Reducing tariff evasion: The role of trade facilitation[*]

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Abstract

Can simplifying customs procedures reduce tariff evasion? We measure tariff evasion as the mis-representation of import values in response to increasing tariffs. In a dataset covering 121 countries and the whole set of HS6 product categories in 2012, 2015, and 2017, we show that simplifying border procedures, that is trade facilitation, reduces tariff evasion. Holding tariff rate constant at its mean, improving a country's overall trade facilitation performance from the 25th percentile to the median reduces tariff evasion by almost 20%. The moderating effect is especially due to improving the pre-shipment legal certainty of customs procedures. Among the potential mechanisms, improving trade facilitation performance is effective in reducing tariff evasion due to under-reporting of import prices, as well as in countries with weaker control of corruption. The results suggest that countries can gradually implement trade facilitation reforms to cost-effectively minimize tariff evasion.

Keywords: Customs procedures; International trade; Tariffs; Tariff evasion; Trade Facilitation Agreement; World Trade Organization.

JEL Classification: F1; F13; F14; H26.

1. Introduction

Customs agencies worldwide control the cross-border movement of goods and collect taxes. They are important for revenue collection as they can regulate anywhere between 20% and 100% of an economy's output (Michael, 2012). To protect tariff revenue customs agencies may verify consignments selectively. The delay in clearance due to physical inspections or complicated verification procedures generate extra costs, which can incentivize traders to engage in tariff evasion. The potential losses from tariff evasion are critical for low income countries which rely significantly on trade tariff revenue (Jean and Mitaritonna, 2010).[1] Regulating customs evasion can therefore be critical for public finance in developing countries.[2]

Evidence on the effectiveness of different measures to curb customs evasion is mixed. For instance, Yang (2008) finds that increased pre-shipping inspection (PSI) in the Philippines incentivized evasion through an alternative duty-avoidance method. Similarly, Javorcik and Narciso (2017) find that WTO accession, which mandates using exporter invoices to undermine arbitrary valuation of merchandise, leads to displacement of tariff evasion to an alternative method. These studies conclude that the overall effect of such measures on customs evasion can be insignificant.

This paper contributes to the literature by documenting the effect of simplifying customs procedures on tariff evasion. We hypothesize that easing customs procedures reduces the incentive for traders to avoid high procedural or verification costs through mis-representing consignment value. Indeed, our analysis suggests that simplifying customs procedures moderates tariff evasion.

Our research focuses on the efficacy of provisions listed in the WTO Trade Facilitation

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[1]Baunsgaard and Keen (2010) report that the share of trade tax revenue in total tax receipts for 2001-2006 was 2.5% for high income countries, 18.1% for middle-income countries and 22% for the low-income countries. Kar and Spanjers (2014) estimate that about 7% to 13% of the government revenue in the five African economies of Ghana, Kenya, Mozambique, Tanzania and Uganda could potentially be lost due to customs mis-invoicing.

[2]While global estimates are scarce, Kar and Spanjers (2014) estimated an outflow of US$ 729 billion in trade mis-invoicing from developing countries in 2012.

Agreement (TFA). The agreement aims to reduce the cost of transaction for traders by reducing border crossing requirements, expediting release of goods, and increasing transparency (Neufeld, 2014).[3] The substantive provisions of the agreement include simplifying access to information for traders; encouraging feedback from traders in designing border-related operations; improving legal certainty of border procedures; improving transparency of charges associated with clearing merchandise and penalties for breaching customs regulations; reducing formalities for customs clearance; and improving co-operation between various agencies that regulate movement of goods within and across countries.

The Organisation for Economic Co-operation and Development (OECD) has compiled eleven country-level trade facilitation indicators (TFIs), which evaluate customs-related policies and their implementation in practice, and which roughly correspond to specific TFA provisions.[4] We group these eleven indicators into eight broad measures of trade facilitation: information availability; involvement of the trading community; advance rulings; appeals procedures; fees and charges; formalities; border cooperation; and governance and impartiality. We also compute a simple average of all measures, to create a country-level proxy for the average trade facilitation performance. The average trade facilitation performance measures the overall simplicity of a country's customs procedures. OECD TFIs are not available annually. We use three waves of TFI data, covering the following years: 2012, 2015 and 2017.

We study how improving trade facilitation mediates the mis-representation of import values in response to rising tariff rates. The positive link between the mis-representation of import values and tariff rates is posited as evidence for tariff evasion in the literature. We capture the mis-representation of import value using the discrepancy between the value of exports reported by all exporting countries to the importing country and the value of imports reported by the importing country from all exporting countries. The discrepancy is calculated at the six

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[3]The TFA differs from earlier multilateral agreements since it eschews a one-size-fits-all model and encourages individual members to adopt policies that are most effective in reducing trade costs.

[4]Out of the eleven OECD TFIs, only one does not relate to the provisions in the TFA. This specific measure concerns the overall governance and impartiality of the customs administration.

digit level of the Harmonized System (HS) classification, and is referred to as missing imports. We estimate the effect of trade facilitation measures on the sensitivity of missing imports to the tariff rate in each product category, importer, and year using a dataset that comprises of 121 countries and the entire set of HS6 product categories in three years 2012, 2015 and 2017, for which trade facilitation data have been collected.

The empirical analysis proceeds in several steps. First, we document a positive association between tariff rate and missing imports. The point estimate suggests that a one percentage point increase in tariff rate is associated with 0.2% to 0.3% increase in missing imports. This result, obtained in a large set of countries and products, highlights that tariff evasion is a global phenomenon. Further, our estimate of the tariff semi-elasticity of missing imports is consistent with recent literature, even if we only keep the importer dimension, instead of bilateral exporter-importer dimension in constructing missing imports.

We next examine if country-level trade facilitation measures weaken the positive association between tariff rate and missing imports. Figure 1 presents preliminary evidence for the moderating effect of trade facilitation performance on tariff evasion (i.e., the positive association between tariff rate and missing imports). It plots missing imports (vertical axis) on the HS6 product tariff rate (horizontal axis). The dashed line represents the relationship for countries that are above the sample median of average trade facilitation performance; the solid line represents the relationship for countries which are below this sample median. In countries with low average trade facilitation performance, we find a positive and statistically significant effect of tariff rate on missing imports. Conversely, in countries with high trade facilitation performance, the slope of the regression line is statistically not different from zero.

The role of trade facilitation performance in moderating the positive link between tariff rate and missing imports is also substantiated in regression analysis, where we control for unobserved country- and product-specific characteristics that can vary over time, and for unobserved product characteristics that are specific to an importing country. The point estimates

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Figure 1 Trade facilitation and tariff evasion: motivation
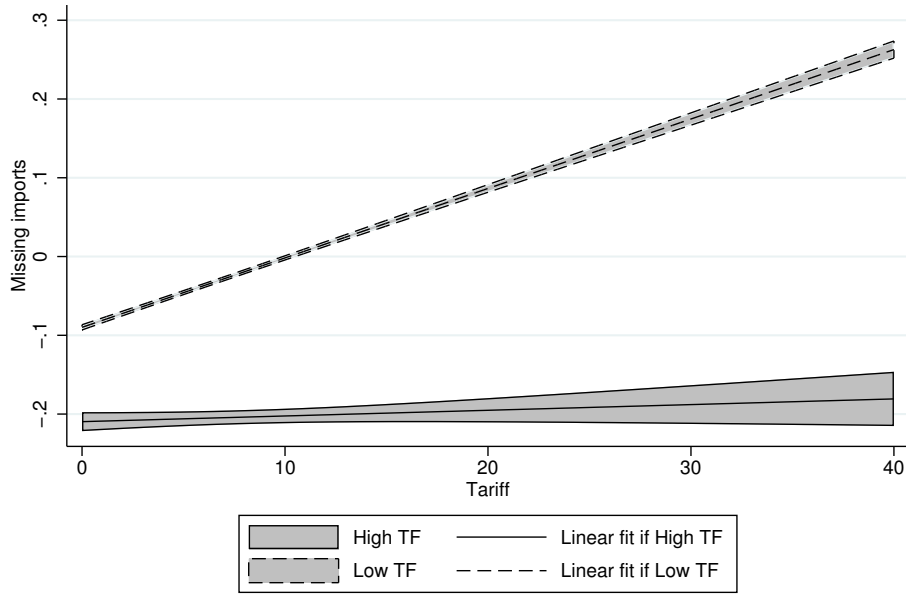
Coeff. if High TF = −0.007 (s.e. = 0.004)
Coeff. if Low TF = 0.002 (s.e. = 0.001)

Notes: Missing imports defined in equation (2) as the difference between the log value of exports reported by all exporting countries to importing country j in HS6 product k in year t (X_{jkt}) and the log value of imports reported by j from all countries in HS6 product k in year t (M_{jkt}), i.e. $mi_{jkt} \equiv \ln\left(1 + X_{jkt}\right) - \ln\left(1 + M_{jkt}\right)$. Tariff is defined as the MFN tariff by importer j on k in t. High TF is a dummy equal to one if the average trade facilitation indicator TF^{AK} is above its sample median. TF^{AK} is the simple average of trade facilitation measures pertaining to information availability (TF^{IA}), involvement of the trade community (consultations) (TF^{IT}), advance rulings (TF^{AR}), appeal procedures (TF^{AP}), fees and charges (TF^{FC}), formalities (TF^{FM}), cooperation (TF^{CP}), and governance and impartiality (TF^{GI}). The sample is the one of column (1) of Table 2. See Section 3.1 and tables A.1-A.2 for variables' description.

imply that, holding tariff rate constant at its mean, improving average trade facilitation performance from the 25th percentile to the median reduces the tariff semi-elasticity of missing imports by almost 20%. We also document that individual trade facilitation measures differ in their effectiveness to reduce tariff evasion. The result is in line with empirical research which shows that some trade facilitation measures are more effective than others in reducing trade costs (Hillberry and Zhang, 2018; Fontagné et al., 2020), and hence should disproportionately affect tariff evasion. We find that pre-shipment legal certainty of border procedures, measured by 'advance rulings', is particularly effective in reducing tariff evasion.

We conduct a series of robustness checks to bolster the main findings. We account for the possibility that missing imports in an HS6 product category could affect country-level trade facilitation policy. We address the potential reverse causality by dropping the most important

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sectors according to their import share in each country. Missing imports in these sectors are most likely to influence trade facilitation policy, and excluding these sectors should minimize the plausible reverse causality. Results show that excluding these sectors has no impact on our baseline findings. We conclude that reverse causality is unlikely to be a factor in our estimations. We also assess our findings in an alternative specification, which is similar to Javorcik and Narciso (2008), and where the United States is used as a reference exporter. The use of a reference exporter ensures that export data are measured consistently. The results are qualitatively similar to our baseline findings and confirm that our results are not affected by how we measure missing imports.

We next examine which potential channels of tariff evasion are sensitive to improving trade facilitation performance. Existing literature identifies three main channels of tariff evasion: mis-classification of the product as a lower tax variety (Fisman and Wei, 2004); under-reporting of import prices (Javorcik and Narciso, 2008; 2017); and under-declaration of import quantities (Rotunno and Vézina, 2012). We find that improving trade facilitation performance is effective in dampening tariff evasion that occurs through under-reporting of import prices.

Finally, we assess if the relationship between trade facilitation and tariff evasion is mediated by other institutional characteristics. In particular, we examine whether the relationship between trade facilitation performance and tariff evasion is sensitive to country-level control of corruption. Importers in countries with weak control of corruption may offer customs officials side payments to avoid detection. We hypothesize that improving trade facilitation performance can reduce the discretionary power of customs officials to apply rules arbitrarily. Hence, improving trade facilitation performance can be particularly effective in reducing tariff evasion in countries with weak control of corruption. Results are in line with this conjecture and confirm that improving trade facilitation performance is more effective in moderating tariff evasion in such countries.

This paper contributes to the literature in several ways. Our main contribution is to the

literature on measures to reduce tariff evasion. The literature mostly examines how improving detection can dissuade tariff evasion. For example, a number of papers study the effectiveness of pre-shipment inspections (PSI), that are carried out by private surveillance companies, and were introduced in some low income countries as a precursor to customs reforms (Anson et al., 2006; Ferreira et al., 2007; Yang, 2008; Sequeira, 2016). The literature finds mixed evidence on their efficacy, mostly due to the creation of perverse incentives for importers and customs officers, and due to poor coordination between PSI vendors and customs administrations. More recently, Javorcik and Narciso (2017) studied the mandatory use of export invoices to undermine arbitrary merchandise valuation, following a country's accession to WTO, and concluded that the overall effect on tariff evasion is insignificant. Our study in contrast examines whether reducing the complexity of customs procedures can improve compliance. We find evidence that simplifying customs procedures can help to reduce customs evasion. The paper thus also relates to a broader public finance literature on tax complexity and compliance (Forest and Sheffrin, 2002; Ulph, 2007; Slemrod, 2007, 2019).

Another contribution is to the empirical literature on the impact of the Trade Facilitation Agreement (Moïsé and Sorescu, 2013; Hillberry and Zhang, 2018; Fontagné et al., 2020). The literature finds that different trade facilitation measures vary in their effectiveness to reduce trade costs. The effectiveness of trade facilitation measures can vary across countries due to the level of development (Moïsé and Sorescu, 2013), or due to the size composition of firms within sectors (Fontagné et al., 2020). We document that while trade facilitation, on average, reduces tariff evasion, not all measures contribute equally. We further show that the impact of average trade facilitation on tariff evasion varies with sector-level characteristics, such as the degree of product differentiation, and with country-level characteristics, such as control of corruption.

We finally contribute to the general literature on tariff evasion. Existing studies either identify tariff evasion among only a few countries (Fisman and Wei, 2004; Javorcik and Narciso, 2008; Rotunno and Vézina, 2012), or their data structure does not account for variation over

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time (Jean and Mitaritonna, 2010) or differences between product categories (Kellenberg and Levinson, 2019).[5] Our work, in contrast, finds evidence for tariff evasion in a dataset that covers 121 countries and all HS6 product categories for three years in the period from 2012 and 2017. We therefore complement the literature and confirm that tariff evasion is a ubiquitous phenomenon.

The rest of the paper is organized as follows. In Section 2 we present a conceptual framework to guide the empirical analysis. We discuss the data in Section 3 and the empirical framework in Section 4. Section 5 presents the main findings. Section 6 concludes.

2.   Conceptual framework: Linking trade facilitation to tariff evasion

2.1.   *Trade facilitation performance and tariff evasion*

Consider a firm that imports a fixed amount of goods into a country. The firm can evade a fraction of taxable amount by mis-representing the true consignment value. The firm can mis-represent consignment value through various mechanisms, such as by mis-classifying a higher taxed product as a lower taxed variety, by under-reporting unit prices or under-declaring product quantities.[6] To protect tariff revenue, a customs agency might impose verification standards that are increasing in import tariffs.[7] For example, the customs administration may seek more documents for verification or physically inspect merchandise that are charged higher tariffs. The potential delay in import clearance or significant physical inspections generate additional costs to the importer. For instance, evidence from Russia suggests that the cost of verification

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[5]A related set of papers use the tariff evasion methodology to identify smuggling of items such as antiques, mineral resources, electronics, and live animals (Fisman and Wei, 2009; Vézina, 2015; Rotunno and Vézina, 2017; Beverelli and Ticku, 2021).

[6]Fisman and Wei (2004), in a seminal paper, found evidence for systematic mis-representation of consignment value which is imported at a higher tariff rate in trade between Hong Kong and China. Subsequent empirical literature (Javorcik and Narciso, 2008, 2017; Rotunno and Vézina, 2012) identified the different channels of tariff evasion.

[7]This assumption implies that a customs agency responds to the increased threat of evasion at higher tariffs by imposing a higher threshold for verification.

and procedural delays added 12% to the total cost of imported products (Ferreira et al., 2007).[8] The higher cost of verification could further incentivize a firm to mis-represent consignment value by mis-classifying across products, or under-reporting unit prices or product quantities. Policies that are designed to facilitate trade, by streamlining and simplifying customs procedures, should undercut procedural costs and hence reduce a firm's incentive to engage in tariff evasion.

Proposition 1 *Improving trade facilitation performance should weaken the incentive for tariff evasion.*

Customs administration can implement a variety of measures to improve trade facilitation performance. For example, a customs administration could facilitate trade by simplifying access to information, by reducing the number or complexity of documents for verification, or by providing importers a mechanism to contest the administrative decisions. Empirical evidence suggests that trade facilitation measures vary in their effectiveness to reduce trade costs. For instance, Hillberry and Zhang (2018) find that ex-ante legal certainty is negatively associated with import costs, while procedures to expedite customs clearance are associated with a lower time to import. Similarly, Fontagné et al. (2020) find that better information availability and improving legal certainty in importing countries disproportionately benefits small firms. Due to the difference in reducing trade costs, we hypothesize that trade facilitation measures also vary in their effectiveness to reduce tariff evasion.

Proposition 2 *Trade facilitation measures could differ in their effectiveness to reduce tariff evasion.*

2.2. Control of corruption, trade facilitation performance, and tariff evasion

The relationship between trade facilitation performance and tariff evasion can be mediated by other institutional features. For instance, a firm's cost of evasion increases with the quality of customs enforcement (Mishra et al., 2008). When the quality of enforcement is low, a firm

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[8]Similarly, according to a global estimate, red tape in customs procedures increase the cost of import by about 7% to 10% of world trade (Messerlin and Zarrouk, 2000).

can avoid detection by offering customs officials side payments (Ferreira et al., 2007). Indeed, evidence from port cities in South Africa suggests that importers are willing to bribe customs officials to "jump queues, avoid storage costs, avoid overnight waits" (Michael, 2012). Improving trade facilitation performance can reduce a firm's incentive to bribe officials in low enforcement environments in two ways. First, trade facilitation, by automating customs procedures, reduces the involvement of customs officials and hence the opportunity for customs' corruption. Second, the transparency in legal provisions or having a dispute resolution mechanism weakens the discretionary power of customs officials to apply rules arbitrarily. Therefore, improving trade facilitation can be more effective in curbing tariff evasion in countries with weak control of corruption.

Proposition 3 *Improving trade facilitation performance should further reduce tariff evasion in countries with weak control of corruption.*

In the following sections we assess whether the data are consistent with our main hypotheses.

3. Data and descriptive statistics

We construct a dataset that covers 121 countries and the whole set of HS6 product categories over the period 2012-2017 for our empirical analysis. The time frame of our analysis is constrained by the availability of facilitation measures for the years 2012, 2015 and 2017 only. This section describes the key variables and their sources, and presents some descriptive statistics.

3.1. Data

Trade and tariff data. Trade and tariff data are sourced from UN COMTRADE and UNCTAD TRAINS, respectively, at the HS6 product classification. To construct the variable missing imports (which proxies discrepancy in trade statistics reported by partner countries), we collect

both data on importer country j's reported value of HS6 product k's imports from the world, and data on the value of product k's exports reported by all other countries to country j. Regarding tariffs, we collect the most-favourite nation (MFN) tariffs of importing country j on product k. MFN tariffs are used because imports from, and export by, the aggregate of all countries (the 'world') are considered in the missing imports variable, which therefore varies along the jkt dimension (see Section 4). MFN tariffs are imposed on most bilateral relationships, and therefore they are likely to be more representative of the tariff of an importer j on HS6 product k in year t. To account for the fact that MFN tariffs are less relevant for countries participating in trade agreements, however, in Section 5.1 we show that the results are unaffected if the effectively applied tariff is used instead of MFN tariff.

Trade facilitation.   Trade facilitation data are sourced from the OECD Trade Facilitation Indicators (TFIs). The TFIs are composed of a set of eleven indicators, listed from (a) to (k) in Table A.1. Each TF indicator is composed of several specific, precise, and fact-based variables related to existing trade-related policies and regulations and their implementation in practice. There is a total of 133 variables, coded as 0, 1, or 2, where the top score (2) corresponds to the best performance. Each indicator is the unweighted average of the variables composing it.[9] The TFI database covers 163 countries at all income levels. The data used in the present analysis paper cover three waves, roughly reflecting policies in place around the years 2012, 2015 and 2017. As shown in Table A.1, we classify the eleven TFIs into eight broad measures, mirroring the substantive provisions of articles 1, 2, 3, 4, 6, 7, 8, and 10 of the WTO Trade Facilitation Agreement (TFA).

The indicator Information Availability, TF^{IA}, which matches the requirements of Article 1 of the TFA, measures the extent to which a country provides web-based information on import and export procedures, whether the information is displayed in one of the official WTO

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[9]The 133 variables are constructed based on a Trade Facilitation Indicators Questionnaire, available in the methodology note on OECD's TFI: `https://www.oecd.org/trade/topics/trade-facilitation/documents/trade-facilitation-indicators-methodology.pdf`.

languages, whether documents and forms are directly available for download on the customs website, and whether the country maintains an inquiry point and offers the possibility to ask questions on customs-related issues by telephone or internet.[10] Information availability should reduce fixed ex-ante information costs for importers (Fontagné et al., 2020).

The indicator Involvement of the trade community, TF^{IT}, which matches Article 2 of the TFA, covers the involvement of the trade community in the design of daily border-related operations. Under Article 2 of the TFA, members are required to: i) consult with traders and other interested parties on new or amended laws and regulations related to the movement, release, and clearance of goods; and ii) give traders and other interested parties time to familiarize themselves with the new laws and regulations by publicising them as early as possible. Involvement of the trade community helps designing a more efficient business environment for traders. Moreover, by reducing uncertainty in the outcome of the border procedures, it increases the transparency and predictability of such business environment (Fontagné et al., 2020).

The indicator Advance rulings, TF^{AR}, which matches Article 3 of the TFA,[11] indicates whether the country provides the exporter with a ruling concerning the tariff classification, the origin, and the valuation method that will apply to the good when it reaches customs. Advance rulings is therefore a measure of ex-ante legal certainty of border procedures.

The indicator Appeal procedures, TF^{AP}, which matches Article 4 of the TFA,[12] is related

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[10]For instance, Lao People's Democratic Republic has an online trade portal (`http://www.laotradeportal.gov.la.`) where all trade-related laws, regulations, measures, restrictions, licensing requirements and tariffs are indexed, cross-referenced, and made searchable by commodity code. The website also includes detailed process maps of business procedures for importing and exporting; full listings of national standards for products; procedures for clearing goods at the border; downloadable forms; and e-alerts which traders can customize to receive information. Mostly due to improvements over time in its trade portal, Lao PDR's score on TF^{IA} increased from 1 in 2015 to 1.8 in 2017.

[11]Article 3 of the TFA mandates that the advance ruling is issued in a reasonable, time-bound manner in response to any written request, and is valid for a reasonable period of time after issuance. The advance ruling is binding, and the member must inform the applicant if the advance ruling is revoked, modified or invalidated. Members have to publish information on the requirements for an advance ruling application, the time period by which an advanced ruling will be issued, and the length of time for which the advance ruling is valid. Finally, members are encouraged to make any information on advance rulings which they consider of significant interest to other interested parties publicly available.

[12]Article 4 of the TFA requires members to guarantee the right to an administrative appeal or review by the appropriate administrative authority, and/or to a judicial appeal or review to anybody who receives an administrative decision from customs. Members have to: i) ensure that the appeal or review procedures are non-discriminatory;

to the existence of the right to appeal to an administrative decision from customs. Appeal procedures is therefore a measure of ex-post legal certainty of border procedures.

The indicator Fees and charges, TF^{FC}, matching Article 6 of the TFA, refers to the disciplines on fees and charges other than import and export duties and other than taxes, e.g. fees for customs services, and on the penalties for a breach of customs laws, regulations, or procedural requirements. Article 6 of the TFA mandates that fees and charges should be transparent, and penalties commensurate to the breach and procedurally fair. Countries with high scores on TF^{FC} will meet these requirements of transparency of customs fees and charges, and of fairness of penalties for the breach of customs laws, regulations or procedural requirements.

The indicator Formalities, TF^{FM}, which matches articles 7 and 10 of the TFA,[13] is constructed, like in Fontagné et al. (2020), as the simple average of three indicators: i) Formalities (documents), ii) Formalities (automation), and iii) Formalities (procedures). The first indicator captures the extent to which the complexity of documents is simplified by relying on international standards, using copies, and reducing the number of documents. The second indicator captures the implementation of automated procedures, electronic interchange of documents (EDI), and the application of risk management procedures. The final indicator captures the development of a single window,[14] and the existence of procedures to apply expedited customs clearance for traders. Overall, uncertainty in processing time will be lower in countries with high scores on TF^{FM}.

The indicator Co-operation, which matches Article 8 of the TFA,[15] is the simple average

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ii) provide the right to a further appeal or review if there is undue delay in providing the original decision; and iii) ensure that everybody who receives an administrative decision is provided with the reasons for it, to allow them recourse to an appeal or review.

[13]Article 7 of the TFA requires members to establish or maintain a series of procedures for the release and clearance of goods for import, export or transit, including electronic payment and the establishment and publication of average release times. Article 10 of the TFA is aimed at minimizing the incidence and complexity of import, export, and transit formalities and decreasing and simplifying import, export, and transit documentation requirements.

[14]A single window is a facility that allows parties involved in trade and transport to lodge standardized information and documents with a single entry point to fulfill all import, export, and transit-related regulatory requirements. If information is electronic, then individual data elements should only be submitted once. See https://tfig.unece.org/contents/single-window-for-trade.htm.

[15]Article 8 of the TFA requires members to ensure that there is internal cooperation and coordination among its authorities and agencies responsible for border controls and procedures dealing with the importation, exportation, and transit of goods. It also requires members to ensure, to the extent possible and practicable, that there is external

of two indicators: i) Internal co-operation, and ii) External co-operation. The former measures co-operation between authorities and agencies responsible for border controls and procedures within the country, while the latter measures co-operation between such authorities and agencies across countries. Internal and external co-operation can further contribute to reduce uncertainty in processing time.

Finally, the indicator Governance and impartiality, which does not match any article of the TFA, is about transparency of customs structures and functions, as well as accountability and ethics policy. The presence of codes of conduct, ethics policies, and sanctions against misconduct is likely to reduce the discretionary power of customs officials to apply rules arbitrarily.

We also compute the average TFI, TF^{AK}, as the simple average of all the eleven TF indicators listed from (a) to (k) in Table A.1. This measure is our proxy for average trade facilitation performance for an importing country j in a given year t.

Other variables. We collect data on other variables to test the underlying mechanisms and to serve as additional controls. We include country-level variables such as the log of GDP per capita (in current US$), which is sourced from the October 2019 edition of IMF's World Economic Outlook, and control of corruption, which is sourced from the World Governance Indicators (WGI).[16] In addition, we collect data on two country-level variables that proxy overall customs efficiency. These variables include Days to import, which is sourced from World Bank's Doing Business indicators, and an index of customs performance from the World Bank's Logistics Performance Index (LPI). At the product level, we include a differentiated good dummy, which equals one if the HS6 product is differentiated, i.e. the product is neither traded on organized exchange nor does it have a reference price according to the Rauch (1999)'s (conservative)

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cooperation and coordination with the border control authorities and agencies of other members with whom it shares a common border. Such coordination may include alignment of working days and hours and of procedures and formalities, development and sharing of common facilities, joint controls and the establishment of one stop border post control.

[16]The control of corruption index is ranked on a scale of -2.5 to 2.5, with higher scores being associated with a stronger control of corruption.

classification.[17]

Tables A.1 and A.2 provide an overview of all variables used in the analysis.

3.2. Descriptive statistics

Table A.3 provides in-sample summary statistics for all variables that are used in the empirical analysis. The average of missing imports is -0.04. The value is close to zero, which suggests that on average, mirror trade statistics reported by partner countries are comparable. The negative sign suggests that reported exports are on average smaller than reported imports.[18] This is expected since imports are calculated including the cost of insurance and freight (CIF). However, the upper tail of the missing imports' distribution consists of positive values. In fact, a quarter of all missing imports observations are positive, which suggests that imports could be systematically undervalued to avoid tariff charges. A global representation of missing imports, averaged across all HS6 products and the three years of the sample (2012, 2015, and 2017) for each country is provided in Figure A.1.

The mean (median) MFN tariff rate in the sample is equal to 6.71% (5%). In the main analysis we only consider tariffs below the 99$^{\text{th}}$ percentile of the distribution, therefore the maximum MFN tariff is 40%. While we discard prohibitive tariff rates (in some cases equal to 3,000%), we provide a robustness check where only tariff rates above 100% are excluded.

4. Empirical strategy

We first estimate the reduced form effect of tariff on customs evasion using the following specification:

$$mi_{jkt} = \beta_1 \tau_{jkt} + \mathbf{FE}_{jt} + \mathbf{FE}_{kt} + \mathbf{FE}_{jk} + \epsilon_{jkt}, \tag{1}$$

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[17]The data are at 4-digit level of aggregation of the SITC Rev. 2 classification. Standard crosswalks, available at `http://wits.worldbank.org/product_concordance.html`, are used to concord them to the HS 2007 classification.

[18]Missing imports are calculated as the difference between (log) exports reported by all partner countries and (log) imports reported by the importing country – see equation (2). A negative sign on missing imports implies that reported exports are less than reported imports.

where mi_{jkt} (missing imports) measures evasion at the importer-HS6 product-year (jkt) level. We calculate the dependent variable as the difference between the log value of exports reported by all exporting countries to importing country j in sector k at time t (X_{jkt}) and the log value of imports reported by country j from all countries (M_{jkt}):

$$mi_{jkt} \equiv \ln\left(1 + X_{jkt}\right) - \ln\left(1 + M_{jkt}\right). \tag{2}$$

The construction of the dependent variable differs from Fisman and Wei (2004), who calculate missing imports at the importer-exporter-HS6 product-year ($jikt$) level, but only for one importer j (China) and one exporter i (Hong Kong). Their sample size is therefore approximately 1,650 observations. As detailed below, we are interested in estimating the moderating effect that country-level trade facilitation might have on tariff evasion (i.e., on the positive correlation between tariffs and missing imports) across importing countries worldwide. Since trade facilitation only varies along the jt dimension, adding the exporter (i) dimension would significantly increase the sample size, but add relatively little information.[19]

In the baseline specification, the construction of the dependent variable also differs from Javorcik and Narciso (2008), who study tariff evasion in ten Eastern European countries. They select a reference exporter to ensure that export data are measured consistently. Germany is selected as the reference exporter because of its high level of governance, and because it is a major trading partner of all the importing countries in their sample. In our baseline specification, we aggregate the exports reported by all partner countries for each importer, instead of considering bilateral trade with a reference exporter, for two reasons. First, this strategy ensures that we do not only select importer-HS6 product categories that comprise bilateral trade with the reference exporter. Second, as we do not have a regional focus, the choice of reference exporter is not self-evident.[20] However, we also consider an alternative specification in Sec-

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[19]Adding the exporter (i) dimension would increase the sample size up to $121 \times 121 \times 5,000 \times 3 = 216$ million observations.

[20]In a recent paper, Javorcik and Narciso (2017) study the effect of WTO accession on mis-representation of

tion 5.2 where we estimate the effect of trade facilitation on tariff evasion at the bilateral level ($jikt$), using United States as the common exporter (i). This helps to determine whether our baseline findings are affected by potential heterogeneous mis-reporting by different exporting countries.

In equation (1), τ_{jkt} represents the tariff rate in HS6 product category k within importer j in year t. Importer-year fixed effects $\mathbf{FE}_{jt}$ account for unobserved country-level characteristics, such as corruption level or trade policy, that could change over time. Product-year fixed effects $\mathbf{FE}_{kt}$ account for unobserved product-level characteristics, such as homogenizing consumption patterns (Kónya and Ohashi, 2007), that can evolve over time. Finally, importer-product fixed effects $\mathbf{FE}_{jk}$ account for unobserved product-level characteristics, such as the political influence of sector k, that are specific to importing country j. β_1 measures the tariff semi-elasticity of missing imports. A priori, $\beta_1 > 0$, i.e. a higher tariff rate is associated with larger missing imports in an HS6 product category.

We first estimate the tariff semi-elasticity in a sample that covers all years from 2012 till 2017. As discussed in Section 3, trade facilitation data cover the years 2012, 2015 and 2017. We therefore also estimate the tariff semi-elasticity of missing imports in the sample only covering these three years. In baseline estimations we exclude tariffs above the 99$^{\text{th}}$ percentile,[21] while we also provide a robustness check where only tariff rates above 100% are excluded (see discussion in Section 3.2).

To estimate the moderating effect of trade facilitation on tariff evasion, we modify equation (1) as follows:

$$mi_{jkt} = \beta_1\tau_{jkt} + \beta_2(\tau_{jkt} \times \text{TF}^m_{jt}) + \mathbf{FE}_{jt} + \mathbf{FE}_{kt} + \mathbf{FE}_{jk} + \epsilon_{jkt} \tag{3}$$

where β_2 is the coefficient of interest. Equation (3) is estimated for each TF^m_{jt}, where m = {IA,IT,AR,AP,FC,FM,CP,GI} indexes measures that cover different aspects of trade facilitation

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import prices for 15 importing countries. They select three reference exporters: Germany, France and the United States.

[21]The 99$^{\text{th}}$ percentile tariff rate in the sample is 40%, while the maximum rate is 3,000%.

(see Section 3 and Table A.1). Further, we include a measure of average trade facilitation performance (TF^{AK}), also described in Section 3 and Table A.1. According to Proposition 1, $\beta_2(TF^{AK}) < 0$, i.e., improving trade facilitation performance, on average, should weaken the positive relationship between tariff rate and missing imports. We also test Proposition 2, assessing which specific trade facilitation measures TF_{jt}^m are effective in reducing tariff evasion.

4.1. Threats to identification

Omitted variable bias. We use a rich set of fixed effects in all estimations to address plausible bias from omitted variables.

Importer-year fixed effects should control for the simultaneous impact of any time-varying country characteristics – such as institutional quality, level of development, endowments of productive factors, and technological advancements – on tariff levels and on evasion.[22]

A second source of endogeneity can be from evolving global tastes that jointly affect tariff rates and evasion in certain product categories. Including product-year fixed effects accounts for this potential omitted variable bias.

Thirdly, lobbying activity of certain sectors may jointly determine missing imports and tariff. For example, sectors using a high share of imported inputs sourced from the same sector might have a greater incentive to mis-report imports and are also likely to lobby for lower tariffs. The inclusion of importer-product fixed effects controls for any product-specific characteristics within an importer country, which should account for lobbying behavior assuming it does not vary over time.[23] Moreover, an importer may apply higher tax on HS6 products where it enjoys low elasticity of foreign export supply (Ludema and Mayda, 2013). These sectors could observe higher missing imports. The inclusion of importer-product fixed effects accounts for this source of omitted variable bias.

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[22]Importer-year fixed effects should for instance account for any improvement in national transport infrastructure which could be correlated with trade liberalization (Javorcik and Narciso, 2008).

[23]Our approach is similar to Ludema and Mayda (2013) who use importer-industry fixed effects to control for lobbying behavior.

Reverse causality.   The coefficient of interest (β_2 in equation (3)) can still be biased due to reverse causality. For example, the government could try to insulate tariff revenue by setting tariff rates in inverse proportion to the missing imports (Fisman and Wei, 2004). While the inclusion of importer-product fixed effects should partially account for this possibility, evasion may become apparent over time and tariffs may be adjusted accordingly (Bussy, 2020). MFN tariffs, however, are determined through multilateral negotiations and it is unlikely that a country can independently set such tariffs in response to missing imports.

Another concern is that missing imports could potentially affect trade facilitation measures. On balance, such a relationship is less probable, i.e., evasion within an HS6 product category is unlikely to guide a country-level policy change. However, tariff evasion in HS6 products that are most critical from a tariff revenue perspective may provide incentive for an importing country to simplify its customs procedures (i.e., to improve its trade facilitation performance). We address the potential reverse causality from missing imports to trade facilitation in a robustness check in which we exclude HS6 products that are in the top decile according to their import shares within importer j.

Measurement error.   Missing imports may be estimated with a measurement error. Discrepancy in the values of mirror trade statistics can arise as exports are recorded in free on board (FOB) terms, while the imports are calculated including the cost of insurance and freight (CIF). These differences are unlikely to be systematically correlated with tariffs and therefore our estimator remains unbiased (Fisman and Wei, 2004). The measurement error can however make our estimator less efficient. This concern is alleviated as the time-invariant component of transport cost which is specific to a importer-product pair is accounted for in our specification, which includes importer-product fixed effects.

5. Results

5.1. *Trade facilitation performance and tariff evasion*

Baseline results. Table 1 presents the estimated effect of tariff rates on customs evasion. Each regression includes the most restrictive set of fixed effects: importer-year, importer-product and product-time. As expected, missing imports are increasing in MFN tariffs. The effect in column (1) is statistically significant at 1% level. The point estimate in column (1) suggests a tariff semi-elasticity of 0.3 for the period from 2012 until 2017. In other words, a one percentage point increase in MFN tariff raises missing imports by 0.3%. While smaller in magnitude compared to the tariff semi-elasticity reported by Fisman and Wei (2004), who only study the trade pattern between China and Hong Kong, the point estimate is similar to studies that use larger country samples (Javorcik and Narciso, 2008; Jean and Mitaritonna, 2010).[24] In columns (2) and (3), where we restrict the sample to years for which trade facilitation data are available, the tariff semi-elasticity is slightly smaller (0.2).[25] These results are relevant because we find a tariff semi-elasticity comparable to the recent literature even if we do not use the bilateral exporter-importer dimension, but only the importer dimension, in the construction of missing imports.

Having established that tariff evasion is ubiquitous across different samples, we assess if trade facilitation measures have a dampening effect on the phenomenon. In Table 2 we report the results from the interaction model (3). The coefficients on the TF interaction terms in columns (1)-(9) of Table 2 correspond to the coefficient of interest (β_2) for different trade facilitation policy measures and their average. In column (1) the measure of average trade fa-

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[24]Fisman and Wei (2004) report the tariff semi-elasticity of around 3 between Hong Kong and China. Subsequent literature has reported tariff semi-elasticities that are much smaller. Mishra et al. (2008) estimate a tariff semi-elasticity of 0.1 for India and its set of trade partners. Javorcik and Narciso (2008) study the trade pattern between Germany and ten Eastern European countries, and find the tariff semi-elasticity estimate to be between 0.4 and 1 depending on the choice of the specification. In a cross-sectional study of 75 countries, Jean and Mitaritonna (2010) estimate the tariff semi-elasticity to be 0.24. In a recent working paper, Bussy (2020) uses a country-product sample that includes 190 countries and all HS6 categories. He studies tariff evasion between 1993 and 2017 and finds a slightly lower tariff semi-elasticity of 0.16 compared to ours.

[25]Columns (2) and (3) of Table 1 use the same years, but different sets of countries. The former uses all available countries, the latter is based on the same sample as Table 2.

Table 1 Tariff rate and missing imports

	(1)	(2)	(3)
Tariff	0.003***	0.002**	0.002**
	(0.001)	(0.001)	(0.001)
Observations	2,819,258	1,324,891	1,187,684
No. of countries	155	137	121
No. of HS6	4,975	4,916	4,863

Notes: *p<0.10, **p<0.05,***p<0.01. Dependent variable: missing imports, defined in equation (2) as the difference between the log value of exports reported by all exporting countries to importing country j in HS6 product k in year t (X_{jkt}) and the log value of imports reported by j from all countries in HS6 product k in year t (M_{jkt}), i.e. $mi_{jkt} \equiv \ln(1 + X_{jkt}) - \ln(1 + M_{jkt})$. Tariff is defined as the MFN tariff by importer j on k in t. Robust standard errors in parentheses. Country-year (jt), country-HS6 product (jk) and HS6 product-year (kt) fixed effects included in all specifications. Column (1) includes years 2012-2017. Column (2) includes years 2012, 2015, and 2017. Column (3) uses the same sample as column (1) of Table 2. See Section 3.1 and tables A.1-A.2 for variables' description.

cilitation performance (TF^{AK}) interacted with MFN tariff is negative and statistically significant at 10% level. The negative sign of the interaction term suggests that improving trade facilitation performance has a dampening effect on tariff evasion. The point estimates imply that, holding tariff rate constant at its mean, improving average trade facilitation performance from the 25th percentile to the median reduces the tariff semi-elasticity of missing imports by almost 20% (see Figure 2). This result confirms Proposition 1, i.e., improvement in trade facilitation performance, on average, weakens the positive effect of tariffs on customs evasion.

Table 2 Trade facilitation and tariff evasion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tariff	0.005***	0.004**	0.001	0.006***	0.004***	0.001	0.003**	0.003***	0.003**
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tariff × TF^{AK}	-0.002*								
	(0.001)								
Tariff × TF^{IA}		-0.001							
		(0.001)							
Tariff × TF^{IT}			0.001**						
			(0.001)						
Tariff × TF^{AR}				-0.004***					
				(0.001)					
Tariff × TF^{AP}					-0.001**				
					(0.001)				
Tariff × TF^{FC}						0.001			
						(0.001)			
Tariff × TF^{FM}							-0.000		
							(0.001)		
Tariff × TF^{CP}								-0.001	
								(0.000)	
Tariff × TF^{GI}									-0.000
									(0.001)
Observations	1,187,684	1,187,684	1,143,541	1,124,212	1,156,742	1,112,370	1,187,684	1,173,937	1,115,283
No. of countries	121	121	115	115	116	110	121	119	113

Notes: *p<0.10, **p<0.05,***p<0.01. Dependent variable: missing imports, defined in equation (2) as the difference between the log value of exports reported by all exporting countries to importing country j in HS6 product k in year t (X_{jkt}) and the log value of imports reported by j from all countries in HS6 product k in year t (M_{jkt}), i.e. $mi_{jkt} \equiv \ln\left(1 + X_{jkt}\right) - \ln\left(1 + M_{jkt}\right)$. Tariff is defined as the MFN tariff by importer j on k in t. TF^{AK} is the simple average of trade facilitation measures pertaining to information availability (TF^{IA}), involvement of the trade community (consultations) (TF^{IT}), advance rulings (TF^{AR}), appeal procedures (TF^{AP}), fees and charges (TF^{FC}), formalities (TF^{FM}), cooperation (TF^{CP}), and governance and impartiality (TF^{GI}). Robust standard errors in parentheses. Country-year (jt), country-HS6 product (jk) and HS6 product-year (kt) fixed effects included in all specifications. Years included: 2012, 2015, and 2017. Number of HS6: 4,863. See Section 3.1 and tables A.1-A.2 for variables' description.

Figure 2 Average trade facilitation: marginal effects
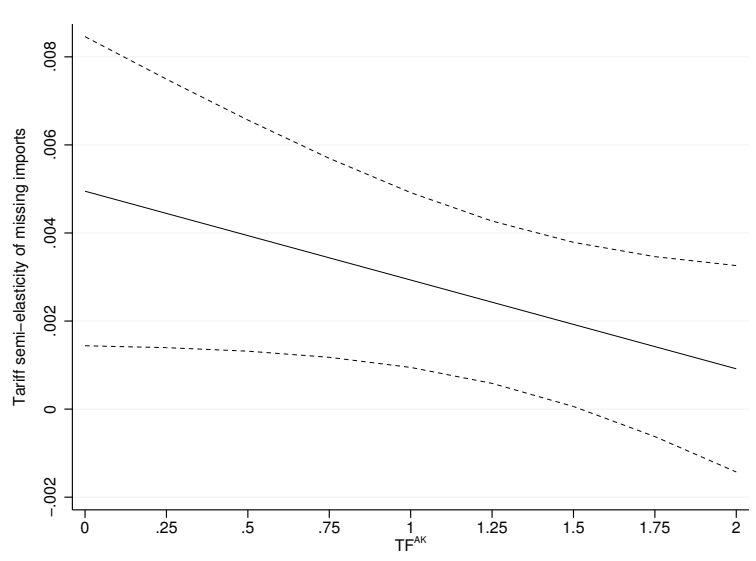
Notes: Marginal effects are computed from the estimates in column (1) of Table 2. The dashed lines display 95% confidence intervals based on the Delta method. Missing imports are defined in equation (2) as the difference between the log value of exports reported by all exporting countries to importing country j in HS6 product k in year t (X_{jkt}) and the log value of imports reported by j from all countries in HS6 product k in year t (M_{jkt}), i.e. $mi_{jkt} \equiv \ln\left(1 + X_{jkt}\right) - \ln\left(1 + M_{jkt}\right)$. Tariff is defined as the MFN tariff by importer j on k in t. TF^{AK} is the simple average of trade facilitation measures pertaining to information availability (TF^{IA}), involvement of the trade community (consultations) (TF^{IT}), advance rulings (TF^{AR}), appeal procedures (TF^{AP}), fees and charges (TF^{FC}), formalities (TF^{FM}), cooperation (TF^{CP}), and governance and impartiality (TF^{GI}). See Section 3.1 and tables A.1-A.2 for variables' description.

We next unpack the effectiveness of different trade facilitation policies in reducing tariff evasion. We find a significant difference in the impact of individual trade facilitation policy measures on tariff evasion, which confirms Proposition 2. The impact of overall trade facilitation performance is accounted for by information on advance rulings (TF^{AR}) and, to a lesser extent, appeal procedures (TF^{AP}). These results are broadly consistent with Hillberry and Zhang (2018), who find that trade facilitation measures related to procedures and to advance rulings help reducing the cost to import.[26]

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[26]The evasion-augmenting effect of the trade facilitation measure related to the involvement of the trading community (TF^{IT}) in column (3) of Table 2 is somewhat puzzling. Fontagné et al. (2020) find that the measure related to involvement of the trading community does not benefit small firms at destination, and could even hamper their trade margin by increasing competition. In absence of firm-level data, we unfortunately cannot verify if firm composition is driving the evasion-augmenting effect of the trade facilitation measure related to the involvement of the trading community.

Robustness checks.   We perform several checks on the main result related to the overall trade facilitation performance (TF^{AK}) in our baseline specification. First, we exclude sectors that are in top decile of the distribution of import shares in country j. These sectors could plausibly drive a reverse causal relationship between missing imports and trade facilitation. Results presented in column (1) of Table 3 show that excluding these sectors does not affect our estimate of overall trade facilitation performance. The result suggests that missing imports in HS6 products do not influence country-level trade facilitation measures. In Column (2) of Table 3, we consider the effect of trade facilitation performance using effectively applied tariffs as a proxy for tariff rate. The dampening effect of trade facilitation performance on tariff evasion is even stronger compared to our baseline specification. The result confirms that our result is not driven by the choice of proxy for import tariffs. Next, instead of excluding tariffs in top 99th percentile, we exclude tariff rates over 100%. This criterion is less conservative, as it allows for the inclusion of 11,533 additional observations relative to column (1) of Table 2. Results presented in column (3) of Table 3 show that trade facilitation performance continues to significantly dampen tariff evasion (the effect is more robust in this specification). Column (4) of Table 3 presents the result while holding trade facilitation performance data constant over years when it is not reported. Trade facilitation performance continues to have a dampening effect on tariff evasion even though the magnitude is relatively smaller. Finally, we assess whether trade facilitation performance could be capturing other country characteristics whose effect on missing imports may vary with the level of tariff. In column (5) of Table 3 we include interactions between HS6 tariffs and (the log of) GDP per capita, and between HS6 tariffs and two customs performance proxies other than TF^{AK}: time to import (in days) and the efficiency of customs and border management clearance (LPI customs index). The effect of trade facilitation performance is robust to the inclusion of these additional interactions.

Table 3 Trade facilitation and tariff evasion: robustness

	Excluding large import shares	Effectively applied tariff	Excluding tariff >100%	TF measures constant over years with no data	Additional interactions
	(1)	(2)	(3)	(4)	(5)
Tariff	0.005**	0.006***	0.004***	0.005***	0.005**
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Tariff × TF$^{\text{AK}}$	-0.002*	-0.004***	-0.002**	-0.001*	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tariff × GDP$_{\text{pc}}$					0.002
					(0.005)
Tariff × DB$_{\text{time}}$					-0.001***
					(0.000)
Tariff × LPI$_{\text{cust.}}$					0.006
					(0.017)
Observations	1,047,798	1,182,416	1,199,217	2,504,661	1,165,416
No. of countries	121	121	121	137	116
No. of HS6	4,851	4,862	4,864	4,970	4,863

Notes: *p<0.10, **p<0.05,***p<0.01. Dependent variable: missing imports, defined in equation (2) as the difference between the log value of exports reported by all exporting countries to importing country j in HS6 product k in year t (X_{jkt}) and the log value of imports reported by j from all countries in HS6 product k in year t (M_{jkt}), i.e. $mi_{jkt} \equiv \ln(1 + X_{jkt}) - \ln(1 + M_{jkt})$. Tariff is defined as the MFN tariff by importer j on k in t in columns (1) and (3)-(5), and as the effectively applied tariff by importer j on k in t in column (2). TF$^{\text{AK}}$ is the simple average of trade facilitation measures pertaining to information availability (TF$^{\text{IA}}$), involvement of the trade community (consultations) (TF$^{\text{IT}}$), advance rulings (TF$^{\text{AR}}$), appeal procedures (TF$^{\text{AP}}$), fees and charges (TF$^{\text{FC}}$), formalities (TF$^{\text{FM}}$), cooperation (TF$^{\text{CP}}$), and governance and impartiality (TF$^{\text{GI}}$). Robust standard errors in parentheses. Importer-year (jt), importer-sector (jk), and HS6 product-year (kt) fixed effects included in all specifications. Years included: 2012, 2015, and 2017, except in column (4), which includes years 2012-2017. See Section 3.1 and tables A.1-A.2 for variables' description.

5.2. *Alternative specification: bilateral data*

In this section we estimate the effect of trade facilitation measures on tariff evasion using a specification that is similar to Javorcik and Narciso (2008). Specifically, we consider the effectiveness of trade facilitation measures in a bilateral specification with United States (US) as the reference exporter. We estimate a specification of the following form:

$$mi_{jkt}^{US} = \beta_1 \tau_{jkt}^{US} + \beta_2 (\tau_{jkt}^{US} \times \text{TF}_{jt}^m) + \textbf{FE}_{jt} + \textbf{FE}_{kt} + \textbf{FE}_{jk} + \epsilon_{jkt}. \qquad (4)$$

Missing imports are defined as the difference between the log value of exports reported by the US to importing country j ($j \neq US$) in HS6 product k at time t (X_{jkt}^{US}) and the log value of imports reported by importing country j ($j \neq US$) from the US (M_{jkt}^{US}), i.e. $mi_{jkt}^{US} \equiv \ln(1 + X_{jkt}^{US}) - \ln(1 + M_{jkt}^{US})$. Tariff is defined as the minimum observed tariff (bound, MFN,

preferential, and effectively applied) by importer j vis-à-vis the US to capture to the extent possible cross-importer variation in market access granted to the US, for instance as a consequence of preferential tariff liberalization. Having the United States as the exporter ensures that the export data are measured consistently. We chose the United States as the reference exporter because it has a high level of governance. Hence any discrepancies in mirror trade statistics are likely to arise due to the importer-side characteristics. Once again β_2 is the coefficient of interest and it measures the mediating effect of trade facilitation on tariff evasion.

Column (1) of Table 4 shows that improving trade facilitation performance has a strong and negative effect on tariff evasion. The effect is statistically significant at 1% level. The point estimates imply that, holding tariff rate constant at its mean, improving average trade facilitation performance from the 25th percentile to the median reduces the tariff semi-elasticity of missing imports by 35%.[27] Further, results in columns (2)-(9) showcase a significant variation in the effectiveness of trade facilitation measures on tariff evasion, even when export data are measured consistently. The results imply that the variation in the effectiveness of trade facilitation measures in our baseline specification is not due to how we measure missing imports.

The results presented thus far corroborate two main findings. First, we find that improving trade facilitation performance, on average, weakens the positive relationship between missing imports and import tariffs. Second, we find that trade facilitation measures differ significantly in their effectiveness. In particular, pre-shipment legal certainty of border procedures or 'advance rulings' (indicator TF^{AR}) appears to be effective in reducing tariff evasion.

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[27]While the magnitude of reduction in tariff semi-elasticity is larger than the baseline estimate, the sample is also different due to 300 fewer HS6 product categories.

Table 4 Trade facilitation and tariff evasion: bilateral flows vis-à-vis the United States

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tariff	0.016***	0.013***	0.008***	0.012***	0.004	0.001	0.011***	0.007***	0.009***
	(0.005)	(0.004)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
Tariff × TF^{AK}	-0.009***								
	(0.003)								
Tariff × TF^{IA}		-0.005**							
		(0.002)							
Tariff × TF^{IT}			-0.002*						
			(0.001)						
Tariff × TF^{AR}				-0.004**					
				(0.002)					
Tariff × TF^{AP}					0.000				
					(0.002)				
Tariff × TF^{FC}						0.002			
						(0.001)			
Tariff × TF^{FM}							-0.005**		
							(0.002)		
Tariff × TF^{CP}								-0.002	
								(0.001)	
Tariff × TF^{GI}									-0.003**
									(0.002)
Observations	417,357	417,357	410,107	406,410	412,281	406,860	417,357	412,530	404,236
No. of importers	123	123	116	115	117	111	123	121	114
No. of HS6	4,563	4,563	4,563	4,561	4,560	4,563	4,563	4,562	4,563

Notes: *p<0.10, **p<0.05,***p<0.01. Dependent variable: missing imports (values) vis-à-vis the United States (US). This is defined as the difference between the log value of exports reported by the US to importing country j ($j \neq US$) in HS6 product k in year t (X_{jkt}^{US}) and the log value of imports reported by importing country j ($j \neq US$) from the US (M_{jkt}^{US}), i.e. $mi_{jkt}^{US} \equiv \ln\left(1 + X_{jkt}^{US}\right) - \ln\left(1 + M_{jkt}^{US}\right)$. Tariff is defined as the minimum observed tariff (bound, MFN, preferential, and effectively applied) by importer j vis-à-vis the US. TF^{AK} is the simple average of trade facilitation measures pertaining to information availability (TF^{IA}), involvement of the trade community (consultations) (TF^{IT}), advance rulings (TF^{AR}), appeal procedures (TF^{AP}), fees and charges (TF^{FC}), formalities (TF^{FM}), cooperation (TF^{CP}), and governance and impartiality (TF^{GI}). Robust standard errors in parentheses. Importer-year (jt), importer-sector (jk), and HS6 product-year (kt) fixed effects included in all specifications. Years included: 2012, 2015, and 2017. See Section 3.1 and tables A.1-A.2 for variables' description.

In the following analysis we quantify the impact of improving trade facilitation on tariff evasion, and identify mechanisms behind the evasion-dampening effect of trade facilitation. We first perform a counterfactual exercise where we assess the effect of a full tariff liberalization conditional on the observed levels of trade facilitation in the importing country. Next, we identity which channels of tariff evasion are particularly sensitive to improvement in trade facilitation. Finally, we explore whether the effectiveness of trade facilitation in reducing tariff evasion is mediated by other country characteristics. In particular, we test Proposition 3, which predicts that trade facilitation can be especially effective in curbing tariff evasion in countries with low control of corruption.

5.3. Quantification

In this section, we provide a counterfactual estimation of the impact of full tariff liberalization on missing imports. The exercise is similar to Beverelli et al. (2017), who estimate the impact of full services trade liberalization on manufacturing productivity in a sample of 57 countries and 18 sectors. First, we quantify the effect of full tariff liberalization at country level. Then, we compare the effect to that of a reference country, to ask two counterfactual questions: 1) what would be the impact of a full tariff liberalization for a given common level of trade facilitation? and 2) how might the impact of same tariff liberalization vary, depending on cross-country differences in the level of trade facilitation?

The results of the quantification exercise are presented in Table 5. Column (1) shows the estimated percentage change in missing imports (without the log transformation) that would be obtained from full tariff liberalization. This is the average (across all sectors and years) marginal effect from the baseline estimations of column (1) of Table 2, computed by assigning to the country its average level of TF^{AK} in the three years of the sample (2012, 2015, and 2017).[28]

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[28]The marginal effects are multiplied by 100 times the negative of tariff, because the counterfactual is full tariff liberalization. This follows equation (6) of Beverelli et al. (2017). The number of countries in the table is 86, while the number of countries in Table 2 is 121. This is because Table 5 only includes countries for which the estimated marginal effects are significant at the 5% level.

Table 5 Quantification

Country	ISO3	%ΔMI	%ΔMI – %ΔMI$_{RC}$ (3) + (4)	Components of (2)		Country rankings	
				Tariff	TF^{AK}	Tariff	TF^{AK}
		(1)	(2)	(3)	(4)	(5)	(6)
Central African Republic	CAF	-7.90	-6.74	-3.24	-3.50	86	86
Algeria	DZA	-5.34	-4.52	-3.40	-1.12	85	65
Ethiopia	ETH	-4.74	-3.84	-3.07	-0.78	84	58
Antigua and Barbuda	ATG	-4.38	-3.04	-1.71	-1.33	73	79
Benin	BEN	-4.20	-3.05	-1.99	-1.06	78	73
Malawi	MWI	-4.15	-3.00	-1.97	-1.03	76	74
Cote d'Ivoire	CIV	-4.12	-3.13	-1.98	-1.15	69	78
Burkina Faso	BFA	-4.10	-3.04	-1.95	-1.09	72	75
Togo	TGO	-3.99	-2.92	-1.99	-0.93	75	70
Belize	BLZ	-3.91	-2.71	-1.32	-1.38	58	83
Zambia	ZMB	-3.78	-2.72	-2.09	-0.63	79	59
Uganda	UGA	-3.74	-2.76	-1.97	-0.79	68	66
Bangladesh	BGD	-3.71	-2.78	-2.31	-0.47	81	53
Mali	MLI	-3.69	-2.65	-1.93	-0.72	70	62
Nepal	NPL	-3.58	-2.75	-1.93	-0.82	65	68
Samoa	WSM	-3.57	-2.38	-1.52	-0.85	63	71
Solomon Islands	SLB	-3.41	-2.20	-0.95	-1.26	51	84
Tanzania	TZA	-3.38	-2.47	-1.97	-0.50	67	54
Madagascar	MDG	-3.37	-2.42	-1.84	-0.58	66	60
Rwanda	RWA	-3.33	-2.24	-2.07	-0.17	80	47
Jamaica	JAM	-3.23	-1.77	-0.99	-0.78	55	77
Fiji	FJI	-3.22	-2.17	-1.54	-0.63	61	63
Maldives	MDV	-3.17	-2.14	-1.47	-0.68	60	64
Tunisia	TUN	-3.15	-2.20	-2.30	0.10	82	30
Pakistan	PAK	-3.09	-2.15	-2.10	-0.05	74	42
Zimbabwe	ZWE	-3.07	-2.18	-2.20	0.01	77	34
Bolivia	BOL	-2.98	-2.21	-1.97	-0.24	64	48
Lesotho	LSO	-2.92	-1.89	-0.93	-0.97	48	82
Senegal	SEN	-2.82	-1.84	-2.01	0.17	71	27
Brazil	BRA	-2.77	-2.04	-2.59	0.54	83	9
Uruguay	URY	-2.64	-1.79	-1.77	-0.02	62	38
Eswatini	SWZ	-2.62	-1.71	-0.87	-0.84	46	81
Paraguay	PRY	-2.59	-1.68	-1.58	-0.10	59	46
Egypt	EGY	-2.52	-1.82	-1.43	-0.39	50	55
Belarus	BLR	-2.52	-1.42	-0.70	-0.72	40	80
Ecuador	ECU	-2.40	-1.73	-1.81	0.08	57	31
Angola	AGO	-2.21	-1.42	-0.85	-0.57	38	72
Jordan	JOR	-2.12	-1.27	-1.42	0.15	54	25
Namibia	NAM	-2.06	-1.21	-0.81	-0.40	39	61
Viet Nam	VNM	-2.05	-1.28	-1.29	0.01	49	35
Kazakhstan	KAZ	-2.03	-1.00	-0.72	-0.28	41	56
Dominican Republic	DOM	-2.01	-1.05	-0.81	-0.24	44	52
India	IND	-1.97	-1.19	-1.58	0.39	56	6
Azerbaijan	AZE	-1.96	-1.01	-1.20	0.19	52	18
China	CHN	-1.88	-1.10	-1.40	0.30	53	12
Russian Federation	RUS	-1.79	-0.80	-0.74	-0.06	43	45
Honduras	HND	-1.75	-0.75	-0.39	-0.36	31	67
Botswana	BWA	-1.75	-0.83	-0.85	0.02	45	33
Bosnia and Herzegovina	BIH	-1.70	-0.85	-0.68	-0.17	36	50
Sri Lanka	LKA	-1.69	-0.76	-0.95	0.19	47	16
Lebanese Republic	LBN	-1.65	-0.79	-0.42	-0.37	27	69
Indonesia	IDN	-1.60	-0.98	-1.13	0.14	42	23
Panama	PAN	-1.60	-0.55	-0.53	-0.02	37	40
Kuwait	KWT	-1.46	-0.59	-0.18	-0.41	14	76
Kyrgyz Republic	KGZ	-1.40	-0.61	-0.59	-0.02	32	41
Nicaragua	NIC	-1.32	-0.33	-0.37	0.04	30	32
El Salvador	SLV	-1.31	-0.34	-0.44	0.10	34	22
Mexico	MEX	-1.28	-0.44	-0.62	0.19	35	13
Oman	OMN	-1.26	-0.41	-0.20	-0.20	15	57
Guatemala	GTM	-1.26	-0.35	-0.41	0.05	29	29
Armenia	ARM	-1.20	-0.38	-0.49	0.11	28	21
Hungary	HUN	-1.18	-0.35	-0.24	-0.11	18	49
Chile	CHL	-1.18	-0.37	-0.58	0.21	33	11
Ukraine	UKR	-1.15	-0.32	-0.20	-0.12	6	51

Continued on next page

Table 5: Quantification – *Continued from previous page*

| Country	ISO3	%ΔMI	%ΔMI – %ΔMI$_{RC}$	Components of (2)		Country rankings	
			(3) + (4)	Tariff	TF^{AK}	Tariff	TF^{AK}
		(1)	(2)	(3)	(4)	(5)	(6)
Moldova	MDA	-1.12	-0.26	-0.36	0.10	26	20
Greece	GRC	-1.10	-0.26	-0.24	-0.03	20	44
Saudi Arabia	SAU	-1.09	-0.28	-0.28	0.00	23	36
Turkey	TUR	-1.08	-0.32	-0.38	0.05	24	28
Palau	PLW	-1.08	0.13	0.54	-0.41	4	85
Qatar	QAT	-1.06	-0.17	-0.17	-0.01	10	39
Mongolia	MNG	-0.99	0.02	-0.17	0.19	25	8
United Arab Emirates	ARE	-0.99	-0.19	-0.26	0.07	12	26
Bahrain	BHR	-0.99	-0.09	-0.16	0.08	16	24
Estonia	EST	-0.96	-0.09	-0.21	0.12	22	15
Spain	ESP	-0.96	-0.15	-0.24	0.09	8	19
Czechia	CZE	-0.95	-0.13	-0.24	0.10	13	17
Italy	ITA	-0.92	-0.12	-0.24	0.12	7	14
Croatia	HRV	-0.88	-0.04	-0.24	0.19	21	3
Poland	POL	-0.88	-0.07	-0.24	0.17	9	7
Bulgaria	BGR	-0.87	-0.03	-0.23	0.19	19	1
Portugal	PRT	-0.87	-0.05	-0.24	0.19	17	2
Belgium	BEL	-0.86	-0.05	-0.24	0.19	11	4
Israel	**ISR**	**-0.80**	**0.00**	**0.00**	**0.00**	**5**	**37**
Peru	PER	-0.52	0.30	0.19	0.11	3	5
Georgia	GEO	-0.38	0.61	0.61	-0.01	2	43
Norway	NOR	-0.19	0.60	0.57	0.03	1	10

Notes: Quantification based on column (1) of Table 2. Reference country (RC) for columns (2)-(4): Israel (indicated in bold). MI = missing imports of equation (2) without the log transformation. Only countries for which the estimated marginal effects from regressions in column (1) of Table 2 are significant at the 5% level are included in the table. For MFN tariff (column (5)), the lower the ranking, the lower average MFN tariff is across years and sectors. For TF^{AK} (column (6)), the lower the ranking, the higher average trade facilitation. See Section 5.3 for details on the quantification exercise. See Section 3.1 and tables A.1-A.2 for variables' description.

There is significant heterogeneity in the estimated impact of full tariff liberalization across countries. Less developed countries, which also tend to have high tariffs and low levels of trade facilitation – see respectively columns (5) and (6) of Table 5 – stand to gain most from tariff liberalization. Accordingly, Figure 3 depicts a positive association between the estimated changes in missing imports from tariff liberalization (in absolute values) and GDP per capita.[29]

To facilitate cross-country comparisons, columns (2)-(4) of Table 5 compare the average percentage change in missing imports in each country with that for a reference country. We select Israel as the reference country because the effect of full tariff liberalization on its missing imports is equivalent to the average effect of full liberalization in the sample. We note, however, that the choice of the reference country does not affect the results, as long as the reference

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[29]Qualitatively similar results as those of Figure 3 are obtained using the numbers in columns (5) or (6) of Table 5, rather than GDP per capita (in logs), on the horizontal axis.

Figure 3 Estimated impact of full tariff liberalization and GDP per capita
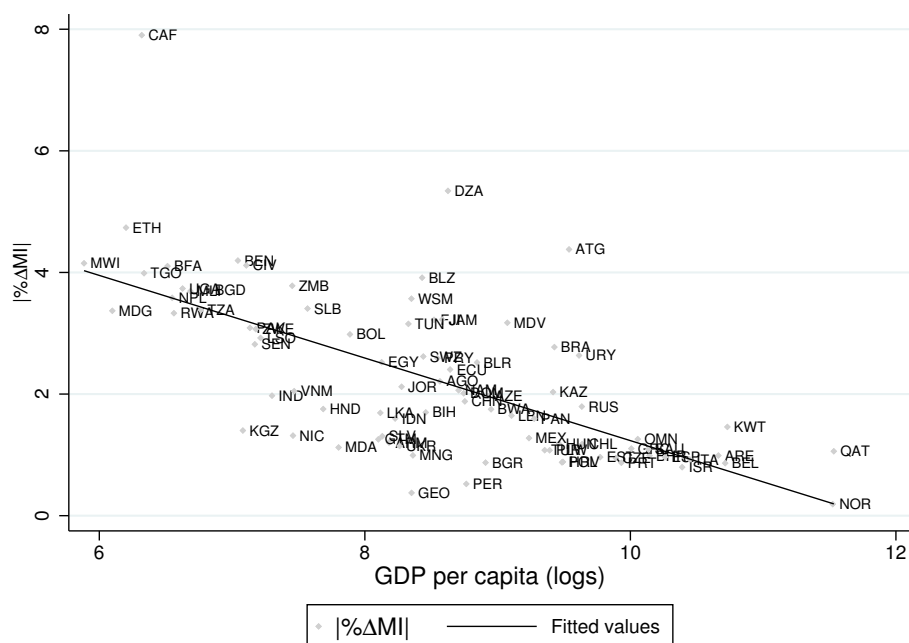
Notes: |%ΔMI| is the absolute values of the estimated percentage change in missing imports (without the log transformation) that would be obtained from full tariff liberalization, averaged across all years and all sectors. The data are from column (1) of Table 5. Data from GDP per capita (in logs) are sourced from IMF World Economic Outlook (WEO) (see Section 3.1 and Table A.2). ISO country codes indicated. See Table 5 for corresponding country names.

country is a relatively advanced economy among the ones listed in Table 5.[30]

Column (2) of Table 5 reports the average across all sectors and years of the difference in the estimated impact of full tariff liberalization between each country and the reference country.[31] The effect is decomposed into two parts. The first part of the effect (column (3)) reflects heterogeneity in MFN tariff rates, which implies that a different policy change is needed in each country to attain full liberalization. In particular, column (3) reports the difference in the marginal effects after aligning the trade facilitation attainment of each country with that of the reference country. Intuitively, the values in column (3) answer the question, "what would be the difference in the marginal effect on missing imports of liberalization if the trade facilitation context were the same as in the reference country?", and therefore capture the impact of

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[30]There is, for instance, a close to perfect correlation between the results that use Israel as reference country and the results that use Belgium, Italy, or Norway as reference country. These results are available upon request.

[31]The reason why the numbers in column (2) of Table 5 are not exactly equal to the difference between the value of column (1) estimated for each country and the value of column (1) estimated for the reference country is that these values are averages across all sectors and years. For a given country-sector-year combination, the difference is exact.

heterogeneity in levels of trade openness. The second part of the effect (column (4)) reflects the contribution of heterogeneity in average trade facilitation to the difference in the estimated impact of full tariff liberalization between each country and the reference country. The values in column (4), in particular, answer the question "how would the impact of the same tariff liberalization change, depending on cross-country differences in the average level of trade facilitation"?

Compare the Central African Republic, the country with highest tariffs and lowest average trade facilitation in Table 5, to Ethiopia, a country with similarly high MFN tariffs, but significantly better TF^{AK}. In absolute terms, the Central African Republic would experience a 7.90% reduction in missing imports under a full tariff cut scenario, compared with a 4.74% reduction in Ethiopia. Relative to the reference country, the reduction in missing imports would be 6.74% in the Central African Republic and 3.84% in Ethiopia. In the Central African Republic, approximately half of the relative reduction in missing imports (3.50 out of 6.74) is due to differences in average trade facilitation between this country and the reference country; the other half (3.24 out of 6.74) is due to differences in tariffs between this country and the reference country. In the case of Ethiopia, most of the differential effect of full tariff liberalization with respect to the reference country is accounted for by differences in tariffs. In particular, differences in tariffs between Ethiopia and the reference country explain 80% of the relative reduction in missing imports (3.07 out of 3.84), while the remaining 20% (0.78 out of 3.84) are due to differences in average trade facilitation between Ethiopia and the reference country. These results reflect the fact that Ethiopia is relatively more different from the reference country in terms of average tariffs (as shown in the rankings of column (5) of Table 5) than in terms of average trade facilitation (as shown in the rankings of column (6) of Table 5) compared to the Central African Republic.

5.4. Channels of tariff evasion and trade facilitation

Existing literature identifies three channels through which tariff evasion can occur. First, tariff evasion can occur through mis-classification of products, i.e. an importer could report a higher taxed product as a lower taxed variety (Fisman and Wei, 2004). Second, tariff evasion can occur through under-reporting of unit prices (Javorcik and Narciso, 2008, 2017). Finally, tariff evasion can occur through under-declaration of product quantities (Rotunno and Vézina, 2012).

To check whether trade facilitation affects these three channels of tariff evasion, we modify the baseline interaction model (3) and introduce product-level characteristics that identify the potential channel of tariff evasion.

First, to test the mis-classification of products channel, we create a dummy variable that equals one if, within each country and year, the HS6 product tariff is higher than the average tariff on similar goods (Fisman and Wei, 2004).[32] A lower average tariff rate on similar products would increase the incentive to evade through mis-classification. A positive sign on the interaction between the above described HS4 tariff dummy and the HS6 tariff would imply evasion through mis-classification. Finally, we interact the mis-classification proxy with our measure of average trade facilitation performance. The triple interaction term identifies whether improving trade facilitation performance can reduce tariff evasion that occurs through mis-classification of products. Results presented in Column (1) of Table 6 fail to detect any effect of trade facilitation performance on reducing evasion through mis-classification of products.

Next, we ask whether trade facilitation can dampen evasion that occurs through under-reporting of unit prices. We modify the baseline interaction model in two ways. First, we follow the literature on detecting evasion through under-reporting and use unit value gap as our dependent variable (Javorcik and Narciso, 2017). We define unit value gap as the difference in unit values of exports of HS6 product k in year t that is reported by the world and by the

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[32]Similar goods are defined as all other products in same HS4 heading. That is, HS6 product k is excluded from the HS4 average.

Table 6 Trade facilitation and tariff evasion: mechanisms

	Mis-reporting	Under-invoicing	Under-declaration of quantities
	(1)	(2)	(3)
Tariff	0.005**	-0.005*	0.006*
	(0.002)	(0.003)	(0.003)
Tariff × TF^{AK}	-0.002	0.004**	-0.003
	(0.001)	(0.002)	(0.002)
Tariff × HS4 tariff dummy	-0.001		
	(0.003)		
Tariff × HS4 tariff dummy × TF^{AK}	0.000		
	(0.002)		
Tariff × Differentiated dummy		0.006	
		(0.004)	
Tariff × Differentiated dummy × TF^{AK}		-0.005*	
		(0.002)	
Tariff × Non-kilo dummy			-0.003
			(0.006)
Tariff × Non-kilo dummy × TF^{AK}			-0.000
			(0.004)
Observations	1,186,788	922,853	1,027,091
No. of countries	121	121	121
No. of HS6	4,863	4,403	4,856

Notes: *p<0.10, **p<0.05,***p<0.01. Dependent variable: missing imports in values, defined in equation (2) in column (1); unit value gap, defined in equation (5) in column (2); missing imports in quantities, defined in equation (6) in column (3). Tariff is defined as the MFN tariff by importer j on k in t. TF^{AK} is the simple average of trade facilitation measures pertaining to information availability (TF^{IA}), involvement of the trade community (consultations) (TF^{IT}), advance rulings (TF^{AR}), appeal procedures (TF^{AP}), fees and charges (TF^{FC}), formalities (TF^{FM}), cooperation (TF^{CP}), and governance and impartiality (TF^{GI}). HS4 tariff dummy is equal to one if, within each country and year, the HS6 product tariff is higher than the average tariff on similar goods. Differentiated dummy is equal to one if the HS6 product is differentiated according to the conservative version of Rauch's (1999) classification. Non-kilo dummy is equal to one if the HS6 product is not measured in kilos. Robust standard errors in parentheses. Country-year (jt), country-HS6 product (jk) and HS6 product-year (kt) fixed effects included in all specifications. Years included: 2012, 2015, and 2017. Number of countries: 121. See Section 3.1, Section 5.4, and tables A.1-A.2 for variables' description.

importer:

$$uvg_{jkt} \equiv \ln\left(\frac{1 + X_{jkt}}{1 + X_{jkt}^{Q}}\right) - \ln\left(\frac{1 + M_{jkt}}{1 + M_{jkt}^{Q}}\right),$$ (5)

where X_{jkt} (X_{jkt}^{Q}) is the value (quantity) of exports reported by all exporting countries to importing country j in sector k at time t, and M_{jkt} (M_{jkt}^{Q}) is the value (quantity) of imports reported by country j from all countries in sector k at time t. Second, we add a dummy variable that equals one if the HS6 product is differentiated according to the conservative version of Rauch's (1999) classification. Differentiated products are those products whose price may range widely because of product quality, and therefore it may be difficult to detect under-pricing (Javorcik and Narciso, 2017). A positive sign on the interaction between the Differentiated dummy

and tariff rate would imply that evasion happens through under-reporting of unit prices. Further, we interact this proxy of evasion through under-reporting with our measure of average trade facilitation performance, to assess whether it can potentially dampen evasion through under-pricing. Results presented in column (2) of Table 6 suggest that improving trade facilitation performance significantly reduces evasion that occurs through under-reporting of unit prices.[33]

Lastly, we test whether trade facilitation could reduce evasion through under-declaration of product quantities. Once more we modify the baseline interaction model model in two ways. Following Javorcik and Narciso (2017), we calculate the dependent variable as the log ratio of the quantity of exports relative to the quantity of imports:

$$mi_{jkt}^{Q} \equiv \ln\left(1 + X_{jkt}^{Q}\right) - \ln\left(1 + M_{jkt}^{Q}\right). \tag{6}$$

Next, we add a dummy variable that equals one if the HS6 product is not measured in kilos (Non-kilo dummy). The idea is that it is easier to weigh a container than to count the number of packaged units (Rotunno and Vézina, 2012). Hence HS6 products that are reported in kilograms would be more difficult to evade through under-declaration of quantity. A positive sign on the interaction between the Non-kilo dummy and tariff rate would imply that evasion in HS6 category happens through under-declaration of quantity. Finally, we interact the proxy for evasion through under-declaration with our measure of average trade facilitation to identity whether improving trade facilitation performance reduces evasion through under-declaration of quantities. Results presented in Column (3) of Table 6 suggest that improving trade facilitation performance does not impact evasion that occurs through under-declaration of product quantities.

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[33]The negative coefficient on Tariff in column (2) of Table 6 – which might be interpreted as inconsistent with tariff evasion – is the tariff semi-elasticity of missing imports at zero level of trade facilitation for homogeneous products. The estimated marginal effects, which are available in Figure A.2, show that this semi-elasticity is negative and statistically significant only for homogeneous products at very low levels of trade facilitation, while it is positive, though not statistically significant, in all other cases.

To sum up the results presented in this section, we find that the evasion-dampening effect of trade facilitation is driven by a reduction in the incentive to evade through under-reporting of unit prices.

5.5. Control of corruption, tariff evasion, and trade facilitation

So far we have assessed the overall dampening effect of trade facilitation on tariff evasion, which is plausibly due to the lowering cost of customs procedures (Proposition 1). However, the relationship between trade facilitation and tariff evasion could be mediated by country-level control of corruption. This is because importers in countries with low control of corruption can avoid detection of tariff evasion by offering side payments to customs officials. Trade facilitation, by automating customs procedures, can reduce the involvement of customs officials and hence the opportunity for corruption at customs. Further, transparency in legal provisions or having a dispute resolution mechanism could weaken the discretionary power of customs officials to apply rules arbitrarily. Hence, trade facilitation should have an additional evasion-reducing effect through harmonizing customs procedures in countries with low control of corruption (Proposition 3).

We modify the baseline interaction model (3) and include a proxy for country-level control of corruption, Low CC dummy, equal to one when the control of corruption (CC) is below a given threshold.[34] Next, we interact the Low CC dummy with Tariff and with TF^{AK}. A negative sign on the triple interaction term would imply that improving trade facilitation reduces tariff evasion more in countries with low control of corruption. Results presented in Table 7 suggest that improving trade facilitation performance further weakens tariff evasion in countries with lowest control of corruption: the magnitude of the triple interaction is progressively smaller as we include countries with higher control of corruption. The dampening effect of

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[34]We define three different Low CC dummies. The first is based on the 10th percentile of the control of corruption index as threshold. The second is based on the 25th percentile of the control of corruption index as threshold. The third is based on the 50th percentile of the control of corruption index as threshold. Control of corruption is sourced from the World Bank's World Governance Indicators.

Table 7 Country-level control of corruption, trade facilitation, and tariff evasion

	Control of corruption (CC) percentile		
	10th	25th	50th
	(1)	(2)	(3)
Tariff	0.006***	0.002	0.005**
	(0.002)	(0.002)	(0.002)
Tariff × TF^{AK}	-0.002	0.000	-0.001
	(0.001)	(0.001)	(0.001)
Tariff × Low CC dummy	0.015*	0.013***	0.001
	(0.008)	(0.003)	(0.003)
Tariff × Low CC dummy × TF^{AK}	-0.019***	-0.011***	-0.002
	(0.007)	(0.003)	(0.002)
Observations	1,187,684	1,187,684	1,187,684

Notes: *p<0.10, **p<0.05,***p<0.01. Dependent variable: missing imports, defined in equation (2) as the difference between the log value of exports reported by all exporting countries to importing country j in HS6 product k in year t (X_{jkt}) and the log value of imports reported by j from all countries in HS6 product k in year t (M_{jkt}), i.e. $mi_{jkt} \equiv \ln\left(1 + X_{jkt}\right) - \ln\left(1 + M_{jkt}\right)$. Tariff is defined as the MFN tariff by importer j on k in t. TF^{AK} is the simple average of trade facilitation measures pertaining to information availability (TF^{IA}), involvement of the trade community (consultations) (TF^{IT}), advance rulings (TF^{AR}), appeal procedures (TF^{AP}), fees and charges (TF^{FC}), formalities (TF^{FM}), cooperation (TF^{CP}), and governance and impartiality (TF^{GI}). Low CC dummy equal to one if control of corruption (CC) is below the 10th percentile (column (1)), or the 25th percentile (column (2)), or the median (column (3)). Robust standard errors in parentheses. Country-year (jt), country-HS6 product (jk) and HS6 product-year (kt) fixed effects included in all specifications. Years included: 2012, 2015, and 2017. Number of countries: 121. Number of HS6: 4,863. See Section 3.1 and tables A.1-A.2 for variables' description.

improving trade facilitation on tariff evasion in countries with low levels of control of corruption, which plausibly occurs through reductions in the discretionary power of customs officials, corroborates Proposition 3.

6. Conclusions

Tax evasion at customs has proven to be one of the most resilient forms of trade costs, which disproportionately affects public finance in developing countries. International trade policy has advanced two approaches to improve compliance. A first approach has been to improve detection to dissuade tariff evasion. The evidence for the efficacy of these policies is however mixed, since traders can substitute to alternative duty-avoidance mechanisms. A second approach has been to reduce the complexity of customs procedures to improve traders' compliance. The latter approach is enshrined in the WTO's Trade Facilitation Agreement which entered into force in 2017. The effectiveness of simplifying customs procedures on tariff evasion, however, has not been previously studied.

We provide evidence from a global dataset that simplifying customs procedures has a robust negative effect on tariff evasion. The simplification of customs procedures is particularly effective in reducing evasion that occurs through the under-reporting of import prices. The effect is also more pronounced in countries with low control of corruption, suggesting that simplified customs procedures can check the discretionary power of customs officials.

Not all measures aimed at simplifying customs procedures that are contained in the WTO's Trade Facilitation Agreement have a significant impact on tariff evasion. Pre-shipment legal certainty of border procedures is particularly effective in moderating tariff evasion, and hence it should be considered as part of any customs reforms strategy. The heterogeneous impact of different trade facilitating measures on tariff evasion suggests that policy makers can gradually simplify customs procedures to minimize tariff evasion efficiently. We therefore corroborate the Trade Facilitation Agreement's approach to eschew a one-size-fits-all model and encourage WTO member countries to adopt policies that are most effective in reducing customs bottlenecks.

Appendix

Table A.1 TFI indicators used

	Indicator	Variable	Description	Corresponding WTO TFA article
(a)	Information availability	TF^{IA}	Enquiry points; publication of trade information, including on Internet.	Art. 1. Publication and Availability of Information
(b)	Involvement of the trade community (consultations)	TF^{IT}	Structures for consultations; established guidelines for consultations; publications of drafts; existence of notice-and-comment frameworks.	Art. 2. Opportunity to Comment, Information Before Entry Into Force and Consultations
(c)	Advance rulings	TF^{AR}	Prior statements by the 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.	Art. 3. Advance Rulings
(d)	Appeal procedures	TF^{AP}	The possibility and modalities to appeal administrative decisions by border agencies.	Art. 4. Appeal or Review Procedures
(e)	Fees and charges	TF^{FC}	Disciplines on the fees and charges imposed on imports and exports; disciplines on penalties.	Art. 6. Disciplines on Fees And Charges Imposed on or in Connection With Importation and Exportation
(f, g, h)	Formalities	TF^{FM}	Average of (f) Formalities (documents), (g) Formalities (automation), and (h) Formalities (procedures).	Art. 7. Release and Clearance of Goods and Art. 10. Formalities Connected With Importation, Exportation and Transit
(i, j)	Cooperation	TF^{CP}	Average of (i) Internal cooperation, and (j) External cooperation.	Art. 8. Border Agency Cooperation
(k)	Governance and impartiality	TF^{GI}	Customs structures and functions; accountability; ethics policy.	
(a)-(k)	Average	TF^{AK}	Simple average of TF^{IA}, TF^{IT}, TF^{AR}, TF^{AP}, TF^{FC}, TF^{FM}, TF^{CP}, and TF^{GI}.	

Notes: Descriptions of the indicators from Table 1 in the methodology note on OECD's TFI: `https://www.oecd.org/trade/topics/trade-facilitation/documents/trade-facilitation-indicators-methodology.pdf`. Description of TFI indicator (f) Formalities (documents): Acceptance of copies, simplification of trade documents; harmonization in accordance with international standards. Description of TFI indicator (g) Formalities (automation): Electronic exchange of data; use of automated risk management; automated border procedures; electronic payments. Description of TFI indicator (h) Formalities (procedures): Streamlining of border controls; single submission points for all required documentation (single windows); post-clearance audits; authorised operators. Description of TFI indicator (i) Internal co-operation: Control delegation to Customs authorities; co-operation between various border agencies of the country. Description of TFI indicator (j) External co-operation: Co-operation with neighbouring and third countries. TFI indicator (k) Governance and impartiality is outside the scope of the WTO's Trade Facilitation Agreement (TFA).

Table A.2 Variables' description

| Variable	Description	Data source
Missing imports (values)	Log difference in value of exports reported by all exporting countries to importing country i in sector k at time t (X_{ikt}) and value imports reported by country i from all countries (M_{ikt}). See equation (2)	UN Comtrade
Unit value gap	Log difference in the unit value of exports reported by all exporting countries to importing country i in sector k at time t and unit value of imports reported by i from all countries. See equation (5)	– "–
Missing imports (quantities)	Log difference in the quantity of exports reported by all exporting countries to importing country i in sector k at time t and quantity of imports reported by country i from all countries. See equation (6)	– "–
Tariff	Log of MFN applied tariff of importing country i in sector k	UNCTAD TRAINS
TF^m	See Table A.1	OECD TFIs
GDP_{pc}	Log of gross domestic product per capita	IMF WEO
DB_{time}	Number of days to import	World Bank DB
$LPI_{cust.}$	Efficiency of customs and border management clearance	World Bank LPI
HS4 tariff dummy	Dummy equal to one if the tariff in sector k in importer i in year t is greater than its corresponding HS4 average (excluding sector k's tariff from the average)	UNCTAD TRAINS
Differentiated dummy	Dummy equal to one if k has no reference price and k's price is not quoted on an organized exchange	Rauch (1999)
Non-kilo dummy	Dummy equal to one if, within i, k is never reported in kilograms between 2012 and 2017	UN Comtrade
Low CC dummy (10th percentile)	Dummy equal to one for observations if the Control of Corruption (CC) index is below its 10th percentile	World Bank WGI's
Low CC dummy (25th percentile)	Dummy equal to one for observations if the Control of Corruption (CC) index is below its 25th percentile	– "–
Low CC dummy (50th percentile)	Dummy equal to one for observations if the Control of Corruption (CC) index is below its 50th percentile	– "–

Notes: TF^m = Trade Facilitation indicator m, $m = \{IA, IT, AR, AP, FC, FM, CP, GI\}$. DB = Doing Business. LPI = Logistics Performance Index. WEO = World Economic Outlook. WGI's = World Governance Indicators.

Table A.3 In-sample descriptive statistics

Variable	Mean	Median	Std Dev	Min	Max	Sample
Missing imports (values)	-0.04	-0.06	1.37	-15.26	13.79	Col. (1) of Table 2
Unit value gap	0.11	-0.01	1.26	-22.48	28.03	Col. (2) of Table 6
Missing imports (quantities)	-0.14	-0.05	1.98	-28.00	23.25	Col. (3) of Table 6
Tariff (MFN)	6.71	5.00	7.53	0	40.00	Col. (1) of Table 2
Tariff (AHS)	4.69	2.50	6.37	0.00	37.02	Col. (2) of Table 3
Tariff (USA)	4.41	2.00	6.19	0	40.00	Col. (1) of Table 4
TF^{AK}	1.39	1.44	0.30	0.28	1.93	Col. (1) of Table 2
TF^{IA}	1.61	1.65	0.29	0	2	Col. (2) of Table 2
TF^{IT}	1.40	1.50	0.48	0	2	Col. (3) of Table 2
TF^{AR}	1.36	1.50	0.60	0	2	Col. (4) of Table 2
TF^{AP}	1.49	1.50	0.39	0	2	Col. (5) of Table 2
TF^{FC}	1.44	1.50	0.48	0	2	Col. (6) of Table 2
TF^{FM}	1.34	1.38	0.35	0.33	2	Col. (7) of Table 2
TF^{CP}	1.27	1.33	0.57	0	2	Col. (8) of Table 2
TF^{GI}	1.53	1.71	0.48	0	2	Col. (9) of Table 2
GDP_{pc}	9.23	9.37	1.32	5.87	11.57	Col. (5) of Table 3
DB_{time}	17.92	15.00	12.69	4.00	73.75	– "–
$LPI_{cust.}$	2.95	2.83	0.57	2.05	4.09	– "–

| Variable	Zeros	Ones	Std Dev	Min	Max	Sample
HS4 tariff dummy	940,793	245,995	0.41	0	1	Col. (1) of Table 6
Differentiated dummy	321,748	601,105	0.48	0	1	Col. (2) of Table 6
Non-kilo dummy	734,313	292,778	0.45	0	1	Col. (3) of Table 6
Low CC dummy (10th percentile)	1,142,106	45,578	0.19	0	1	Col. (1) of Table 7
Low CC dummy (25th percentile)	977,087	210,597	0.38	0	1	Col. (2) of Table 7
Low CC dummy (50th percentile)	662,674	525,010	0.50	0	1	Col. (3) of Table 7

Notes: See tables A.1-A.2 for variables' description.

Figure A.1 Missing imports, country-level averages
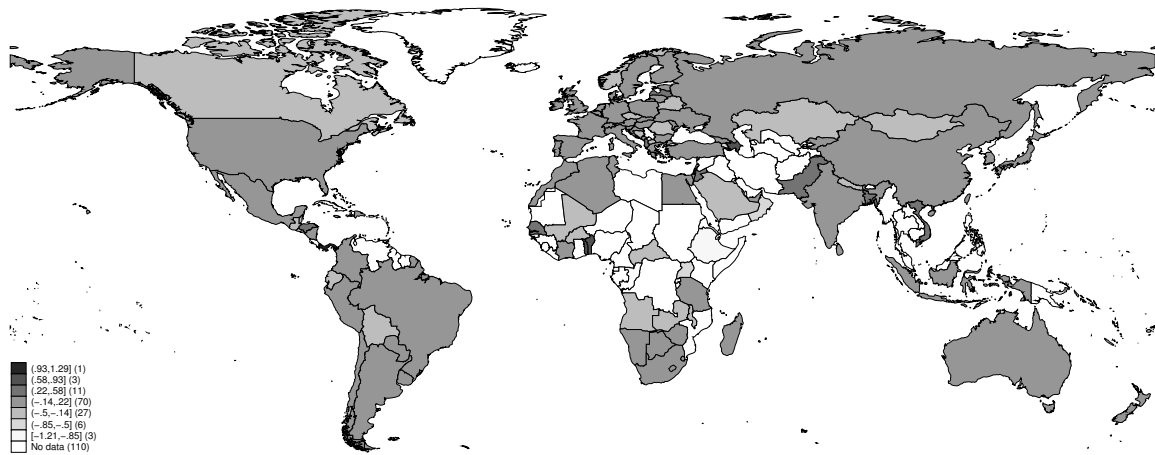
Notes: Countries covered: 121 importers of column (1) of Table 2. The figure displays averages – within importer j across HS6 products k and the three years t of the sample (2012, 2015, 2017) – of missing imports, defined in equation (2) as the difference between the log value of exports reported by all exporting countries to importing country j in HS6 product k in year t (X_{jkt}) and the log value of imports reported by j from all countries in HS6 product k in year t (M_{jkt}), i.e. $mi_{jkt} \equiv \ln\left(1 + X_{jkt}\right) - \ln\left(1 + M_{jkt}\right)$.

Figure A.2 Average trade facilitation: marginal effects as a function of Differentiated dummy
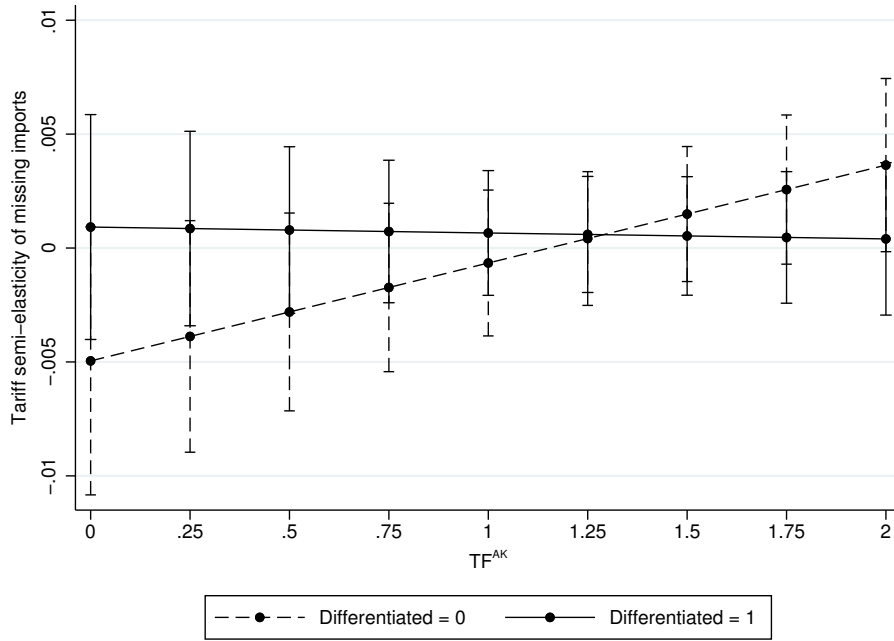
Notes: Marginal effects are computed from the estimates in column (2) of Table 6. The vertical lines display 95% confidence intervals based on the Delta method. TF^{AK} is the simple average of trade facilitation measures pertaining to information availability (TF^{IA}), involvement of the trade community (consultations) (TF^{IT}), advance rulings (TF^{AR}), appeal procedures (TF^{AP}), fees and charges (TF^{FC}), formalities (TF^{FM}), cooperation (TF^{CP}), and governance and impartiality (TF^{GI}). Missing imports are measured as the unit value gap, defined in equation (5) as $uvg_{jkt} \equiv \ln\left(\frac{1+X_{jkt}}{1+X_{jkt}^{Q}}\right) - \ln\left(\frac{1+M_{jkt}}{1+M_{jkt}^{Q}}\right)$, where X_{jkt} (X_{jkt}^{Q}) is the value (quantity) of exports reported by all exporting countries to importing country j in sector k at time t, and M_{jkt} (M_{jkt}^{Q}) is the value (quantity) of imports reported by country j from all countries in sector k at time t. Tariff is defined as the MFN tariff by importer j on k in t. See tables A.1-A.2 for variables' description.

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