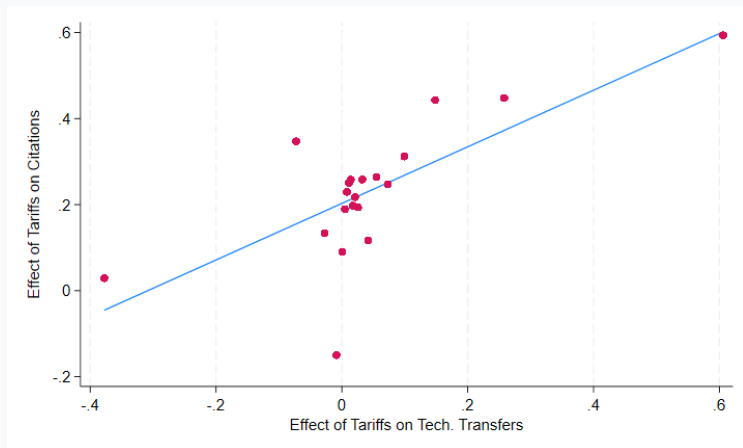
- Results suggest that citation to foreign firms increase because of technology transfers
- If that is true, markets sending more technologies should receive more citations
- Long difference model:

$$\Delta y_{o,s} = \beta(Z_{o,s}) \Delta \tau_{o,s}^{inst} + \eta_{o,s} + X'_{o,s} \kappa + \epsilon_{o,s}$$

- $\beta(Z_{o,s})$ reduced form effect as function of $Z_{o,s}$
- $\beta(Z_{o,s})$ estimated using random-forest (Wagner and Athey (2018), Athey and Imbens (2019))

Markets Sending **More** Technology Receive **More** Citations

Figure: Correlation Between the Effect of Tariffs on Technology Transfers and on Citations



Empirical Results

- Tariffs increase:
 - international technology transfers
 - citations to foreign patents

⇒ **More Trade, Less Diffusion**

- Citations are:
 - directed to firms transferring technology to Brazil
 - made by firms in the same zip code of those receiving technology
 - markets sending more technology receive more citations

⇒ **Transferred technology spreads among Brazilian firms**

Alternative Explanations

- **FDI:**
 - tariffs do not affect FDI

Alternative Explanations

	(1) <i>IHS N.For. Partners</i>	(2) <i>IHS N.Firms F.Owned</i>	(3) <i>II(At Least 1 Firm)</i>	(4) <i>IHS N.For. Partners,3y</i>	(5) <i>IHS N.Firms F.Owned,3y</i>	(6) <i>II(At Least 1 Firm,3y)</i>
Tariff	-0.0436 (0.0287)	-0.0249 (0.0239)	-0.0236 (0.0227)	-0.0495 (0.0636)	-0.0284 (0.0542)	0.00282 (0.0476)
N	1,053,236	1,053,236	1,053,236	1,053,236	1,053,236	1,053,236

Alternative Explanations

- **FDI:**
 - tariffs do not affect FDI
- **Tariffs on Inputs:**
 - results are the same after controlling for input tariff
- **Tariffs Against Brazil:**
 - results are the same after controlling for tariffs against Brazil

MODEL

Model: Diffusion through Technology Transfers

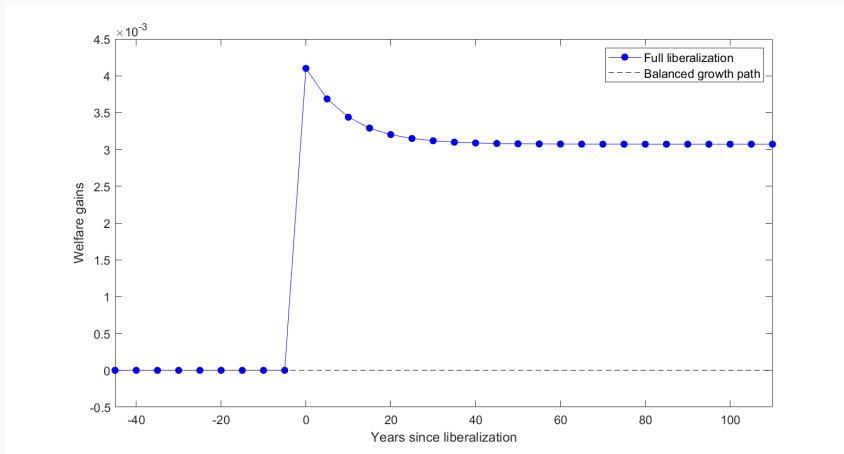
- Augment Buera and Oberfield (2020)
- Important elements:
 1. foreign firms face a trade-off between transferring technology and exporting to Brazil
 2. Brazilian firms learn from exporters and from technology transfers
- An increase in tariff:
 - increases technology transfers;
 - increases diffusion because firms learn more from foreign technologies

Calibration: From Micro to Macro

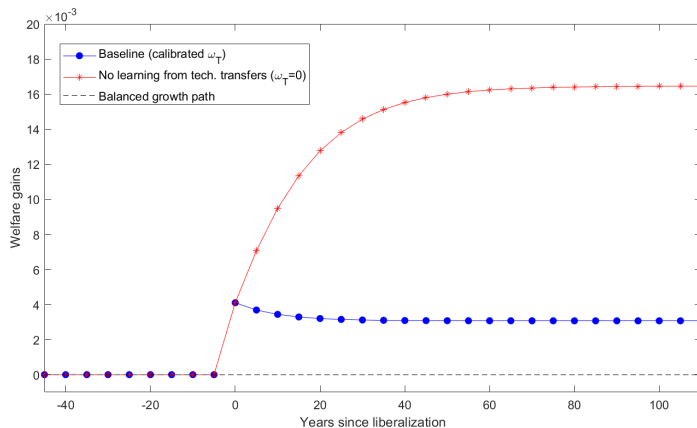
- Two important moments:
 - learning from technology transfers relative to learning from exporters
 - increase in technology transfers as response to import tariff
- Calibration strategy:
 - generate tariff changes in the model
 - run in model generated data the same regressions
 - calibrate model to reproduce effect of tariff on citations and on technology transfers

QUANTITATIVE RESULTS

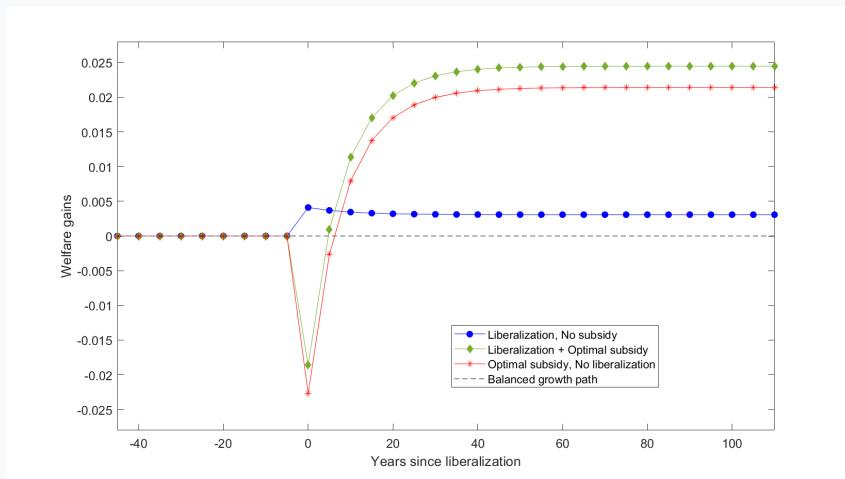
Liberalization: Static Gains but Dynamic Losses



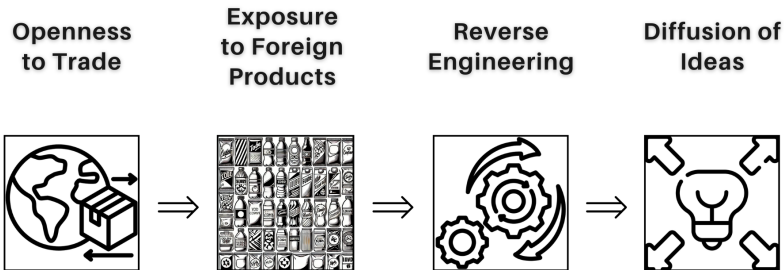
Diffusion from Technology Transfers Matter for Welfare!



Gains from Trade are Larger with Subsidy to Technology Transfers



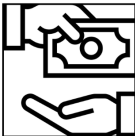
Your View Before this Talk:



Implication: Trade openness leads to **ECONOMIC GROWTH**

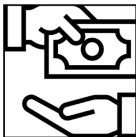
More Trade, **Less** Diffusion

Increase in
Tariffs

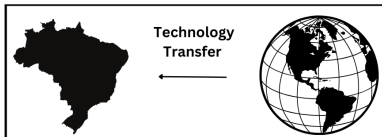


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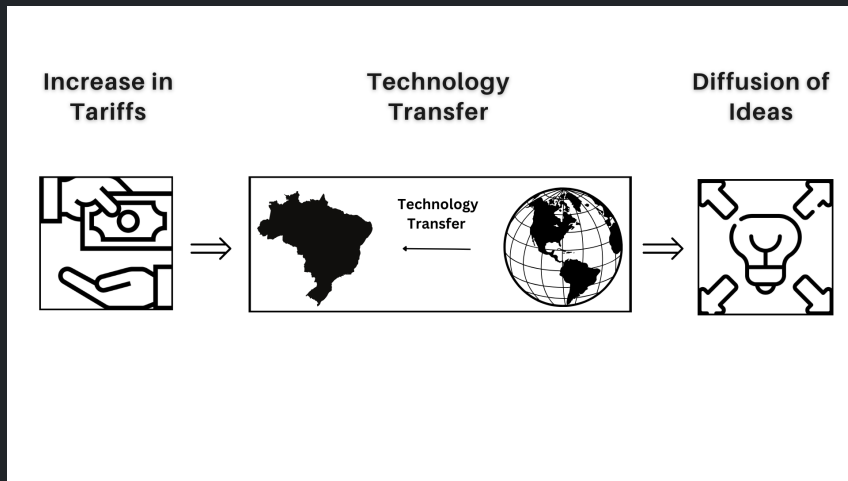
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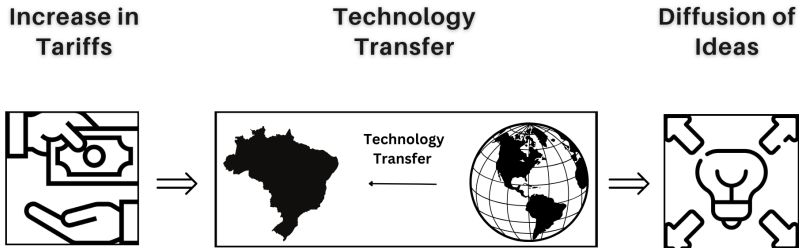
Technology
Transfer



More Trade, **Less** Diffusion



More Trade, Less Diffusion



Implication: Trade openness should be accompanied by a subsidy to technology transfers