IMPLEMENTING THE TRADE FACILITATION AGREEMENT

FROM GLOBAL IMPACTS TO VALUE CHAINS

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NO. 67

September 2019

ADB SOUTH ASIA WORKING PAPER SERIES

ASIAN DEVELOPMENT BANK

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ADB South Asia Working Paper Series

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The authors thank Silvia Sorescu of the Organisation for Economic Co-operation and Development for sharing data on the trade facilitation indicators and for providing useful comments, and also Fahad Khan of ADB for providing helpful comments. We thank Mitch Abdon for providing assistance with a previous version of this paper.

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ISSN 2313-5867 (print), 2313-5875 (electronic)
Publication Stock No. WPS190444-2
DOI: http://dx.doi.org/10.22617/WPS190444-2

Notes:
In this publication, "$" refers to United States dollars.

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ABSTRACT

This paper uses a newly developed empirical methodology, general equilibrium pseudo maximum likelihood, to estimate and conduct counterfactual simulations using a gravity model of bilateral trade augmented with a variable capturing the extent to which importing economies have implemented the provisions of the World Trade Organization Trade Facilitation Agreement (TFA). The method is fully theory-consistent and, unlike previous work, takes account of the general equilibrium effects. Concretely, we find that full implementation of the TFA could boost world trade by close to $344 billion or 3.5% of the baseline (2015), with a corresponding change of 0.15% in global real output. In addition, we show that the bulk of these gains accrue to economies based on their own reforms of import procedures, and do not depend on the actions of trading partners. Finally, we find suggestive evidence that TFA implementation could promote the further development of value chain trade particularly in middle-income economies, by shifting the composition of manufactured goods trade further toward intermediates.

JEL Classification: F13, F14, O24

Keywords: trade facilitation, gravity model, general equilibrium, global value chains

ABBREVIATIONS

APEC	–	Asia-Pacific Economic Cooperation
CES	–	constant elasticity of substitution
GE	–	general equilibrium
ISIC	–	International Standard Industrial Classification
OECD	–	Organisation for Economic Co-operation and Development
PPML	–	Poisson pseudo maximum likelihood
RTA	–	regional trade agreement
TFA	–	Trade Facilitation Agreement
TFI	–	trade facilitation indicator
TiVA	–	trade in value added
WTO	–	World Trade Organization

I. INTRODUCTION

1. Average applied tariffs have declined by almost half since the establishment of the World Trade Organization (WTO)—from a simple average of 11.2% in 1995 to 6.0% in 2016.[1] Consistent with Robert Baldwin's (1970) famous analogy of "draining the swamp," as applied tariffs have fallen around the world, attention has increasingly shifted to nontariff measures that increase the costs of trade. Arvis et al. (2016a) show that trade costs—in the sense of the full wedge between producer prices in the exporting economy and consumer prices in the importing economy—are at least an order of magnitude higher than applied tariffs, amounting to perhaps 82% for manufactured goods in high-income economies, but 227% for the same products in low-income economies. Although part of the difference between these high figures and the historically low levels of tariffs is due to "natural" trade barriers such as distance or historical links, nontariff measures also have undue impacts on bilateral trade. Arvis et al. (2016a) show that bilateral trade costs are strongly influenced by factors such as logistics and connectivity, in addition to history and geography. Policies centered around trade facilitation have focused on lowering trade costs along these dimensions, and have now received new impetus with the entry into force of the WTO Trade Facilitation Agreement (TFA) on 22 February 2017.

2. Trade facilitation has been defined in various ways. Researchers and policymakers have used a "broad" definition and a "narrow" definition. The broad definition is associated with the Asia–Pacific Economic Cooperation (APEC), where trade facilitation was conceptualized as the full range of policies other than reductions in tariffs that could lower international trade costs (Shepherd 2016). The narrow definition is typically focused on administrative procedures at the border, involving customs as well as other agencies involved in clearance of goods. This area is the focus of the TFA, and we limit consideration here to this narrow approach to trade facilitation in the interest of focusing on the part of the overall area with the most salient policy implications at the present time.

3. There is now extensive evidence on trade facilitation, both in the broad and narrow senses. Recent research has focused on two dimensions: (i) the use of nontraditional data sources that can support stronger causal identification, and (ii) modeling the impacts specifically of the TFA as opposed to more general policies designed to reduce trade costs. The first approach is typified by Volpe Martincus, Carballo, and Graziano (2015), who used shipment-level data from Uruguay over the 2002–2011 period to analyze the impact of border delays on export behavior. Their claim for a causal effect is strong, as their model exploits the conditional random allocation of shipments to different verification channels based on risk analysis. Concretely, Volpe Martincus, Carballo, and Graziano (2015) find that a 10% extra delay at the border translates into a 3.8% decline in exports. Not only do producer firms reduce foreign sales in the face of delays, but overseas buyers also appear to be less willing to deal with firms subject to these kinds of shocks. Together, these findings provide a strong rationale for believing that better trade facilitation—which reduces border delays and decreases the uncertainty associated with shipment times—can boost trade in developing economies like Uruguay.

4. The second strand of the literature looks at the effects of the measures contained in the TFA, based on the trade facilitation indicators (TFIs) of the Organisation for Economic Co-operation and Development (OECD). The TFIs closely track the correspondence between economies' trade facilitation policies and the requirements of the TFA. The WTO (2015), for example, uses both a gravity model and a computable general equilibrium model to look at the trade impacts of the TFA, using the TFIs as the data source for applied policies. The WTO report finds that full implementation of the TFA could increase world exports by $0.75 trillion–$3.6 trillion (WTO 2015). The computable general

[1] Source: United Nations Conference on Trade and Development's TRAINS database, accessed through the WITS platform.

equilibrium model uses an estimate of the extent to which TFA implementation could reduce bilateral trade costs due to Moïsé and Sorescu (2013), while the gravity modeling exercise starts from scratch and estimates the model on a global dataset then conducts counterfactual simulations. We discuss the methodology for that part of the study further below. For present purposes, we simply highlight that, at the level of economy pairs, the available data clearly support the hypothesis that better trade facilitation is associated with more trade. In addition, Beverelli, Neumuller, and Teh (2015) show that the impacts of trade facilitation are not only felt at the intensive margin—i.e., more trade between existing partners in existing goods—but also at the extensive margin—i.e., economy pairs are more likely to initiate trade and introduce new products.

5. Our paper builds on and extends this literature in two main ways. First, we apply a newly developed modeling framework from the gravity literature: the general equilibrium (GE) Poisson pseudo maximum likelihood (PPML) methodology due to Anderson, Larch, and Yotov (2015). The framework provides a fully theory-consistent way for analyzing the relationship between economy-level (i.e., de facto most-favored nation) trade policies and bilateral trade flows, and for conducting counterfactual simulations that fully respect the constraints imposed by microeconomic theory. Moreover, this approach allows for endogenous changes in output and expenditures that can be translated into estimates of the welfare impacts of reform. To our knowledge, this is the first time that the GE PPML approach has been applied to study the impacts of the TFA. By demonstrating the applicability of this approach to an important policy question, as well as its ease of implementation, we believe we are helping lay the foundation for more rigorous investigation of policy-relevant issues in international trade that can be usefully understood through the same framework.

6. This approach poses major constraints on the structure of the model, the appropriate econometric method, and the type of data required. Our approach is fully consistent with Anderson, Larch, and Yotov (2015), and as such represents the best estimate currently available of the impact of TFA implementation. Concretely, we account for indirect (general equilibrium) effects in our simulations, unlike in other contributions such as the WTO (2015).

7. Our second innovation is to investigate the potential for trade facilitation to have a differential impact on final goods versus intermediates, and therefore to affect the development of value chain trade, which relies heavily on trade in intermediates. Our approach to identifying final and intermediate flows relies on results from the literature on input–output relationships as embodied in the OECD–WTO Trade in Value Added (TiVA) dataset, and thus represents a significant improvement over previous work such as that of Saslavsky and Shepherd (2014), which relied on ex ante classifications of goods and did not allow for mixed-use goods.

8. We find strong evidence that economy pairs where the importer has better trade facilitation tend to trade more than other economy pairs. This result remains after controlling for standard gravity variables, including the existence of a trade agreement between the two economies. On an impact basis, we find that a 1% improvement in an importing economy's trade facilitation environment, as measured by its TFI score, is associated with a 0.2% increase in bilateral trade. This effect is more muted than what has been found in previous studies due, we believe, to the fact that we have panel data available, and so rely on changes in trade facilitation policy over time, rather than across economies, to achieve identification. In addition, we find suggestive evidence of differential effects according to the stage of production: for final manufactured goods, the elasticity is just over 0.3, whereas for intermediate manufactured goods, it is just under 0.3. However, the difference in coefficients is not statistically significant.

9. We conduct a number of counterfactual simulations using our econometric estimates. First, we consider unilateral reforms by a selection of Asian economies. The purpose of this approach is to show that even though TFA implementation primarily affects the import side of the border in the first instance, general equilibrium effects mean that it can also promote exports—regardless of whether or not trading partners undertake reforms. However, most economies are actively engaged in TFA implementation now, so the scenario of unilateral reforms as such is not realistic, although the idea of one economy moving forward more quickly than its trading partners is clearly relevant.

10. For the second set of counterfactual simulations, we consider full implementation of the TFA, which means that all economies take their TFI scores to a level of 2. This is clearly an ambitious scenario, given, first, that not all provisions of the TFA are mandatory: some are included on a "best endeavors" basis only. In addition, developing economies have flexibility under the Agreement's terms to only implement selected parts of its mandatory provisions through their Category A notifications; measures included in Categories B and C will either be implemented after an extended transition period, or only upon receiving specific technical assistance and capacity building. Despite these limitations, the full implementation benchmark provides a useful guide to the economic stakes of the TFA, and the act of simulating the effects of economies all having the same level of trade facilitation performance makes it possible to show the links between the relative depth of reforms and the resulting trade effects. After accounting for general equilibrium effects, trade impacts are substantial: a total increase in exports of around $344 billion in our sample of 63 economies that account for 93% of world gross domestic product. The resulting change in global real output is smaller at 0.15% of baseline (2015). However, both figures mask considerable variations across economies. Among the trade effects, all economies experience an increase in exports, but the range is wide: from 5.3% in the Philippines to 1.4% in Singapore. As is typical in trade policy simulations, the largest relative gains accrue to those economies that reform the most. In real output terms, the largest effect is in Cambodia at 1.9%, and the smallest is in the United States at 0.06%. Economic size, combined with depth of reforms, exerts a strong influence on these results.

11. When we consider final and intermediate goods separately, we find that full implementation of the TFA could have an effect on the depth and composition of value chains around the world. Specifically, our simulations suggest that trade in final goods could increase by 5.2%, compared with 5.4% for intermediate goods. As a result, intermediate goods in total world merchandise would increase from 57.0% to 57.1%. Although small in an absolute sense, it is important to see this change in the context of the global rise of global value chains, which has occurred over decades. Indeed, in the decade from 2005 to 2015, the proportion of intermediates in total manufactured goods trade only rose by 0.6 percentage points, so a counterfactual change of 0.1 percentage points is not negligible within that broader context.

12. Against this background, the paper proceeds as follows. Section II discusses our data and conducts some preliminary analysis. Section III presents our econometric model, and discusses the methodology for counterfactual simulations. The following section presents results, focusing on key findings from the econometric model, and the output of the simulations. Section V concludes and presents policy implications.

II. DATA

13. Table 1 presents a summary of the data used in this paper. We now discuss the main elements of the dataset in more detail.

Table 1: Data and Sources

Variable	Source
Trade (X_{ij})	Bilateral exports, including self-trade are taken from the OECD–WTO TiVA dataset. Data are in current dollars. Data for 2012 and 2015 are used.
Regional trade agreement (RTA_{ij})	Indicator whether both economies *i* and *j* are part of the same regional or preferential trade agreement, sourced from the Egger and Larch (2008) database.
Trade facilitation (TFI_j)	OECD–TFI for 2012 and 2015 are used.
Trade cost variables	Data on distance ($dist_{ij}$), common language ($comlang\_off_{ij}$), common border ($contig_{ij}$), colonial relations ($colony_{ij}$ and $comcol_{ij}$), and landlocked are from CEPII. A dummy variable for self-trade ($intl_{ij}$) is constructed from the trade data.

CEPII = Centre d'Etudes Prospectives et d'Informations Internationales, OECD = Organisation for Economic Co-operation and Development, TFI = trade facilitation indicator, TiVA = trade in value added, WTO = World Trade Organization.
Source: Authors' compilation.

A. Policy Data

14. The key variable for our model is a measure of the degree to which economies have implemented the TFA. Under the provisions of the agreement, developed economies must implement all provisions upon its entry into force, i.e., as of February 2017. Developing economies have more flexibility, consistent with the WTO principle of special and differential treatment. They can notify provisions according to three categories—A, B, and C—based on their readiness to implement and need for external technical assistance and capacity building. Category A obligations are to be implemented upon entry into force, i.e., as of February 2017. Category B obligations have longer implementation periods, based on timelines set out in the relevant notifications. Category C obligations are only to be implemented after an extended transition period and the receipt of assistance and support for capacity building from developed economies.

15. Although other indicators of trade facilitation have been developed—the World Bank's logistics performance index is an example (Arvis et al. 2016b)—with the advent of the TFA, there was clearly a need to track implementation patterns relating to new policies and procedures required by the TFA. To fill this gap, the OECD came up with the TFIs (Moïsé, Orliac, and Minor 2011; Moïsé and Sorescu 2013). Initially, it comprised 12 indicators and was later expanded to 16 in 2015 (Moïsé and Sorescu 2015). These indicators cover the different aspects of border management such as advance rulings, appeals procedures, fees and charges, and transit facilitation in case of land-based trade. The full list of indicators and its description is in Table 2. To quantify the state of customs practices, the OECD identifies a wide range (a total of 97) of border management and customs practices and procedures, and places them into these 16 baskets. Table 2 lists the practices covered under the various TFIs. Based on a detailed study of custom practices in the 16 areas, and in some cases, supported by secondary data, the OECD then scored procedures as 0 (worst), 1, or 2 (best). Scores on the individual policies within each of the 16 areas were then averaged to come up with score for each indicator for each economy.

Table 2: Components of the Trade Facilitation Indicators

Indicator	Description
A. Information availability	Refers to both web-based and other forms of publications about customs and border-related rules and procedures, including transparency mechanism, such as enquiry points
B. Involvement of the trade community	Refers to consultations between traders and the government to ensure the involvement of the trade community to the design and operation of border-related policies and procedures
C. Advance rulings	Refers to prior statements by the customs administration to requesting traders concerning the classification, origin, valuation method, etc., applied to specific goods at the time of importation; the rules and process applied to such statements
D. Appeal procedures	Refers to the number of basic characteristics of the appeal system, such as, transparency, fairness, accessibility, timeliness, and effectiveness of the applicable rules and outcomes
E. Fees and charges	Refers to publicly available information on applicable fees and charges imposed on exports and imports
F. Formalities—documents	Refers to the simplification of documentary requirements, extent of harmonization of trade documents, and the acceptance of copies
G. Formalities—automation	Refers to automated borders, electronic interchange of documents, and application of risk management procedures
H. Formalities—procedures	Refers to single windows, pre-arrival processing, physical inspections, post-clearance audits, separation of release from clearance, and the concept of authorized traders, among others
I. Border agency cooperation—internal	Refers to cooperation between agencies, control delegation, and regular meetings held at the national level
J. Border agency cooperation—external	Refers to alignment of work hours, alignment of procedures and formalities, development and sharing of common facilities, and joint controls with bordering and third economies
K. Consularization	Refers to information on consular transaction requirements
L. Governance and impartiality	Refers to a list of good governance characteristics, including clearly established and transparent structures and functions, the existence of a Code of Conduct and an ethics policy, internal audits, and transparent provisions for financing and for internal sanctions in the customs administration
M. Transit fees and charges	Refers to publicly available information on applicable fees and charges imposed on transit fees and charges
N. Transit formalities	Refers to information on transit formalities and documentation, transit infrastructure, single windows for transit trade, pre-arrival processing for transit trade, physical inspection
O. Transit guarantees	Refers to the kind of guarantees required, amount of guarantee, whether or not supported by some form of agreement, timeliness and full release of guarantee, and use of convoys
P. Transit agreements and cooperation	Refers to existence of bilateral or multilateral agreements supporting transit trade, simplification of documentation, and cooperation between agencies of the economies involved

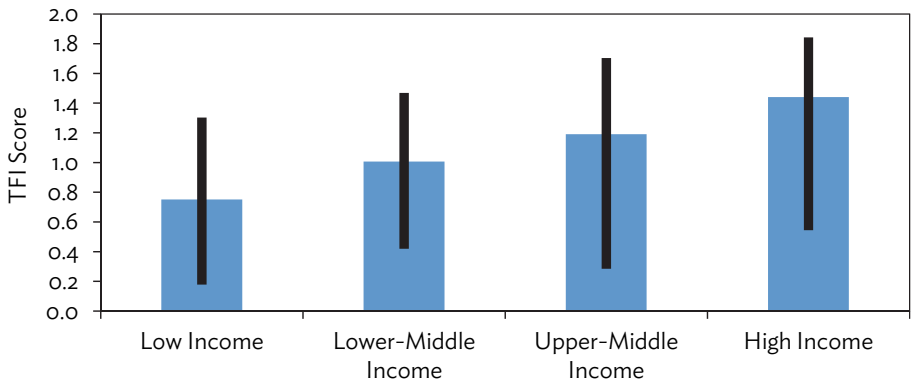
Source: Organisation for Economic Co-operation and Development.

16. The TFIs are available for 2012, 2015, and 2017, of which we use the first 2 years since our trade and production data are only available through 2015. The TFIs cover 132 economies for 2012 and 163 economies for 2015. The database comprises scores for 11 of the 12 indicators. The 11th indicator is "Consularization," which contains information on consular transaction requirements, but is not included as only 59 developing economies have the required information and only 22 of these 59 developing economies currently impose consular transaction requirements. The four indicators introduced in 2015 had also been intended to be included in the 2012 release, but data collection and control problems were more substantial than for other indicators, so we exclude them here.

17. Naturally, the 11 individual TFIs are strongly correlated to each other. Including them individually in a regression model would likely not give meaningful results, as the correlation among them would lead to unduly large estimated standard errors, and imprecise estimates. We therefore favor compressing the indicators into a single composite indicator for empirical work. We work with the simple average across all individual indicators to produce a single number per economy. As a robustness check, we undertake a principal components analysis and find that the first principal component has loadings that are very stable across the individual indicators, and it is correlated at 0.99 with the simple average. In the interest of simplicity and transparency, we therefore take the average of the individual TFIs to make our composite TFI for empirical work.

18. Figure 1 presents the TFIs by World Bank income group. The bars represent simple averages. As is clear, trade facilitation performance is improving in per capita income. However, the lines, which indicate the minimum to maximum range, are telling of a different dynamic: there is great dispersion in performance across economies within the same income group. For instance, the average low-income economy has a higher score than that of the lowest performing high-income economy (Palau, 0.544). The ranges are overlapping across income groups, which indicates that counterfactual simulations based on given changes within groups may produce large impacts for some economies across all groups, assuming that bilateral trade is increasing in TFI score. We return to this point below.

Figure 1: Average and Range for the Trade Facilitation Indicators, 2015, by Income Group



TFI = trade facilitation indicator.
Note: World Bank income classification is used.
Sources: Organisation for Economic Co-operation and Development; and authors' calculations.

B. Trade Data

19. The standard source for trade data is the United Nations Commodity Trade (UN Comtrade) database. However, it does not include data on self-trade, i.e., goods that are produced and consumed within the same economy. Yotov et al. (2017) show that such data are important for gravity models, in particular those that seek to estimate the effects of nondiscriminatory policies. This is the case with trade facilitation, as the policy is the same across all trading partners and does not vary by economy pair. We therefore use the OECD–WTO TiVA dataset, which includes data on exports in gross shipments (not value added) terms. It has balanced trade data by International Standard Industrial Classification (ISIC) sector Revision 4, along with gross production data at the same level of disaggregation. By subtracting world exports from total production, we can obtain a measure of self-trade (for intermediate and final goods, we work directly with the input–output tables to obtain the required figures). The TiVA data are available for 64 economies, which account for over 90% of world trade. Although the data focus on OECD economies, they also include developing economies from all regions, and as such can be informative about bilateral trade patterns beyond the developed world, and between developed and developing regions (Shepherd 2019).

20. In addition to the availability of carefully constructed data on self-trade, the TiVA dataset has the advantage of linking to rigorously assembled inter-economy input–output table. We can use this table to assemble measures of goods used as intermediates and those used in final consumption. The distinction is important from a policy point of view, because global value chains trade heavily in intermediate relative to final goods. This approach is superior to catalogs based on standard trade classifications (e.g., Saslavsky and Shepherd 2014), as it takes account of dual use goods, i.e., it allows for part of a sector's production to be destined for final consumption, and another part to be destined for use as intermediate inputs. It represents the most sophisticated method available for identifying trade in intermediate goods, and thus for quantifying changes in the trading environment due in part to value chains (Shepherd 2019).

21. For our empirical analysis, we take total merchandise trade, namely ISIC sectors 1–5, 10–14, and 15–37; for the value chain analysis, we take data on manufactured goods only (ISIC sectors 15–37). Figure 2 shows the evolution of the percentage of intermediate goods in total merchandise trade over the period for which data are available, 2005–2015. Although there are pullbacks in the face of global economic shocks such as the global financial crisis of 2008, there is a clear upward trend before and after the crisis. We view the increasing share of intermediates in total merchandise trade as consistent with the rise of global value chains around the world, which has been documented in detail elsewhere using a variety of metrics (e.g., Johnson and Noguera 2012, and Antras et al. 2012).

C. Other Gravity Variables

22. We source standard gravity controls, such as distance and geographical or historical linkages, from the CEPII distance dataset. For self-trade, distance is set equal to the economy's internal distance from the same dataset, and dummy variables for geographical and historical linkages are set to zero.

23. Our final source of data is Egger and Larch (2008), who collected comprehensive data on regional and preferential trade agreements. We extract a dummy variable equal to unity if an economy pair has such an agreement in force between them. We use this to control for other aspects of trade policy that may drive bilateral shipments. Again, we set the dummy equal to zero for self-trade observations.

Figure 2: Share of Intermediates Goods in Total Merchandise Trade, 2005–2015

Sources: Trade in Value Added dataset; and authors' calculations.

D. Preliminary Analysis

24. Before moving to a fully specified econometric model in the next section, we first present some basic properties of the data. First, Table 3 presents summary statistics for the total merchandise trade sample, with distance and the importer TFI converted to logarithms. Of note is that the final dataset consists of 64 exporters and 63 importers, based on the combined availability of trade data and TFI data. Second, the trade data contain 121 zero observations, but no missing observations. The reason is that the TiVA dataset is balanced, i.e., import and export flows are reconciled using national accounts data and matrix rebalancing techniques. Given the high level of aggregation of the data—total merchandise trade—it is unsurprising that the number of zero observations is relatively low.

Table 3: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Trade	7,488	12.289	231.093	0.000	13,615.020
Log(Dist)	7,488	1.541	1.094	−5.008	2.986
Contig	7,488	0.034	0.182	0.000	1.000
Colony	7,488	0.026	0.160	0.000	1.000
Comcol	7,488	0.020	0.139	0.000	1.000
Comlang_off	7,488	0.070	0.256	0.000	1.000
Intl	7,488	0.984	0.124	0.000	1.000
Log(TFIj)	7,488	0.368	0.164	−0.208	0.637
RTA	7,488	0.470	0.499	0.000	1.000

Source: Authors' calculations.

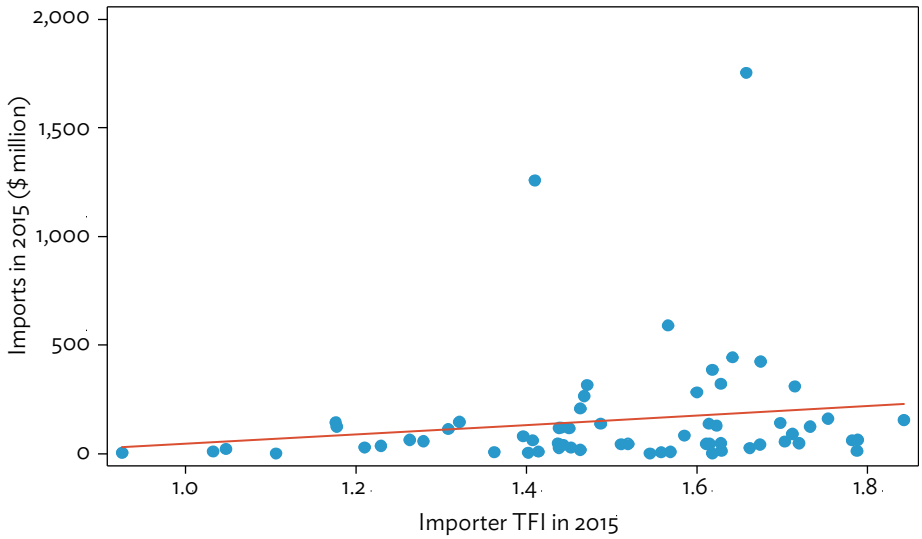
25. Table 4 presents a correlation matrix for the same variables. At the bilateral level, there is a positive association between the composite TFI variables and trade, but it is very weak. To see the association between the two variables more clearly, we aggregate the data to the importer level—i.e., we look at total imports aggregated across all sources, rather than bilateral trade. Figure 3 presents the results. The association remains positive and is somewhat stronger, although it is still not statistically significant. Of course, there is much more going on in the determination of even aggregate trade flows than just trade facilitation, so it is likely important to embed the variable in a more sophisticated model before more meaningful results emerge. It is to that task that the remainder of the paper turns.

Table 4: Correlation Matrix

	Trade	Log(Dist)	Contig	Colony	Comcol	Comlang_off	Intl	Log(TFIj)	RTA
Trade	1.000								
Log(Dist)	−0.082	1.000							
Contig	0.003	−0.336	1.000						
Colony	−0.005	−0.067	0.175	1.000					
Comcol	−0.007	−0.042	0.074	−0.023	1.000				
Comlang_off	−0.007	−0.033	0.161	0.278	0.138	1.000			
Intl	−0.329	0.374	0.024	0.021	0.018	0.035	1.000		
Log(TFIj)	0.010	0.036	−0.028	0.006	−0.006	0.106	0.000	1.000	
RTA	−0.038	−0.461	0.156	0.002	−0.018	0.023	0.119	0.058	1.000

Source: Authors' calculations.

Figure 3: Association between the Trade Facilitation Indicators and Total Imports



TFI = trade facilitation indicator.
Sources: Organisation for Economic Co-operation and Development; Trade in Value Added dataset; and authors' calculations.

III. ECONOMETRIC MODEL

26. Theory-consistent gravity models are well known in the trade literature. Anderson, Larch, and Yotov (2015) developed a simple method for conducting theory-consistent policy simulations using the familiar structural gravity model derived from constant elasticity of substitution (CES) preferences across economies for national varieties differentiated by origin (the Armington assumption). The model takes the following form:

$$X_{ij} = \left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} Y_i E_j \tag{1}$$

$$P_j^{1-\sigma} = \sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma} Y_i \tag{2}$$

$$\Pi_i^{1-\sigma} = \sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} E_j \tag{3}$$

$$p_j = \frac{Y_j^{\frac{1}{1-\sigma}}}{\gamma_j \Pi_j} \tag{4}$$

where X_{ij} is exports in value terms from economy i to economy j; E_j is expenditure in economy j; Y_i is production in economy i; t_{ij} captures bilateral trade costs; σ is the elasticity of substitution across varieties; P_j is inward multilateral resistance, which captures the dependence of bilateral shipments into j on trade costs across all inward routes; Π_i is outward multilateral resistance, which captures the dependence of bilateral shipments out of i on trade costs across all outward routes; p_j is the exporter's supply price of economy j; and γ_j is a positive distribution parameter of the CES function (Shepherd 2019).

27. Most commonly, the model represented by (1) through (4) is estimated by fixed effects, which collapses it into the following empirical setup:

$$X_{ij} = exp\left(T_{ij}\beta + \pi_i + \chi_j\right)e_{ij} \tag{5}$$

where T is a vector of observables capturing different elements of trade costs; π is a set of exporter fixed effects; χ is a set of importer fixed effects; and e is a standard error term (Shepherd 2019).

28. The model has a number of salient features, which are well known but which need restating. First, its structure makes clear that the elasticity of trade with respect to particular bilateral trade costs—such as membership of a regional trade agreement (RTA)—specified within t_{ij} is not an accurate summary of the impact of a change of trade costs on trade. The reason is that the multilateral resistance indices depend on trade costs across all partners, which means that the model takes account of general

equilibrium effects. This point is typically recognized at the estimation stage, when fixed effects by exporter and by importer are included to account for multilateral resistance. However, when a counterfactual simulation is conducted, the effects need to be passed through the two price indices, not simply extracted from the relevant regression coefficient. This point is much less commonly appreciated in the literature.

29. Second, if the model is estimated by PPML with fixed effects as recommended by Santos Silva and Tenreyro (2006), then Fally (2015) shows that the estimated fixed effects correspond exactly to the terms required by the structural model. In other words, if (5) is estimated correctly, then it follows that

$$\widehat{\Pi_i^{1-\sigma}} = E_0 Y_i \exp(-\pi_i) \tag{6}$$

$$\widehat{P_j^{1-\sigma}} = \frac{E_j}{E_0} \exp(-\pi_i) \tag{7}$$

where E_0 corresponds to the expenditure of the economy corresponding to the omitted fixed effect (typically an importer fixed effect) in the empirical model, and the normalization of the corresponding price terms in the structural model (Shepherd 2019).

30. Let $\hat{\beta}$ be the PPML estimates of the trade cost parameters in (5). To see the impact of a counterfactual change in trade costs, such as the elimination of an RTA between two trading partners, we can reestimate (5) imposing $\hat{\beta}$ as a constraint and with counterfactual trade costs T_{ij}^c:

$$X_{ij} = exp\left(T_{ij}^c \hat{\beta} + \pi_i + \chi_j\right) e_{ij} \tag{8}$$

31. Estimating (8) with PPML and the original trade data means that output and expenditure remain constant, so the PPML fixed effects adjust to take account of changes in multilateral resistance brought about by the change in bilateral trade costs. Once estimates have been obtained, counterfactual values of relevant indices can be calculated, but they are conditional on fixed output and expenditure although they take account of general equilibrium reallocations. In particular, $\widehat{X_{ij}}$ from (8) provides counterfactual values of bilateral trade that are consistent with the general equilibrium restrictions of theory, but which still sum to give observed output and expenditure, consistent with a remarkable property of the PPML estimator (Arvis and Shepherd 2013, Fally 2015, and Shepherd 2019).

32. It is possible to push the model further, by allowing counterfactual changes in factory-gate prices to drive changes in output and expenditure which, in turn, lead to additional changes in trade flows until the system converges. Specifically, endogenous responses in output and expenditure are as follows in an endowment economy where trade imbalance ratios $\phi_i = E_i/Y_i$ remain constant:

$$Y_i^c = \left(\frac{p_i^c}{p_i}\right) Y_i \tag{9}$$

$$E_i^c = \left(\frac{p_i^c}{p_i}\right) E_i \tag{10}$$

33. Anderson, Larch, and Yotov (2015) propose an iterative approach to solving the system. First, use structural gravity to translate changes in output and expenditure into changes in trade flows:

$$X_{ij}^{c} = \frac{\left(t_{ij}^{1-\sigma}\right)^{c}}{t_{ij}^{1-\sigma}} \frac{Y_i^c E_j^c}{Y_i E_j} \frac{\Pi_i^{1-\sigma} P_j^{1-\sigma}}{(\Pi_i^{1-\sigma})^c \left(P_j^{1-\sigma}\right)^c} \tag{11}$$

Where superscript c indicates counterfactual values obtained from constrained estimation of (8) and calculation of relevant indices. Counterfactual values of output and expenditures come from applying market clearing conditions $p_i = \left(\frac{Y_i}{Y}\right)^{1/1-\sigma} \frac{1}{\gamma_i \Pi_i}$, which makes it possible to translate changes in the fixed effects between (8) and (5) into first order changes in factory-gate prices:

$$\frac{p_i^c}{p_i} = \frac{\exp\left(\widehat{\pi_i^c}\right)}{\exp\left(\widehat{\pi}_i\right)} \tag{12}$$

34. Further changes occur in a second order sense, as changes in prices lead to further changes in output and expenditure which, in turn, drive changes in trade. By iterating the PPML estimation and calculation of changes until convergence, it is possible to obtain full endowment general equilibrium estimates of trade flows and relevant indices.

35. To summarize, Anderson, Larch, and Yotov (2015) show that starting with the standard structural gravity model, it is possible to design a simple approach for first estimating the model's parameters, and then using the estimated parameters to perform counterfactual simulations in a way that is fully consistent with the general equilibrium implications of gravity theory. The methodology can be broken down as follows:

(i) Estimate the model using PPML and fixed effects to obtain estimates of trade costs and trade elasticities for the baseline.
(ii) Solve the gravity system using the output from step 1 to provide baseline values of all indices.
(iii) Define a counterfactual scenario in terms of an observable trade cost variable.
(iv) Solve the counterfactual model in conditional general equilibrium, i.e., direct and indirect changes in trade flows at constant output and expenditure.
(v) Solve the counterfactual model in full general equilibrium, i.e., direct and indirect changes in trade flows with endogenous output and expenditure driven by trade-induced changes in factory-gate prices.

36. Yotov et al. (2017) provide a detailed explanation of the above steps, as well as Stata code for implementing them in a general setting. We adopt their approach and freely adapt their code here. Concretely, we use PPML to estimate (8) on a single year of data (2011) with the following trade costs function:

$$\begin{aligned} T_{ij}\beta = {} & \beta_0 \log\left(dist_{ij}\right) + \beta_1 contig_{ij} + \beta_2 colony_{ij} + \beta_3 comcol_{ij} + \beta_4 comlang\_off_{ij} \\ & + \beta_5 intl_{ij} + \beta_6 \log\left(TFI_j\right) * intl_{ij} + \beta_7 RTA_{ij} \end{aligned} \tag{13}$$

where *dist* is bilateral distance, *contig* is a dummy taking the value of one where economies share a common land border, *colony* is a dummy equal to unity when one economy was a colony of the other, *comcol* is a dummy equal to unity when the two economies had a common colonizer, *comlang_off* is a dummy equal to unity where economies have a common official language, *intl* is a dummy equal to one for international transactions (exporter and importer are different economies), *TFI* is the TFI for the importing economy, and *RTA* is a dummy equal to one if the two economies are members of the same RTA.

37. The coefficient of primary interest is β_6, which gives the elasticity of bilateral trade flows with respect to importer trade facilitation. Intuitively, trade facilitation performance is highly likely to be endogenous to trade: economies that trade more have an incentive to improve their trade facilitation performance. Given this mechanism, the bias in single-year estimates is likely to be positive, i.e., in the direction of finding too strong of an effect. As a result, we therefore first estimate the model using a panel for 2012 and 2015, with exporter-year, importer-year, and economy pair fixed effects, along with the TFI variable. Identification then comes only from the combination of changes in the TFI over time, and the difference between trade flows where border procedures do not matter (internal trade) versus those where they do (international trade). This rigorous fixed effects specification should help reduce simultaneity bias. In theory, we could adopt the same approach for the RTA dummy, but there is insufficient variation over the short 2012–2015 period to enable proper identification.

38. After estimating the above model, we then estimate a second stage model for 2015 only, to serve as the simulation test bed. We constrain the TFI coefficient to equal the value from the first (panel) regression, then include economy pair data in the form of standard gravity controls, as the pair fixed effects have to be dropped. This second model is of the form stated above, with exporter and importer fixed effects only.

IV. RESULTS

39. We estimate the model (set out in the previous section) on data for both years using fixed effects and the TFI variable only, and then for a single year using a constrained model.

A. Estimation Results

40. Table 5 presents the estimation results. The first column reports results from the panel data model, where the TFI is the only independent variable. Despite the rigor of the fixed effects specification, the estimate is precise and economically meaningful: the estimated elasticity of trade flows with respect to the TFI is 0.174, which is statistically significant at the 1% level.

41. The next column shows the extent to which our panel specification reduces endogeneity bias, which, as noted, would tend to result in overestimates. When we estimate over a single year (2015) and include control variables rather than pair fixed effects, the estimate of the TFI parameter increases to 4.161, and is again statistically significant at the 1% level. There are good reasons for preferring the panel estimate, so we enter it as a constraint in the next model (hence, no standard error is reported) based on the coefficient estimate from the panel regression results shown in column 1, and add gravity controls, keeping data for 2015 only. In this column 3 model, all controls have the expected signs and sensible magnitudes, but only the distance coefficient, the coefficient on the colony dummy, and the RTA dummy are statistically significant at the 10% level or better. Nonetheless, the model provides a good fit

to the data, and control variables have similar magnitudes across the column 2 and column 3 specifications.

Table 5: Estimation Results

	Total			Intermediate goods		Final goods	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log(TFIj)*Intl	0.174 **	4.161 ***	0.174	0.269***	0.269	0.317***	0.317
	(0.074)	(0.541)		(0.092)		(0.070)	
Log(Distance)		−0.683 ***	−0.667 ***		−0.676 ***		−0.633 ***
		(0.053)	(0.051)		(0.056)		(0.059)
Contig		0.267	0.215		0.182		0.305
		(0.221)	(0.235)		(0.228)		(0.251)
Colony		0.149	0.236 *		0.229 *		0.264 **
		(0.121)	(0.122)		(0.135)		(0.133)
Comcol_off		0.222 *	0.218		0.341 *		0.248 *
		(0.133)	(0.186)		(0.185)		(0.135)
Comlang		−0.043	0.176		0.245		0.111
		(0.166)	(0.147)		(0.169)		(0.156)
Intl		−4.687 ***	−3.113 ***		−3.159 ***		−3.039 ***
		(0.263)	(0.198)		(0.219)		(0.230)
RTA		0.114	0.199 *		0.281 **		0.141
		(0.102)	(0.109)		(0.120)		(0.122)
Observations	7,444	4,032	4,032	7,470	4,032	7,470	4,032
R2	0.984	0.974	0.998	0.998	0.996	0.998	0.996
Exporter-Year FE	Yes	No	No	Yes	No	Yes	No
Importer-Year FE	Yes	No	No	Yes	No	Yes	No
Economy Pair FE	Yes	No	No	Yes	No	Yes	No
Exporter FE	No	Yes	Yes	No	Yes	No	Yes
Importer FE	No	Yes	Yes	No	Yes	No	Yes

FE = fixed effects, PPML = Poisson pseudo maximum likelihood, R2= R-squared.
Notes: Estimation is by PPML in all cases, with exports as the dependent variable (total merchandise in columns 1–3, manufactured goods in columns 4–5). Robust standard errors adjusted for clustering by economy pair are in parentheses below the parameter estimates. Statistical significance is indicated as follows: * (10%), ** (5%), and *** (1%).
Source: Authors' estimates.

42. The following columns repeat the exercise for final and intermediate manufactured goods. The first stage output is suppressed, but the TFI coefficient is positive and 1% statistically significant in both cases. Again, gravity controls have the expected signs and magnitudes in the single year models, and the pattern of statistical significance is broadly similar to what is seen in the aggregate model except that the common colonizer dummy is also statistically significant in both cases now.

43. For total trade, the model in column 1 suggests that a 1% increase in an importer's TFI score is associated with a 0.2% increase in trade. For final goods, the elasticity is slightly higher at 0.32, while for intermediates, it is slightly higher at 0.27. However, there is no statistically significant difference in the coefficients across columns. Just looking at the elasticities would suggest that final goods are more sensitive to changes in trade facilitation performance than are intermediate goods, but that interpretation neglects general equilibrium effects, which can be complex due to the nonlinear nature of the underlying model. We therefore turn to counterfactual simulations of the models to better elucidate these questions.

B. Counterfactual Simulations

Total Trade

44. We first consider a simple set of counterfactuals using the model for total trade. This set of simulations abstracts from policy issues to consider reform by individual economies acting unilaterally. We take a set of Asian economies, namely Cambodia, India, the People's Republic of China (PRC), the Philippines, and Viet Nam. The rationale for examining unilateral reform is that it lays bare the ways in which imports and exports interact in this model through bilateral trade costs, and could shed light on the question whether or not the TFA—which primarily affects the import side of trade policy, although it does also have some implications for the export side—will unduly encourage imports at the expense of exports, thus worsening the balance of payments in developing economies. Although economists generally believe that the balance of trade is determined by macroeconomic factors such as the balance between savings and investment, the idea that the TFA could provoke balance of payments problems in developing economies is unfortunately widespread in policy circles (e.g., South Centre 2013).

45. Concretely, we use the model to run five separate simulations, in each of which one economy fully implements the TFA, i.e., increases its TFI score to 2.0. No other economy undertakes any reforms. Results in terms of impacts on exports, imports, and real output are summarized in Table 6; although we present results together in one table for ease of reference, they are, in fact, based on five separate and independent simulations of unilateral reform. We report results in terms of full general equilibrium impacts, as explained above. Full results are available on request, but as a result of the simulation structure, impacts on third economies are minimal except in the PRC's case, where there are some significant spillover effects on neighbors. Otherwise, almost the whole impact accrues to the economy undertaking the reforms.

46. All economies in Table 6 see significant trade increases over baseline following full TFA implementation. In all economies except the PRC, exports expand relatively more rapidly than imports. Although this does not necessarily mean that trade deficits narrow—that result depends on the initial balance of trade in each economy, in addition to the relative changes in exports and imports[2]—it shows that TFA implementation, even unilaterally, is far from just about facilitating imports. What is the economic mechanism lying behind this result, given that the econometric model does not include any measure of trade facilitation on the export side? As the TFA is implemented, it brings down the price of imported goods relative to exported goods. As a result, there is an incentive for domestic production to shift from import-competing sectors to export sectors. Exports expand as a result. This dynamic is well known in different forms in the trade literature, but it is important to bring it out in a policy sense.

[2] In addition, our model does not explicitly consider savings and investment, which are viewed by most economists as the fundamental determinants of the trade balance.

Table 6: Simulation Results—Unilateral Full Implementation of the Trade Facilitation Agreement, Export, Imports, and Real Output (percentage changes over baseline)

Economy	Exports	Imports	Real Output
Cambodia	2.032	1.895	1.538
China, People's Republic of	2.357	2.977	0.042
India	2.578	1.707	0.116
Philippines	3.311	2.318	0.313
Viet Nam	2.721	2.559	0.284

TFA = trade facilitation agreement.
Notes: Table reports results of five separate and independent simulations of unilateral full policy reform in each individual listed economy, with no reforms elsewhere. Baseline refers to the respective estimated values of exports, imports, and real output in 2015.
Source: Authors' calculations.

47. Second, the Table 6 simulations show that economies can gain substantially in trade and welfare terms from unilateral reforms, or alternatively, from moving further and faster on TFA implementation than other economies. Moreover, real output changes are largest in smaller economies, which suggests that even small developing economies have an interest in pursuing TFA implementation with vigor. There are considerable differences across economies in Table 6 in terms of the trade and output effects of TFA implementation. This variation is driven by different baselines of TFI performance, which means that some economies reform more than others to reach full implementation, as well as economic size: the relative size of self-trade, namely the domestic market, tends to diminish the size of the effect in the counterfactual, particularly for real output. We stress that all of the effects reported in Table 6 occur in the absence of any reforms by trading partners. So TFA implementation is not a case where reciprocity is crucial to reaping trade or welfare gains, although as we show later, the gains from reform are larger still when economies engage in concerted action.

48. For our next simulation, we consider a global scenario in which all economies reform together. We are interested in examining the distribution of gains across developed and developing economies for the same absolute change in performance. We therefore add 0.1 to each economy's TFI score, up to the maximum of 2.0. The purpose of this simulation is to show the way in which gains are distributed across different income groups for the same absolute change in performance.

49. Results in terms of impacts on exports, imports, and real output by World Bank income group are summarized in Table 7, with full results in Appendix, Table A.1. The estimation sample based on TiVA data does not include any low-income economies, but does include economies from the other three income groups. First, we see that changes in trade outcomes are strong across all groups. It is by no means true that the main trade benefits of the TFA accrue to high-income economies, to the exclusion of lower-income economies. In fact, the largest export gains in relative terms accrue to the lower-middle-income group, followed by the upper-middle-income group, and then the high-income group. Real output increases significantly in all groups, but importantly, the gain is again highest in the lower-middle-income group. Of course, these average numbers mark considerable variation across economies. In terms of export impacts, effect sizes range from 0.4% in Latvia to nearly 1.3% in Hong Kong, China. There is a clear association between the starting level of an economy's TFI score and the size of the

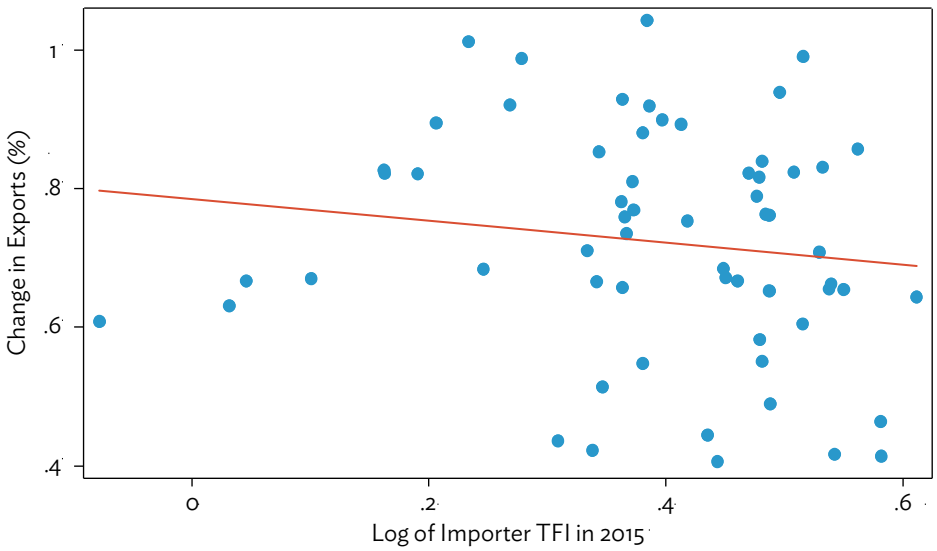
estimated export impact (Figure 4).[3] The reason, of course, is that 0.1 points represents a larger relative change for economies with lower scores. But again, the change is on the import side, not the export side directly. Nonetheless, the model clearly shows that economies that reform relatively more by streamlining their import regimes tend to benefit more in terms of export impacts. Although the point is not of primary importance from the point of view of economic analysis, it is crucial in political economy terms, given continued policy and popular focus on exports.

Table 7: Simulation Results by Income Groups for a Global 0.1 Point Increase in Trade Facilitation Indicators, Export, Imports, and Real Output (percentage changes over baseline)

Income Group	Exports	Imports	Real Output
High income	0.797	0.746	0.043
Upper-middle income	0.849	0.999	0.024
Lower-middle income	0.958	0.870	0.054

TFI = trade facilitation indicator.
Notes: Table reports results of reform scenario where TFI score of each importer increases by 0.1 from their value in 2015 up to maximum value of 2. Baseline refers to the respective estimated values of exports, imports, and real output in 2015.
Source: Authors' calculations.

Figure 4: Association between Initial Importer and Simulated Change in Exports for a Global 0.1 Point Increase in Trade Facilitation Indicators



TFI = trade facilitation indicator.
Note: The plot excludes two outlier observations on the United States and Hong Kong, China.
Sources: Organisation for Economic Co-operation and Development; and authors' calculations.

[3] For purposes of Figure 4, two observations are excluded as they are outliers.

50. Our final simulation is the most policy relevant of the three. We consider full TFA implementation by all economies in the sample. Results are presented by income group in Table 8, with a breakdown by economy in Appendix, Table A.2. As in Table 7, all income groups gain in terms of trade and real output from this scenario. In export terms, the order of relative gains is again decreasing in income level—i.e., the lower-middle-income group has the largest percentage gain over baseline. Turning to real output, the largest impact is again in the lower-middle-income group, followed this time by the high-income group, and then the upper-middle-income group. The takeaway from these summary figures is that developing economies have much to gain from implementing as much of the TFA as possible, and that analysis extends to lower-income economies, not just the large emerging markets.

Table 8: Simulation Results by Income Groups for Global Full Implementation of the Trade Facilitation Agreement, Export, Imports, and Real Output (percentage changes over baseline)

Income Group	Exports	Imports	Real Output
High income	3.087	2.927	0.170
Upper-middle income	3.978	4.632	0.119
Lower-middle income	4.568	4.076	0.275

TFA = trade facilitation agreement.
Notes: Table reports results of a reform scenario in which all economies fully implement the TFA and attain a trade facilitation indicator score of 2. Baseline refers to the respective estimated values of exports, imports, and real output in 2015.
Source: Authors' calculations.

51. If we sum this scenario for the world as a whole, we find that exports increase by 3.5% or nearly $344 billion, while real output increases by 0.15%. These gains are significant from an economic point of view, but likely represent an upper bound, at least in the short term. All developing economies may not be able to fully implement the TFA in the near future, but only those obligations they have listed within Category A, with Category B obligations to follow later, and Category C only upon the receipt of appropriate assistance. Nonetheless, our results suggest that even a more realistic implementation scenario, well within the upper bound, could have significant trade and welfare implications.

52. It is instructive to compare the outcomes for individual versus collective action by comparing Table 6 with the relevant results from the global scenario in Appendix, Table A.2. Since the changes in TFI score are the same in both cases, the difference represents the impact of reforms by trading partners, as opposed to reforms at home. For Cambodia, unilateral reform brings an increase in exports of 2.0%, as compared with 3.4% under the global scenario. In the case of the PRC, unilateral reform increases exports by 2.4%, compared with 4.0% under the global scenario. For India, the corresponding figures are 2.6% and 4.8%; for the Philippines, 3.3% and 5.3%; and for Viet Nam, 2.7% and 4.7%. In all cases, over 50% of the gains from TFA implementation can be achieved through unilateral action by individual economies, regardless of what their trading partners do. Of course, multilateral reform gives a bigger boost to economic activity by simultaneously opening foreign and domestic markets, but this is not an instance where strict reciprocity should be the touchstone of action.

Value Chain Trade

53. Thus far, we have focused on the implications of TFA implementation for aggregate trade. But it is plausible that this policy change will have an effect on the composition of trade, not just its value. In particular, it might have different effects on trade in final and intermediate goods, an issue that the TiVA dataset is particularly well equipped to deal with.

54. We have already presented estimation results that distinguish between final and intermediate goods. We now consider counterfactual simulations of the two models separately, using the same scenario as the previous one, i.e., full global implementation of the TFA. We run independent counterfactuals on final goods and intermediate goods, then examine the ratio of intermediate goods in total trade as our variable of interest. An increase in this ratio would be consistent with an increase in value chain activity following implementation of the TFA.

55. Table 9 presents the results by income group. First, we see that the proportion of intermediates in total goods trade is increasing in per capita income, as would be expected. Comparing baseline and simulated numbers shows that the lower- and upper-middle-income groups see an increase in trade in intermediates relative to final goods, with the largest change in relative terms in the upper-middle-income group, followed by the lower-middle-income group; there is a small fall in the high-income group. Although the differences appear small, it is important to keep in mind the scale from Figure 2: the nearly 0.3 percentage point increase in the proportion of intermediates in total trade among the upper-middle-income economies is about half the increase that took place on a worldwide basis between 2005 and 2015, a period that was admittedly interrupted by the global financial crisis. As a result, value chain deepening in middle-income economies following TFA implementation could amount to something like half a decade's worth of integration on a worldwide basis. We conclude that these numbers are suggestive of a significant impulsion from TFA implementation toward greater value chain trade particularly in middle-income economies, although Appendix, Table A.3 shows that impacts differ greatly across economies. Value chain trade is, of course, a complex phenomenon driven by a wide range of factors. We do not suggest that it is solely or even primarily driven by trade facilitation, but simply highlight that TFA implementation is one global policy change that could provide a fillip to value chain trade.

Table 9: Simulation Results by Income Groups for Global Full Implementation of the Trade Facilitation Agreement, Share of Intermediate and Final Goods in Total Goods Exports
(%)

Income Group	Baseline	Simulation
High income	57.954	57.896
Upper-middle income	55.983	56.232
Lower-middle income	54.260	54.423

TFA = trade facilitation agreement.
Notes: Table reports results of a reform scenario in which all economies fully implement the TFA and attain a trade facilitation indicator score of 2. Baseline refers to the share of intermediate goods in total exports in 2015.
Source: Authors' calculations.

V. CONCLUSION AND POLICY IMPLICATIONS

56. This paper has used a theory-consistent econometric method to obtain estimates of the sensitivity of bilateral trade with respect to importer trade facilitation performance. It has then, in a consistent way, conducted counterfactual simulations in which various improvements in trade facilitation are considered. Concretely, we find that a substantial proportion of the benefits of the TFA in terms of trade impacts can be had by economies acting unilaterally, i.e., not requiring full reciprocity from trading partners, although the gains from concerted action are, of course, larger; the point is even stronger in terms of real output, where the largest portion of the gains come from an economy's own reforms. Second, we have shown that there is no evidence that facilitating imports through the TFA will lead to a relative surge of imports in developing economies: relative price effects ensure that exports adjust to the changes, and in most cases, we find that simulated changes in exports and imports are similar in percentage terms. Third, our results show that the gains from the TFA are larger according to how much an individual economy reforms: bigger policy changes lead to bigger impacts. Finally, we have found suggestive evidence that TFA implementation could promote trade in intermediate relative to final goods, and as a result, in numerous economies, deepen value chain trade.

57. The key policy message from our results is that developing economies have a strong interest in being ambitious in their TFA implementation plans. The Agreement gives them great latitude in deciding which elements to adopt and on what time frame. From an economic standpoint, they should work toward as complete as possible an implementation plan over a reasonable time frame, in order to enjoy maximum benefits in terms of increased trade and real output. Of course, stating that point does not sideline the real challenges or implementation costs involved in some parts of the Agreement, but should serve as motivation to move forward not only within Category A, but also Categories B and C where extended time periods or technical assistance are required. At the same time, developed economies will need to be active in developing technical assistance programs to help willing economies move forward as far as possible with TFA implementation.

58. In addition to its substantive points, our paper shows the relative ease with which the newly developed GE PPML methodology can be applied to produce theory-consistent estimates of the impact of a policy change, taking full account of general equilibrium effects. Numerically, our results are broadly consistent with the existing literature. However, unlike in previous work, our results take account of the constraints imposed by theory, in particular when conducting counterfactual simulations. We expect that this approach will be widely used by applied researchers in the future to address a range of important trade policy questions, in particular those depending on economy-specific (as opposed to pair-specific) parameters.

APPENDIX

Table A.1: Simulation Results for a Global 0.1 Point Increase in Trade Facilitation Indicators, Export, Imports, and Real Output (percentage changes over baseline)

Economy	Exports	Imports	Real Output
Argentina	0.893	0.867	0.052
Australia	0.857	0.787	0.051
Austria	0.655	0.699	0.095
Belgium	0.759	0.742	0.101
Brazil	0.899	0.927	0.039
Brunei Darussalam	0.670	0.910	0.167
Bulgaria	0.548	0.517	0.179
Cambodia	0.608	0.605	0.277
Canada	0.663	0.687	0.095
Chile	0.781	0.832	0.088
China, People's Republic of	0.853	1.202	0.014
Colombia	0.789	0.686	0.084
Costa Rica	0.672	0.573	0.130
Croatia	0.514	0.458	0.197
Cyprus	0.445	0.343	0.222
Czech Republic	0.711	0.786	0.107
Denmark	0.653	0.723	0.103
Estonia	0.436	0.437	0.223
Finland	0.605	0.649	0.121
France	0.840	0.730	0.064
Germany	0.685	1.062	0.040
Greece	0.822	0.642	0.145
Hong Kong, China	1.279	0.460	0.043
Hungary	0.684	0.748	0.134
India	1.043	0.863	0.041
Indonesia	0.929	0.971	0.047
Ireland	0.417	1.078	0.078
Israel	0.895	0.919	0.081
Italy	0.822	0.889	0.043
Japan	0.939	1.001	0.021
Kazakhstan	0.667	0.769	0.205
Korea, Republic of	0.762	1.204	0.035
Latvia	0.406	0.381	0.215
Lithuania	0.464	0.448	0.172

continued on next page

Table A.1 continued

Economy	Exports	Imports	Real Output
Luxembourg	0.422	0.478	0.216
Malaysia	0.810	1.020	0.062
Malta	0.551	0.434	0.172
Mexico	0.920	0.838	0.045
Morocco	0.658	0.559	0.152
Netherlands, The	0.654	0.857	0.072
New Zealand	0.824	0.763	0.070
Norway	0.666	0.830	0.108
Peru	0.769	0.757	0.098
Philippines	1.012	0.850	0.080
Poland	0.763	0.727	0.083
Portugal	0.754	0.689	0.102
Romania	0.735	0.660	0.121
Russian Federation	0.827	1.023	0.086
Saudi Arabia	0.822	1.099	0.080
Singapore	0.414	1.504	0.027
Slovakia	0.582	0.631	0.128
Slovenia	0.490	0.524	0.165
South Africa	0.831	0.754	0.061
Spain	0.881	0.826	0.057
Sweden	0.667	0.731	0.101
Switzerland	0.708	0.807	0.072
Taipei,China	0.644	1.196	0.035
Thailand	0.817	0.941	0.058
Tunisia	0.631	0.610	0.223
Turkey	0.988	0.795	0.065
United Kingdom	0.991	0.590	0.051
United States	1.235	0.493	0.017
Viet Nam	0.921	0.971	0.078

TFI = trade facilitation indicator.
Notes: Table reports results of reform scenario where TFI score of each importer increases by 0.1 from their value in 2015 up to maximum value of 2. Baseline refers to the respective estimated values of exports, imports, and real output in 2015.
Source: Authors' calculations.

Table A.2: Simulation Results for Global Full Implementation of the Trade Facilitation Agreement, Export, Imports, and Real Output (percentage changes over baseline)

Economy	Exports	Imports	Real Output
Argentina	3.853	3.716	0.231
Australia	2.855	2.727	0.166
Austria	2.278	2.469	0.319
Belgium	3.338	3.226	0.468
Brazil	3.958	4.038	0.177
Brunei Darussalam	3.640	5.023	1.053
Bulgaria	2.399	2.233	0.848
Cambodia	3.388	3.312	1.906
Canada	2.168	2.272	0.296
Chile	3.538	3.736	0.418
China, People's Republic of	3.992	5.572	0.065
Colombia	3.034	2.646	0.327
Costa Rica	2.672	2.270	0.529
Croatia	2.265	1.977	0.960
Cyprus	1.831	1.383	0.969
Czech Republic	3.275	3.601	0.528
Denmark	2.472	2.756	0.390
Estonia	1.965	1.945	1.162
Finland	2.258	2.441	0.447
France	3.180	2.785	0.243
Germany	2.727	4.261	0.163
Greece	4.391	3.281	0.858
Hong Kong, China	4.294	1.728	0.144
Hungary	3.415	3.702	0.744
India	4.786	3.894	0.195
Indonesia	4.306	4.455	0.229
Ireland	1.449	3.640	0.251
Israel	4.818	4.835	0.469
Italy	3.230	3.522	0.171
Japan	3.621	3.948	0.083
Kazakhstan	3.725	4.296	1.348
Korea, Republic of	3.007	4.854	0.142
Latvia	1.641	1.526	0.917
Lithuania	1.596	1.565	0.528
Luxembourg	1.801	2.047	1.048
Malaysia	3.685	4.649	0.294

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Table A.2 continued

Economy	Exports	Imports	Real Output
Malta	2.115	1.667	0.668
Mexico	4.048	3.615	0.204
Morocco	2.922	2.436	0.723
Netherlands, The	2.198	2.913	0.230
New Zealand	3.018	2.840	0.255
Norway	3.055	3.813	0.531
Peru	3.429	3.334	0.459
Philippines	5.312	4.302	0.447
Poland	2.950	2.831	0.322
Portugal	3.178	2.881	0.446
Romania	3.341	2.951	0.586
Russian Federation	4.533	5.561	0.515
Saudi Arabia	4.532	6.038	0.484
Singapore	1.406	5.067	0.085
Slovakia	2.223	2.421	0.493
Slovenia	1.846	1.980	0.622
South Africa	2.925	2.721	0.213
Spain	3.923	3.626	0.265
Sweden	2.650	2.913	0.411
Switzerland	2.466	2.855	0.247
Taipei,China	2.024	3.867	0.106
Thailand	3.261	3.809	0.237
Tunisia	3.477	3.282	1.461
Turkey	5.041	3.908	0.350
United Kingdom	3.502	2.154	0.180
United States	4.456	1.842	0.063
Viet Nam	4.693	4.875	0.424

TFA = trade facilitation agreement.
Notes: Table reports results of a reform scenario in which all economies fully implement the TFA and attain a trade facilitation indicator score of 2. Baseline refers to the respective estimated values of exports, imports, and real output in 2015.
Source: Authors' calculations.

Table A.3: Simulation Results for Global Full Implementation of the Trade Facilitation Agreement, Share of Intermediate and Final Goods in Total Goods Exports
(%)

Economy	Baseline	Simulation
Argentina	50.561	50.368
Australia	67.131	66.903
Austria	60.921	60.810
Belgium	61.320	61.291
Brazil	54.806	54.627
Brunei Darussalam	49.864	49.357
Bulgaria	61.707	61.715
Cambodia	50.646	50.498
Canada	58.477	58.392
Chile	59.897	59.406
China, People's Republic of	54.568	55.038
Colombia	57.060	56.837
Costa Rica	52.129	52.056
Croatia	53.007	52.931
Cyprus	45.589	45.463
Czech Republic	56.857	57.057
Denmark	50.569	50.548
Estonia	59.569	59.615
Finland	65.425	65.399
France	55.296	55.134
Germany	52.956	53.064
Greece	58.127	57.764
Hong Kong, China	41.529	41.732
Hungary	51.789	52.135
India	54.469	54.567
Indonesia	55.526	55.561
Ireland	48.461	48.448
Israel	59.483	59.715
Italy	53.770	53.832
Japan	62.825	62.690
Kazakhstan	69.918	69.549
Korea, Republic of	62.876	63.187
Latvia	60.872	60.820
Lithuania	55.395	55.325
Luxembourg	64.536	64.350
Malaysia	62.207	62.501

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Table A.3 continued

Economy	Baseline	Simulation
Malta	56.805	56.787
Mexico	40.805	41.194
Morocco	49.158	48.882
Netherlands, The	57.920	57.892
New Zealand	58.208	58.112
Norway	58.083	57.779
Peru	55.233	54.935
Philippines	55.709	55.373
Poland	58.129	58.135
Portugal	56.799	56.667
Romania	58.063	58.016
Russian Federation	65.810	65.633
Saudi Arabia	69.865	68.274
Singapore	67.349	67.303
Slovakia	58.700	58.870
Slovenia	62.472	62.528
South Africa	64.211	64.151
Spain	57.769	57.742
Sweden	58.589	58.470
Switzerland	45.658	46.028
Taipei,China	72.067	71.919
Thailand	59.225	59.400
Tunisia	56.537	56.509
Turkey	57.543	57.215
United Kingdom	58.514	58.189
United States	57.767	57.437
Viet Nam	52.126	53.108

TFA = trade facilitation agreement.
Notes: Table reports results of a reform scenario in which all economies fully implement the TFA and attain a trade facilitation indicator score of 2. Baseline refers to the share of intermediate goods in total exports in 2015.
Source: Authors' calculations.

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Implementing the Trade Facilitation Agreement

From Global Impacts to Value Chains

This paper uses a new methodology that factors in general equilibrium effects to estimate the potential impacts of the World Trade Organization's Trade Facilitation Agreement (TFA). The results reveal that full implementation of the TFA could boost the value of global trade by $344 billion, a 3.5% increase compared to the 2015 baseline. The evidence suggests that TFA implementation could also further the development of value chains around the world, especially in middle-income economies, as it would promote a shift from manufactured goods toward intermediate goods.

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