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**Working Paper**

## Implementing the Trade Facilitation Agreement (TFA): estimates of reduction in time at customs for the United Nations' vulnerable economies

FERDI Working Paper, No. P296

**Provided in Cooperation with:**

Fondation pour les études et recherches sur le développement international (FERDI), Clermont-Ferrand

*Suggested Citation:* de Melo, Jaime; Sorgho, Zakaria; Wagner, Laurent (2021) : Implementing the Trade Facilitation Agreement (TFA): estimates of reduction in time at customs for the United Nations' vulnerable economies, FERDI Working Paper, No. P296, Fondation pour les études et recherches sur le développement international (FERDI), Clermont-Ferrand

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# Implementing the Trade Facilitation Agreement (TFA): estimates of reduction in time at customs for the United Nations' vulnerable economies\*

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All members of the WTO participate in the Trade Facilitation Agreement (TFA) that is to reduce border and documentary compliance in customs. Successful implementation should benefit all countries, the developing countries and more particularly the three categories of vulnerable countries receiving special status at the UN: Least Developed Countries (LDCs), the Landlocked Developing Countries (LLDCs) and the Small Island Developing States (SIDS). This paper gives plausible estimates (in the sense of realizable at the country and group levels) of reduction in trade costs from a successful implementing of the TFA.

**JEL categories:** F1, F13, F14, F15.

**Keywords:** International trade, trade policy, Trade Facilitation, LDCs, LLDCs, SIDS.

\* Paper prepared for the LDC Future Forum: Achieving Sustainable Development in Least Developed Countries-Towards LDC5 (5-7 October 2021 in Helsinki, Finland).



... / ...

The paper starts with a presentation of the TFA noting its two principal characteristics. First, the TFA is a rules-based bottom-up approach built into the agreement that takes into account countries' implementation capabilities, an important feature for the three groups of UN vulnerable countries. Second, the TFA provisions are monitorable (e.g. provisions like the publication of information, advance rulings, appeal or review of decisions, transparency, and border agency cooperation). In preparation for the agreement, the OECD has assembled large amount of indicators of the state of implementation of provisions in the TFA summarized in a TFI (Trade Facilitation Index). TFI values for 2019 are then used to evaluate econometrically the impact of implementing TFA on the waiting-time reduction at customs for a sample of 160 countries.

Average ad-valorem equivalents (AVEs) of reduction of time in customs estimates for each UN-grouping (LDCs, LLDCs, and SIDS) show averages in the range 2.1%-2.9% for imports and 1.9%-2-7% for exports. Larger gains are obtained for a more ambitious implementation of the TFA. Importantly, gains are larger for each of the three groupings than for other developing countries, a corroboration that the UN vulnerable categories capture an aspect of vulnerability.

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## Acronyms and Abbreviations

AfCFTA: African Continental Free Trade Area

ASEAN: Association of Southeast Asian Nation

ASYCUDA: Automated System for Customs Data

DB: Doing Business

GATT: General Agreement on Tariffs and Trade

HS6: Harmonized System at 6-digit level

LDC (s): Least developed country (ies)

LIC (s): Low income country (ies)

LLDC (s): Landlocked developing country (ies)

LPI: Logistics Performance Index

MERCOSUR: *Mercado Común del Sur* (i.e., Southern Common Market)

NTM: Non-trade measures

OECD: Organisation for Economic Co-operation and Development

REC (s): Regional economic community (ies)

RTA (s): Regional Trade Agreement (s)

SDT: Special and Differential Treatment

SIDS: Small Island Developing States

SPS: Sanitary and Phytosanitary measures

TBT: Technical Barriers to Trade

TFA: Trade Facilitation Agreement

TFI (s): Trade Facilitation Indicator (s)

UK: United Kingdom

UN: United Nations

US: United states of America

WBES: World Bank Enterprise Surveys

WCO: World Customs Organization

WGI (s): World Governance Indicator (s)

WTO: World Trade Organization

## 1. Introduction

The Trade Facilitation Agreement (TFA) signed in 2013 with entry into force in 2017 is the first multilateral agreement since the creation of the WTO. All WTO members participate. Successful implementation should benefit the three categories of countries (number of countries in each group in parenthesis) receiving special status at the UN: Least Developed Countries (46), Landlocked Developing Countries (32) and Small Island Developing States (19). Implementing the TFA has the particularity that progress can be monitored relatively easily. In particular, trade costs at the border covered by the TFA – for which technical support for implementation should be forthcoming – may be higher for the UN-classified vulnerable countries, for example for the LLDCs or SIDS relative to other LDCs.

The principal focus of the TFA is to reduce the time it takes to cross-borders, that is time spent in customs. Best practices on Trade Facilitation recommended by the World Customs Organization are part of the TFA but Services-related dimensions of trade facilitation are not included. The TFA is rules-based rather than discretionary with specified appeal and review procedures. It is a ‘bottom up approach’ where low-income countries have extensive leeway in implementing the Agreement and high-income countries are not under the obligation to provide technical assistance. This flexibility may be welcome, although for those countries not implementing these time-saving measures, it implies a loss of competitiveness relative to those who will implement them. For example, in the case of the African Continental Free Trade Area (AfCFTA) – whose principal objective is to reduce the currently high intra-African Trade costs – if implementation is slow, will not fall as rapidly as they would under full implementation, slowing the growth of intra-African trade. This will slow integration along the AfCFTA and likely have other deleterious effects.<sup>1</sup> These same remarks apply to the three vulnerable UN-country groupings.

The paper discusses the objectives of the TFA, how their implementation might affect the three groups of UN vulnerable countries with a focus on prospects for individual

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<sup>1</sup> Simulations reported by Minor and Wamsley (2017) suggest that if African countries (or LDCs delay implementation), customs revenue will be less than if they avoid implementation delays as assumed for other groups (developing and developed) because they will attract less foreign direct investments which would raise customs revenues.

countries in a comparative setting under different options about plausible scenarios of implementation capability at the country level. Section 2 situates trade facilitation measures covered by the TFA, the focus of this paper, in the larger definition of what is understood by trade facilitation. Data sets covering a large number of countries are discussed. Section 3 describes the structure of the TFA with the leeway incorporated in the agreement that rationalizes the different speed of implementation across countries built into the Agreement to take into account countries' implementation capabilities which is important for the three groups of vulnerable countries that are the focus of this paper.

The two remaining sections focus on estimating expected improvements in customs efficiency (captured by reduced times in customs) of implementing the TFA. The model draws on Trade facilitation indicators (TFI) values for 2019 provided by the OECD. Section 4 presents a model that gives accurate predictions of observed times in customs for imports and exports. Section 5 then uses these estimates to predict reductions in time at the country level from two scenarios. Results are reported at the country level and for each one of the three UN vulnerable categories. The results suggest large ranges for average improvements in customs efficiency for each one of the three groups UN vulnerable groups.

## **2. Trade costs and Trade Facilitation**

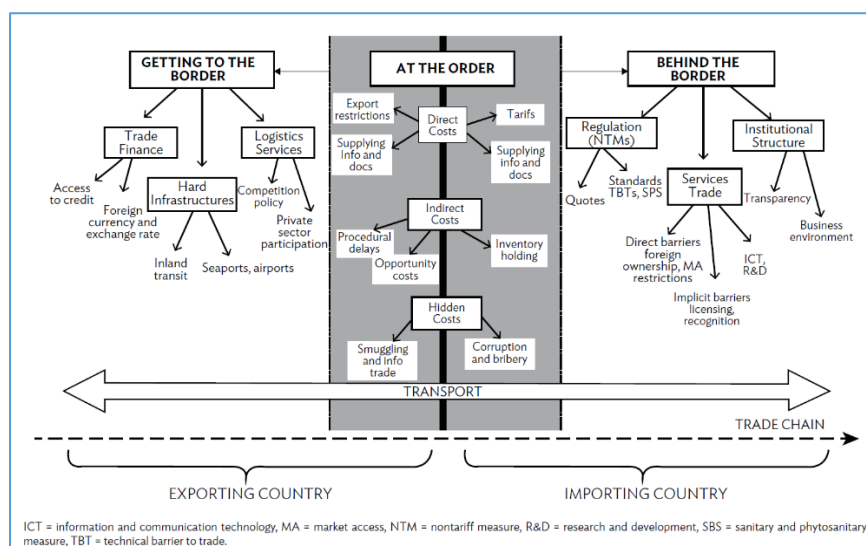
Trade costs are defined as the full wedge between producer prices in the exporting country and consumer prices in the importing country (Anderson and Van Wincoop, 2003). These include 'natural barriers' like history, geography, distance, connectivity and policy – imposed barriers like tariffs, non-tariff measures at the border – plus the host of 'getting-to-the border' and 'behind-the-border' measures shown the Figure 1. To give orders of magnitude, using the Arvis et al. (2016) calibration methodology, Melo et al. (2020, Figure 10) estimate that average bilateral trade costs for Low-income African countries relative to trade costs of the largest trading countries was reduced from 274% in 1995 to 238% in 2015.<sup>2</sup>

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<sup>2</sup> The sample includes 25 LICs and bilateral trade costs are relative to the average for the 15 largest world importers: US, China, Germany, Japan, UK, France, Hong Kong, Netherlands, Republic of Korea, Italy, India, Canada, Belgium, and Spain. The corresponding reduction estimates for 9 upper middle-income countries are from 203% in 1995 to 161% in 2015.

Trade facilitation is part of the trade costs shown in the Figure 1. The broad definition of trade costs includes the full range of policies in the exporting and importing country identified in Figure 1. The narrow definition includes all administrative procedures at the border identified in the center of Figure 1. The TFA is about reducing trade costs at the border, i.e. at customs.

**Figure 1. Trade Costs at the border and beyond**



**Source:** Moise and Le Bris (2013, p.12)

Time spent at the border is an important component of total time between origin and destination, accounting for 37 percent of total time for Peruvian maritime import data in 2013 (Volpe, 2016, p.3). Reducing border times is the focus of the TFA. For the office on the High Representative for the 91 vulnerable countries in the three country groupings (LDCs, LLDCs, SIDS), the issue is the relative importance of policy-imposed trade barriers (tariffs and NTMs) and the other elements of trade costs identified in the Figure 1. In particular, trade costs at the border covered by the TFA – for which technical support for implementation should be forthcoming – may be higher for the UN-classified vulnerable countries and different across groupings.

Three data sources cover time and costs associated with crossing borders:

- (i) customs data over time on all shipments by product and mode of shipment;
- (ii) survey-based single-valued unidimensional measures (Doing Business (DB) and Logistics Performance Index (LPI)), both gathered for a large number of countries;

(iii) survey-based firm-level custom-specific measure of border time (World Bank Enterprise Surveys (WBES)) transactions for all products, sometimes to all destinations.

Customs data are the most detailed, allowing to establish a causal relation between outcome and treatment as for example in the case of all HS6 product-level exports of Uruguayan firms via the ‘green’ (no customs inspection) and ‘red’ lanes (customs inspection)’ over a long period.<sup>3</sup> Covering all shipments through customs provides internal validity. However, this comes at the expense of external validity because data from customs for a single country (e.g. Uruguay) or a few countries is not sufficiently representative of the wider population of countries of interest here to allow for group-level comparisons and comparisons across groups.

Since our interest is about comparisons across countries and groups of countries, we opt for the survey-based approach that has the broadest country coverage, aware that this choice delivers patterns at the country-grouping level at the expense of establishing causality.

Since 2016, DB gives times at the border for three different procedures: (i) domestic transportation; (ii) documentary compliance that captures the time to satisfy requirements of government agencies in exporting and importing partners (including transit country if applicable) ; (iii) time and costs for border compliance in the domestic economy only as well as port or border handling. The TFA is about reducing time for border compliance.<sup>4</sup> A handful of freight-forwarders at best accounting for a few percentage of exports are included. Most recent data are for 2019.<sup>5</sup>

For the LPI, also a survey-based measure, information is gathered from an online survey covering over 1000 multinational freight-forwarders and express carriers.

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<sup>3</sup> Based on all shipments through customs over the period, and controlling for for unobserved heterogeneity related to product composition and destination, Volpe et al. (2015) estimate that a 10% increase in the median time spent in customs is associated, on average, with a 1.8 percentage point reduction in the growth of firm-level exports.

<sup>4</sup> For imports, the standardized case study is a shipment of 15 metric tons of container imports of auto parts from the main supplier while for exports, it is for the main export (containerized or not) with the largest foreign sale from COMTRADE data.

<sup>5</sup> Hallward-Driemer and Pritchett (2015, fig. 1C) show large discrepancies in the time to cross customs according to DB (21 days) and those from enterprise surveys (6 days). This suggests that DB data are more likely to represent official rather than actual times.

Those surveyed are to report time at different steps on the supply chain to the warehouse (exports) port (imports). They are also to give customs clearance times broken down between those subject to (and those not subject to) inspection.

**Table 1. Average time (in hours) at the border by group: DB vs. LPI.**

|   | LLDC | LDC | SIDS |
|---|------|-----|------|
| <b>Lead time to import (in hours)</b>   |      |     |      |
| <b>Border compliance (DB data)</b>      | 66   | 108 | 66   |
| <b>Documentary compliance (DB data)</b> | 80   | 98  | 40   |
| <b>Customs clearance (LPI data)</b>     | 122  | 150 | 48   |
| <b>Lead time to export (in hours)</b>   |      |     |      |
| <b>Border compliance (DB data)</b>      | 49   | 80  | 57   |
| <b>Documentary compliance (DB data)</b> | 62   | 75  | 41   |
| <b>Customs clearance (LPI data)</b>     | 210  | 220 | 40   |

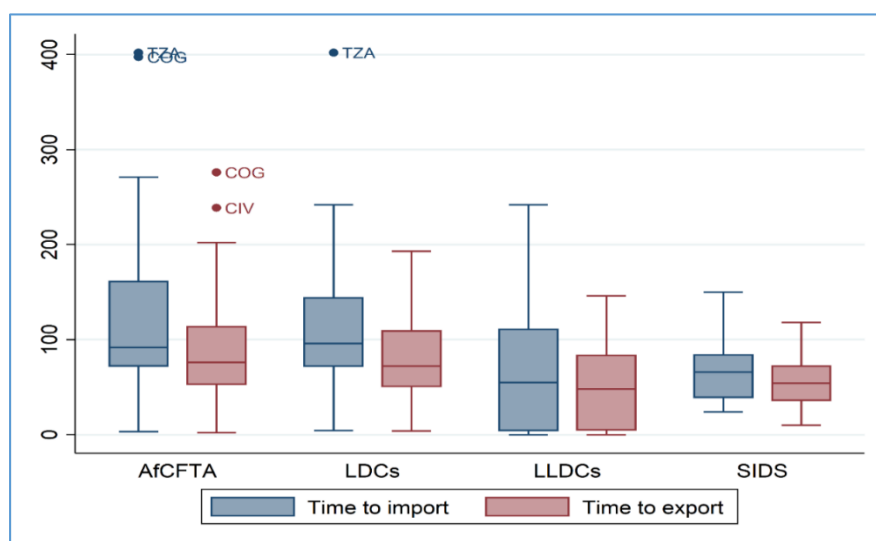
**Notes:** DB sample: 43 Least Developed countries (LDCs); 35 Landlocked developing countries (LLDCs); 34 Small Islands Developing States (SIDS). LPI sample: 13 LDCs; 16 LLDCs; 3 SIDS.

**Source:** Authors' calculations from World Bank, Doing Business (DB) data 2020 and Logistic Performance Index (LPI) Surveys 2018. Note that DB data 2020 capture regulatory reforms implemented between May 2018 and May 2019.

Table 1 reports average compliance time (in hours) at customs for imports and for exports by country groups with the corresponding averages from the LPI data. Note that the DB sample is much larger for each country than the corresponding LPI sample. In fact, there are only 3 countries covering the SIDS group. The small sample of countries covered by the LPI disqualifies it as appropriate for this exercise. Likewise, while the WBES survey data cover 32 developing countries, but only one country belongs to the SIDS group. So, by default, we rely on the DB data.<sup>6</sup>

<sup>6</sup> Since 2015, DB takes as standards for imports, a shipment of 15 metric tons of containerized auto parts from the economy from which it imports the largest value of these goods, and for exports the main product (containerized or not) with the largest foreign sale to the largest purchaser of this product.

**Figure 2. Distribution of Lead time for border compliance**



**Notes:** Times in hours. Middle bar is mean value, shaded area is interquartile range and minimum maximum values correspond to  $\pm 1.5$  times interquartile range. Number of countries per group in parenthesis: LDCs (43); LLDCs (35); SIDS (34).

**Source:** Authors' calculations from World Bank, Doing Business (DB) data 2020. Data captures regulatory reforms implemented between May 2018 and May 2019.

Figure 2 confirms that average time in customs is always less for exports across all groups since exports are not subject to inspection via 'red lanes'. Average times at customs, and spreads are lowest for SIDS, presumably because some of the required inspections will have been carried out at port of entry or transit countries.

### 3. Trade facilitation at customs, obligations and flexibilities in the TFA

The TFA signed by all WTO members is rules-based with specified appeal and review procedures. This contributes to reducing uncertainty in international trade transactions.

#### 3.1 Obligations and Flexibilities in the TFA

The TFA has three parts. Section I lays out substantive disciplines, Section II specifies Special and Differential Treatment (SDT) provisions and defines the approach taken to implementation of disciplines by developing countries, and Section III deals with institutional arrangements (WTO, 2014). The TFA embodies a number of disciplines on border clearance procedures and transit that complement existing WTO rules on transit (Art. V GATT), fees and formalities (Art. VIII GATT), and transparency (Art. X

GATT). None of these measures has been fully implemented by any country. The TFA is limited in focus to matters that are under the purview of the GATT – it does not address services-related dimensions of trade facilitation such as logistics, transport or distribution services and it does not re-open or extend specific agreements on customs valuation, import licensing, rules of origin, SPS or TBT. Among its provisions, the TFA includes publication of information, advance rulings, appeal or review of decisions, transparency, border agency cooperation, and the setting up of formalities that implement least trade-restrictive measures to achieve underlying policy objectives (e.g. “single-window” systems, a ban on mandatory Pre-Shipment Inspection (PSI) for classification/valuation). The introduction of measures making the use of customs brokers mandatory will be forbidden. Freedom of transit (i.e. the prohibition of non-transport related fees) is an objective which is most important for landlocked countries.

Best practices on Trade Facilitation recommended by the World Customs Organization (WCO) included in the revised Kyoto Convention of 2006 on Trade Facilitation will require member States to establish and maintain procedures that will help expedite the release and clearance of goods in transit. These best practices are laid down in a detailed article that also obliges Member States to allow (to the extent possible) traders to make payments electronically for duties, fees and other customs charges. Neufeld (2014) notes that most Regional Trade Agreements (RTAs) signed after the launch of the TFA negotiations in 2004 included trade facilitation provisions and that many measures in the final TFA had been inspired by trade facilitation initiatives included in RTAs (see Hoekman, 2016).

Since implementing the TFA requires significant resources, which are scarce especially in LDCs, but also in many LLDCs and SIDS, it is important to keep in mind the non-bindingness of the TFA for developing-country signatories. Indeed, it is only after LDCs obtained recognition of SDT with a wide-ranging exemption from commitments that the TFA agenda took off. That language said that LDCs would “only be required to undertake commitments to the extent consistent with their individual development, financial and trade needs or their administrative and institutional capabilities” (Neufeld, 2014a, p. 7). As noted by Neufeld, this is a new interpretation of SDT away from a longer transition period to one in which developing countries and LDCs would

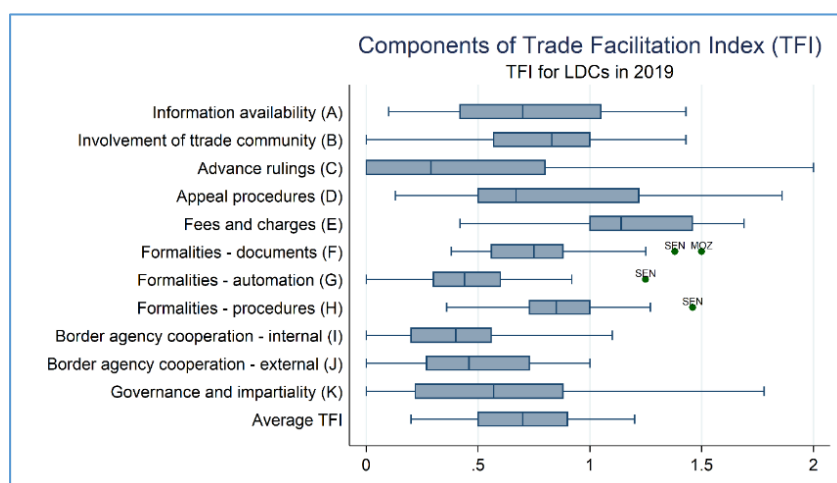
not be required to implement aspects of the TFA when required support for infrastructure is not forthcoming.

This bottom-up approach, giving extensive leeway eschewed the usual ‘one-size-fits all’ format of WTO multilateral negotiations. Carve-out from commitments was so extensive that Hoekman (2016) notes that the occurrence of the wording “should” in the TFA provisions is twice as high as in the related WTO agreements on customs valuation and import licensing. Technical assistance not forthcoming, TFA provisions cannot be enforced through the WTO dispute settlement mechanism. Thus, the TFA presents no effective commitment threat for signatories. In sum, the TFA is a best-shot endeavor based on promises rather than on legal content. On the one hand, developing countries do not have to engage into bargaining as they only have to submit schedules of the substantive provisions of Section I dealing with limits and procedures for customs administration that they would accept – what Finger (2014) notes is akin to a tariff agreement without tariff schedules. On the other hand, the TFA will not solve the implementation problem within the GATT/WTO legal system which does not obligate the Donor members who would step forward to provide financial assistance.

### **3.2. Measuring Customs performance**

In preparation for the TFA and following the signing of the TFA in December 2013, the OECD has produced and released a series of 11 Trade Facilitation Indicators (TFIs). These indicators were initially set up to capture the category of trade facilitation policies and procedures reflected in the text of the TFA. Currently this is the most detailed catalogue of the policies and procedures used in border management agencies around the world and arguably the best we have to assess the trade cost handicaps for trade in goods faced across countries. The TFIs can also serve to monitor progress toward the completion of reforms relating to the performance of customs mandated by the TFA. These indicators (identified from A to K) monitor the targets mandated by the TFA. Each of the eleven indicators can take a value between 0 (no implementation of TFA) and 2 (full implementation of TFA). Some indicators are averages of subcomponents. A higher value indicates better customs performance for the indicator.

**Figure 3. Trade Facilitation Indicators in 2019, across the LDC Group**

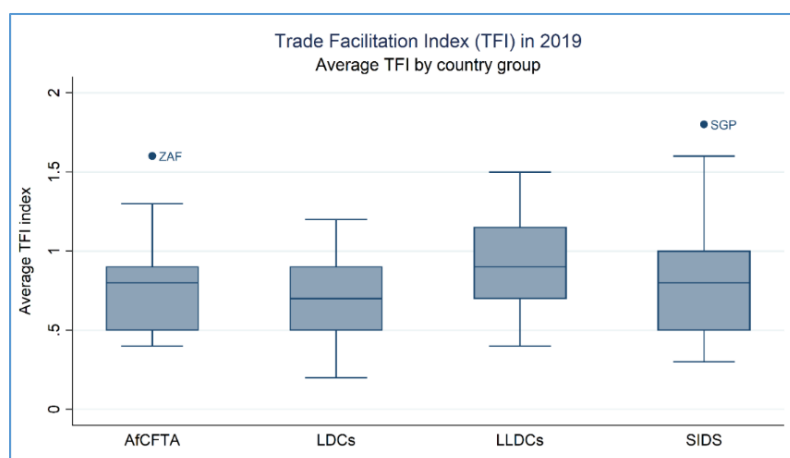


**Notes:** Data for 35 of 46 least developed countries (LDCs). Indicator scores range from 0 (no implementation) to 2 (full implementation of TFA). Box plot. Middle bar is mean value, shaded area is interquartile range and minimum maximum values correspond to  $\pm 1.5$  times interquartile range. Average TFI (bottom) is the average of components (A)-(K) for the 35 LDCs.

**Source:** Authors' calculations from OECD TFI data 2019.

As example, Figure 3 displays the distribution of each component (A to K) and the aggregated TFI across the LDC group of countries with at the bottom (average TFI) which is an average of all TFI components (A to K). Average scores for advance rulings (C) and appeals procedures (D) are low and spread widely across the group. The aggregated TFI, for each country in our sample, is the TFI-related variable used in the econometric estimates reported in section 4.

**Figure 4. Trade Facilitation Indicators in 2019, by Country Group**



**Notes:** Indicator scores range from 0 (no implementation) to 2 (full implementation of TFA). Box plot: Middle bar is mean value, shaded area is interquartile range and minimum maximum values correspond to  $\pm 1.5$  times interquartile range. Average TF index is the average of components (A)-(K) for each country.

**Source:** Authors' calculations from OECD, TFI data 2019.

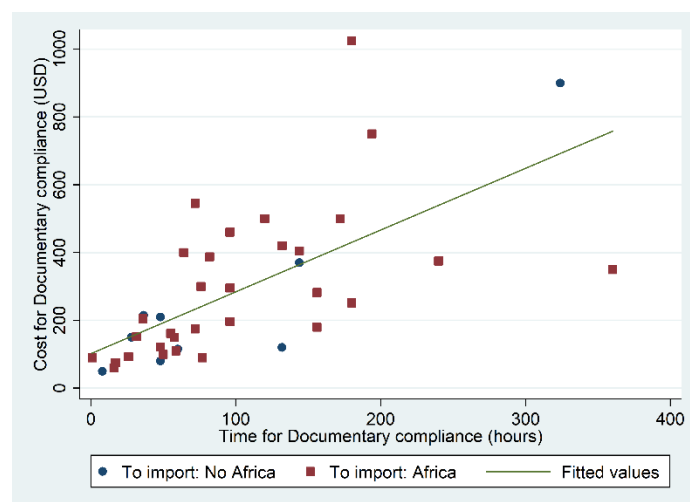
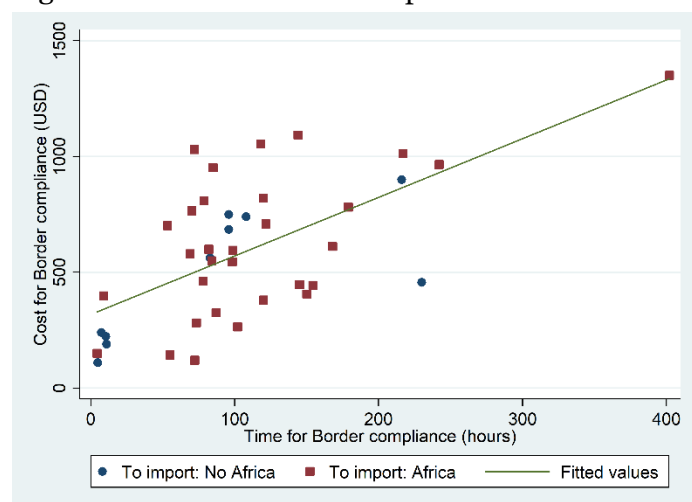
Figure 4 displays the distribution of the aggregated TFI (in Figure 3) for each country group. The LLDC group has a higher average index than the SIDS group. Singapore stands out with a value of (1.8) out of a maximum possible score of 2.0. This means that Singapore has fully implement the provisions of the TFA by the structural and functional reforms in the way of trade liberalization. For almost all targets (indicators), Singapore has get excellent score (between 1.85 and 2), except for Internal border agency co-operation (1.5) and External border agency co-operation (0.91). Even if Singapore is a “good student”, it should pursuit its efforts on internal co-operation, for instance a better co-ordination between the documentary controls and the physical inspections; but mostly, the country have to further involve in co-operation and exchange border programmes with neighbouring and third countries.

### **3.3. Expected benefits from implementing the TFA**

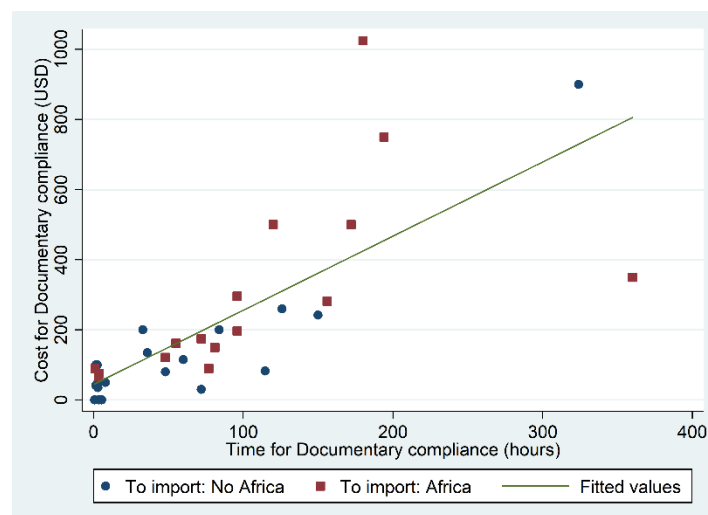
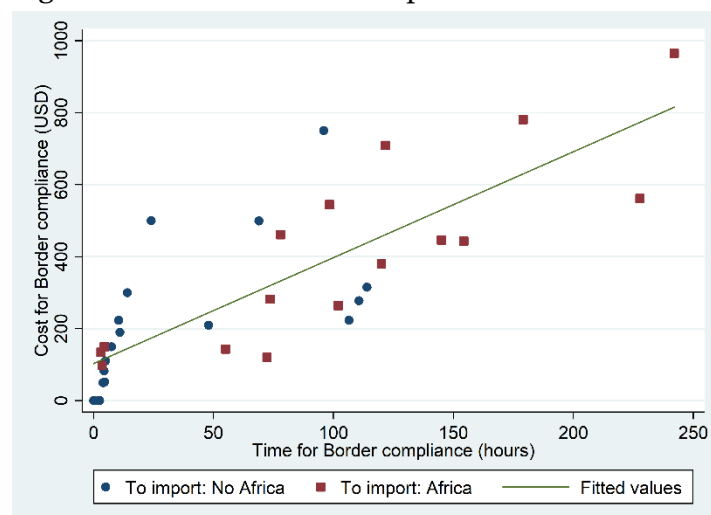
Reduction in fixed trade costs should encourage greater diversification to more markets and/or to more products to the same market. Part of fixed costs is time in customs and associated monetary costs. Reduction in fixed costs should also lead to greater participation in supply chain trade at both the regional and global levels where goods have to cross borders multiple times. Figure 5 plots time and costs to import for each country in each group, each time comparing with the corresponding values for the remaining developing countries.

**Figure 5. Time vs. costs to import (Border and Documentary compliance)**

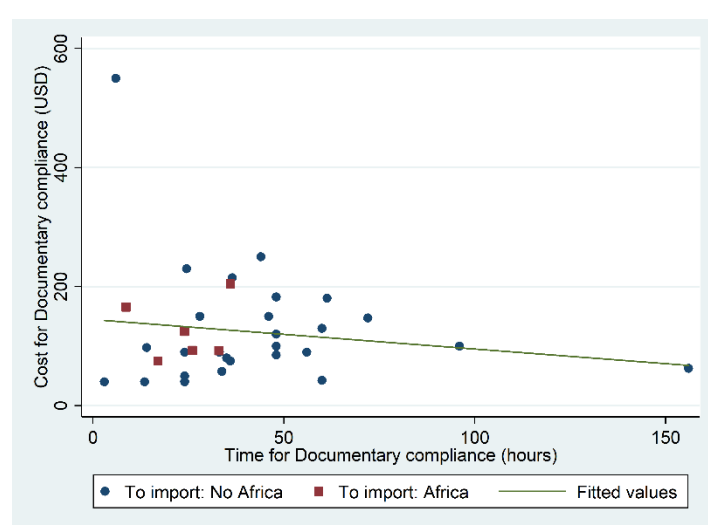
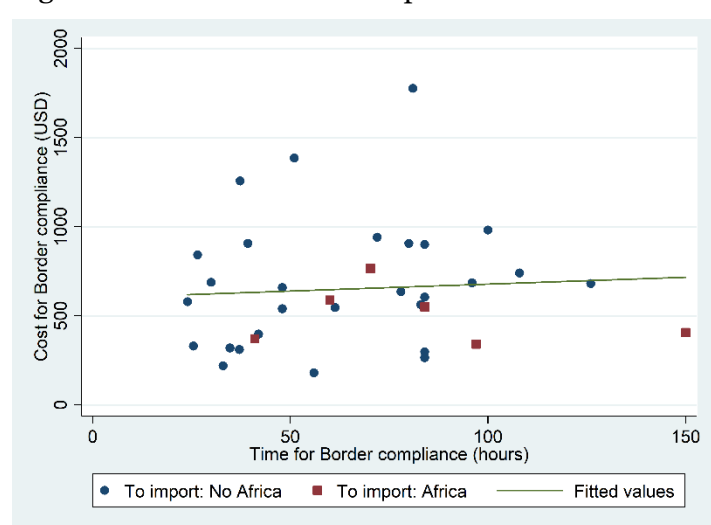
**Figure 2a. Time vs. costs to import – LDCs**



**Figure 2b. Time vs. costs to import – LLDCs**



**Figure 2c. Time vs. costs to import – SIDS**



**Note:** African countries are in square.

**Source:** Authors' calculation from World Bank, DB 2020 data.

Subject to caveats on the quality of the data, several patterns stand out. First, time spent in customs and associated compliance costs are greater for imports than for exports. Second, time spent in customs and compliance costs are lowest for ASEAN but not so for the other two comparators, Andean Community and MERCOSUR that also have landlocked countries. Third, there is great dispersion in averages for both imports and exports across regional economic communities (RECs).

Training of customs clearance officials and customs brokers reduces clearance time at customs. According to Doing Business (2020) estimates, economies where clearance officers receive regular training reduce customs clearance time by 34% relative to those that do not provide regular training (World Bank, DB 2020, p.46). Pilot testing for phased implementation of ASYCUDA also reduced clearance times for Angola and Lesotho (World Bank, DB 2019, Box 5.1).

As an order of magnitude of estimated gains from reduced clearance times, take the time in customs for imports and exports of the African Union of 211 hours was lowered to the average time of 122 hours for ASEAN. This is an average reduction of 3.7 days. Apply the mean estimate of Hummels and Schaur (2015) of a per day reduction in trade costs equivalent to 1.3% tariff on imports at destination. This reduction in time spent in customs for the African Union would then be equivalent to a reduction in trade costs of 4.8%. This estimate suggests a stiff penalty on traded activities.<sup>7</sup> Furthermore, in a world of trade in tasks where intermediates are processed in different jurisdictions, the 2.3 extra days for imports are a penalty for downstream exports, a cost 'surcharge' of  $2.3 \times 1.3 = 3.0$  percent.

Greater diversification is expected from a reduction in the costs of trade, as the fixed costs that prevent exporters from diversifying the same product to more markets, or other products in the same market, are reduced. In addition, exporters with diversified export baskets are expected to be more resilient to shocks. Firms that have not exported before may be able to export when fixed costs fall (Melitz, 2003). Trade facilitation can therefore increase existing exports (intensive margin effect) and create new trade flows (extensive margin effect). The expansion of existing exports and the

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<sup>7</sup> These estimates are illustrative since part of the time spent in customs for exports is likely to be higher because comparative advantage is likely to be in agricultural products that require additional SPS-related controls at customs.

creation of new exports should also result from the reduction of export uncertainty. Taking into account other factors affecting bilateral trade, Moisé and Sorescu (2013) find a positive correlation between bilateral trade and higher values for TFI indicators in 2012. Using the same data, Beverelli et al (2015) find that increases in the number of products exported per destination and the number of destinations are associated with higher values of the TFI. They estimate that the largest gains occurred in Latin America and SSA.

A reduction in transit time is the second source of cost savings to trade that can be expected from the implementation of the TFA. These gains are expected to be greater for the countries with the highest transit times in customs. As noted above since 2015, time in customs for the Landlocked countries only measure time at the country's border, not the time at the border in transit countries. Estimates of the reduction in customs clearance time resulting from improved TFI values reflect steps taken by each country with better scores then translating into lower costs to trade. Then, controlling for other observable factors, a reduction in time at customs should then be associated with an increase in the volume of trade as shown in several studies. Hillberry and Zhang (2017) and Melo and Wagner (2016) used earlier TFI values reported in days to estimate reductions in time to import and export when TFI scores are improved. Below we carry out a similar exercise with values of time in customs for 2019 reported in hours applying more estimators that give better predictions of time in customs that are better suited for estimating expected gains from TFA implementation.

#### **4. Empirical framework**

In earlier estimates, Hillberry and Zhang (2017) and Melo and Wagner (2016) reported estimates of TFA implementation using data reported in days using a discrete-time transition model to estimate the conditional probability that a shipment will clear customs on a given day. This discretization is no longer necessary with the new DB now reported in hours. This model returns widely inaccurate prediction of hours to clear customs.<sup>8</sup> Instead, we propose a zero-inflated estimator that takes into account that the population consist of two groups of countries (those in a deep customs union like the European Union where time in customs is zero) and those where time

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<sup>8</sup> From an average error of around 4 days using days in import customs to an average error of 813 hours (or 33 days) when using hourly data.

in customs tends to zero. As shown below, this estimation strategy is more appropriate for estimating the effects of implementing the TFA in developing countries.

#### 4.1 Model and Estimator

The Poisson model constitutes the starting point of any analysis based on count data as is the case with the time to import (and export) from the doing business. Poisson regression is similar to regular multiple regressions except that the dependent variable is an observed count that follows the Poisson distribution. It is assumed that large counts are rare. Hence, Poisson regression is similar to logistic regression, which also has a discrete response variable. However, the response is not limited to specific values as it is in logistic regression.

The Poisson distribution models the probability of  $y$  events during a specified exposure period,  $t$ . (here the number of hours in customs) with the formula:

$$\Pr(Y = y|\mu, t) = \frac{e^{-\mu t} \mu t^y}{y!} \quad (y = 0, 1, 2, \dots)$$

The parameter  $\mu$  or the Poisson incidence rate may be interpreted as the risk of a new occurrence of the event and is determined by a set of  $k$  regressor variables such as:

$$\mu = \text{texp}(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)$$

This vector of  $k$  regressors is kept close to the ones used in Hillberry and Zhang (2017) and Melo and Wagner (2016) and includes three distinct groups:

- 1) Geographical variables (land size in sq-km, landlocked dummy variable, OECD dummy variable, SIDS dummy variable);
- 2) Basic structural economic variables (GDP, GDP per capita, GDP per capita squared, LPI infrastructure quality index);
- 3) Policy variables (e.g. strength of rule of law, a component of the reflected by the aggregation of the six indicators from the World Bank's World Governance Indicator (WGI) and;
- 4) The aggregated TFI (average of TFI components A-K) that captures customs performance addressed by the TFA.

This work covers 165 countries (see Table A3) - including 32 LLDCs, 35 LDCs, and 24 SIDS – and using most recent data (2019/2020). Dummies on landlocked countries, OECD countries, and SIDS countries are from the United Nations classifications. Data on Land size and GDP are from the World Bank’s World Development Indicators (WDI). LPI infrastructure quality index are from the Logistic Performance Index Surveys. Data on rule of law are from the World Bank’s World Governance Indicator (WGI). Data on TFIs are from OECD.

For simplicity, we discuss the choice of the estimator only in the case of imports (see Table A1). The regression coefficients are estimated using the method of maximum likelihood. However, the Poisson model performs poorly when the data are over-dispersed which seems to be the case for time to import.<sup>9</sup> With a mean of 64 hours and a standard deviation of 71 hours our data seems to be over-dispersed which is confirmed by the greater than one Pearson statistic (=32.01) associated with the estimated Poisson for which the results are displayed in Table A1 (column 1) in appendix. In cases of overdispersion, the standard negative binomial regression model is more appropriate. Negative binomial regression is a generalization of Poisson regression which loosens the restrictive assumption that the variance is equal to the mean made by the Poisson model. The traditional negative binomial regression model is then based on the Poisson-gamma ( $\Gamma$ ) mixture distribution where the Poisson distribution is generalized by including a gamma noise variable which has a mean of 1 and a scale parameter of  $\nu$  to be estimated. The new distribution is given by:

$$\Pr(Y = y|\mu, \alpha) = \frac{\Gamma(y + \alpha^{-1})}{\Gamma(y + 1)\Gamma(\alpha^{-1})} \left( \frac{\alpha^{-1}}{\alpha^{-1} + \mu t} \right)^{\alpha^{-1}} \left( \frac{\mu t}{\alpha^{-1} + \mu t} \right)^y \quad (y = 0, 1, 2, \dots)$$

where,  $\alpha = \frac{1}{\nu}$

As evaluated by the AIC or BIC statistics, the negative binomial model fits the data much better than the Poisson model (column 2 in Table A1). Finally, as discussed above, the presence of a significant number of zeros in our left-hand side variable can also lead to biased estimates, the Poisson and negative-binomial models being unable to replicate this characteristic in the data as displayed in Table A2 (panel a). We see

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<sup>9</sup> The Poisson distribution assumes that the mean and variance of the response variable are equal for a given set of covariates. When the mean and variance are equal, the data are said to be equi-dispersed. When the variance is greater than the mean, the data are said to be over-dispersed.

that 14.8% of the countries in the sample display a time to import equal to zero, but the Poisson model predicts that only 0.05% would have zero time in customs and the negative-binomial only 6.5%. Clearly those models underestimate the probability of zero counts.

One way to model this type of situation is to assume that the data come from a mixture of two populations, one where the counts is always zero (with probability  $\pi$ ), and another where the count has a Poisson or Negative-Binomial distribution (with probability  $1-\pi$ ). In this model zero counts can come from either population, while positive counts come only from the second one. Therefore, the probability distribution of the zero-inflated Poisson or zero-inflated Negative binomial (ZINB) random variable  $y$  can be written:

$$\Pr(y = j) = \begin{cases} \pi + (1 - \pi)g(y = 0) & \text{if } j = 0 \\ (1 - \pi)g(y) & \text{if } j > 0 \end{cases}$$

where  $\pi$  is the logistic link function defined below and  $g(y) = \Pr(Y = y|\mu, t)$  is the Poisson distribution or  $g(y) = \Pr(Y = y|\mu, \alpha)$ , the negative binomial distribution given above.<sup>10</sup>

In the context of using the TFI data to estimate the gains in reduced time at customs from implementing the TFA, we can suppose that those countries that are deeply integrated in customs union as those in the European Union are drawn from a different population than the developing countries that are the focus of this paper. Members of this first group wouldn't spend any time in import customs, whereas members of the second group would spend 0,1,2,...n hours - a count that may be assumed to have a Poisson or Negative-Binomial distribution. The distribution of the outcome can then be modeled in terms of two parameters, the probability of 'always zero', and the mean number of hours for those not in the 'always zero' group as suggested by the zero-inflated binomial presented above. According to Table A1 (column 3 and 4) and Table A2 (panel a), the zero-inflated Negative-binomial model fits the data better than the zero-inflated Poisson model.

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<sup>10</sup> The estimating equation remains similar and the vector of control variables can be split in four groups: geographical variables (land size in sq-km, landlocked dummy variable, OECD dummy variable, SIDS dummy variable), basic structural economic variables (GDP, GDP per capita, GDP per capita squared, LPI infrastructure quality index), policy variables (WGI) and the TFI variables.

Another way to check appropriateness is to create groups based on the linear predictor, compute the mean and variance for each group and to plot the mean-variance relationship. Figure A1 shows that the Poisson variance function does a good job for the bulk of the data, but fails to capture the high variances of the countries with the largest reported time to import which are the countries of interest here. The zero-inflated negative binomial variance function is not too different but, being a quadratic, does a better job at the high end. The zero inflated negative binomial model appears to fit the data better than the Poisson model.

Table A2 (panel b) compares the mean absolute difference between observed and predicted time to import for this model with those obtained by the discretization methodology of Hillberry and Zhang (2017). While the Hillberry and Zhang (2017)'s model lead to an average error of 741 hours, the zero-inflated negative binomial fits the data better with an error of 'only' 31.42 hours.

Consistent with Hillberry and Zhang (2017) and Melo and Wagner (2016), the TFI proxy variable is significantly and negatively associated with time in import and export customs in every model (see Table A1 in appendix). Thus, a higher TFI score is significantly associated with less time spent in customs for imports and exports. For the following sections, especially for simulating the time gains as well as calculating the trade costs reduction from implementing the TFA, we use ZINB estimates.

## **4.2. Results**

Table 2 gives the ZINB results of the relationship between the number of hours required to clear customs (from the Doing Business 2020) and the set of regressors selected above. The core results retained for the simulations reported in section 5 are presented in columns 4 for imports and 7 for exports. Covariates display the expected signs. Among variables of interest that turn out to be significant predictors of time in import customs, governance indicators – notably the average values of both WGIs and TFIs – are significantly correlated with the amount of time required to clear customs according to the DB indicators. As the simulations reported in section 5, at-the-border soft infrastructure reforms aligned with the TFA are predicted to have a strong impact on trade facilitation.

**Table 2. ZINB estimates: Impact of TFA on Waiting time at customs**

| Specifications                         | Time to import       |                      |                      |                      |                      |                      | Time to export       |
|--|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|  | Col. (1)             | Col. (2)             | Col. (3)             | Col. (4)             | Col. (5)             | Col. (6)             | Col(7)               |
| TFI (2019)                             | -1.182***<br>(0.224) | -1.451***<br>(0.254) | -1.486***<br>(0.346) | -0.845**<br>(0.417)  | -1.168***<br>(0.422) | -0.981**<br>(0.404)  | -1.319***<br>(0.410) |
| GDP                                    |                      |                      | 0.200**<br>(0.087)   | 0.110<br>(0.096)     | 0.171*<br>(0.094)    | 0.144*<br>(0.079)    | -0.031<br>(0.089)    |
| GDP/capita                             |                      |                      | -1.114<br>(0.832)    | -1.570*<br>(0.870)   | -1.524*<br>(0.917)   | -2.308**<br>(0.949)  | 0.326<br>(0.802)     |
| (GDP/capita) <sup>2</sup>              |                      |                      | 0.053<br>(0.048)     | 0.084*<br>(0.051)    | 0.078<br>(0.054)     | 0.122**<br>(0.055)   | -0.016<br>(0.047)    |
| Area (Km2)                             |                      | 0.138***<br>(0.039)  | 0.056<br>(0.055)     | 0.056<br>(0.057)     | 0.050<br>(0.057)     | 0.042<br>(0.057)     | 0.125**<br>(0.053)   |
| OECD dummy                             |                      | -0.771***<br>(0.278) | -0.794***<br>(0.307) | -0.599*<br>(0.330)   | -0.725**<br>(0.327)  | -0.467<br>(0.350)    | -0.360<br>(0.313)    |
| LLDC dummy                             |                      | -0.790***<br>(0.220) | -0.686***<br>(0.239) | -0.664***<br>(0.240) | -0.689***<br>(0.248) | -0.743***<br>(0.250) | -0.375*<br>(0.217)   |
| SIDC dummy                             |                      | -0.170<br>(0.292)    | 0.182<br>(0.345)     | 0.310<br>(0.350)     | 0.228<br>(0.357)     | 0.554+<br>(0.367)    | -0.206<br>(0.328)    |
| WGI (2018)                             |                      |                      |                      | -0.562**<br>(0.244)  |                      | -0.515**<br>(0.232)  | -0.060<br>(0.230)    |
| Rule of Law                            |                      |                      |                      |                      | -0.245<br>(0.242)    |                      |                      |
| Mob. Cellular sub.<br>(per 100 people) |                      |                      |                      |                      |                      | 0.376<br>(0.338)     |                      |
| Infrastructure Index                   |                      |                      | -0.065<br>(0.278)    | 0.168<br>(0.300)     | 0.072<br>(0.319)     |                      | 0.012<br>(0.284)     |
|  |                      | (0.292)              | (0.345)              | (0.350)              | (0.357)              | (0.367)              | (0.328)              |
| Constant                               | 5.545***<br>(0.265)  | 4.441***<br>(0.562)  | 6.192*<br>(3.523)    | 8.457**<br>(3.685)   | 7.846**<br>(3.845)   | 10.087**<br>(3.928)  | 3.228<br>(3.308)     |
| Nb. of Obs.                            | 160                  | 158                  | 138                  | 138                  | 138                  | 142                  | 138                  |
| Incl. Zero-obs.                        | 22                   | 22                   | 22                   | 22                   | 22                   | 22                   | 16                   |

**Notes:** Dependent variable: number of hours in customs from the World Bank's Doing Business 2019. Significance of estimates: + p<0.15, \* p<0.10, \*\* p<0.05, \*\*\* p<0.01; t-statistics in parentheses.

ZINB: Zero-inflated negative binomial. Venezuela and RDC excluded.. To save space, coefficients from the inflate equation to predict zero observations are not reported. Trade Facilitation Index (TFI) is the simple average of the 11 components of the TFI indicators of the OECD. Variable "Rule of law" is taken from the 6 components of the World Governance Indicators of the World Bank. "Infrastructure Index" corresponds to the Infrastructure component of the World Bank's Logistic Performance Index. Only countries for which all 11 TFI components are available are included in the sample.

**Source:** Authors' estimations from OECD and World Bank data.

Also, as expected, the relationship between time in import customs and GDP per capita is negative and nonlinear. This is consistent with the fact that time in customs tend toward zero hours. Note that time to clear import customs from the DB tend to understate the challenges faced by landlocked countries as the LLDC dummy turns out negative and highly significant. The SIDS dummy is not significant suggesting that while handicapped by remoteness and larger shipping costs, all else equal, SIDS do not appear to experience longer time to clear customs. Institutional development and notably at-the-border institutions and infrastructure do not seem to be significantly correlated with the time in import customs. Finally, contrary to Hillberry and Zhang (2017) and Melo and Wagner (2016), by using updated data and a larger sample of countries, we do not find any significant relationship between proxies for hard infrastructure development on time to clear customs.

## **5. Simulating time-reductions in customs from implementing the TFA**

The ZINB estimates of Table 2 are now used to compute counterfactual scenarios simulating the gain in reduced time (in hours) at customs for imports and exports suggested from improved values of the OECD TFI values resulting from implementing the TFA. Table 3 reports the simulated time gain at borders for each recognized UN grouping: LDCs, LLDCs, SIDS. We add membership in the African Continental Free Trade Area (AfCFTA) since an objective of AfCFTA is to reduce trade costs. We consider two illustrative scenarios, reporting average group gains in Table 3 and country level estimates for the SIDS and LDC groupings in Figure 6. Note that reported group averages are simple averages, leaving the possibility of large influence on average values by more extreme observations. The two scenarios are:

1. Each country's TFI converges to the average of the top 2 TFI within the group (simulation 1);
2. Each country's TFI converges to the average value of the top 2 TFIs in sample (simulation 2).

Simulation 1 could be considered a plausible objective for the medium-term and simulation 2 a more aspirational long-term objective. Together, the estimates give a range of estimates at the country and group levels. Panel a) reports estimates for imports and panel b for exports.

Our simulated time reductions are then converted to average tariff equivalents (AVEs) using the mean estimated value of a one-day reduction in trading time of Hummels and Schaur (2013). They estimate that one day (24 hours) is equivalent to a 0.6 to 2.1 percentage point tariff reduction in the destination country. Our conversion takes their mean estimate of 1.3 percentage point per 24-hour reduction. The simulated time reductions are reported in cols. 5 and 6 and the corresponding AVEs in cols. 7 and 8.

Before commenting on the results which are counterfactuals from the predicted time in customs (col 2), note that for all groups, predicted averages are quite close to the observed values (col.1) for the whole sample and for the AfCFTA groupings. This is the case for both time in customs for imports and for exports. For the mostly low-income groupings (LDCs, LLDCs, SIDS), average predicted times in customs are overestimated. Note also that the new DB estimates for LLDCs are lower than previously now that time in customs is no longer tallied at port of entry but at arrival in customs in the LLDCs.

**Table 3. Time-reducing estimates of TFA implementation: Group averages**

|   | Lead Time at customs (DB) | Predicted Lead time at customs (Model) | Lead time at customs after Simul. (1) | Lead time at customs after Simul. (2) | Time reduction in hours (Simul. 1) | Time reduction in hours (Simul. 2) | AVE <sup>(a)</sup> of reduction in TC in % (Simul. 1) | AVE <sup>(a)</sup> of reduction in TC in % (Simul. 2) |
|---|---------------------------|--|---------------------------------------|---------------------------------------|------------------------------------|------------------------------------|---|---|
| Column  | Col. 1                    | Col. 2                                 | Col. 3                                | Col. 4                                | Col. 5                             | Col. 6                             | Col. 7  | Col. 8  |
| <b>Panel a. Lead Time at Border to Import</b> |                           |  |                                       |                                       |                                    |                                    |   |   |
| LDCs (43)                                     | 117                       | 135                                    | 82                                    | 48                                    | -53                                | -87                                | 2,9   | 4,7   |
| LLDCs (35)                                    | 65                        | 77                                     | 44                                    | 30                                    | -34                                | -47                                | 1,8   | 2,6   |
| SIDS (34)                                     | 66                        | 70                                     | 36                                    | 30                                    | -34                                | -40                                | 1,8   | 2,1   |
| AfCFTA (53)                                   | 130                       | 129                                    | 91                                    | 70                                    | -38                                | -59                                | 2,1   | 3,2   |
| SAMPLE (138)                                  | 68                        | 67                                     | 55                                    | 47                                    | -11                                | -20                                | 0,6   | 1,1   |
| <b>Panel b. Lead Time at Border to Export</b> |                           |  |                                       |                                       |                                    |                                    |   |   |
| LDCs (43)                                     | 89                        | 93                                     | 43                                    | 19                                    | -50                                | -74                                | 2,7   | 4,0   |
| LLDCs (35)                                    | 52                        | 68                                     | 30                                    | 17                                    | -37                                | -51                                | 2,0   | 2,8   |
| SIDS (34)                                     | 54                        | 54                                     | 18                                    | 14                                    | -35                                | -40                                | 1,9   | 2,1   |
| AfCFTA (53)                                   | 93                        | 92                                     | 57                                    | 42                                    | -35                                | -50                                | 1,9   | 2,7   |
| SAMPLE (138)                                  | 54                        | 52                                     | 39                                    | 33                                    | -12                                | -19                                | 0,7   | 1,0   |

**Notes:** These estimates are based on ZINB Results covering 138/165 countries (see Table 2, col. 4 and 7). They are reported following four categories of countries (number of countries in each group in parenthesis): LDCs: least developed countries - LLDCs: landlocked developing countries – SIDS: Small Islands Developing States – AfCFTA: African Continental Free Trade Area. All values are simple average per group. Simulations from Table 2, Col. (4) for Time to import; Col. (7) for Time to export.

<sup>(a)</sup> The ad valorem equivalent (AVE) of reduction in trade costs (TC) is the simulated gain (to import/export) divided by 24, times 1.3% from Hummels and Schaur (2013). These AVEs in % (reported in col. 7 and 8) are calculated from the results of simulation 1 and simulation 2, respectively. For example, for the LDCs group, simulation 1 gives a gain of  $135-82=53$  hours resulting in an AVE of around 2.9%  $[(53/24)*1.3]$ .

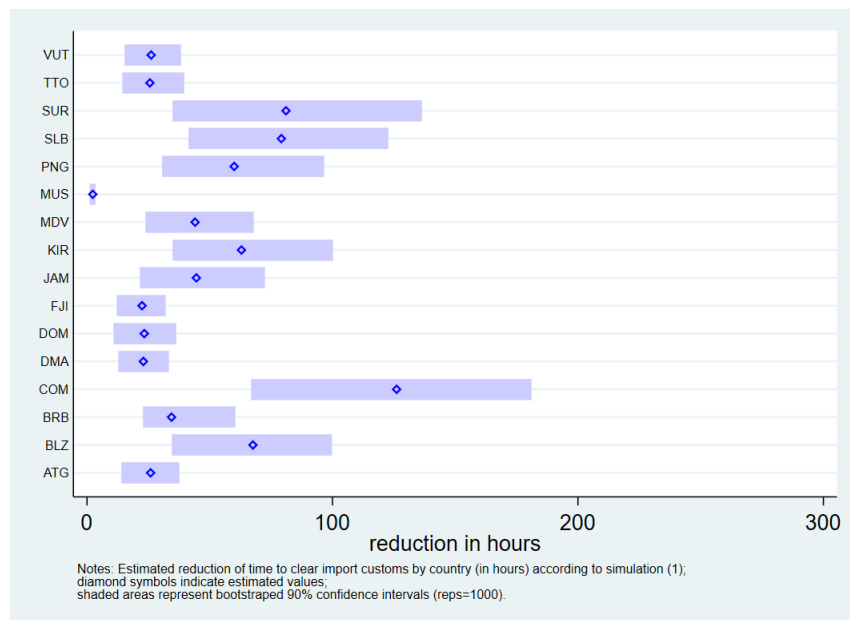
**Simulations:** Scenario (1) – Convergence to the top-2 average within each country group convergence: Within each country group, all countries converge to the average of the top 2 TFA index. | Scenario (2) – Convergence to the top-2 average in Sample: The TFA index of each country takes the average value of the top 2 TFA index in sample.

Since our estimates in Table 2 show that time in customs is negatively related to TFI values, simulations involving an improvement in TFI scores at the country level will lead to the lower times reported in cols. 5 and 6. By design, the more ambitious improvements in TFI values in simulation 2 deliver larger time reductions in customs. Taking the more plausible estimates for simulation 1 in col 5, the estimates suggest average reduced time by group in customs between 1 and 2 days on the import side for the several African groupings. These translate into AVEs in the range 1.8%-2.9% in col. 7. And in the ambitious scenario, the corresponding average AVEs in col. 8 are 2.1%-4.7%. For the entire sample, average estimated time in customs for exports is 13% lower than for imports. Estimated reductions in time at customs on the export side in part b are lower than for imports, but not by much.

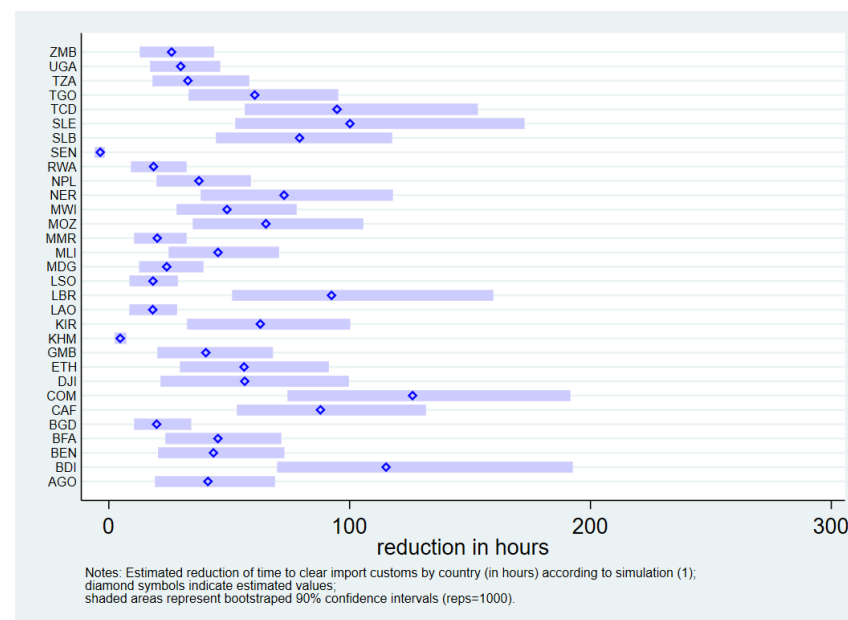
Comparing group averages, the two largest groups, LDCs and AfCFTA, show the largest gains from TFA implementation. However, because of membership overlap, comparison of group averages is not very instructive. For the two non-overlapping groups, SIDS and LLDCs, actual and estimated average times in customs are very close. As the distribution of TFI values are close for both groups (see Figure 4), the simulations return close values for estimated gains.

**Figure 6: Country-level estimates of reduction in hours at customs (for importers) from TFA implementation.**

**SIDS: Simulation (1)**



**LDCs: Simulation (1)**



**Notes:** These estimates at country level are computed from Table 2 (col. 4) and Table 3 (col. 3, Panel a), considering two country groups: LDCs: least developed countries – SIDS: Small Islands Developing States. Only the simulation (1) is reported: Convergence to the top-2 average within each country group convergence: Within each country group, all countries converge to the average of the top 2 TFI values in the respective group.

Shaded areas represent the bootstrapped 90% confidence intervals from 1000 replications. In the case of membership overlap (e.g. Comoros [COM]), reported means and range are the same in both columns. For Burundi (BDI), the average estimated gain is about 115 hours with a range (70-190 hours). Countries listed in reverse alphabetical order.

**Source:** Authors' estimates

Figure 6 reports estimates at the country level for each country in the LDCs and SIDS grouping. Because these estimates are orders of magnitude, we report ranges of estimates. Figure 6 shows that the range of estimates is large, confirming caution in interpreting these estimates.

## **6. Conclusions**

This paper started with a description of data sets on aspects of customs performance for a large group of countries that include most in the three UN-defined groups of vulnerable countries: LLDCs, LDCs, SIDS. We then discussed the bottom-up characteristic of the TFA that gives countries leeway for implementation suggesting caution about what to expect from implementing the TFA. OECD Trade Facilitation Indexes (TFI) values for 2019 were then used to estimate time in customs for imports and exports. The model's estimates closely match observed values reported in Doing Business. These encouraging results provided support for two counterfactual simulations, one plausible, another ambitious, in terms of improvements in customs performance. Average ad-valorem equivalents (AVEs) tariffs of reduction of time in customs for each UN-grouping (LDCs, LLDCs, and SIDS) show averages in the range 2.1%-2.9% for imports and 1.9%-2.7% for exports. Larger gains are obtained for a more ambitious implementation of the TFA. Country-level results show large range in estimates for each country, an indication that these should be interpreted as orders of magnitude.

Importantly, gains are larger for each of the three groupings than for other developing countries. Even though customs efficiency does not enter into the classification of vulnerable groups at the UN, these estimates show that the UN classification captures a relative under-performance of customs (at least as captured by TF indices) for the vulnerable group of countries in the UN classification. These remarks apply also to AfCFTA. Thus, the estimates suggest that significant improvements would be expected from implementing the TFA possible for LDCs, LLDCs and SIDS, and African countries engaged in the AfCFTA.

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## Annex Tables and Figures

**Table A1. Comparison of estimates using Poisson, Negative binomial and ZINB**

| Estimators  | <i>Poisson</i>       | <i>Negative Binomial</i> | <i>Zero-inflated Poisson</i> | <i>Zero-inflated Negative Binomial</i> |
|---|----------------------|--------------------------|------------------------------|--|
|   | (1)                  | (2)                      | (3)                          | (4)                                    |
| <b>Dependent : Time to import (in hours), border compliance</b> |                      |                          |                              |  |
| GDP per capita  | -1.053*<br>(0.570)   | -2.094**<br>(0.966)      | -0.912*<br>(0.523)           | -1.570**<br>(0.731)                    |
| (GDP per capita) <sup>2</sup>                                   | 0.056+<br>(0.036)    | 0.117**<br>(0.059)       | 0.049+<br>(0.033)            | 0.084*<br>(0.043)                      |
| GDP   | 0.099<br>(0.080)     | 0.218**<br>(0.102)       | 0.087<br>(0.077)             | 0.110+<br>(0.071)                      |
| Area in km <sup>2</sup>   | 0.043<br>(0.053)     | 0.103+<br>(0.065)        | 0.040<br>(0.050)             | 0.056<br>(0.051)                       |
| OECD dummy  | -1.075***<br>(0.388) | -1.437***<br>(0.442)     | -0.552+<br>(0.367)           | -0.599*<br>(0.360)                     |
| LLDC dummy  | -0.616***<br>(0.195) | -0.691***<br>(0.214)     | -0.621***<br>(0.190)         | -0.664***<br>(0.213)                   |
| SIDS dummy  | 0.108<br>(0.226)     | 0.546*<br>(0.319)        | 0.015<br>(0.215)             | 0.310<br>(0.262)                       |
| TFI 2019  | -0.784***<br>(0.285) | -1.393***<br>(0.368)     | -0.813***<br>(0.260)         | -0.845***<br>(0.292)                   |
| WGI 2018  | -0.780***<br>(0.204) | -0.352<br>(0.262)        | -0.731***<br>(0.191)         | -0.562***<br>(0.207)                   |
| Infrastructure  | 0.215<br>(0.225)     | -0.129<br>(0.322)        | 0.227<br>(0.219)             | 0.168<br>(0.224)                       |
| Constance   | 6.307***<br>(2.183)  | 8.644**<br>(3.693)       | 6.042***<br>(1.989)          | 8.457***<br>(2.711)                    |
| Nb. of observations   | 138                  | 138                      | 138                          | 138                                    |
| <b>AIC</b>  | 4650                 | 1317                     | 3920                         | 1276                                   |
| <b>BIC</b>  | 4682                 | 1353                     | 3985                         | 1344                                   |

**Notes:** The Table displays coefficients. The dependent variable is the number of days in import customs from the World Bank's Doing Business. The t-statistics in parentheses, + p<0.15, \* p<0.10, \*\* p<0.05, \*\*\* p<0.01. The Trade Facilitation Index is the simple average of the 11 components of the Trade Facilitation Indicators of the OECD. The rule of law variable is of the 6 components of the World Governance Indicators of the World Bank. The Infrastructure Index corresponds to the Infrastructure component of the World Bank's Logistic Performance Index. Only countries for which all 11 TFI components are available are included in the sample.

**Source:** Authors' estimations based on OECD & World Bank data.

**Table A2. Goodness of fit: Poisson, Negative binomial and ZINB**

Panel a. Observed and predicted probability of Time to import being equal to zero

| Model                                  | Probability |
|--|-------------|
|  |             |
| <i>Observed from data</i>              | 15,94%      |
| <i>Poisson</i>                         | 0,05%       |
| <i>Negative Binomial</i>               | 6,19%       |
| <i>Zero-inflated Poisson</i>           | 15,94%      |
| <i>Zero-inflated Negative Binomial</i> | 14,87%      |

**Notes:** These statistics are based on Results in Table A1.

**Source:** Authors' calculation from estimates in Table A1

Panel b. Absolute difference between observed and predicted time to import (in hours)

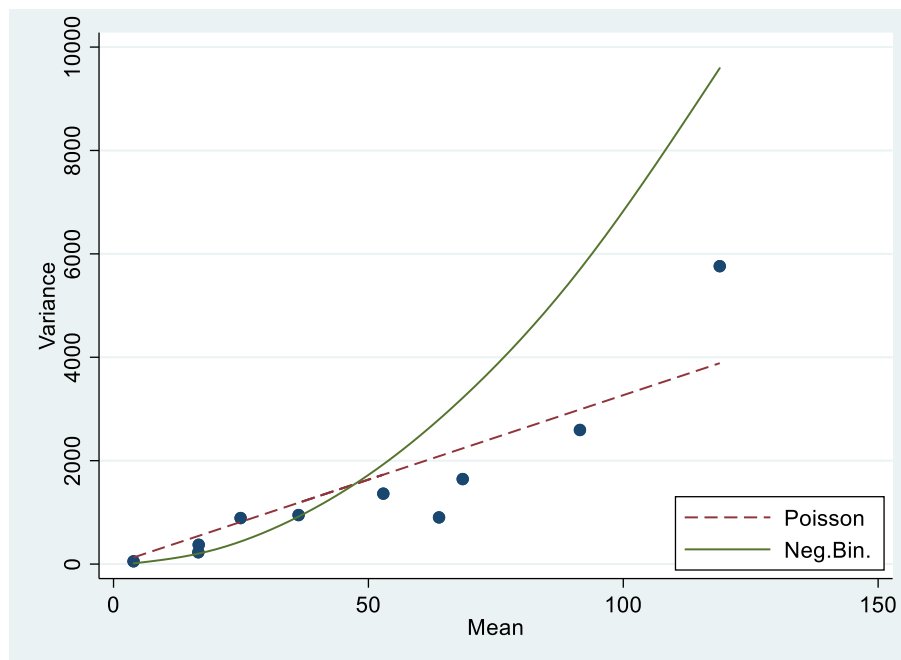
| Model                                  | Obs. | Mean  | Std. Dev. | Min  | Max    |
|--|------|-------|-----------|------|--------|
|  |      |       |           |      |        |
| <i>Poisson</i>                         | 138  | 31,20 | 33,60     | 0,67 | 238,98 |
| <i>Negative Binomial</i>               | 138  | 33,64 | 39,57     | 0,26 | 265,40 |
| <i>Zero-inflated Poisson</i>           | 138  | 30,61 | 33,87     | 0,39 | 235,47 |
| <i>Zero-inflated Negative Binomial</i> | 138  | 31,42 | 35,84     | 0,43 | 256,78 |

**Notes:** These statistics are based on Results in Table A1.

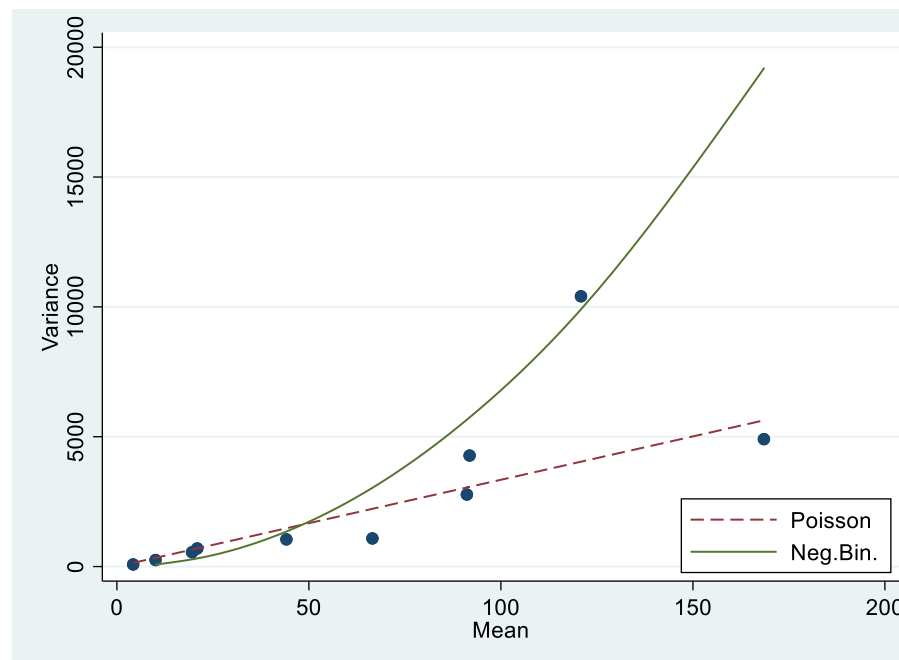
**Source:** Authors' calculation from estimates in Table A1.

**Figure A1. Mean-Variance relationship by deciles of distribution of time to export (import) in hours**

**Data: Time at Border to Export**



**Data: Time at Border to Import**



**Note:** The graph are based on the Zero-inflated Poisson and Zero-inflated negative-binomial (ZINB) Results in Table A1.

**Source:** Authors' estimates from Table 3.

**Table A3. List of countries (165)**

| ISO3 code | Country name             | AfCFTA | LDCs | LLDCs | SIDS | OTHER |
|-----------|--------------------------|--------|------|-------|------|-------|
| AGO       | Angola                   | ✓      | ✓    |       |      |       |
| ALB       | Albania                  |        |      |       |      | ✓     |
| ARE       | United Arab Emirates     |        |      |       |      | ✓     |
| ARG       | Argentina                |        |      |       |      | ✓     |
| ARM       | Armenia                  |        |      | ✓     |      |       |
| ATG       | Antigua and Barbuda      |        |      |       | ✓    |       |
| AUS       | Australia                |        |      |       |      |       |
| AUT       | Austria                  |        |      |       |      |       |
| AZE       | Azerbaijan               |        |      | ✓     |      |       |
| BDI       | Burundi                  | ✓      | ✓    | ✓     |      |       |
| BEL       | Belgium                  |        |      |       |      |       |
| BEN       | Benin                    | ✓      | ✓    |       |      |       |
| BFA       | Burkina Faso             | ✓      | ✓    | ✓     |      |       |
| BGD       | Bangladesh               |        | ✓    |       |      |       |
| BGR       | Bulgaria                 |        |      |       |      | ✓     |
| BHR       | Bahrain                  |        |      |       | ✓    |       |
| BHS       | Bahamas                  |        |      |       | ✓    |       |
| BIH       | Bosnia and Herzegovina   |        |      |       |      | ✓     |
| BLR       | Belarus                  |        |      | ✓     |      |       |
| BLZ       | Belize                   |        |      |       | ✓    |       |
| BOL       | Bolivia                  |        |      | ✓     |      |       |
| BRA       | Brazil                   |        |      |       |      | ✓     |
| BRB       | Barbados                 |        |      |       | ✓    |       |
| BRN       | Brunei Darussalam        |        |      |       |      | ✓     |
| BTN       | Bhutan                   |        | ✓    | ✓     |      |       |
| BWA       | Botswana                 | ✓      |      | ✓     |      |       |
| CAF       | Central African Republic | ✓      | ✓    | ✓     |      |       |
| CAN       | Canada                   |        |      |       |      |       |
| CHE       | Switzerland              |        |      |       |      |       |
| CHL       | Chile                    |        |      |       |      | ✓     |
| CHN       | China                    |        |      |       |      | ✓     |
| CIV       | Cote d'Ivoire            | ✓      |      |       |      | ✓     |
| CMR       | Cameroon                 | ✓      |      |       |      | ✓     |
| COD       | Congo, Dem. Rep.         | ✓      | ✓    |       |      |       |
| COG       | Congo, Rep.              | ✓      |      |       |      | ✓     |
| COL       | Colombia                 |        |      |       |      | ✓     |
| COM       | Comoros                  | ✓      | ✓    |       | ✓    |       |
| CRI       | Costa Rica               |        |      |       |      | ✓     |
| CUB       | Cuba                     |        |      |       | ✓    |       |
| CYP       | Cyprus                   |        |      |       |      |       |
| CZE       | Czech Republic           |        |      |       |      |       |
| DEU       | Germany                  |        |      |       |      |       |
| DJI       | Djibouti                 | ✓      | ✓    |       |      |       |
| DMA       | Dominica                 |        |      |       | ✓    |       |
| DNK       | Denmark                  |        |      |       |      |       |
| DOM       | Dominican Republic       |        |      |       | ✓    |       |
| DZA       | Algeria                  | ✓      |      |       |      | ✓     |

|     |                       |   |   |   |   |   |
|-----|-----------------------|---|---|---|---|---|
| ECU | Ecuador               |   |   |   |   | ✓ |
| EGY | Egypt, Arab Rep.      | ✓ |   |   |   | ✓ |
| ESP | Spain                 |   |   |   |   |   |
| EST | Estonia               |   |   |   |   |   |
| ETH | Ethiopia              | ✓ | ✓ | ✓ |   |   |
| FIN | Finland               |   |   |   |   |   |
| FJI | Fiji                  |   |   |   | ✓ |   |
| FRA | France                |   |   |   |   |   |
| FSM | Micronesia, Fed. Sts. |   |   |   | ✓ |   |
| GAB | Gabon                 | ✓ |   |   |   | ✓ |
| GBR | United Kingdom        |   |   |   |   |   |
| GEO | Georgia               |   |   |   |   | ✓ |
| GHA | Ghana                 | ✓ |   |   |   | ✓ |
| GMB | Gambia, The           | ✓ | ✓ |   |   |   |
| GRC | Greece                |   |   |   |   |   |
| GTM | Guatemala             |   |   |   |   | ✓ |
| HKG | Hong Kong SAR, China  |   |   |   |   | ✓ |
| HND | Honduras              |   |   |   |   | ✓ |
| HRV | Croatia               |   |   |   |   | ✓ |
| HUN | Hungary               |   |   | ✓ |   |   |
| IDN | Indonesia             |   |   |   |   | ✓ |
| IND | India                 |   |   |   |   | ✓ |
| IRL | Ireland               |   |   |   |   |   |
| ISL | Iceland               |   |   |   |   |   |
| ISR | Israel                |   |   |   |   |   |
| ITA | Italy                 |   |   |   |   |   |
| JAM | Jamaica               |   |   |   | ✓ |   |
| JOR | Jordan                |   |   |   |   | ✓ |
| JPN | Japan                 |   |   |   |   |   |
| KAZ | Kazakhstan            |   |   | ✓ |   |   |
| KEN | Kenya                 | ✓ |   |   |   | ✓ |
| KGZ | Kyrgyz Republic       |   |   | ✓ |   |   |
| KHM | Cambodia              |   | ✓ |   |   |   |
| KIR | Kiribati              |   | ✓ |   | ✓ |   |
| KOR | Korea, Rep.           |   |   |   |   |   |
| KWT | Kuwait                |   |   |   |   | ✓ |
| LAO | Lao PDR               |   | ✓ | ✓ |   |   |
| LBN | Lebanon               |   |   |   |   | ✓ |
| LBR | Liberia               | ✓ | ✓ |   |   |   |
| LKA | Sri Lanka             |   |   |   |   | ✓ |
| LSO | Lesotho               | ✓ | ✓ | ✓ |   |   |
| LTU | Lithuania             |   |   |   |   | ✓ |
| LUX | Luxembourg            |   |   |   |   |   |
| LVA | Latvia                |   |   |   |   | ✓ |
| MAR | Morocco               | ✓ |   |   |   | ✓ |
| MDA | Moldova               |   |   | ✓ |   |   |
| MDG | Madagascar            | ✓ | ✓ |   |   |   |
| MDV | Maldives              |   |   |   | ✓ |   |
| MEX | Mexico                |   |   |   |   | ✓ |
| MKD | North Macedonia       |   |   | ✓ |   |   |

|     |                    |   |   |   |   |   |
|-----|--------------------|---|---|---|---|---|
| MLI | Mali               | ✓ | ✓ | ✓ |   |   |
| MLT | Malta              |   |   |   |   |   |
| MMR | Myanmar            |   | ✓ |   |   |   |
| MNE | Montenegro         |   |   |   |   | ✓ |
| MNG | Mongolia           |   |   | ✓ |   |   |
| MOZ | Mozambique         | ✓ | ✓ |   |   |   |
| MUS | Mauritius          | ✓ |   |   | ✓ |   |
| MWI | Malawi             | ✓ | ✓ | ✓ |   |   |
| MYS | Malaysia           |   |   |   |   | ✓ |
| NAM | Namibia            | ✓ |   |   |   | ✓ |
| NER | Niger              | ✓ | ✓ | ✓ |   |   |
| NGA | Nigeria            | ✓ |   |   |   | ✓ |
| NIC | Nicaragua          |   |   |   |   | ✓ |
| NLD | Netherlands        |   |   |   |   |   |
| NOR | Norway             |   |   |   |   |   |
| NPL | Nepal              |   | ✓ | ✓ |   |   |
| NZL | New Zealand        |   |   |   |   |   |
| OED | OECD members       |   |   |   |   | ✓ |
| OMN | Oman               |   |   |   |   | ✓ |
| PAK | Pakistan           |   |   |   |   | ✓ |
| PAN | Panama             |   |   |   |   | ✓ |
| PER | Peru               |   |   |   |   | ✓ |
| PHL | Philippines        |   |   |   |   | ✓ |
| PLW | Palau              |   |   |   | ✓ |   |
| PNG | Papua New Guinea   |   |   |   | ✓ |   |
| POL | Poland             |   |   |   |   | ✓ |
| PRT | Portugal           |   |   |   |   |   |
| PRY | Paraguay           |   |   | ✓ |   |   |
| QAT | Qatar              |   |   |   |   | ✓ |
| ROU | Romania            |   |   |   |   | ✓ |
| RUS | Russian Federation |   |   |   |   | ✓ |
| RWA | Rwanda             | ✓ | ✓ | ✓ |   |   |
| SAU | Saudi Arabia       |   |   |   |   | ✓ |
| SDN | Sudan              | ✓ | ✓ |   |   |   |
| SEN | Senegal            | ✓ | ✓ |   |   |   |
| SGP | Singapore          |   |   |   | ✓ |   |
| SLB | Solomon Islands    |   | ✓ |   | ✓ |   |
| SLE | Sierra Leone       | ✓ | ✓ |   |   |   |
| SLV | El Salvador        |   |   |   |   | ✓ |
| SRB | Serbia             |   |   | ✓ |   |   |
| SUR | Suriname           |   |   |   | ✓ |   |
| SVK | Slovak Republic    |   |   |   |   |   |
| SVN | Slovenia           |   |   |   |   |   |
| SWE | Sweden             |   |   |   |   |   |
| SWZ | Eswatini           | ✓ |   | ✓ |   |   |
| TCD | Chad               | ✓ | ✓ | ✓ |   |   |
| TGO | Togo               | ✓ | ✓ |   |   |   |
| THA | Thailand           |   |   |   |   | ✓ |
| TJK | Tajikistan         |   |   | ✓ |   |   |
| TON | Tonga              |   |   |   | ✓ |   |

|     |                     |   |   |   |   |   |
|-----|---------------------|---|---|---|---|---|
| TTO | Trinidad and Tobago |   |   |   | ✓ |   |
| TUN | Tunisia             | ✓ |   |   |   | ✓ |
| TUR | Turkey              |   |   |   |   | ✓ |
| TWN | Taiwan, China       |   |   |   |   |   |
| TZA | Tanzania            | ✓ | ✓ |   |   |   |
| UGA | Uganda              | ✓ | ✓ | ✓ |   |   |
| UKR | Ukraine             |   |   |   |   | ✓ |
| URY | Uruguay             |   |   |   |   | ✓ |
| USA | United States       |   |   |   |   |   |
| UZB | Uzbekistan          |   |   | ✓ |   |   |
| VEN | Venezuela, RB       |   |   |   |   | ✓ |
| VNM | Vietnam             |   |   |   |   | ✓ |
| VUT | Vanuatu             |   |   |   | ✓ |   |
| WSM | Samoa               |   |   |   | ✓ |   |
| YEM | Yemen, Rep.         |   | ✓ |   |   |   |
| ZAF | South Africa        | ✓ |   |   |   | ✓ |
| ZMB | Zambia              | ✓ | ✓ | ✓ |   |   |
| ZWE | Zimbabwe            | ✓ |   | ✓ |   |   |

**Note:** Sample includes 35 Least Developed countries (LDCs), 32 Landlocked developing countries (LLDCs), 24 Small Islands Developing States (SIDS), and 60 other developing countries (excluding LDC, LLDC, SIDS categories).

*“Sur quoi la fondera-t-il l’économie du monde qu’il veut gouverner? Sera-ce sur le caprice de chaque particulier? Quelle confusion! Sera-ce sur la justice? Il l’ignore.”*

Pascal



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