Trade Persistence Heterogeneity

Mariarosaria Comunale Justas Dainauskas Povilas Lastauskas

International Monetary Fund

London School of Economics and Political Science

Queen Mary University of London and Vilnius University

ESEM 2023,

Barcelona School of Economics

The views expressed in this article are those of the authors and should not be attributed to the International Monetary Fund, its Executive Board, or its management.

Outline

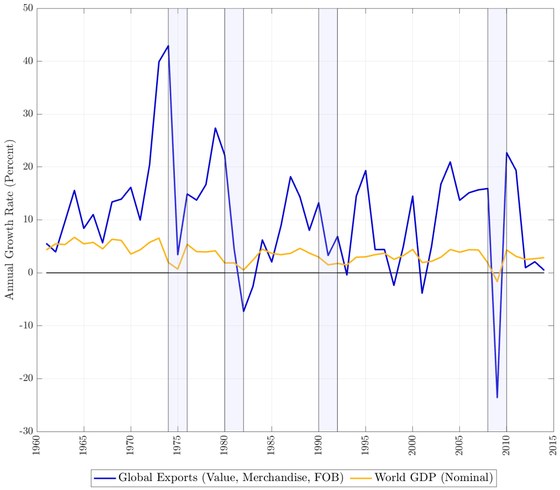
Introduction

- Trade adjustment patterns:
  1. Infrequent at *extensive* margin.
  2. Volatile, but neither permanent nor transitory at *intensive* margin.

- Workhorse gravity model:
  i. Static: *no transitional dynamics*;
  ii. Homogeneous trade elasticities: *Pooled OLS*;
  iii. Homogeneous exposure to **common** shocks: *country-time FE*.

- In practice:
  a. Short/long-run **welfare** gains from trade can be different;
  b. Trade between some countries is more **persistent**;
  c. Some countries & trade pairs are more susceptible to "common" shocks.

Dynamics of Global Trade and GDP Growth Rates



This Paper

- **Dynamic** gravity model with manifold **heterogeneity**:
  1. Newton+ gravity: *lagged trade flows and resistance*;
  2. Mean Group (MG) estimation of **bilateral** elasticities;
  3. Errors w/ Common Correlated Effects (CCE);
  4. Importer-specific trade **imbalances**.

- Theoretical "toy" model:
  - i. *Armington*-type world economy;
  - ii. Two stages of production;
  - iii. "Shared history" externality.

- We focus on:
  - a Trade persistence coefficients;
  - b Prediction performance "horse race";
  - c Counterfactual fit of trade flows.

Result preview

- Cross-sectionally averaged **trade persistence coefficients**:
  1. CCEMG: 0.35 (std. of 0.15);
  2. CCEP: 0.37;
  3. MG: 0.55;
  4. FE: 0.91 (country and time FE); 0.682 (country-time FE).

  ∴ <u>Parameter heterogeneity</u> and <u>common factors</u> are important.

- **GVC** participation and **trade history** matter for dynamics and adjustment to shocks.

- CCEMG better fits the **timing** of trade adjustments.

Outline

Selected Literature

- **Gravity:** Anderson and van Wincoop (2003); Head and Mayer (2014).
  Contrib.: *dynamics and manifold heterogeneity*.

- **Trade Adjustment Dynamics:** Yotov and Olivero (2012); Alvarez (2017); Anderson et al. (2020).
  Contrib.: *heterogeneity and productivity motive for trade persistence*.

- **Shared History**
  - **Learning-by-Importing:** Ethier (1982); Grossman and Helpman (1995); Keller (2004); Acharya and Keller (2009); Amiti and Konings (2007); Elliott et al. (2016); Halpern et al. (2015); Zhang (2017).
  - **Supply Chains & Persistence:** Grossman et al. (2023); Finck and Tillmann (2022).

  Contrib.: *dynamics-inducing positive externality*.

- **Metrics:** Pesaran and Smith (1995); Pesaran (2006); Chudik and Pesaran (2015).
  Contrib.: *neglected heterogeneity in dynamic panel models + dynamic factors*.

Outline

Setup

- Discrete time: $t = \{0, 1, 2, ...\}$;
- Many countries: $i, j \in \{1, 2, ..., N\}$;
- Sequential production: 1st wholesale, 2nd distribution;
- Unit mass of wholesale varieties: $\omega \in [0, 1]$;
- Distributor merges wholesale varieties into consumption good;
- Inelastic labour supply;
- Iceberg costs: $d_{ij} - 1 > 0$.

History Externality I

- Wholesale production:

$$m_{ij,t}(\omega) = z_{i,t} h_{ij,t}(\omega). \tag{1}$$

- Distribution:

$$x_{ij,t} = e_{ij,t} m_{ij,t} \qquad \text{with} \quad m_{ij,t} = \left[\int m_{ij,t}(\omega)^{1-1/\eta} d\omega \right]^{1/(1-1/\eta)}, \tag{2}$$

  where $\eta > 1$.

- In other words,

$$x_{ij,t} = \left[\int e_{ij,t}^{1-1/\eta} m_{ij,t}(\omega)^{1-1/\eta} d\omega \right]^{1/(1-1/\eta)}, \tag{3}$$

  where $e_{ij,t}$ can be thought of as shared *history* between i and j.

- The course of history is viewed as an externality influencing trade sourcing decisions over time, but outside equilibrium the repr. household treats history as exogenously given.

History Externality II

- Example of **learning-by-importing** or **supply relationships (habits)**:

$$e_{ij,t} = x_{ij,t-1}^{\chi_{ij}}, \tag{4}$$

where $\chi_{ij} \geq 0$, such that $x_{ij,t} \geq m_{ij,t}$.

- Generally, $e_{ij,t}$ can accommodate different configurations of historical dependence:

$$e_{ij,t} := \tilde{e}_{ij,t} \prod_{s=1}^{S} x_{ij,t-s}^{\chi_{ij,s}} \tag{5}$$

such that $\chi_{ij,s} \to 0$ for all $i, j \in N$ and $s > 0$, then shared history $e_{ij,t}$ boils down to an exogenous preference or taste shifter, $\tilde{e}_{ij,t}$. Furthermore, if $\tilde{e}_{ij,t}$ is time-invariant, then it corresponds to the standard *Armington* weight.

- Another alternative would be to assume that $\chi_{ij,s} = \chi_{ij}^{s}$ instead of zero, where the coefficient χ_{ij} may be interpreted as the bilateral path-dependence elasticity.
- We do not aim to test the performance of any one particular mechanism or notion of history, but rather uncover data-supported representation of the dynamic gravity model and estimate the trade flow persistence.

Iceberg Costs

- Competitive price of $x_{ij,t}$:

$$\tilde{P}_{ij,t} = \frac{d_{ij} W_{i,t}}{e_{ij,t} z_{i,t}}. \tag{6}$$

- Our model features standard iceberg costs at the intensive margin $d_{ij} - 1 > 0$. Let $P_{ij,t}(\omega) > 0$ denote the 'import' price of $m_{ij,t}(\omega)$. The aggregate price index of the wholesale varieties (i.e., the price of the aggregate bundle $m_{ij,t}$) is given by:

$$P_{ij,t} = \left[\int_0^1 P_{ij,t}(\omega)^{1-\eta} d\omega \right]^{1/(1-\eta)}. \tag{7}$$

- By the same token, under perfect competition, the break-even price of the composite good $x_{ij,t}$, henceforth denoted as $\tilde{P}_{ij,t}$, is proportional to $P_{ij,t}$, such that altogether we have:

$$\tilde{P}_{ij,t} = \frac{d_{ij} P_{ii,t}}{e_{i,t}}. \tag{8}$$

- Clearly, the cost of the composite good $x_{ij,t}$ at present depends on the historical relationships summarised by $e_{i,t}$.

Dynamic Gravity Equation

Lemma

Consider a special case when $\chi_{ij} \in (0,1)$ for all $i \in n \setminus j$, and $\chi_{ij} \neq \chi_{ji}$ for all $i \in n \setminus j$, and/or the iceberg costs are asymmetric, such that $d_{ij} \neq d_{ji} > 1$ for all $i \in n \setminus j$, then the gravity equation features the multilateral trade imbalances.

- Trade flows from i to j at time t in worldwide equilibrium:

$$A_{ij,t} = \Xi_{j,t} \left[\frac{d_{ij}}{\Phi_{i,t} P_{j,t}} \right]^{1-\eta} \prod_{s=1}^{S} \left(\frac{d_{ij} Y_{i,t-s}^{\eta/(1-\eta)}}{\Phi_{i,t-s} A_{ij,t-s} Y_{j,t-s} Y_{t-s}^{\eta/(1-\eta)}} \right)^{\chi_{ij}^{s}(1-\eta)}, \tag{9}$$

where

$A_{ij,t} := \frac{X_{ij,t} Y_t}{Y_{i,t} Y_{j,t}}$ are "size-adjusted" bilateral trade flows.

$\Xi_{j,t} > 1$ is importer j multilateral trade deficit (i.e. $\Xi_{j,t} < 1$ is surplus).

$P_{j,t}$ is importer j aggregate cost of living.

$\Phi_{i,t}$ is exporter i multilateral trade resistance.

Y_t, $Y_{i,t}$, and $Y_{j,t}$ are nominal GDP.

Outline

Learning-by-importing Gravity Equation

Taking logs on both sides of (9) gives the following log-linear specification:

$$\ln A_{ij,t} = \underbrace{(\eta-1)\sum_{s=1}^{S}\chi_{ij}^{s}\ln A_{ij,t-s}}_{\text{size-adjusted bilateral trade flows}} + \underbrace{\ln \Xi_{j,t}}_{\text{destination trade imbalance}}$$
$$- \underbrace{(\eta-1)\sum_{s=0}^{S}\chi_{ij}^{s}\ln d_{ij}}_{\text{bilateral resist.}} + \underbrace{(\eta-1)\sum_{s=0}^{S}\chi_{ij}^{s}\ln \Phi_{i,t-s}}_{\text{source outward mult.'l res.}} + \underbrace{(\eta-1)\ln P_{j,t}}_{\text{destination inward mult.'l res.}}$$
$$- \underbrace{\eta\sum_{s=1}^{S}\chi_{ij}^{s}\ln Y_{t-s}}_{\text{world size}} + \underbrace{\eta\sum_{s=1}^{S}\chi_{ij}^{s}\ln Y_{i,t-s}}_{\text{source size}} + \underbrace{(\eta-1)\sum_{s=1}^{S}\chi_{ij}^{s}\ln Y_{j,t-s}}_{\text{destination size}}. \tag{10}$$

Methodology

- The gravity equation (10) is a large N (39) and large T (65 years: 1950-2014) panel regression model. It extends the interactive fixed effects of Bai (2009) into a three-dimensional data structure.
- Our model captures variation over $t = 1, 2, ..., T$ and also spatial variation across the source country $i = 1, 2, ..., N$ and the destination country $j = 1, 2, ..., N - 1$, such that for all $j \neq i$:

$$\ln A_{ij,t} = \beta_0 + \mathbf{x}'_{ij,t}\boldsymbol{\beta}_{ij} + u_{ij,t}, \quad (11)$$

$$u_{ij,t} = \boldsymbol{\lambda}'_{ij}\phi_t + \varepsilon_{ij,t}, \quad (12)$$

$$\mathbf{x}_{ij,t} = \boldsymbol{\gamma}'_{ij}\phi_t + \boldsymbol{\nu}_{ij,t}, \quad (13)$$

where $\ln A_{ij,t} := \text{FLOW}_{ij,t}$ are the size-adjusted trade flows (log) $\mathbf{x}_{ij,t} = [\text{FLOW}_{ij,t-1}, \text{TB}_{j,t}, \text{GDP}_{i,t-1}, \text{GDP}_{j,t-1}, \text{GDP}_{t-1}]'$ is vector of all common and country-specific observable variables.

Methodology

We can expand the error structure as follows:

$$\boldsymbol{\lambda}'_{ij}\phi_t = \begin{bmatrix} \lambda_{1ij} & \lambda_{2ij} & \lambda_{3ij} & \lambda_{4ij} \end{bmatrix} \begin{bmatrix} 1 \\ \phi_{j,t} \\ \phi_{i,t} \\ \phi_{i,t-1} \end{bmatrix}$$

$$= \begin{bmatrix} -(1+\chi_{ij})(\eta-1) & (\eta-1) & (\eta-1) & \chi_{ij}(\eta-1) \end{bmatrix} \begin{bmatrix} \ln d_{ij} \\ \ln P_{j,t} \\ \ln \Phi_{i,t} \\ \ln \Phi_{i,t-1} \end{bmatrix} \quad (14)$$

- ϕ_t represent some configuration of the unobservable vector of dynamic common factors (inward and outward multilateral resistances in our case) and $\boldsymbol{\lambda}_{ij}$, γ_{ij} the country-pair-specific factor loadings.
- Our theory identifies the heterogeneity of learning-by-importing specific to each country pair χ_{ij} from the trade persistence coefficient $\beta_{1ij} = \chi_{ij}(\eta-1)$.

Results: Coefficient Estimates (Baseline)

VARIABLES	**CCEMG** $FLOW_{ij,t}$	**FE I & FE II** $FLOW_{ij,t}$		**MG** $FLOW_{ij,t}$	**CCEP** $FLOW_{ij,t}$
$FLOW_{ij,t-1}$	0.347***	0.907***	0.682***	0.548***	0.374***
	(0.00825)	(0.00451)	(0.00732)	(0.00643)	(0.0161)
$TB_{j,t}$	0.975***	0.219***	—	0.803***	0.612***
	(0.126)	(0.0279)	—	(0.0714)	(0.0801)
$GDP_{i,t-1}$	-0.312***	-0.00174	—	-0.183***	-0.296***
	(0.0778)	(0.00749)	—	(0.0149)	(0.0338)
$GDP_{j,t-1}$	-0.117	-0.0239***	—	-0.132***	-0.195
	(0.0954)	(0.00714)	—	(0.0150)	(0.0271)
GDP_{t-1}	0.228			0.322***	
	(0.201)			(0.0397)	
Time Fixed Effects	N	Y		N	N
Country/Pair Fixed Effects	Y	Y		N	N
Unobservable Common Factors	Y	N		N	Y

Note: Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

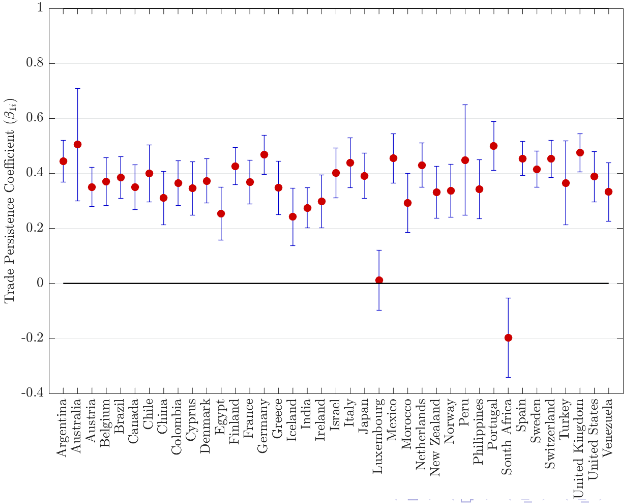
Results: Coefficient Estimates

- Trade persistence coefficients in different cases:
  - w/o UCF and w/ PE (i.e., FE): 0.91 or 0.68.
  - **w/ UCF and w/o PE (i.e., CCEMG): 0.35**.
  - w/o UCF and w/o PE (i.e., MG): 0.55.
  - w/ UCF and w/ PE (i.e., CCEP): 0.37.
- **CCEMG predicts unitary trade flow elasticity to trade imbalance**.
- The signs and magnitudes of the CCEMG estimates are **broadly consistent** with the theoretical coefficients.
- **Robustness checks**: excluding the multilateral trade imbalance (vs. our theoretical model), re-parameterized version, using different estimators (e.g. augmented mean group, different UCF, different set of fixed effects).

Parameter heterogeneity

- Between -0.2 and 0.5. All different from 0 (static) and 0.91/0.68 (FE).

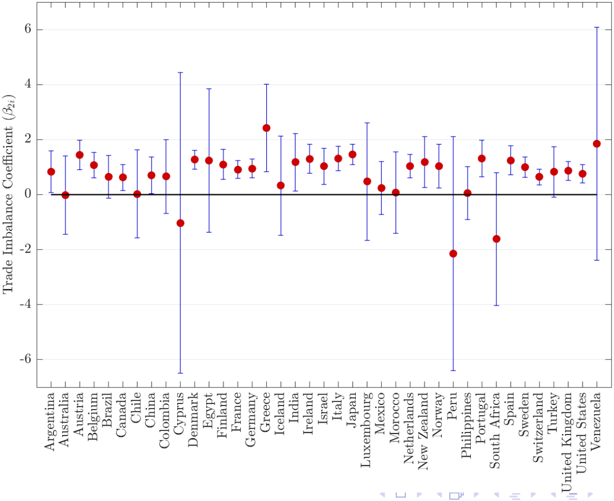
Figure: Country-Specific Trade Persistence Coefficients



Parameter heterogeneity

- Between -2 and 2.5. Significance 26/39. Clustered in unit (like theory).

Figure: Country-Specific Trade Imbalance Coefficients



Introduction
Literature
Toy Model
Empirical Analysis
Trade Persistence
Pair example
Summary
Future research
Thanks!
Bibliography

Outline

What is Behind the Trade Persistence?

Table: What Drives Bilateral Trade Persistence?

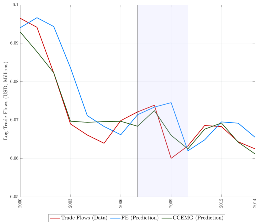
VARIABLES	All (1) ln β_{1ij}	$t_{\beta_{1ij}} > 1.64$ (2) ln β_{1ij}	$t_{\beta_{1ij}} > 1.96$ (3) ln β_{1ij}	$t_{\beta_{1ij}} > 2.575$ (4) ln β_{1ij}
ln(Bilateral FVA)	-0.0536	0.0242	0.0304	0.0407**
	(0.0463)	(0.0202)	(0.0194)	(0.0202)
Colony	0.568**	0.198	0.122	0.214*
	(0.225)	(0.180)	(0.191)	(0.122)
Common language	0.115*	0.0205	0.0421	0.0134
	(0.0688)	(0.0388)	(0.0357)	(0.0335)
ln(Distance)	-0.101***	-0.0707***	-0.0489***	-0.0490***
	(0.0323)	(0.0174)	(0.0163)	(0.0147)
Constant	-0.404	0.208	0.0557	0.376
	(0.684)	(0.321)	(0.306)	(0.290)
Observations	1,302	923	864	725
R-squared	0.174	0.220	0.234	0.253

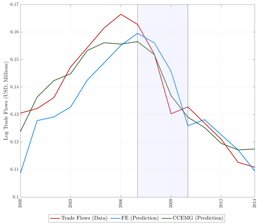
Notes: Robust standard errors associated with the Huber/White/sandwich coefficient estimates are displayed in parentheses. All regression models incorporate source- and destination-country-specific fixed effects.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Outline

Example: USA and China Trade Flows

- Trade persistence: USA-CHN=0.44 and CHN-USA=0.76.
- USA faces a more flexible and faster adjustment process, with less dependence on Chinese inputs in its production.
- More reasonable estimation of adjustment dynamics in CCEMG.





- Short- vs long-run effect of shocks: see in case of $\Xi_{j,t}$ (larger the trade persistence more years to adjust).

Outline

Summary

- **Theory of learning-by-importing**: common trade shocks cause **sharp, synchronized, but heterogeneous** trade flow adjustments.
- **Derived dynamic gravity equation**: 39 countries (1950-2014).
- **CCEMG**: heterogeneity pair-level and unobserved common factors.
  - **Multilateral trade imbalance**: important determinant of flows.
  - **GVC** participation and **trade history** matter for dynamics and adjustment to shocks.
- Empirical results show two causes of trade persistence predicted by static/symmetric dynamic equations:
  1. Inference based on **pooled coefficient estimators**.
  2. Ill-suited modelling of **unobservable common factors**.

Outline

A few directions of future research

- **Separating short- to long-run run effects**: portraying substantial structural heterogeneity (see Boehm et al. (2020)).
- **Dynamic non-linear panel regression models**: to appropriately account for the "zero trade problem" & parameter heterogeneity & unobservable common factors.
- **Functional elasticities**: varying by the GVC participation and as more elaborate technology to account for GVC complexity.

Policy Implications

Global Trade Needs More Supply Diversity, Not Less

About the Blog

APRIL 12, 2022

By Davide Malacrino, Adil Mohommad, and Andrea Presbitero

عربي, 中文, Español, Français, 日本語, Português, Русский

Countries with trade partners that implemented more stringent lockdowns had a sharper drop in imports. Though trade flows have adjusted, more diversified global value chains could help lessen the impact of future shocks.

The demand and supply shocks unleashed by the pandemic were expected to lead to a dramatic collapse in trade, but international commerce has proven more resilient than during previous global crises.

Marketing: previous version

VOX[EU] CEPR Research-based policy analysis and commentary from leading economists

Create account | Login | Subscribe

Columns Covid-19 Vox Multimedia Publications Blogs&Reviews People Debates Events About

By Topic By Date By Reads By Tag

Supply chains and trade flows volatility in the face of global shocks

Mariarosaria Comunale, Justas Dainauskas, Povilas Lastauskas 09 March 2021

International trade flows are volatile, imbalanced, and fragmented across offshored supply chains. But there is still a lack of understanding about why global trade shocks, such as the Covid-19 pandemic, result in synchronised, but remarkably unequal trade flow responses across countries. This column argues that less-integrated countries focusing on arm's-length trade experience the greatest trade flow disruptions in response to global trade shocks, while trade flows between more integrated countries relying on intermediate imports tend to dip less and bounce back more rapidly.

46

The outbreak of the Covid-19 pandemic has caused a worldwide disruption in trade flows. According to the WTO, a 9.2% decline in the volume of world merchandise trade for 2020 is expected, with a rebound of 7.2% in 2021. The drop in trade is around two to three times larger than the drop predicted for world GDP (a drop of 3.5% is most recently forecasted by the IMF, in the updates to the *World Economic Outlook* released in January 2021). The adjustment is very heterogeneous – the WTO calculates 14.7% and 11.7% declines in export volumes in the US and Europe, respectively, and a mere 4.5% drop in Asia. These developments resemble what has been known as the Great Trade Collapse of 2008-09 (Baldwin 2009, 2020) during which the world GDP shrank by 1%, while the value of global trade flows slumped by some 10% in a remarkably synchronised fashion across the world (Alessandria et al. 2010).

These international trade patterns before, during, and after the Great Recession, can be seen in Figure 1, which encapsulates three empirical facts. First, independently of the country group, there

Related

Trade imbalances and the rise of protectionism
Samuel Delpeuch, Etienne Fize, Philippe Martin

Trade and Covid-19: Lessons from the first wave
Alvaro Espitia, Aaditya Mattoo, Nadia Rocha, Michele Ruta, Deborah Winkler

Where globalisation was hiding, and how far it might go
James Anderson, Yoto Yotov

The Greater Trade Collapse of 2020
Richard Baldwin

Mariarosaria Comunale
Principal Economist at the Bank of Lithuania, Research Fellow at Vilnius University & Research Associate at CAMA, Australian National University.

Justas Dainauskas
Post-Doctoral Fellow, LSE

Povilas Lastauskas
Director, Center for Excellence in Finance and Economic Research, Bank of Lithuania

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Research > Research for the World > Economics > Shaping the Post-COVID World

ECONOMICS, SHAPING THE POST-COVID WORLD

Helping to predict trade flows at a time of global crisis

In today's globalised world, the ramifications of a global shock can be significant, disrupting trade flows between countries in ways that have been hard to predict. Research by Mariarosaria Comunale, Justas Dainauskas and Povilas Lastauskas sheds new light on how countries can seek to minimise disruption.

Outline

Thanks for your attention! ☕

emailto: mcomunale@imf.org, j.dainauskas@lse.ac.uk, p.lastauskas@cantab.net

Outline

Bibliography I

References

Acharya, R. C. and W. Keller (2009): "Technology transfer through imports," *Canadian Journal of Economics*, 42, 1411–1448.

Alvarez, F. (2017): "Capital Accumulation and International Trade," *Journal of Monetary Economics*, 91, 1–18.

Amiti, M. and J. Konings (2007): "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia," *American Economic Review*, 97, 1611–1638.

Anderson, J. E., M. Larch, and Y. V. Yotov (2020): "Transitional Growth and Trade with Frictions: A Structural Estimation Framework," *The Economic Journal*, 130, 1583–1607.

Anderson, J. E. and E. van Wincoop (2003): "Gravity with Gravitas: A Solution to the Border Puzzle," *American Economic Review*, 93, 170–192.

Bai, J. (2009): "Panel Data Models With Interactive Fixed Effects," *Econometrica*, 77, 1229–1279.

Boehm, C. E., A. A. Levchenko, and N. Pandalai-Nayar (2020): "The Long and Short (Run) of Trade Elasticities," Working Paper 27064, National Bureau of Economic Research.

Chudik, A. and M. H. Pesaran (2015): "Common Correlated Effects Estimation of Heterogeneous Dynamic Panel Data Models with Weakly Exogenous Regressors," *Journal of Econometrics*, 188, 393–420.

Elliott, R. J. R., L. Jabbour, and L. Zhang (2016): "Firm productivity and importing: Evidence from Chinese manufacturing firms," *The Canadian Journal of Economics / Revue canadienne d'Economique*, 49, 1086–1124.

Ethier, W. (1982): "National and International Returns to Scale in the Modern Theory of International Trade," *American Economic Review*, 72, 389–405.

Grossman, G. M. and E. Helpman (1995): "Technology and trade," in *Handbook of International Economics*, ed. by G. M. Grossman and K. Rogof, Elsevier, vol. 3 of *Handbook of International Economics*, chap. 25, 1279–1337.

Halpern, L., M. Koren, and A. Szeidl (2015): "Imported Inputs and Productivity," *American Economic Review*, 105, 3660–3703.

Bibliography II

Head, K. and T. Mayer (2014): "Chapter 3 - Gravity Equations: Workhorse, Toolkit, and Cookbook," in *Handbook of International Economics*, ed. by G. Gopinath, E. Helpman, and K. Rogoff, Elsevier, vol. 4 of *Handbook of International Economics*, 131 – 195.

Keller, W. (2004): "International Technology Diffusion," *Journal of Economic Literature*, 42, 752–782.

Pesaran, M. H. (2006): "Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure," *Econometrica*, 74, 967–1012.

Pesaran, M. H. and R. Smith (1995): "Estimating Long-Run Relationships from Dynamic Heterogeneous Panels," *Journal of Econometrics*, 68, 79–113.

Yotov, Y. V. and M. Olivero (2012): "Dynamic Gravity: Endogenous Country Size and Asset Accumulation," *Canadian Journal of Economics*, 45, 64–92.

Zhang, H. (2017): "Static and dynamic gains from costly importing of intermediate inputs: Evidence from Colombia," *European Economic Review*, 91, 118–145.