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Determinants and pervasiveness of the evasion of customs duties

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Abstract: Evasion of customs duties is a serious concern in developing countries, where tariff receipts are often important, but their collection is often problematic. We study theoretically and empirically the determinants of evasion across countries and products, based on a systematic analysis of discrepancies in trade declarations - when available - for both partners. We conclude that evasion of customs duties is greater in poorer countries, especially where the rule of law is limited. The consequences are likely to be the most serious in the poorest countries, where we find a one percentage point higher tariff to be associated on average with an understatement of imports of 1% or more. We assess some policy remedies and conclude that automated customs data treatment may be particularly useful.

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Introduction

Because tariff receipts are collected at specific locations –customs clearance points- they are generally considered to benefit from lower collection costs than most other taxes. This might explain why, despite their suboptimality, tariffs are frequently used as revenue devices by low-income countries (Aizenman, 1985): according to Baunsgaard and Keen's data (2009), the share of trade tax revenue in total tax receipts in 2001-2006 amounted to an average of 2.5% in high-income countries, 18.1% in middle-income countries and 22% in low-income countries.[1] In nine countries, tariff receipts accounted for more than half of the tax revenue in at least one year in this period. While collection of tariff duties may be almost anecdotal for rich countries, it is a serious matter for most developing countries where the available evidence suggests that the mechanism is far from perfect: achieved tariff collection rates, computed as assessed collected taxes compared to what should have originated from imports given statutory protection, are frequently less than 70% in Africa, and in some cases they do not reach 50%.[2] Also, these figures may be overstated, to the extent that they are based on trade statistics, which also may not be accurate. For instance, an official United Nations' (UN) letter, based on an undisclosed study conducted by a private company, cites a figure of 80% of customs taxes *not* being collected in the Democratic Republic of Congo (UN, 2005, p. 15).

[1] Assessing tariff receipts in developing countries is difficult. The main statistical source is the International Monetary Fund (IMF) *Government Finance Statistics,* but for many countries in this database, the tariff receipts item actually includes other tax sources such as excise duties, sales taxes, or so-called 'phytosanitary' or 'statistical' taxes. Baunsgaard and Keen (2009) complement these data with information drawn from the IMF's periodic consultations with member countries. We are grateful to them for making the data available to us. We computed the figures reported here as unweighted means across countries and years.

[2] In their study on the Common Market for Eastern and Southern Africa (COMESA), Brenton et al. (2007) assess average tariff collection rates at about 72% for Ethiopia, 77% for Madagascar, 73% for Malawi, 66% for Zambia and less than 50% for Mauritius. Concerning the *Communauté Economique et Monétaire de l'Afrique Centrale* (CEMAC), Gallezot and Laborde (2007) report tax collection rates of 44% for Cameroon and 62% for the Central African Republic. Decaluwé et al. (2008) report tariff collection rates for the Economic Community of West African States (ECOWAS) ranging from 38% for Togo, to 88% for Burkina Faso; other ECOWAS countries include Ghana (84%), Guinea (81%), Nigeria (51%), Benin (45%), Mali (86%), Niger (63%), Senegal (67%), Cote d'Ivoire (67%). The data required to compute these figures are frequently confidential and/or difficult to access.

There are many ways to evade customs duties, ranging from fallacious declarations to bribery and smuggling, all resulting in actual collection costs being understated. A number of features can favour tax evasion, for instance poor levels of law enforcement or distribution of tariffs. This raises questions about the effectiveness of the collection of customs and how it is affected by tariff liberalization. Should tariff revenue losses associated with tariff changes be computed at face value, i.e. based on statutory protection, or is the relationship more complex? Would targeted reforms be likely to improve customs duty collection?

The double declaration of trade flows - by importer and exporter - offers an opportunity to gauge the importance of these unlawful practices: while evading customs duties generally requires the importer to sidestep import registration requirements, the situation is different for exporters. Bhagwati (1964, 1967) pioneered the use of discrepancies between 'matched' declarations (often referred to as mirror declarations) at product level to reveal customs duties evasion: the results pointed to underinvoicing of imports in Turkey, in particular for manufactured products. More recently, Fisman and Wei (2004) focused on Chinese imports from Hong-Kong. Their work shows that higher tariffs are associated statistically with lower declarations by the importing country compared to the mirror declarations made by the exporter. The relationship is not negligible: Fisman and Wei find that a 1 percentage point increase in the tax rate is associated with a 3% increase in tax evasion. Following Mishra et al. (2008), we refer to this semi-elasticity of evasion with respect to tariff, as evasion elasticity.

Van Dunem and Arndt (2009) using the same approach for the case of Mozambique find an evasion elasticity half as a large as in the Chinese case. Applying the same approach to trade between Germany and ten Eastern European countries in 1992-2003, Javorcik and Narciso (2008) find support for the hypothesis that higher product-level tariffs spur higher levels of tariff evasion,

again with estimated elasticities that tend to be weaker than those found by Fisman and Wei. Javorcik and Narciso show that the relationship between reporting discrepancies and tariffs is stronger for differentiated than for homogenous products, which they explain by the greater ease to conceal the real value of goods when they are differentiated, as also suggested by Bhagwati (1967). Mishra et al. (2008) show that there is a comparable relationship between tariffs and discrepancies in reported trade flows in India during the 1990s, although smaller than the one found by Fisman and Wei for China. The gap, however, appears to be declining over time. Bouët and Roy (2010) using a comparable framework, study Nigeria, Kenya and Mauritius and find a positive and significant evasion elasticity for all three countries.

These case studies suggest that customs duty evasion is not specific to a few countries and is likely linked to the quality of institutions. However, they do not assess the pervasiveness of the phenomenon or identify cross-country determinants of its magnitude. In this paper, we take a broader view, first using a simple model to study how evasion is likely to vary with ease of enforcement and with institutions. While Mishra et al.'s (2008) model of tariff evasion is based on an assumed cost of evasion, our model explicitly describes the interaction between importing firms and customs officers, in order to clarify how the institutional setup can influence evasion. We study discrepancies in mirror trade declarations in relation to the tariff duties for all countries for which data are available for 2004. This systematic approach allows us to assess the pervasiveness of customs duty evasion worldwide and to empirically evaluate the model predictions about cross-product and cross-country determinants.

Recent work (Johnson, 2001; Keen, 2003; De Wulf and Sokol, 2005) emphasizes that strategies implemented specifically to reduce corruption are unlikely to be successful unless supported by an improved broader legal environment. Based on the numerous attempts to reform

customs administrations and on the most relevant tools and principles proposed by experts in this area, targeted measures should be considered. We extend our empirical analysis to assess the effectiveness of specially designed policy measures.

Our analysis provides the first worldwide picture of customs duty evasion. It suggests that the phenomenon is widespread in intermediate and poor countries, especially when the rule of law is limited. This means in particular that assessing the fiscal consequences of trade policies based on tariff duties taken at face value, may lead to significant overstatements. We also find significant empirical support for the effectiveness of some, but not all, targeted policy remedies considered. Extensions dealing with discrepancies in quantities and unit values, and with cases of no declared imports, but declarations from exporting partners, are consistent with these findings.

The paper is organized as follows. Section 2 presents a simple model, sketching the determinants of customs duty evasion and their interaction with institutional frameworks and product characteristics. Section 3 presents the empirical approach and provides a description of the data and the descriptive statistics. Sections 4 and 5 present the econometric analysis of determinants and possible remedies. Extensions and robustness checks are discussed in Section 6.

1 Theoretical analysis: evasion, tariffs and institutions

We present a simple model of the determinants of customs duty evasion and their interaction with the institutional framework. Mishra et al. (2008) provides a useful general analysis of this issue, based on the simple hypothesis that there is a positive cost to smuggling or avoiding taxes, increasing in the fraction of the imports smuggled and the quality of law enforcement by government, with a marginal cost of smuggling also increasing in the fraction smuggled and in enforcement quality. In this context, Mishra et al. show (for usual cost functions)

that the elasticity of evasion with respect to tariffs is a decreasing function of the quality of tariff enforcement.

Since our analysis covers different types of policy measures aimed at fighting customs duty evasion, we develop the theoretical analysis in order to be more specific about the mechanisms at work and the influence of the institutional framework. Adapting Mookherjee and Png's (1995) analysis of corruptible law enforcers, we explicitly model the interaction between customs officers and importers.

We consider a firm importing a fixed amount M,[3] facing an ad valorem tariff duty t. The importer can choose to conceal the true value of the shipment and to declare an import value of only $(1-\gamma)M$, where $0 \leq \gamma \leq 1$. The main ways to evade custom duties are discussed in the next section. Upon clearance, the customs officer may disclose the true value of the shipment, with probability $d(\gamma, \epsilon) = \epsilon\gamma^2$, where $\epsilon \in [0;1]$ is an index measure of external factors influencing this probability.[4] As emphasized in particular by Javorcik and Narciso (2008) and Mishra et al. (2008), product differentiation is an important such factor, because the true value of a shipment is more difficult to assess for differentiated than for homogenous products. For simplicity, we refer to ϵ as ease of enforcement in what follows. The probability of disclosure is assumed, therefore, to be increasing and convex in the share of import smuggled, reflecting the

[3] We assume this amount to be given exogenously, as, e.g., in Mishra et al. (2008), but assuming otherwise would leave most of the subsequent results unchanged.

[4] In the simple specification used here, ϵ is the probability of complete smuggling being discovered (i.e., the probability that $\gamma = 1$). However, using $f(\epsilon)$ instead of ϵ, where f is any function such that $f > 0, f' > 0$, would not change the results, meaning that this interpretation should not be considered essential.

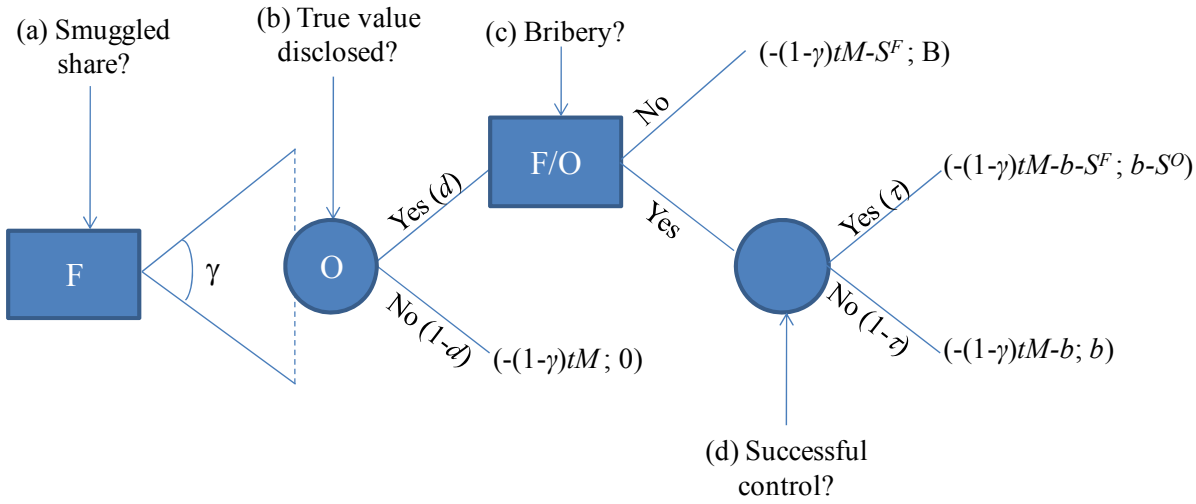
fact that concealing the true value of the shipment is increasingly difficult, in both average and marginal terms, as the share smuggled increases.[5]

If the customs officer discovers the true value of the shipment, assuming it has been understated by the importer (i.e., $\gamma > 0$), he should sanction the importing firm with a penalty S^F. In this case, we assume the customs officer to be rewarded with a bonus proportional to the tariff revenue recovered, $B = \beta^O t\gamma M$ where $0 \leq \beta^O \leq 1$, as in Anson et al. (2006). However, the customs officer may be open to a bribe b from the importer to overlook the understatement. In this case, the customs officer is exposed to an administrative control. The probability that such control is applied, reveals the bribery *and* gives rise to a sanction depends on a variety of factors, including the effort expended by government on these controls and on measures aimed specifically at improving the customs administration (see below), as well as the credibility of sanctions.[6] For simplicity, we represent this probability by an index measure, τ, which refers to transparency in what follows. When a case of bribery is discovered, the customs officer is sanctioned with the penalty S^O and the importer with the penalty S^F. The sequence of events is summarized in Figure 1, adapted from Mookherjee and Png (1995).

[5] For simplicity, the probability is assumed proportional to the squared value of the smuggled share, but using γ^n with any $n > 1$ would not alter the results.

[6] For simplicity, we assume that this probability does not depend on the share smuggled, e.g., because the control technology is the same for the customs officer and the administrative controller.

Figure 1: Sequence of decisions and events



Note: F refers to the importing firm, O to the customs officer. In each case, the payoffs for the importer and the customs officer are shown in parentheses. Figure 1 describes cases where the importer understates the shipment value (i.e. $\gamma > 0$). If $\gamma = 0$, the payoffs are $(-tM; 0)$.

Needless to say, the decision to engage or not in bribery does not involve only an economic dimension. As suggested by Allingham and Sandmo (1972), nonpecuniary factors should be taken account of in the agents' utility functions. However, here we ignore this dimension and focus exclusively on purely economic incentives, assuming agents to be risk neutral. We solve the model backward, by assessing first under which conditions bribery might take place. In the event of the true shipment value being disclosed, the importer expects to gain $-b + (1-\tau)S^F$ from bribing the customs officer, whose expected benefit from accepting the bribe is $b - \tau S^O - B$. Bribery may take place if and only if it is jointly beneficial to both agents, i.e.

$$(1) \qquad (1-\tau)S^F - \tau S^O - B \geq 0$$

If bribery takes place, we assume for simplicity that the bribe is set as the Nash bargaining solution between importer and customs officer, assuming equal bargaining power.[7] The benefits they draw from bribery then equalize, with a bribe defined as

$$b = [\tau S^O + (1-\tau)S^F + B]/2 \quad (2)$$

Assuming that the parameters are such that bribery is profitable, the importer's expected payoff can be written as:

$$\Pi^F(\gamma) = -(1-\gamma)Mt - C(M,\gamma,\tau,\epsilon,t) \quad (3)$$

where $C(M,\gamma,\tau,\epsilon,t) = d\,[\tau S^O + (1+\tau)S^F + B]/2$ is the expected cost to the importer of smuggling a share γ of its shipment. This expression makes clear the parallels with the models proposed in Slemrod (2001) and Mishra et al. (2008). In our case, however, the cost of avoidance is derived explicitly from a description of the interaction between the importer and the customs officer.

As emphasized, for instance by Yitzhaki (1974) referring to tax income avoidance, the form taken by the penalty to which agents are exposed is important. Usually it depends on the value or tax understatement.; a simple form encompassing both is $S^i = \left(s_1^i + s_2^i t\right)\gamma M,\ i = O, F$, where s_1^i and s_2^i are positive parameters. As discussed by Anson et al. (2006), components are unlikely all to be simultaneously non-zero, but this general form allows discussion of various different cases in a unified framework. In what follows, it is useful to note that, whatever these parameters, $C_\gamma \geq 0,\ C_t \geq 0,\ C_{\gamma t} \geq 0,\ C_{\gamma\gamma} \geq 0,$ and $tC_{\gamma t} \leq C_\gamma$. These properties are logical consequences of the fact that the cost of evasion here is the product of the probability of

[7] This assumption, also made by Mookherjee and Png (1995), is not essential here, but it simplifies the calculations.

disclosure, which is increasing and convex in the share smuggled, by a combination of penalties, which are increasing functions of the share smuggled and of the tariffs. The last property reflects the fact that sanctions are, at most, proportional to tariffs.[8]

The importer sets the smuggled share γ so as to maximize its payoff. The first order condition is

(4) $$\Pi^{F\prime}(\gamma) = Mt - C_\gamma = 0$$

Provided the institutional variables ϵ and τ are large enough to ensure that C_γ is negative for γ equal to 1, this condition characterizes an interior solution γ^* for γ.[9] Deriving this condition with respect to *t* implies that:

(5)

$$\sigma = \frac{\partial \gamma^*}{\partial t} = \frac{C_\gamma - tC_{\gamma t}}{tC_{\gamma\gamma}} \geq 0$$

The partial derivative of the smuggled share with regards to tariff, denoted here as σ, is conveniently dubbed 'evasion elasticity' by Mishra et al. (2008). This result means that a higher tariff leads the importer to magnify the understatement of the shipment value, because a higher tariff increases the benefit more strongly than the cost of evasion. Moreover we find this effect to be nonlinear: $\partial\sigma/\partial t \leq 0$ (see Appendix 1). Deriving the first-order condition with respect to ϵ shows that

[8] This property parallels the additional assumption made in Mishra et al.'s (2008, Appendix A) case IV, the only case where *t* is among the determinants of the cost of evasion, according to which the marginal cost of evasion with respect to tariff is declining. We do not know of a case, either theoretical or real, where penalties would be more than proportional to the tariff (i.e., where the second derivation of the penalty with respect to the tariff would be positive).

[9] The second order condition is obviously satisfied and the derivation is positive in zero.

(6) $$C_{\gamma\epsilon} + C_{\gamma\gamma}\frac{\partial\gamma^*}{\partial\epsilon} = 0$$

which implies $\partial\gamma^*/\partial\epsilon \leq 0$, meaning that the share smuggled is lower when the ease of enforcement is larger (e.g. for homogenous products). Because we cannot directly measure the share smuggled, but only its slope with regard to the tariff, we want to know whether the ease of enforcement modifies this slope. In Appendix 1, we show that deriving equation (5) with respect to ϵ gives that $\partial^2\gamma^*/\partial\epsilon\partial t \leq 0$, i.e. $\partial\sigma/\partial\epsilon \leq 0$: i.e., easier enforcement also reduces the evasion elasticity.

A similar analysis demonstrates that both the share smuggled and the evasion elasticity decline if transparency is increased ($\partial\gamma^*/\partial\tau \leq 0$ and $\partial\sigma/\partial\tau \leq 0$, see Appendix 1).[10] In addition, $\partial^2\gamma^*/\partial\tau\partial\epsilon \geq 0$ and $\partial^2\sigma/\partial\tau\partial\epsilon \geq 0$, meaning that the benefits from greater transparency are larger when enforcement is more difficult.

While this model is fairly general, several issues are worth considering. Firstly, penalties may include a constant component, for instance if the customs officer is exposed to firing or to other disciplinary sanctions when convicted of corruption. We show in Appendix 1 (case II) that the same general conclusions may be reached in this case.

Another concern has to do with the way importers and customs officers interact. The importer usually has to declare the shipment value before undergoing customs' examination, hence the sequence considered so far. However, it cannot be ruled out that the importer offers the customs officer a bribe beforehand and decides jointly with him which value to declare. The share smuggled is then jointly set by both agents so as to maximize their joint profit. In such a case, the question of the ability of the customs officer to unveil the true value of the shipment is pointless. The results presented above as to the influence of tariffs and transparency still hold (as demonstrated in Appendix 1, case III), but the ease of enforcement should not matter.

[10] An additional restriction on the parameters needs to be made in order to be able to draw conclusions about elasticity, but it is likely to hold in most cases.

Finally, it is questionable whether the inspection effort of customs officers is exogenous or not (Anson et al., 2006). Since evasion is more likely for high-tariff products, customs officers may choose to devote more effort to control these products. We study the case of endogenous effort in Appendix 1 (case IV), where customs officers are assumed to set effort so as to maximize their payoff, given the cost such effort involves for them and the benefit expected from enhanced probability to unveil the true value of the shipment. In this context, we show that as soon as sanctions and bonuses depend upon tariffs, customs officers benefit from inspecting highly-taxed products more closely. Since importers anticipate the closer scrutiny high-tariff products will be subject to, this may lead to a reversed relationship between tariff level and evasion (i.e., negative evasion elasticity) for high enough tariffs.[11] Below a threshold tariff level (dependent on the structure of sanctions and bonuses), however, the evasion elasticity is always positive. We also show that in any case, the derivative of the sign of the evasion elasticity with respect to ease of enforcement is opposite to the sign of the elasticity itself.

This theoretical analysis leads to testable predictions about the determinants of customs duty evasion: evasion elasticity should decrease with the ease of enforcement and with transparency, with a negative second derivation with regard to these two variables. The main results are robust to the alternative settings considered, although ease of enforcement should not matter if collusion dominates, while paradoxical results cannot be ruled out for high tariffs if the inspection effort is endogenous.

[11] Slemrod and Yitzhaki (2000) describe a number of situations where such reversed relationship may arise.

2 Empirical approach

Since evasion cannot be measured directly, the first empirical step is to define the form of the dependent variable, then we present the methodology to analyse evasion, followed by a discussion of the data sources and treatments.

2.1 Measurement and methodology

Evasion of customs duties occurs through four main channels: underreporting of unit value; underreporting of taxable quantities; misclassification, by shifting to a product classification with a lower tariff duty; and smuggling, generally defined as imports crossing the border without being registered by a customs officer (see e.g. Fisman and Wei, 2004; Javorcik and Narciso, 2008). In every case, evasion is reflected in understated import value at customs clearance, i.e. as reported by the importer—although a correct declaration of the import value does not prevent fraud from occurring for a particular shipment. For the exporter, evading customs duties does not require that the exporter's declaration, in the country of origin, is faked. Importers and exporters declarations are independent and the latter is not available to the importing country's authorities.[12]

Tariff evasion can be on the basis of a shipment value registered by the importer being lower than the value stated by the exporter. Thus, the gap between the shipment values reported by trading partners can be used as an indirect measure of the extent of evasion. While there may be other reasons why exporters' and importers' declarations do not tally (see below), only tariff evasion explains why the corresponding gaps are correlated to tariffs. In practice, Fisman and Wei

[12] Smuggling may not be recorded in export statistics, in which case official statistics will be of little help, as emphasized by Deardorff and Stolper (1990).

(2004) and subsequent studies use the log-difference between the values reported by the exporting and the importing countries, for the same flow, as a proxy for tariff evasion. In addition to being widely used, this is convenient: any constant margin between the valuations of exports and imports (such as the cost, insurance and freight (CIF) margin (see below), or a constant proportion of misclassified imports, as assumed by Fisman and Wei) would show up as a constant. Therefore, we can measure tariff evasion through trade gaps in value (following Javorcik and Narciso's terminology), defined as the difference between the logarithm of the value declared by the trading partners:

$$(7) \qquad trade\ gap_{ijk} = ln\, X_{ijk} - ln\, M_{ijk}$$

where *X* and *M* respectively refer to the values reported by exporter and importer, for exports of product *k* from country *i* (the 'partner') to country *j* (the 'reporter'). *X* and *M* are mirror declarations, referring to the same flow.

Statistical records report import values including CIF, which corresponds to the actual value at customs clearance. Export values *X,* on the other hand, are usually reported free-on-board (FOB). This difference could drive a systematic wedge between reported exports and imports, that is unrelated to tax-induced evasion. To resolve this wedge is not straightforward, since its magnitude is difficult to assess (see e.g. Hummels and Lugovskyy, 2006, Gaulier et al., 2008, and the references therein). A useful first-order approximation is that the CIF-FOB margin is separable into a product-specific margin, and a margin specific to each country pair: $\ln X^*_{ijk} = ln\, X_{ijk} + \lambda_k + \mu_{ij} + \nu_{ijk}$, where X^*_{ijk} refers to the CIF value of exports, and λ_k and μ_{ij} are constants. Since these constants are unknown, comparing the level of trade gaps across countries and products would be futile, because it would be impossible to disentangle differences in CIF and FOB margins from misstatements. If appropriately controlled for, however, these margins do

not prevent us from studying evasion elasticity. This is particularly true if, as we assume in what follows, the residual term *v* has zero mean and is independent from the corresponding tariff duty t_{ijk}.

We focus on the determinants of evasion elasticity by studying the link between trade gaps in value and tariff duties, based on the following generic model:

(8) $$trade\ gap_{ijk} = \alpha_k + \beta_{ij} + \sigma_{ik}\, t_{ijk} + u_{ijk}$$

where *u* is an error term. α and β are fixed effects by product and by country pair, controlling for differences in the CIF-FOB margin and for any other unobserved determinant of trade gaps constant across the corresponding subsets of trade flows. Any systematic difference between the declared values of the importer and the exporter, specific to the exporter, the importer, the exporter-importer pair, or to the product, is absorbed by these fixed effects. The coefficient of interest is the evasion elasticity σ. Since the above theoretical model predicts that evasion elasticity depends on the ease of enforcement and on transparency, σ should be variable across products and importers, as in equation (8). However, identification based on this specification is problematic, given the very large number of products and countries. Therefore, we impose restrictions on the pattern of evasion elasticities, assuming σ to be constant within two categories of products, homogenous and non-homogenous, and to vary across countries as a linear function of the countrywide variables, Z_i^n (n=1, … N, where N is the total number of variables taken into account). We do this on the premise that the ease of enforcement should be greater for homogenous products, the value of which is easier to assess, and that the countrywide variables should be the determinants of what we refer to as transparency in the above model. Thus, the specification to be estimated is:

(9) $$trade\ gap_{ijk} = \alpha_k + \beta_{ij} + \sigma\ t_{ijk} + \sigma_h homog_k\ t_{ijk} + \sum_n \sigma_n Z_i^n t_{ijk} + u_{ijk}$$

where $homog_k$ is a dummy variable equal to 1 if product *k* is classified as homogenous. Some products may be intrinsically more prone to misstatement than others, e.g., because they are less voluminous for a given value (diamonds are an extreme case), which may be the source of a specific form of heteroskedasticity. We account for this using standard errors clustered at product level.

This specification raises concerns about dimensionality. As argued below, for the present analysis we need the data to be as detailed as possible. Thus, for all countries reporting sufficiently reliable statistics (75 in our estimation sample, see below), we make use of data on bilateral trade at the six-digit product level (more than 5,000 in the Harmonized System—HS). Therefore, equation (9) should include more than 10,000 fixed effects (number of products plus number of country pairs), which would make estimation intractable for a sample like ours of more than half a million observations. Within transformation would resolve this problem, since the parameters of interest could be estimated on the transformed regression, without fixed effects. Unfortunately, this transformation cannot be applied in the context of a two-way error-components model with unbalanced panels. However, the model can be transformed in a way that is adapted to this context. Extending the method proposed by Wansbeek and Kapteyn (1989), Davis (2002) shows that estimates of the parameters of interest (i.e., other than fixed effects) on a full model such as the one described in equation (9), can be obtained equivalently from a transformed model. The transformation required is a projection on the null space of the matrix composed of indicator variables denoting observations on products and country pairs.[13] While full

[13] In Davis's (2002) notation, the transformation requires pre-multiplying the model by the orthogonal projection on the null-space of the matrix $\Delta = (\Delta_{prod}, \Delta_{countries}), Q_{[\Delta]}$, where Δ_{prod} is a *N* by *K* matrix (*N* the total

development of the corresponding algebra is impossible given the dimensionality, tailor-made programming taking advantage of the structure of the sparse matrices involved makes the transformation tractable. In what follows, all estimates in levels are based on this 'within' transformation.

2.2 Data and descriptive statistics

The method described so far relies on analysis of the gaps between trading partners' declarations to infer information about customs duty evasion. Bilateral trade data at the HS-6 level are sourced from the UN Comtrade database. The analysis is only possible if both countries report their (original and complete) trade statistics in this database, which applies to 152 countries for imports and 150 for exports. A potentially overwhelming problem in putting this principle into practice is the rather bad quality of trade statistics. The discrepancies between mirror declarations have been emphasized repeatedly, and illustrated on a large scale by Hummels and Lugovskyy (2006). We expect parts of these discrepancies to reflect evasion, and we have acknowledged the need to control for the CIF-FOB margin. However, there are also many other reasons why trade statistics could be plagued with measurement error, including unintentional incorrect identification of importers and exporters; unintentional product misclassifications; currency conversions; time lag and yearly classification; confidentiality when the number of firms is very low; reporting error; and different customs valuation practices (see e.g. De Wulf, 1981; Yeats, 1995).

number of observations, *K* the number of products), with element (n,k) equal to 1 if observation *n* concerns product *k*, and zero otherwise. $\Delta_{countries}$ is defined equivalently for country pairs instead of products. We adapt this method to the present case of weighted estimations and implement it using the software Mata.

As a result, our dependent variable is estimated with potentially large measurement errors. We argue that this does not prevent our using these data to infer information about evasion, because there is no real reason why measurement errors should be correlated to tax evasion. If the measurement error in the dependent variable is unrelated to the error term, it will render the estimation less efficient, but will not be the source of any bias. This is the reason for our insistence on the most detailed data available, for all countries where reliable data exist, even though (as already mentioned) this entails burdensome treatment. We rely on a large sample to enable us to identify the variables of interest accurately, despite the noise linked to measurement errors. It could be argued also that some variables influencing trade gaps are omitted from our model, e.g. export taxes or subsidies if applied, which could likely influence declared export values. To the extent that they are not correlated with tariff duties, however, these omitted variables should not bias the coefficients of interest: in what follows, identification of the variables of interest does not rely on the level of the trade gaps, but only on the way they are related to tariffs.

The main limitation to extension of the sample is the need to measure bilateral applied protection at product level. This is possible on a large scale for 2001 and 2004, based on MAcMap-HS6 (ITC and Cepii), which provides ad-valorem equivalents of most-favoured nation (MFN) and preferential applied duties at the six digit level, for 166 importing countries and 208 partners. Preferential arrangements, non-ad valorem tariffs and tariff-rate quotas are taken into account.

All the additional variables are detailed in Appendix 2. As regards measures of corruption, largely controversial for their subjectiveness, we mainly rely on Kaufman's et al. (2008) Control of corruption (CC) index. This is a widely recognized index, available for a large number of

countries for both years under study. It also presents the advantage of being part of a set of indicators also encompassing rule of law and government effectiveness, in which we are also interested for this study. Since corruption measurement is necessarily difficult and subject to caution, we check the robustness of our analysis using two additional indicators also available for a large number of countries in 2001 and 2004: International Country Risk Guide's index of corruption (ICRG), and Transparency International's Corruption Perception Index (CPI).[14]

Limiting measurement errors to the extent possible is important to improve estimation efficiency. Thus, we cross-check and filter the data in several ways. First, we focus on the homogeneity of reporting practices, by retaining data only from countries following UN recommendations on key points. We disregard values lower than $10,000, since this is the value used by several countries as the minimum threshold below which they do not declare trade flows. We exclude from the sample countries maintaining multiple exchange rate regimes according to the IMF, countries with only partial autonomy, countries with de facto autonomous regions, and the countries most heavily involved in re-exporting. Intra-EU trade flows are also disregarded because their measurement rests on specific methods. Finally, we exclude countries where close inspection of the data revealed massive problems. As a result of this successive data filtering, we have a sample of 75 countries (see list in Appendix 2, which describes data filtering in more detail).

Additional concerns may arise for specific products. We exclude from the analysis HS chapters 43 (fur skins and furs), 84 (nuclear reactors), 88 (aircraft), 89 (ships), 93 (arms and

[14] None of these measures specifically captures corruption in customs, which is our main concern, even if they can be considered a good proxy for it. To our knowledge, the only corruption indicator specific to the custom administration is the one contained in the Institutional Profiles Database, http://www.cepii.fr/ProfilsInstitutionnelsDatabase.htm. Unfortunately the data are not available for the year 2004.

ammunition) and 97 (arts and antiques), as well as HS heading 9601 (worked ivory), since trade in these sectors is frequently restricted or kept confidential (on the smuggling of art, see Fisman and Wei, 2009). Chapters 22 (beverages) and 24 (tobacco) are also disregarded, because we cannot adequately control for the widespread excise duties levied in these sectors, which are often collected at customs clearance points.[15] Finally, we exclude trade in ores and oil (Chapters 26 and 27), for which the origin and destination of shipping are frequently unknown.

When comparing partner-country trade data, we would expect the value reported by the importer to exceed the mirror declaration by the exporter, due to the CIF-FOB margin. Also, it is generally assumed that imports are monitored better than exports. Accordingly, to précis Bhagwati (1964), a flow for which reported imports are inferior to the value reported by the exporter can be considered as exhibiting a discrepancy in the '*perverse direction'*, which may be interpreted as a *prima facie* evidence of under-invoicing of imports.[16]

[15] Without relevant information on these excise duties, our estimates suffer from the omission of this variable, which potentially is important for explaining fraud in these sectors.

[16] Over-reporting of exports is not excluded, especially when a form of subsidy is attached to exporting, or when currency conversion is not free, but there are far fewer incentives to bias invoicing in this respect, than to cheat over import values. In addition, and as already mentioned, export misstatements do not bias our econometric estimates as long as they are not correlated to tariffs.

Table 1 – Exports reported by partners, as a share of reported imports (average ratio by group of countries and by level of applied tariff rates, 2004)

	All products (1)	t=0 (2)	0<t<10 (3)	10≤t<20 (4)	20≤t (5)
All countries	0.97	0.95	0.96	1.03	1.27
By Income Level					
High	0.92	0.90	0.91	0.92	0.83
Upper-middle	0.94	0.93	1.01	0.98	1.04
Lower-middle	1.00	0.94	0.97	1.15	1.77
Low	1.12	1.22	0.99	1.17	1.71
By corruption level					
Low	0.90	0.91	0.90	0.94	0.80
Lower-middle	0.97	0.89	1.05	0.97	1.02
Upper-middle	0.97	0.94	0.91	1.01	1.56
High	1.04	1.08	0.98	1.20	1.68

Source: Authors' calculations based on MAcMap-HS6 (ITC and CEPII), Comtrade (UN) and Kaufman et al. (2008).
Scope: Countries and products included in the estimation sample (see text).
Note: Income level groups as defined by the World Bank. Groupings by corruption level built from splitting the country sample, ranked by decreasing level of control of corruption index, in four quarters. Ratios are computed country by country. The figures presented here are unweighted, cross-country averages.

The general pattern presented in Table 1 is consistent with these priors: on average across all countries and products, reported imports exceed reported exports, although by only 3% of the total (the average ratio of exports reported by partners over reported imports equals 0.97, column 1, row 1). For all income groups except high-income countries, the discrepancy takes the perverse direction when products with ad-valorem equivalent (AVE) applied tariff duty above 20% are considered separately. Also, it is striking that the average level of this ratio is higher for lower-income countries, in most cases by a substantial amount. More generally, the pattern in Table 1 is of an increasingly perverse average discrepancy between reported imports and exports as countries get poorer and MFN duties get larger (although the large discrepancy for duty-free products for low-income countries is an exception). A similar picture emerges when countries are grouped by corruption level. This preliminary evidence is consistent with the assumption that discrepancies in trade declarations to some extent reflect tax evasion, which is more widespread the lower the quality of the importer's institutions and the higher the tariff rate. It suggests also that the phenomenon is quantitatively important: for the two lowest ranked country groups in

terms of income level or control of corruption, the average ratio exceeds 1.5 for products with MFN tariff above 20%, an extremely large discrepancy by any standard, and reaches 1.77 for high-tariff products in lower-middle income countries, more or less twice what might be considered a 'normal' value for this ratio.

3 Estimating cross-country patterns of customs duty evasion

Since trade gap is an indirect measure of customs duty evasion, checking its consistency through several straightforward tests is a useful step from which to begin the analysis and allows us to study cross-country patterns of customs duty evasion.

3.1 Consistency check and preliminary assessment

The estimates in level presented here are all based on specifications similar to equation (9). They include fixed effects by product and by country-pair, and the model is estimated using the 'within' transformation proposed by Wansbeek and Kapteyn (1989) and extended by Davis (2002), as described above. We check first that the trade gap is positively and significantly related to the preferential applied tariff duty (column 1), and that this relationship is stronger for differentiated than for homogenous products (column 2). The average estimated evasion elasticity is 0.24, and 0.35 for non-homogenous products, significantly different from zero in each case at standard significance levels. Using the liberal or the conservative dummy variable for homogenous products makes little difference (column 3).[17] We use the conservative dummy in

[17] Using a dummy for differentiated products (which is not an exactly complementary category) makes little difference to the other variables. Mishra et al. (2008) suggest building an alternative product classification based on the standard deviation at the world level of log unit values, product by product (products with standard deviation above the 75th percentile being considered as differentiated). This variable is found also to be significant and alters the other results very little.

what follows, but using the liberal definition does not alter the results. We check whether the intensity of this relationship is positively correlated to other measures of corruption. This is done by introducing interaction terms with the control of corruption index developed by the World Bank Institute. We find that tighter control of corruption (i.e., lower corruption—see Appendix 2 for definition and sources) is associated with a weaker link between tariffs and trade gaps, as witness by the negative and significant estimated coefficient of the interaction term. Because the intensity of this link may depend upon the nature of the product, an additional term is considered which allows the interaction to differ for homogenous products. This term is found to be positive and significant, a result consistent with the model insight that the extent of evasion (or its elasticity) is more sensitive to institutional quality when enforcement is more difficult, as is the case for non-homogenous products.

Table 2: Trade gap and corruption measures (2004)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Tariff	0.26 ***	0.38 ***	0.39 ***	0.44 ***	0.45 ***	0.49 ***	0.46 ***	0.32 ***	0.38 ***
	(5.95)	(5.78)	(5.79)	(6.59)	(6.62)	(7.59)	(6.20)	(5.33)	(8.59)
Tariff, homogenous prod.		-0.26 ***		-0.10	-0.18 **	-0.16 *	-0.10	-0.10	-0.18 ***
		(-3.62)		(-1.44)	(-2.26)	(-1.90)	(-1.05)	(-1.50)	(-3.34)
Tariff, hom. prod. (liberal dummy)			-0.28 ***						
			(-3.73)						
Tariff * control of corruption				-0.22 ***	-0.31 ***	-0.29 ***	-0.31 ***		
				(-7.39)	(-6.99)	(-5.73)	(-4.85)		
Tariff * ctrl corruption, hom. prod.					0.17 ***	0.17 ***	0.20 ***		
					(3.52)	(3.42)	(3.11)		
Squared tariff						-0.05	-0.01		
						(-1.43)	(-0.13)		
Squared tariff, homog. prod.							-0.06		
							(-0.80)		
Tariff * CPI index								-0.19 ***	
								(-7.31)	
Tariff * CPI index, homog. prod.								0.10 ***	
								(3.51)	
Tariff * ICRG corruption index									-0.17 ***
									(-6.00)
Tariff * ICRG corr. index, hom. pr.									0.08 **
									(2.32)
Adj. R-squared	0.075	0.076	0.076	0.076	0.076	0.076	0.076	0.068	0.068
Observations	565,267	534,012	534,012	534,012	534,012	534,012	534,012	532,258	529,588

Note: The dependent variable is the trade gap in value as defined in equation (7). The specification follows equation (9). All estimates in level, for year 2004. All estimations include fixed effects by reporter-partner pairs and by HS6 product. Estimates are based on the transformation for unbalanced panels proposed by Wansbeek and Kapteyn (1989)

and developed by Davis (2002). All regressions are weighted by the inverse of the number of observations by reporter, so that the total weight attached to each reporter is 1. t statistics, based on standard errors clustered on six-digit products, reported in parenthesis. See text and Appendix 2 for details on variable definitions and sources.

Since the model predicts that evasion elasticity should decline with the tariff, we introduce the squared tariff in the specification (column 6), and allow this term to differ for homogenous products (column 7). While negatively signed, as predicted by the model, this effect is never significant. This finding is consistent with the mixed findings on the non-linearity of the impact of tariffs on evasion, which was found to be significant by Fisman and Wei (2004) for China, but not by Mishra et al. (2008) for the case of India. More importantly, it does not affect substantially the coefficients of other variables. As an additional check, estimations (8) and (9) are based upon alternative measurements of control of corruption, CPI and ICRG. The results are comparable to the previous ones, especially in terms of evasion elasticity and its link to corruption.

Overall, these results confirm the relevance and consistency of trade gaps as indirect indicators of the extent of customs duty evasion. By the same token, they suggest that the phenomenon is both widespread, in line with anecdotal evidence, and substantial, especially for differentiated products. Investigating the phenomenon in more depth requires us to account better for cross-country heterogeneity.

3.2 Evasion: Cross-country differences and institutional determinants

Since corruption indices are likely to cover *inter alia* corrupt customs administrations, they cannot be considered meaningful independent variables. Nevertheless, we need to account for cross-country differences in institutional quality, given their obvious relevance. A common concern in attempting this is the strong collinearity between institutional variables, which makes it difficult to identify the separate influence of each dimension. In addition, an extensive literature

shows that there are close links between institutions and income per capita as a result of two-way causality. Since disentangling these relationships is beyond the scope of this paper, we rely on Kaufman et al.'s (2008) database and focus on two institutional dimensions that are particularly relevant here. The first is the rule of law index, 'measuring perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence' (Kaufman et al., 2008, p. 7). The rule of law is important for determining to what extent potential penalties are credible threats in the case of unlawful practices. The second dimension is government effectiveness, 'measuring perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies' (Kaufman et al., 2008, p. 7). Government effectiveness could influence the thoroughness and chances of success of customs control, but also the reality that control customs officers are likely to face.

Other potential determinants of cross-country differences in evasion need to be considered. Contiguity may matter because the existence of a common frontier is likely to make smuggling easier. World Trade Organization (WTO) membership is another potential determinant, to the extent that Article VII of the General Agreement on Tariffs and Trade (GATT) sets out principles aimed at harmonizing customs valuation practices and at making them as close as possible to actual values (see discussion in the next section). Finally, the complexity of the tariff structure may open the door to fraud through product misclassification. We control for this possibility by considering each country's cross-product variance of MFN duties as a potential determinant of

evasion.[18] The estimates show that, among these three variables, only contiguity makes a significant difference, increasing evasion elasticity by approximately 0.15 on average (Table 3, column 1). WTO membership and tariff variance are found not to be significant.[19] For the sake of parsimony, these two variables are not included in the subsequent estimations.

Measures more specifically targeted at fighting custo

ms fraud should also be considered. Given the strong specificity of national practices in relation to these measures, however, they are bound to depend on the extent of customs fraud. These variables, therefore, are likely to exhibit significant endogeneity. To avoid bias, we do not include them in these estimations in level; we analyse them in the next section, based on estimates in differences.

To assess the influence of institutions, first we introduce the interaction between tariffs and log GDP per capita (measured at purchasing power parity—PPP): the negative and significant estimated coefficient suggests that the evasion elasticity declines with income level (Table 3, column 1). The estimated sensitivity to log GDP is lower for homogenous products.

Separately testing a similar interaction with these two institutional variables gives very similar results (unreported estimates). This is not surprising given the strong collinearity between the corresponding measures of institutional quality. For the same reason, identifying the respective contributions of each dimension of institutions is difficult, and introducing at least two of these measures in the same specification results in imprecise estimates of the corresponding

[18] In unreported estimates, we used the variance of MFN tariffs within the chapter to which the product belongs, for the country considered. The results were not significantly different.

[19] Interactions between these variables and a dummy for homogenous products were introduced in unreported estimates. In each case, the effects were found to be stronger for differentiated than for homogenous products, but the difference is insignificant and does not alter the magnitude and significance of other coefficients. Interactions between these variables and income level is also not significant.

effects (results available on request). We sidestep this difficulty by taking PPP log GDP per capita as a benchmark, assuming that it catches a variety of institutional aspects. Each of the remaining two institutional indicators is then orthogonalized to the log GDP per capita, by using the residual of a cross-country regression of the index over a constant and log GDP per capita, instead of the index itself.[20]

Even when orthogonalized to income level, an improved rule of law is found to reduce evasion elasticity significantly (at the 5% level) (Table 3, column 2). This influence is less for homogenous products, although the difference is not found to be significant. For the orthogonalized index of government effectiveness, similar results are found, but they retain limited statistical significance (column 3).[21]

The bottom line is that in each case the evasion elasticity is positive (although lower for homogenous products), but declines when 'institutional quality' increases (although less so for homogenous products). Institutional dimensions are difficult to disentangle, but the rule of law seems to be especially relevant. These results are consistent with the model's prediction if institutional quality is understood to be positively related to ease of enforcement (ϵ) and/or transparency (τ), given that ease of enforcement should be higher for homogenous products. It should be noted that the estimated evasion elasticity of the sample mean is also remarkably stable across estimations, around 0.4 for non-homogenous products.[22]

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[20] E.g., for the rule of law index (RL), the orthogonalized index is defined as the estimated residual $\hat{u}_i$ of the cross-country regression $RL_i = a + b\ ln(GDPpc_i) + u_i$, over all countries for which data are available.

[21] Actually, the results for both variables hardly differ, which is not surprising given that the pairwise cross-country correlation between these variables is 0.76. For the same reason, including both orthogonalized variables in the same estimation results in imprecise estimates.

[22] The sample mean of the log GDP per capita (in thousand USD) is 2.12.

Table 3: Cross-section analysis of the determinants of customs duty evasion (2004)

	(1)	(2)	(3)	(4)	(5)	(6)
Tariff	1.17 ***	1.05 ***	1.05 ***	1.05 ***	0.95 ***	0.92 ***
	(6.30)	(7.26)	(7.25)	(7.25)	(5.99)	(5.85)
Tariff, homogenous prod.	-0.38 **	-0.40 **	-0.40 **	-0.40 **	-0.50 ***	-0.50 ***
	(-2.30)	(-2.41)	(-2.43)	(-2.41)	(-2.72)	(-2.73)
Tariff * ln(GDPpc)	-0.31 ***	-0.31 ***	-0.32 ***	-0.31 ***	-0.26 ***	-0.26 ***
	(-5.11)	(-5.63)	(-5.83)	(-5.61)	(-4.22)	(-4.20)
Tariff * ln(GDPpc), homogenous prod.	0.13 **	0.13 **	0.13 **	0.13 **	0.16 **	0.16 **
	(2.28)	(2.10)	(2.25)	(2.10)	(2.40)	(2.44)
Tariff * contiguity	0.11 *	0.11 *	0.12 **	0.11 *	0.02	0.03
	(1.84)	(1.84)	(2.04)	(1.84)	(0.42)	(0.55)
Tariff * WTO	-0.19					
	(-1.32)					
Tariff * MFN variance	-0.24					
	(-0.54)					
Tariff * orthog. rule of law		-0.18 **		-0.18 **	-0.25 ***	-0.25 ***
		(-2.39)		(-2.37)	(-3.01)	(-3.00)
Tariff * orthog. rule of law, homogenous pr.		0.15 *		0.15 *	0.20 **	0.20 **
		(1.76)		(1.76)	(1.96)	(1.97)
Tariff * orthog. gov't eff.			-0.16 *			
			(-1.84)			
Tariff * orthog. gov't eff., homogenous prod.			0.12			
			(1.06)			
Tariff - tariff on similar prod.				-0.005		
				(-0.05)		
Tariff * exporter's BPI					-0.13 ***	-0.23 ***
					(-3.17)	(-2.69)
Tariff * ln(exporter's GDPpc)						0.15
						(1.48)
Adj. R-squared	0.076	0.076	0.076	0.076	0.079	0.079
Observations	534,012	534,012	534,012	534,012	420,919	420,919

Note: As in Table 2. "Orthog." refers to institutional variables orthogonalized with respect to the log GDP per capita (see text for details). To ease comparison, exporter's log GDP per capita is demeaned when interacted with tariff in column 7.

As Fisman and Wei (2004) point out, low tariff levels for some products may create the incentive to mislabel a similar imported product. Based on the average tariff for the four-digit category of the product, they find this effect to be significant for China. This finding is confirmed by Mishra et al. (2008) for India, while Javorcik and Narciso (2008) do not find it to be significant in the case of trade between Germany and Eastern European countries. We test the significance of this effect by introducing in the specification the difference between the tariff applied to the

product and the mean tariff applied by the country within the four-digit product classification (column 4).[23] The variable is not found to be significant.

An additional concern, not accounted for in the model above, is that the likelihood of the exporter smuggling and/or being prepared to pay a bribe might vary across exporting countries. This 'supply side of corruption' is precisely what the Bribe Payers Index (BPI), computed by Transparency International is supposed to evaluate.[24] Since this index is not available for 2004, we use instead the country-mean for 2002 and 2006 if information for both years is available (if information for only one of these years is available, we use this figure). Any partner effect constant across products is absorbed by the fixed effects, but we can estimate the interaction between BPI and tariffs. We find the interaction to be negative and significant, suggesting that evasion also depends significantly on the partner country's practices (column 5). The incomplete coverage of this variable reduces the number of observations, but the results for other variables are not significantly affected. An additional interaction term between tariffs and the log GDP per capita of the exporter is not significant and does not modify other coefficients significantly, suggesting that BPI provides a good summation of exporters' practices. The same is true of interactions using exporter's institutional variables instead of log GDP per capita.

Although the specifications estimated so far include a number of controls, including fixed effects by pairs of trading partners and by products, raises two main concerns. The first is that product specificities may materialize differently depending on the trading partner. If this is the

[23] In unreported estimates, we included the interaction between this difference with tariff for similar products and income levels. The significance was not retained. Using the minimum or first decile instead of the mean to characterize tariffs for similar products also makes no significant difference.

[24] See http://www.transparency.org/policy_research/surveys_indices/bpi. The index ranges theoretically between 0 and 10, a higher score indicating that engaging in bribery is perceived to be less common among the country's exporters. Before computing the interaction with tariffs, we demean this variable by removing its sample weighted mean (6.2).

case, the fixed effects would not allow is to control fully for unobserved heterogeneity. The second concern is related to endogeneity, which would arise if policy makers set higher tariffs for products more likely to be the object of customs duty evasion, in order to increase bribery opportunities. Indeed, if country specificities interact with product specificities, potential rents for the same product might differ across countries, with consequences for tariff levels. Taking advantage of the availability of complete data for another year, i.e. 2001, we can resolve both these concerns by relying on differences rather than levels to estimate evasion elasticities, based on the difference over time in equation (10), assuming the coefficients to be constant over time. While such differentiation removes the fixed effects, we maintain reporter fixed effects to control for possible country-specific disturbances linked, e.g., to exchange rate movements or to changing transportation costs (e.g. resulting from better infrastructure). This approach has an obvious cost: it greatly reduces the information available to identify the relationship under study, due to the requirement that we require data for 2001 and 2004, and especially because the variance in tariff changes over the period 2001-2004 is relatively small compared to the variance in tariff levels in 2004. The accuracy of the estimates is reduced accordingly, as reflected in the lower significance of all the variables. Nevertheless, the results, which are available on request, are consistent with those obtained from the estimates in levels. Both the evasion elasticity and its interaction with income level are lower when estimated in differences (a finding possibly reflecting delayed adjustment, especially with regard to changes in income level), but confidence intervals at standard significance level overlap. In contrast to the estimates in level, the influences of the rule of law index and government effectiveness are not found to be significant, either on their own or when combined (and orthogonalized) to log GDP per capita - perhaps due to the reduced accuracy of these estimates in differences.

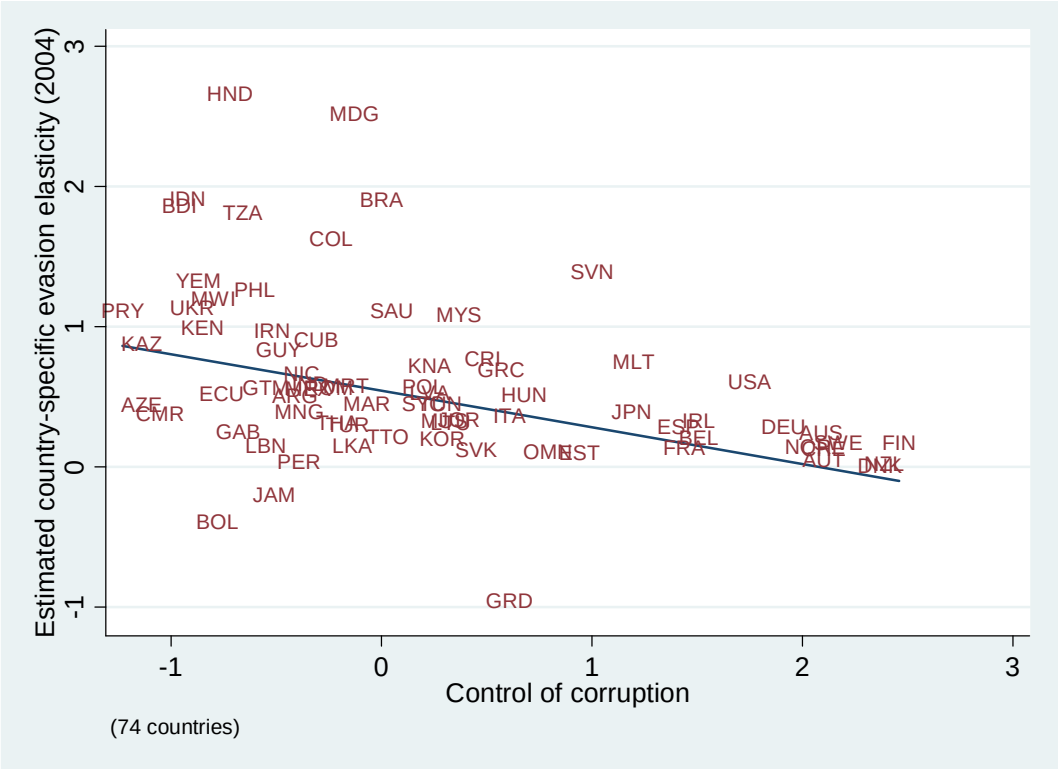
3.3 Estimating country-specific evasion elasticities

The cross-country pattern of customs duties evasion can be illustrated by estimating country-specific evasion elasticities (σ_i), based on the following equation:

(10) $$trade\ gap_{ijk} = \alpha_k + \beta_{ij} + \sigma^{hom} homog_k t_{ijk} + \sigma^{cont} contig_{ij} t_{ijk} + \sigma_i\ t_{ijk} + u_{ijk}$$

As before, this equation accounts for pairwise country fixed effects and product fixed effects. It takes account also of the potential influence of product homogeneity and contiguity between trading partners upon the evasion elasticity, consistent with the previous estimations. Estimated country-specific evasion elasticities ($\hat{\sigma}_i$) are plotted in Figure 2, where the horizontal axis features Kaufman's et al. (2008) index of control of corruption. The negative correlation between evasion elasticity and control of corruption is clear, although it is less strong for countries with higher levels of corruption. This would be expected given the poor quality of the trade statistics in many of these countries, which might also explain the odd estimate for Grenada. On the whole, these country-specific estimates are consistent and confirm that customs duties evasion is widespread, and likely sizeable in many developing countries.

Figure 2: Estimated country-specific evasion elasticities and index of control of corruption (2004)



Note: Each country is represented by its three-letter ISO code (see list in Appendix 2, Table A.1), centred vertically and horizontally on the country-specific values. Coefficients estimated based on equation (10), with observations weighted by the inverse of the number of observations by reporter, so that the total weight attached to each reporter is 1. The control of corruption index is sourced from Kaufman et al. (2008). The solid line materializes the fitted values from an unweighted regression.

4 Which remedies?

Evasion of customs duties has been identified as a cause for serious concern for numerous developing countries, prompting conspicuous investment, in many cases, of resources to reform

and modernize customs administrations. These efforts have often benefited from financial and technical support from the donor community and frequently have been carried out in the context of adjustment programmes. There is no quick fix to the problem of customs corruption, but a number of lessons can been learnt from experience (see in-depth analyses in Hors, 2001, Keen, 2003, and de Wulf and Sokol, 2005). Below we discuss these policy measures in the context of our analysis and then present our econometric analysis.

4.1 Measurable dimensions of customs reforms

The core principles of customs reform include the necessity to simplify rules and procedures, to minimize the scope for discretion, to streamline the organization and management of customs administrations and to enhance transparency. The reform process raises a number of complex questions which are beyond the scope of this paper, and are discussed in depth by several of the authors cited in this paper. Comprehensive reform requires a detailed and consistent approach, involving a number of policy measures which it is impossible to include in an aggregate, quantitative analysis. However, we can account for a few important policy measures (see Appendix 2 for details of corresponding variable definitions and sources):

- *Implementation of the Agreement on Customs Valuation (ACV)*: WTO membership may matter to the extent that harmonization of customs valuation practices is among the objectives pursued in the GATT (Article VII). In the estimations in this paper, WTO membership is not found *per se* to be a significant determinant of customs duty evasion, perhaps because corresponding commitments are fairly loose. The Agreement on Implementation of Article VII of the GATT (now generally referred to as ‚ACV), signed in 1979 as a result of the Tokyo Round, clarifies the form that these harmonized

valuation practices should take, by establishing that customs value should be based on transaction value, i.e., the price actually paid or payable for the goods being valued (see Goorman and de Wulf, 2005). Five alternative methods, to be used in a well defined order, are listed for cases where it is not possible to use the transaction value. Methodologies that are deemed more arbitrary, such as minimum values, are prohibited by the ACV. The Uruguay Round amended the agreement by stating that, in case of disagreement, a customs officer could require an importer to establish the accuracy of the value declared ('shifting the burden of the proof" decision). The ACV thus contains rather specific commitments. However, its implementation did not become mandatory until the Uruguay Round agreement (1995) and was problematic for developing countries, despite the five-year implementation delay granted under the special and differential treatment provisions of the agreement. According to Goorman and de Wulf (2005, p. 158), among the developing countries requesting the five-year implementation delay, only 2 had fully implemented the ACV by 2000, 15 had applied it with reservations, 22 requested an extension to the initial delay, and 23 countries, mostly the poorest ones, neither invoked the five-year delay, nor notified the WTO about their adoption of the legislation. While the effectiveness of the ACV in improving customs administrations in developing countries is questionable (Finger and Schuler, 2000), its implementation is an interesting variable to take into account in the analysis, given the commitments it entails.

- *Use of the Asycuda system*: Information and communication technologies are powerful tools to ensure the transparency of customs procedures, but the development of appropriate systems is complex and costly. For this reason, since the early 1980s, the UN Conference on Trade and Development (UNCTAD) has made available to

developing countries the Automated System for Customs Data (Asycuda), which has been adopted by more than 85 countries. Asycuda is an automated customs management system that can handle all customs clearance-related processes by implementing simplified and harmonized procedures, using standardized trade documents (e.g., UN Layout key, or Single Administrative Document) and international classifications (e.g. use of commodity description and coding systems). Asycuda is adapted to individual countries' needs. Compared to paper-based procedures, Asycuda facilitates and accelerates clearance of goods, it improves the quality of the statistics on foreign trade and revenue and it makes control of customs operations easier. While the Asycuda is provided at no cost, its implementation and subsequent updating require substantial (often co-financed) investment.

- *Pre-Shipment Inspection (PSI)*: Many developing countries keen to improve the collection of customs duties, hire private companies to inspect imports before they are shipped to the country. The PSI company is required *inter alia* to check the value, quantity and classification of shipments above a threshold declared value. Since 1963, when PSI was first adopted by Zaire, the number of countries hiring PSI companies has increased greatly, encouraged by the recommendations of private donors and the WTO (see the WTO agreement on PSI). Since its introduction, PSI has been seen as a second-best solution for countries without the institutional capacities and power to engage in full-fledged reform. However, studying the case of the Philippines, Yang (2008) argues that PSI introduced as an isolated initiative is unlikely to have much effect on collected tax revenue, since smugglers often sidestep controls by splitting up

shipments to stay below the threshold set for PSI inspection[25] or by importing through export processing zones. The theoretical analyses in Johnson (2001) and Anson et al. (2006) also question the effectiveness of PSI in deterring evasion, emphasizing the key roles played by the way that information from the PSI company is circulated and used, by accompanying policies (audits, ex-post reconciliations) and, more generally, by the institutional framework. Empirically, Anson et al. (2006) find that the introduction of PSI reduced fraud in the Philippines, increased it in Argentina, and had no significant effect in Indonesia.

The simplification of procedures and rules is another dimension we would like to account for, but while some indicators do exist, none of them is available on a large scale, for the period we study.[26] Note, however, that the variance of MFN tariffs, included in previous estimations, can be viewed as a specific dimension of simplification, to the extent that tariff heterogeneity is relevant to rent-seeking opportunities, as emphasized by Gatti (1999). As mentioned in the theoretical analysis above, information on the penalties incurred by customs officers and importers is also be important, as is information on customs officers' salaries. Since we do not have these data, we cannot include these items in the quantitative analysis.

4.2 Econometric assessment

The initial state of the customs administration is an obvious determinant of the likelihood of specific policy actions, such as those described above, being undertaken. As a result, estimates in level of the impact of these specific actions on tariff evasion would suffer from an endogeneity

[25] Governments usually pay a minimum fee for each inspection, so PSI companies are required only to inspect shipments worth more than a certain declared value.

[26] The World Bank's Doing Business indicators related to trade costs and delays start from 2006.

bias. This problem could be solved by relying on estimates in differences to assess whether a policy change is reflected in a change in evasion elasticity, based on the differentiation over time of equation (10).[27] The difference over time of the generic term for evasion elasticity is $\Delta(\sigma t_{ijk}) = \bar{\sigma}\Delta t_{ijk} + \bar{t}_{ijk}\,\Delta\sigma$, where a bar over a variable refers to its mean over time. The second term on the right-hand side reflects changes over time in evasion elasticity, which may stem from policy actions. Accordingly, the corresponding terms introduced in the specification follow the form $\bar{t}_{ijk}\,\Delta(policy_i)$, where 'policy' is an indicator of a policy measure aimed at fighting customs duty evasion. Reporter fixed effects are also included in all regressions.

Because of a lack of space we report information on the policy variables' definitions and sources in Appendix 2.

The first policy variable evaluated is the automation of customs data, as measured through investment in Asycuda systems. The variable used is either the amount invested in these systems over the period, or a dummy variable indicating that significant investment in such systems is initiated during this period. Using either measure, investment in Asycuda systems is estimated to reduce evasion elasticity significantly and substantially (Table 4, columns 1 and 2). We then can assess whether ratifying the ACV agreement over the period makes a significant difference. Among the 66 countries in the sample for estimations in differences, 12 ratified the agreement between 2001 and 2004; this ratification is estimated to be associated with a decline in the estimation elasticity, although the statistical significance of this effect is weak (column 3).

[27] The rule of law index orthogonalized with GDP per capita, is never significant in these estimates in differences. The interaction between GDP per capita and product homogeneity is not either. They are not included in the estimates reported.

Hiring a PSI company is another way to fight customs duty evasion, but a change in this regard during the period under study is not associated to any significant impact on the evasion elasticity (column 4). Next we test the significance of the interaction between PSI and income level. Consistent with the above mentioned analysis (Yang, 2008; Anson, 2006; Johnson, 2001), the efficiency of the PSI programme in fighting corruption appears to be conditional on the institutional framework. The results are tentative given the small number of countries concerned, but they suggest that hiring a PSI company tends to be more efficient for richer countries (column 5).

Table 4: Policy remedies to customs evasion, estimates in differences (2001-04)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Δ Tariff	0.57 **	0.58 **	0.61 ***	0.62 ***	0.65 ***	0.58 **	0.58 **	0.68 **	0.69 **
	(2.51)	(2.51)	(2.66)	(2.71)	(2.84)	(2.55)	(2.52)	(2.20)	(2.21)
Δ Tariff, homogenous prod.	-0.09	-0.10	-0.09	-0.09	-0.08	-0.08	-0.09	-0.11	-0.11
	(-0.95)	(-1.06)	(-0.95)	(-0.97)	(-0.86)	(-0.84)	(-0.95)	(-0.95)	(-1.00)
Δ [Tariff * ln(GDPpc)]	-0.16 **	-0.17 **	-0.18 **	-0.18 **	-0.20 **	-0.17 **	-0.17 **	-0.21 **	-0.21 **
	(-2.07)	(-2.11)	(-2.31)	(-2.35)	(-2.52)	(-2.16)	(-2.17)	(-1.97)	(-2.02)
Δ Tariff * contiguity	0.18	0.20 *	0.19	0.19	0.19	0.18	0.19 *	0.37 ***	0.38 ***
	(1.54)	(1.69)	(1.64)	(1.64)	(1.60)	(1.51)	(1.66)	(2.58)	(2.67)
Tariff * Δ Asycuda	-2.33 ***					-2.31 ***		-2.56 ***	
	(-2.70)					(-2.66)		(-2.91)	
Tariff * Δ Asycuda (dummy)		-1.60 ***					-1.60 ***		-1.63 ***
		(-2.73)					(-2.73)		(-2.79)
Tariff * ACV ratified 2001-04			-0.16			-0.09	-0.17	0.04	-0.05
			(-1.20)			(-0.67)	(-1.23)	(0.21)	(-0.30)
Tariff * PSI initiated 2001-04				-0.11	0.97 ***	0.98 ***	1.00 ***	0.99 ***	1.02 ***
				(-0.80)	(2.82)	(2.84)	(2.89)	(2.78)	(2.87)
Tariff * PSI in'd 2001-04 * ln(GDPpc ini)					-0.71 ***	-0.71 ***	-0.72 ***	-0.76 ***	-0.77 ***
					(-4.11)	(-4.11)	(-4.15)	(-4.31)	(-4.37)
Δ [Tariff] * exporter's BPI								-0.21 ***	-0.20 ***
								(-3.53)	(-3.41)
Adj. R-squared	0.0143	0.0142	0.0139	0.0139	0.0139	0.0143	0.0143	0.0162	0.0161
Observations	303,689	303,689	303,689	303,689	303,689	303,689	303,689	255,174	255,174

Note: The dependent variable in the change in trade gaps in value, is as defined in equation (7). Reporter fixed effects included in all regressions. All regressions are weighted by the inverse of the number of observations by reporter, so that the total weight attached to each reporter is 1. t statistics, based on standard errors clustered on six-digit products, reported in parenthesis. See text and Appendix 2 for details.

It is impossible to control for all the dimensions of reform, and these policy variables might be argued to reflect a more general, unobserved movement of policy reform, aimed at improving customs administration. This possibility is difficult to rule out, since such wide-ranging reform would involve the policies measured, together with other aspects. Were we analysing only wide-ranging reforms, we would expect to observe a positive correlation between the policy measures studied. However, this is not the case, since none of the pairwise correlations between the Asycuda, ACV and PSI variables is positive. Another way to address this concern is to assess jointly the impact of these policy variables. Doing so does not significantly change the assessed impact of each individual policy variable (columns 6 and 7). We also tested whether the impact of investment in Asycuda systems and ACV agreement ratification depends on the country's income level, and whether it differs for homogenous products. None of these interaction terms was found to be significant (results available on request). Exporters' practices, as measured through the BPI index, have a significant impact and their inclusion does not alter significantly the estimated coefficients of other variables (columns 7 and 8).

5 Extensions and robustness checks

Further light can be shed on customs duty evasion by studying two additional dimensions of trade declarations: quantities reported by each partner, and missing flows, i.e. cases where an export flow declared by the partner is not reported at all by the importer. We then analyse the economic significance of our results.

5.1 Disentangling between forms of evasions: quantities and unit values

Evasion may take many different forms. As discussed in Fisman and Wei (2004) and in subsequent studies, insights about the precise form of evasion can be gained when data are available in quantity (with the same unit for both trading partners). In this case, trade gaps in

value can be decomposed between gaps in quantities and gaps in unit value, allowing underreported imported quantities to be disentangled from undervaluation.[28]

Based on the most representative specifications used in the analysis above, we find that the main qualitative results for gaps in value are also valid for both quantity and unit value gaps (Table 5): the coefficient of the applied tariff level is positive and significant in both cases, exhibiting as before a negative interaction with income level. The rule of law index, orthogonalized with log GDP per capita, is still estimated to reduce the evasion elasticity, but it is only significant for unit values. In addition to ad-valorem equivalent tariffs, we consider separately the ad-valorem equivalent of their specific component. This variable only retains limited statistical significance, perhaps due to the limited number of products for which specific tariffs are applied. The impact of contiguity on evasion is again found to be positive, although it is only significant for quantities, consistent with the hypothesis that sharing a frontier makes smuggling easier. Exporters' practices, as measured through the BPI, are only found to matter for quantities, for which better practices reduce the evasion elasticity.

The most striking difference between quantity and unit value gaps is the role of product homogeneity, estimated to be important and significant for unit values (in level as well interaction), and insignificant for quantities. These results support our assumption that product homogeneity makes it easier to assess shipment value: it reduces the incentives to cheat on unit values, without significant bearing for fraud on quantities. In sum, the results point to both underreporting and undervaluation as being widespread modalities of customs duty evasion, with comparable importance, although fraud on unit values reduced by almost half for homogenous products.

[28] Data on international trade in quantity are known to be less reliable than data in value, probably because quantities are often indicated for information only. In order to prevent erroneous data from blurring the analysis, we filter the data used in the estimations. To avoid conditioning on the dependant variable, which would originate a bias, we condition data for quantity gap estimates by a restriction on unit value gaps, and reciprocally. In each case, the restriction is that log-gaps should not be lower than -1 or larger than 1.

Table 5: Determinants of quantity and unit value trade gaps, estimates in levels (2004)

	Quantity gaps			Unit value gaps		
	(1)	(2)	(3)	(4)	(5)	(6)
Tariff	0.60 ***	0.60 ***	0.50 ***	0.64 ***	0.64 ***	0.70 ***
	(3.84)	(3.83)	(2.85)	(5.25)	(5.30)	(5.24)
Tariff, homogenous prod.	0.05	0.05	0.05	-0.28 **	-0.28 **	-0.30 **
	(0.28)	(0.27)	(0.25)	(-2.50)	(-2.48)	(-2.44)
Tariff * ln(GDPpc)	-0.24 ***	-0.24 ***	-0.20 ***	-0.22 ***	-0.22 ***	-0.27 ***
	(-3.69)	(-3.70)	(-2.69)	(-4.39)	(-4.34)	(-4.81)
Tariff * ln(GDPpc), homogenous pr.	-0.01	-0.005	-0.003	0.10 **	0.09 **	0.12 ***
	(-0.11)	(-0.07)	(-0.04)	(2.29)	(2.22)	(2.66)
Tariff * orthog. rule of law	-0.06	-0.06	-0.14	-0.24 ***	-0.24 ***	-0.24 ***
	(-0.71)	(-0.71)	(-1.55)	(-4.19)	(-4.21)	(-3.76)
Tariff * orth. rule of law, homog. pr.	0.09	0.10	0.13	0.21 ***	0.21 ***	0.19 ***
	(0.96)	(0.97)	(1.13)	(3.81)	(3.81)	(2.88)
Tariff * contiguity	0.15 ***	0.15 ***	0.08	0.02	0.02	0.04
	(2.59)	(2.58)	(1.35)	(0.69)	(0.71)	(1.21)
Tariff, specific component	0.15 *	0.15 *	0.16	0.10 *	0.11 *	0.18 **
	(1.84)	(1.83)	(1.40)	(1.90)	(1.93)	(2.48)
Tariff - tariff on similar prod.		0.05			-0.05	
		(0.47)			(-0.98)	
Tariff * exporter's BPI			-0.08 **			-0.01
			(-2.01)			(-0.41)
Adj. R-squared	0.069	0.069	0.078	0.165	0.165	0.174
Observations	317,192	317,192	245,463	246,625	246,625	189,075

Note: As in Table 2.

5.2 Missing flows and the extreme smuggling assumption

It is not uncommon that no import flow be reported by a country, for a product for which its partner declares being exporting a non-zero amount.[29] Using a dependant variable expressed in logarithm as we did until now does not allow taking the corresponding information into account. Still, a straightforward possible interpretation of such observations is that the products may have been smuggled into the country of destination, so that it is declared by the exporter, but remains unnoticed by the importing country's authorities. Mishra et al. (2008) refers to this as the complete smuggling assumption. Another possibility is that the products may have entered the country of destination under a different product classification—in which case misclassification may be deliberate, in favor of a less heavily taxed product.

[29] The symmetric case also occurs (a non-zero flow being declared by the importer, but not by the exporter), but it is less clear how it should be interpreted in our context, apart as resulting from errors.

We check the relevance of this assumption by estimating the probability of a non-zero flow reported by the exporter being unreported by the importer. In order to account for unobserved heterogeneity, the estimation is based on differences between 2001 and 2004:[30] we focus on partner-reporter-product triplets for which a non-zero flow is observed on both sides in 2001 and a non-zero flow is reported by the exporter in 2004, and we estimate using a probit model the probability of the flow not being reported anymore by the importer in 2004. Such cases correspond to situations where the flow disappears from the screen of the importer, so to say. The trade gap in value in 2001 is included to control for time-invariant, unobserved heterogeneity influencing the importer's capacity to report adequately trade values, for any specific product and partner. To account for the fact that larger flows are less likely not to be reported, we also control for the logarithm of the exported value reported by the partner in 2004, and by reporter in 2001.

The relevance of these controls is confirmed by the estimates (Table 6): the probability of imports not being reported anymore is larger the higher the lagged trade gap, the lower the export value reported by the partner, and the lower the value reported in 2001 by the importer, with strong significance of marginal effects in each case. The main variable of interest, tariff, is estimated to be significant: the probability of a flow not being reported anymore by the importer is increased by 0.2 to 0.5% on average for products where the applied tariff increased over the period by ten percentage points. This effect is found to be insignificantly attenuated for homogenous products, and it tends to be stronger for poor countries. These estimates are consistent with the assumption that the good has been either smuggled or misclassified: the incentives for both types of fraud increase with the level of the tariff.

[30] Note in addition that estimations in level would be problematic here, because the Wansbeek-Kapteyn transformation applied previously cannot be used in this context of a nonlinear model. Only a full-fledge estimation including dummies by country pair and by product would be correct, but it would not be tractable with the entire sample. Focusing on differences allows sidestepping this hurdle while better controlling for unobserved heterogeneity.

Table 6: Determinants of imports not being reported anymore by the importer in 2004

	(1)	(2)	(3)	(4)
Trade gap in 2001	0.007 ***	0.008 ***	0.007 ***	0.008 ***
	(16.48)	(16.36)	(16.48)	(16.36)
Log value reported in 2004 by the exporter	-0.007 ***	-0.007 ***	-0.007 ***	-0.007 ***
	(-18.57)	(-18.37)	(-18.56)	(-18.37)
Log value reported in 2001 by the importer	-0.009 ***	-0.009 ***	-0.009 ***	-0.009 ***
	(-20.18)	(-19.33)	(-20.18)	(-19.33)
Δ Tariff	0.025 ***	0.033 ***	0.043 *	0.042 *
	(2.73)	(3.59)	(1.75)	(1.70)
Δ Tariff, homogenous prod.		-0.011		-0.010
		(-0.64)		(-0.58)
Δ [Tariff * ln(GDPpc)]			-0.006	-0.003
			(-0.69)	(-0.36)
Observations	389,510	368,331	389,510	368,331

Note: Probit estimates, marginal effects reported. All regressions are weighted by the inverse of the number of observations by reporter, so that the total weight attached to each reporter is one. Values are expressed in thousand USD. t statistics, based on standard errors clustered on six-digit products, reported in parenthesis. See text and Appendix 2 for details.

Given the empirical support found for the complete smuggling assumption, it makes sense to complement the analysis with a variable taking into account the information about missing declarations. Following Mishra et al. (2008), we build an alternative variable of tariff evasion by applying a one plus log transformation to trade declarations:[31]

$$ext\_evasion_{ijk} = ln(1 + X_{ijk}) - ln(1 + M_{ijk})$$

The most relevant specifications used above are then re-estimated with this alternative dependant variable. The results of estimates in differences are similar to those found so far, with sign and significance unchanged in almost all cases (Table 7). The main noteworthy difference is that the estimated evasion elasticity is larger under the extreme smuggling assumption. The interaction with income level is still significant (except in column 1), and those with Asycuda and PSI variables are hardly changed. Unreported estimates in level, available on request, are also very similar to those obtained without the extreme smuggling assumption, with the increased

[31] This transformation is applied to trade flows expressed in thousand dollars.

evasion elasticity being again the main difference. As a whole, these estimates confirm the robustness of our results.

Table 7: Determinants of customs evasion, estimates in differences (2001-04) under the extreme smuggling assumption

	(1)	(2)	(3)	(4)	(5)	(6)
Δ Tariff	1.27 ***	0.85 **	0.78 ***	0.77 ***	0.88 **	0.85 **
	(2.82)	(2.19)	(3.02)	(2.96)	(2.57)	(2.49)
Δ Tariff, homogenous prod.	-0.09	-0.16	-0.07	-0.08	-0.01	-0.02
	(-0.62)	(-1.02)	(-0.50)	(-0.58)	(-0.08)	(-0.13)
Δ [Tariff * ln(GDPpc)]	-0.19		-0.19 **	-0.19 **	-0.23 *	-0.22 *
	(-1.62)		(-2.07)	(-2.05)	(-1.85)	(-1.78)
Δ Tariff * contiguity	0.07	0.14	0.04	0.06	0.25	0.26
	(0.45)	(0.92)	(0.24)	(0.36)	(1.22)	(1.27)
Δ [Tariff * WTO membership]	-0.50	-0.52				
	(-1.25)	(-1.25)				
Δ [Tariff * MFN variance]	-0.12	-1.10				
	(-0.10)	(-0.93)				
Δ [Tariff * rule of law]		-0.003				
		(-0.02)				
Tariff * Δ Asycuda			-1.92 **		-1.28	
			(-2.28)		(-1.47)	
Tariff * Δ Asycuda (dummy)				-1.47 **		-1.48 **
				(-2.44)		(-2.44)
Tariff * ACV ratified 2001-04			0.03	-0.03	0.18	0.14
			(0.22)	(-0.20)	(1.06)	(0.84)
Tariff * PSI initiated 2001-04			1.68 ***	1.69 ***	1.64 ***	1.64 ***
			(4.19)	(4.22)	(3.86)	(3.87)
Tariff * PSI initiated 2001-04 * ln(GDPpc)			-1.35 ***	-1.35 ***	-1.37 ***	-1.37 ***
			(-6.56)	(-6.58)	(-6.40)	(-6.41)
Δ Tariff * exporter's BPI					-0.22 ***	-0.22 ***
					(-2.86)	(-2.84)
R-squared	0.018	0.018	0.018	0.018	0.019	0.019
Observations	405,741	405,741	405,741	405,741	335,836	335,836

Note: As in Table 4.

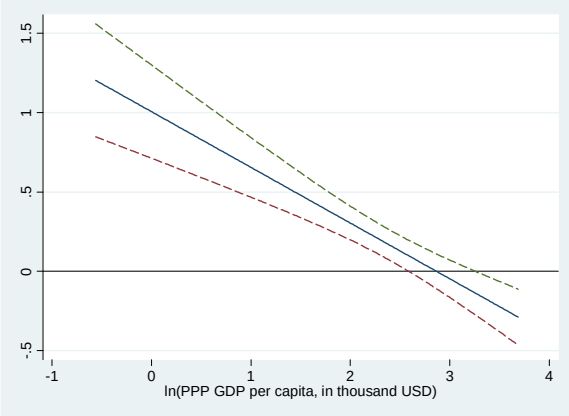
5.3 Does it matter? Economic significance and possible consequences

A simple yet natural question at this stage is: Does tariff evasion really matter? The answer is not straightforward given the strong heterogeneity observed across countries. Since income level appears as the main cross-country determinant of the extent of tariff evasion, we

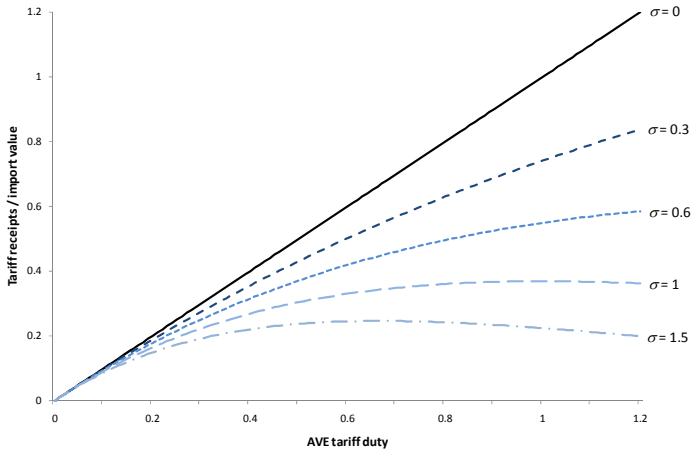
address this question first by computing the estimated evasion elasticity conditional on countries' income levels, based on the estimate reported in Table 3, column 4 (Figure 3, Panel A). The marginal effect plotted is for non-contiguous countries, assuming the orthogonalized rule of law index to be zero. While the estimated evasion elasticity is not significantly different for countries with income levels above approximately $16,000, it is strongly significant for poor countries, with a confidence interval centred on 1 for the poorest countries in the sample.

Figure 3: Estimated evasion elasticity by income level and implications for tariff receipts

Panel A: Estimated evasion elasticity between non-contiguous partners, by income level



Panel B: Tariff receipts as a proportion of import value for different values of the evasion elasticity



Note: Panel A depicts authors' computations based on estimates reported in Table 3, column 2. The marginal effect is computed as $\hat{\beta}_t + ln(GDPpc) * \hat{\beta}_{t*LogGDPpc}$, and its standard error as $\left(V(\hat{\beta}_t) + \ln^2(GDPpc) * V(\hat{\beta}_{t*lnGDPpc}) + 2ln(GDPpc) * COV(\hat{\beta}_t, \hat{\beta}_{t*lnGDPpc})\right)^{\frac{1}{2}}$. The dotted lines represent the 5% confidence interval. Curves in Panel B are defined by equations $y = xe^{-\sigma x}$.

Assuming that no evasion takes place for zero tariffs, the specification employed implies that, for an actual trade flow worth \$1 (as declared by the partner), the value reported by the importer, on which duties can be collected, is $e^{-\sigma t}$, where σ is the evasion elasticity and t the tariff duty. Accordingly, the collected tariff receipt is $te^{-\sigma t}$. Thus, maximum receipts are collected for $t = 1/\sigma$ when evasion elasticity is not zero, meaning that a declining marginal effect of tariffs on revenue is not excluded for poor countries, even for products with a very low price elasticity of demand. More generally, the gap with respect to receipts without evasion is sizeable as illustrated in Figure 3 (Panel B). For instance, a 50% ad-valorem duty will result in only 43% of the value of actual imports being collected if the evasion elasticity is 0.3, 37% for an elasticity of 0.6, 30% for 1 and only 24% if the elasticity is 1.5. Were this tariff to be halved, the decrease in tariff receipts, at constant imports, would not amount to the 25% resulting from their calculation at face value: they would be respectively 20, 16, 11 or only 6% for an evasion elasticity worth respectively 0.3, 0.6, 1 and 1.5. Neglecting customs duty evasion may thus be seriously misleading when assessing the possible fiscal impact of a liberalization agreement. The mirror image of this overstatement of fiscal consequences is that the trade impact of liberalizations may be overstated when tariffs are imperfectly collected, even though the theoretical analysis above makes it clear that avoiding taxation also involves costs.

6 Concluding remarks

Anecdotal evidence on customs duty evasion abounds, and a few recent case studies have proved its relevance for specific countries by studying the gaps in reported trade flows. By extending the analysis to all countries for which suitable data are available, this study gauges the pervasiveness and magnitude of this phenomenon, as well as its determinants. Our results show

that customs duty evasion is widespread and uneven. Differences across products matter, because the value of homogenous products is easier to assess, but cross-country differences seem to be more significant. Although the role of specific institutions is difficult to disentangle, evasion is clearly more important among low-income countries, which tend also to have weaker institutions. Even controlling for income level, a higher degree of rule of law is found to limit the extent of evasion. In contrast, we find no significant influence of WTO membership or of the dispersion of tariffs across products. We also find evasion to be far more widespread for imports from countries where exporting firms are more likely to engage in bribery: exporter practices are thus another important determinant of evasion.

There is no quick fix to the complex issue of customs duty collection, and policy responses generally entail wide-ranging reforms. However, a few key policy measures that lend themselves to quantification can be assessed econometrically. This analysis points to investments in Asycuda systems of automated customs data treatment as potentially powerful levers to fight evasion. Results for PSI are mixed (and tentative) since their efficiency seems to depend strongly on income level, with potentially perverse effects for the poorest countries. Ratification of the WTO agreement on customs valuation, on average, is not found to have a significant impact.

The quality of trade data is known to be poor at a detailed level. While measurement error in the dependent variable is not a source of bias in a linear model such as the one in this paper, it reduces the efficiency of estimates. The large number of observations helps to overcome this problem in our case, as confirmed by the robustness of the findings to a variety of controls and changes in specifications, including the use of differences rather than levels. As a result, we believe our estimates provide useful and reliable information on the extent and determinants of evasion, despite the unlawfulness of these practices.

Our estimates suggest that an evasion elasticity around 1 (or more) is common in poor countries, meaning that the share of imports evading taxation is 1% higher for a one percentage point higher tariff duty. This is a very large order of magnitude and the consequences may be important given the significant share that tariff receipts often represent in developing countries' public revenue. This should be borne in mind when thinking about the merits of tariffs with respect to other taxes. Another important implication is that neglecting evasion may lead to significantly overstating the fiscal consequences of liberalizations in poor countries, where concerns about replacement are correspondingly the most serious (Baunsgaard and Keen, 2009). More generally, given the pervasiveness of evasion, thinking about tariff receipts based on face values could be very misleading in the case of low-income countries.

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Appendix 1: Theoretical analysis—additional details

Case I: Corruption, exogenous inspection effort (base case, developed in the main text)

The cost of evasion writes $C = \left[\tau\left(s_1^O + s_2^O t\right) + (1+\tau)(s_1^F + s_2^F t) + t\beta^O\right]\epsilon\gamma^3 M/2$, so that equation (5) can be rewritten:

(A.1)

$$\sigma = \frac{\partial\gamma^*}{\partial t} = \frac{C_\gamma - tC_{\gamma t}}{tC_{\gamma\gamma}} = \left[\frac{\tau s_1^O + (1+\tau)s_1^F}{\tau(s_1^O + s_2^O t) + (1+\tau)(s_1^F + s_2^F t) + t\beta^O}\right]\frac{\gamma^*}{2t}$$

This expression shows that $\sigma \geq 0$ and $\partial\sigma/\partial t \leq 0$. Derivating with respect to ϵ,

(A.2)

$$\frac{\partial\sigma}{\partial\epsilon} = \left[\frac{\tau s_1^O + (1+\tau)s_1^F}{\tau(s_1^O + s_2^O t) + (1+\tau)(s_1^F + s_2^F t) + t\beta^O}\right]\frac{1}{2t}\frac{\partial\gamma^*}{\partial\epsilon} \leq 0$$

Similar computations can be done for transparency. Derivating the FOC with respect to τ,

(A.3) $$C_{\gamma\tau} + C_{\gamma\gamma}\frac{\partial\gamma^*}{\partial\tau} = 0$$

Since $C_{\gamma\tau}$ is unambiguously positive, this proves that $\partial\gamma^*/\partial\tau \leq 0$. Derivating (A.1) with respect to τ,

(A.4)

$$\frac{\partial\sigma}{\partial\tau} = \left[\frac{\tau s_1^O + (1+\tau)s_1^F}{\tau(s_1^O + s_2^O t) + (1+\tau)(s_1^F + s_2^F t) + t\beta^O}\right]\frac{1}{2t}\frac{\partial\gamma^*}{\partial\tau} + \frac{s_1^O s_2^F - s_1^F s_2^O + \beta^O(s_1^O + s_1^F)}{[\tau(s_1^O + s_2^O t) + (1+\tau)(s_1^F + s_2^F t) + t\beta^O]^2}\frac{\gamma^*}{2}$$

Replacing the partial derivative $\partial\gamma^*/\partial\tau$ by its expression,

(A.5)

$$\frac{\partial\sigma}{\partial\tau} = -\frac{\left[\tau s_1^O + (1+\tau)s_1^F\right]\left[s_1^O + s_2^O t + s_1^F + s_2^F t\right] + 2t\left[s_1^F s_2^O - s_1^O s_2^F + \beta^O(s_1^O + s_1^F)\right]}{[\tau(s_1^O + s_2^O t) + (1+\tau)(s_1^F + s_2^F t) + t\beta^O]^2}\frac{\gamma^*}{4t}$$

The sign of this expression cannot be established unconditionally, but it can only be positive if $2ts_1^O s_2^F \geq 2t\left[s_1^F s_2^O + \beta^O(s_1^O + s_1^F)\right] + [\tau s_1^O + (1+\tau)s_1^F][s_1^O + s_2^O t + s_1^F + s_2^F t]$.

Irrespective of the value of t and τ, a sufficient condition for the sign to be negative is thus $s_1^F s_2^O \geq s_1^O s_2^F$, i.e. that the customs officer's penalty is more dependent in the tariff rate than the

importer's penalty.[32] This is in particular the case if the base for computing the penalty (value understatement or tax understatement) is the same for the importer and the customs officer (i.e., $s_1^F s_2^O - s_1^O s_2^F = 0$). In this context, $\partial\sigma/\partial\tau \leq 0$.

To study the interaction between efficiency and transparency, let us rewrite (6) as $\partial\gamma^*/\partial\epsilon = -\mathrm{C}_{\gamma\epsilon}/\mathrm{C}_{\gamma\gamma} = -\gamma^*/2\epsilon$. Derivating with respect to τ,

(A.6)

$$\frac{\partial^2\gamma^*}{\partial\tau\partial\epsilon} = -\frac{1}{2\epsilon}\frac{\partial\gamma^*}{\partial\tau} \geq 0$$

Derivating (A.5) with respect to *t* then shows in addition that $\partial^2\sigma/\partial\epsilon\partial\tau \geq 0$.

Case II: Corruption, exogenous inspection effort, penalty with a fixed component

Let $S^i = s_2^i t\gamma M + s_3^i$, $i = O, F$ be the penalties to which the importer and the customs officer are exposed. s_3^i is the fixed component of the penalty, and we will note $s_3 = s_3^O + s_3^F$. The cost of evasion writes $C = 1/2\left[\tau\left(s_2^O t\gamma M + s_3^O\right) + (1+\tau)(s_2^F t\gamma M + s_3^F) + \beta^O t\gamma M\right]\epsilon\gamma^2$, so that equation (5) can be rewritten:

(A.7)

$$\sigma = \frac{\partial\gamma^*}{\partial t} = \frac{C_\gamma - tC_{\gamma t}}{tC_{\gamma\gamma}} = \left[\frac{\tau s_3^O + (1+\tau)s_3^F}{\tau(3s_2^O t\gamma M + s_3^O) + (1+\tau)(3s_2^F t\gamma M + s_3^F) + 3\beta^O t\gamma M}\right]\frac{\gamma^*}{t}$$

This proves that $\sigma \geq 0$ (and $\partial\sigma/\partial t \leq 0$) and the demonstration in the main text that $\partial\gamma^*/\partial\epsilon \leq 0$ is still valid. As in case I, derivating (A.7) with respect to ϵ shows in addition that $\partial\sigma/\partial\epsilon \leq 0$.

As in case I, (A.3) shows that $\partial\gamma^*/\partial\tau \leq 0$, but an additional parameter restriction is needed in order to conclude about the sign of the second derivative with regards to t and τ:

(A.8)

[32] If the importer's penalty is far more dependent on the tariff rate than the customs officer's penalty, then an increased transparency makes the cost of evasion less sensitive to tariffs, which may offset the dissuasive effect of enhanced transparency.

$$\frac{\partial\sigma}{\partial\tau} = \frac{3\gamma^{*2}M\left(s_3^O s_2^F - s_3^F s_2^O + s_3^O\beta^O + s_3^F\beta^O\right)}{[\tau(3s_2^O t\gamma^* M + s_3^O) + (1+\tau)(3s_2^F t\gamma^* M + s_3^F) + 3\beta^O t\gamma^* M]^2} + \frac{1}{t}\left[\frac{\left[\tau s_3^O + (1+\tau)s_3^F)\right]^2}{[\tau(3s_2^O t\gamma^* M + s_3^O) + (1+\tau)(3s_2^F t\gamma^* M + s_3^F) + 3\beta^O t\gamma^* M]^2}\right]\frac{\partial\gamma^*}{\partial\tau}$$

The sign of the first term depends upon the pattern of penalties and bonuses. In any case, the second term is always negative; and as soon as $s_3^O + s_3^F > 0$, it dominates for small enough values of *t*. Under a given threshold tariff level, we can then conclude that $\partial\sigma/\partial\tau \leq 0$. Note in addition that, in the absence of bonus, assuming that penalties are proportional for the two agent categories (i.e., $s_3^O s_2^F - s_3^F s_2^O = 0$) is enough to conclude that $\partial\sigma/\partial\tau \leq 0$.

Case III: Collusion

An alternative hypothesis is that the importer and the customs officer collude to set the declared value of the shipment. In this case, there is no point about the disclosure of the shipment's true value by the customs officer, but the probability of successful control must still be considered. We take into account the fact that this probability is linked to the share smuggled,[33] and we write it as $\tau\gamma^2$. Assuming penalties to take the same form as previously, the joint benefit for the customs officer and the importing firm of smuggling a share γ of the shipment is then

(A.9) $$\Pi(\gamma) = -(1-\gamma)tM - \tau\gamma^2(S^O + S^F) = -(1-\gamma)tM - \tau\gamma^3 M(s_1 + s_2 t)$$

Where we have noted for convenience $s_1 = s_1^O + s_1^F$ and $s_2 = s_2^O + s_2^F$. The benefit is calculated in comparison to the case where the import value is normally declared. Note that a possible bonus would not play any role here. The first order condition of maximization gives

(A.10)

$$\gamma^* = \left(\frac{t}{3\tau(s_1 + s_2 t)}\right)^{\frac{1}{2}}$$

As a consequence, $\sigma = \partial\gamma^*/\partial t \geq 0$, $\partial\sigma/\partial t \leq 0$, $\partial\gamma^*/\partial\tau \leq 0$ and $\partial\sigma/\partial\tau \leq 0$, meaning that the results established in a context of corruption still hold here.

[33] This was not the case under corruption, because the controller was assumed to be able to disclose the true value of the shipment when and only when the customs officer disclosed it.

Case IV: Corruption, endogenous inspection effort

Let us assume that customs officers adapt endogenously their inspection effort, product by product. Noting $e \in [0;1]$ this effort, let $d = e\epsilon\gamma^2$ be the probability for the customs officer to unveil the true value of the shipment. As in Anson et al. (2006), let $c(e) = Me^2/2$ be the cost for the customs officer of this inspection effort. The bribe offered if the true value is disclosed is the same as in the case of exogenous inspection effort, as is the bonus offered to the customs officer in the case he catches and denounces the fraud. The condition for bribery to take place is the same as in the main text. Here also, we assume this condition to be met, meaning that the customs officer accepts the bribe.

Assuming the penalties to take the same form as in case I, it is not possible to conclude about the sign of the derivatives of interest (e.g. $\partial\gamma^*/\partial\epsilon$ and $\partial\gamma^*/\partial\tau$) unconditionally. However, it is possible as soon as the base for computing the penalty (value understatement or tax understatement) is the same for the importer and the customs officer (i.e., $s_1^F s_2^O - s_1^O s_2^F = 0$). For the sake of simplicity, we thus directly make this assumption, and we note α the real such that $s_j^F = \alpha s_j,\ j = 1,2$, with $s_j = s_j^F + s_j^O$. α is the penalty inflicted to the importer as a share of the total penalty.

The net benefit expected by the customs officer from accepting a bribe is

(A.11)

$$\Pi^C(e) = [(1-\tau)S^F - \tau S^O + B]e\epsilon\gamma^2/2 - Me^2/2 = [(\alpha-\tau)(s_1 + s_2 t) + \beta^O t]Me\epsilon\gamma^3/2 - Me^2/2$$

Since τ is the probability of successful control of the customs officer's work, it is necessary lower than unity. It is also reasonable to assume this probability to be rather low, and in particular lower than α (i.e. $\alpha - \tau > 0$), the penalty inflicted to the importer as a share of the total penalty. For a given value of γ, the customs officer's profit is maximized for

(A.12) $$e = \epsilon\gamma^3/2\ [(\alpha-\tau)(s_1 + s_2 t)\ + \beta^O t\ ]$$

For a given value of e, importers set γ^* so as to maximize their payoff, $\Pi^F(\gamma) = -(1-\gamma)Mt - \frac{1}{2}\left[(\alpha+\tau)(s_1 + s_2 t) + \beta^O t\right]e\epsilon\gamma^3 M$. The FOC implies

(A.13)

$$\gamma = \left[\frac{2t}{3e\epsilon(\alpha+\tau)(s_1 + s_2 t) + \beta^O t}\right]^{\frac{1}{2}}$$

Equations (A.12) and (A.13) can be thought of as response functions: customs officers and importers take the behaviour of each others as given. In the equilibrium, these two equations jointly determine e^* and γ^*:

(A.14)

$$\gamma^* = \left[\frac{4t}{3\epsilon^2[(\alpha-\tau)(s_1+s_2t)+\beta^O t][(\alpha+\tau)(s_1+s_2t)+\beta^O t]}\right]^{\frac{1}{5}}$$

(A.15)

$$e^* = \frac{1}{2\epsilon^5}\left[\frac{4t}{3(\alpha+\tau)(s_1+s_2t)+\beta^O t}\right]^{\frac{3}{5}}\left[(\alpha-\tau)(s_1+s_2t)+\beta^O t\right]^{\frac{2}{5}}$$

The extent of evasion thus declines with the ease of enforcement, as previously ($\partial\gamma^*/\partial\epsilon \leq 0$). In contrast to previous cases, however, it increases with transparency ($\partial\gamma^*/\partial\tau \geq 0$), because importers anticipate the lower effort customs officers devote to control when transparency is high. The way the tariff influences evasion is characterized by

(A.16)

$$\sigma = \frac{\partial\gamma^*}{\partial t} = \frac{3\epsilon^2 4(4t)^{-\frac{4}{5}}}{5}\,\frac{(\alpha^2-\tau^2)({s_1}^2-{s_2}^2t^2)-\beta^O t^2}{\left(3\epsilon^2\left[(\alpha-\tau)(s_1+s_2t)+\beta^O t\right]\left[(\alpha+\tau)(s_1+s_2t)+\beta^O t\right]\right)^{6/5}}$$

Assuming that $s_1 > 0$, this shows that the evasion elasticity is always positive for tariffs below a threshold level, equal to s_1/s_2 in the absence of bonus. This threshold level is larger, the smaller the share of sanctions proportional to value understatement with respect to the sum of the share proportional to tax understatement and of the bonus. Below this threshold tariff level, the evasion elasticity is negative. In sum, as soon as sanctions and bonuses depend upon tariffs, customs officers benefit from inspecting highly-taxed products more closely. As a result, the evasion elasticity can be negative (and increasing with transparency) for high enough tariffs. In any case, the derivative of the evasion elasticity with respect to ease of enforcement is of the opposite sign than the elasticity itself.

Appendix 2: Data—Sources and definitions

Cross-checking and filtering the data

Limiting measurement errors as much as possible is important to improve the efficiency of the estimates. We cross-checked and filtered the data in several ways. We first focus on the homogeneity of reporting practices, retaining only data from countries following UN recommendations on key points (unless otherwise specified, the recommended answer is yes): Is the statistical value of imported goods a CIF-type value? (Question 53[34]); Is the statistical value of exported goods an FOB-type value? (Question 54); Do you classify imports *by country of origin* or production? (Question 58; UN recommendation in italics); Do you classify exports by country of last known destination? (Question 62); Do you use customs declarations as a source? (Question 106). This filter resulted in significant downsizing of the sample, but it is likely to improve data quality substantially (see Gaulier et al., 2008). Another concern is that some countries do not report in their statistics values under a minimum threshold, often set at $10,000. To avoid any bias ensuing from cross-country differences in this respect, we disregard values lower than $10,000.

Countries maintaining multiple exchange rate regimes according to the IMF are also excluded from the sample, since such configuration gives rise to specific incentives to fake import declarations (see e.g. Bhagwati, 1964). In addition, only fully independent territories are taken into account, and countries with de facto autonomous regions are disregarded.[35] Re-exports may also cause problems, since they are frequently subject to ambiguous or misleading declarations. We deal with this concern by relying only on special trade declarations, which exclude warehoused and re-exported goods. In addition, we exclude those reporters most heavily involved in such trade, namely Hong-Kong, China, Singapore, the Netherlands and Panama. Intra-EU trade flows, the measurement of which rests on specific methods, are also excluded from the sample.

Data inspection revealed massive problems for a group of countries, which although officially considered declaring countries seem only occasionally to report their data. This is the case of members of the Economic Community of West African States (ECOWAS), as well as the

[34] Question numbers refer to UN National Compilation of Reporting Practices (see http://unstats.un.org/unsd/tradereport/compliance.asp).

[35] Moldova and Georgia are the two countries excluded. The existence of a de facto autonomous region means that government does not completely control its statistical territory, which is usually an important source of fraud and declaration problems.

United Arab Emirates and Syria. For a few other countries, trade flows are very frequently not reported by partners, probably because they are included in aggregate in the partner's geographical classification. This is the case of ex-Yugoslavian countries (except Slovenia), Albania, Andorra, Belarus, Luxembourg and Namibia. Data on these countries as reporters or partners were removed from the sample. In addition to these specific cases, we set as a prerequisite that the ratio between the total value declared by the partners and by the country itself for its imports lies between 0.75 and 1.5.[36] As casual examination confirms, the statistics of countries not matching this basic pre-request are unsuitable for proper econometric analysis. As a result of these successive steps of data filtering, we are left with a sample of 75 countries (see Table A.1).

Variables definition and sources

Evasion: Gap between the declared export and import for a given product at the HS6 level by country pairs. Source: Comtrade Database.

Tariff: Detailed protection (MFN and preferential Tariff) at the HS6 level for 166 importing countries and 208 partners. Source: MAcMap-HS6 database, http://www.cepii.fr/anglaisgraph/bdd/macmap.htm.

Control of Corruption: 'The extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as elite "capture" of the state'. Governance Indicator, ranking 212 countries from -2.5 to 2.5, with higher values corresponding to better outcome. Source: Kaufman et al., 2008.

The International Country Risk Guide (ICRG) corruption index measures "in which measure the governmental executives may be corruptible". Although it takes into account the likelihood that governmental executives ask for "special payments and bribes connected with import and export licenses, exchange controls, tax assessments, police protection, or loans", this measure is more concerned with actual or potential corruption in the form of excessive patronage,

[36] These bounds are chosen based on the prior that a normal ratio is slightly above 1 due to the CIF-FOB margin. This ratio is computed for flows with other countries in the sample before this criterion is applied. It leads to the exclusion of St Vincent, Dominica, Cyprus, Syria, Cambodia (the total value reported by partners is more than 1.5 times the value reported by the country for these 5 countries), as well as St-Lucia, Zambia, Uganda (the ratio is below 0.75 for these 3 countries).

nepotism, job reservations, 'favor-for-favors', secret party funding, and suspiciously close ties between politics and business." It codes corruption in 140 countries with a long time series (1982-2004), from 0 to 6, where low scores mean high levels of corruption. To ease comparability, the index is demeaned, subtracting its sample weighted mean. Source http://www.prsgroup.com/ICRG_Methodology.aspx.

Corruption Perceptions Index (CPI): 'the degree to which corruption - "the abuse of entrusted power for private gain" - is perceived to exist among public officials and politicians'. CPI Index, orders 91 countries in 2001 and 145 in 2004, from 0 to 10. A higher score means less (perceived) corruption. To ease comparability, this index is demeaned, subtracting its sample weighted mean, and rescaled by a factor 0.5. Source: http://transparency.org.

Bribe Payers Index (BPI), computed by Transparency International to evaluate 'the supply side of corruption - the likelihood of firms from the world's industrialised countries to bribe abroad'. See http://www.transparency.org/policy_research/surveys_indices/bpi. The index ranges theoretically between 0 and 10, a higher score indicating that engaging in bribery is perceived to be less common among the country's exporters. Before computing the interaction with tariffs, we demean this variable by removing its sample weighted mean (6.2). Source: http://www.transparency.org/policy_research/surveys_indices/bpi.

Rule of Law (RL): 'The extent to which agents have confidence in and abide by the rules of society, including the quality of property rights, the police, and the courts, as well as the risk of crime'. Governance Indicator, ranking 212 countries from -2.5 to 2.5, with higher values corresponding to better outcome. Source: Kaufman et al., 2008.

Government Effectiveness (GE): "the quality of public services, the capacity of the civil service and its independence from political pressures; the quality of policy formulation". Governance Indicator, ranking 212 countries from -2.5 to +2.5, with higher values corresponding to better outcome. Source: Kaufman et al. (2008).

Gatt Valuation Agreement (ACV): adoption by a WTO member of uniform rules for the evaluation of goods at customs. Source: Annual Report of the Committee on Customs Valuations (WTO n.d.).

Automated System for Customs Data (ASYCUDA) software: The first variable used is the amount (in $ million) invested over the 2000-03 period. A one-year lag is introduced, assuming

that investment in year *n* are effective starting from year *n*+1. From our estimation sample, 15 countries had a non-zero investment in Asycuda systems over 2000-03. The alternative variable is a dummy indicating that significant investment in such systems is initiated during this period. Only investments exceeding $100,000 (over the period) are considered significant, since expenses under this threshold generally correspond to preparatory or accompanying studies, which do not reflect *per se* a decisive step in the implementation. Source: authors' elaboration based on UNCTAD (www.asycuda.org).

Pre-Shipment Inspection (PSI): hiring a private company which inspects the value of requiring imports, before shipments to the importing country. Nine countries in the estimation sample hired a PSI company in 2004. Two countries (India and Indonesia) started doing so between 2001 and 2004, and two countries (Argentina and Bolivia) ceased to do so. Source: Johnson (2001) for 2001, and World Bank (2005) for 2004.

Contiguity: geographical contiguity of country pairs. Source: CEPII (http://www.cepii.fr).

Homogeneous product: Using Rauch (1999), products are classified into three groups: homogenous goods (their price is set in organized exchanges), differentiated goods (not having any quoted price, and thus treated as differentiated) and an in-between category (not traded in an organized exchange, but having some quoted reference price - e.g. industry publications). Two classification schemes are proposed, 'liberal' and 'conservative', to resolve possible ambiguities when classifying products into the three categories. Source: Rauch (1999).

Table A.1: Reporting countries in the sample for 2004 and number of observations in the estimation sample by product group

Country	ISO	Diff.	Hom.	n.c.	Country	ISO	Diff.	Hom.	n.c.
Argentina	ARG	6,237	2,866	476	Lithuania	LTU	1,702	525	140
Australia	AUS	15,802	4,942	1,278	Madagascar	MDG	626	191	61
Austria	AUT	4,231	1,015	306	Malawi	MWI	887	287	70
Azerbaijan	AZE	1,776	430	177	Malaysia	MYS	9,340	4,431	806
Belgium	BEL	6,145	2,483	422	Malta	MLT	511	61	27
Bolivia	BOL	2,149	689	192	Mauritania	MRT	92	32	7
Brazil	BRA	8,674	4,119	760	Mauritius	MUS	2,003	828	161
Burundi	BDI	124	28	11	Mexico	MEX	12,827	4,731	1,027
Cameroon	CMR	787	248	105	Mongolia	MNG	724	88	53
Colombia	COL	5,215	2,513	427	Morocco	MAR	5,009	2,044	359
Costa Rica	CRI	3,679	1,242	278	New Zealand	NZL	8,570	2,617	642
Cuba	CUB	2,462	640	212	Nicaragua	NIC	1,620	456	136
Denmark	DNK	4,674	1,037	298	Norway	NOR	14,375	3,807	1,126
Ecuador	ECU	4,426	1,492	322	Oman	OMN	2,115	589	152
Estonia	EST	1,323	381	126	Paraguay	PRY	1,845	614	150
Finland	FIN	3,870	872	265	Peru	PER	4,772	1,833	379
France	FRA	10,031	3,371	710	Philippines	PHL	5,834	2,893	518
Gabon	GAB	428	116	37	Poland	POL	4,102	1,396	299
Germany	DEU	12,860	5,002	979	Qatar	QAT	1,769	276	146
Greece	GRC	3,533	945	240	Romania	ROM	10,790	3,973	895
Grenada	GRD	363	110	35	Saudi Arabia	SAU	9,730	2,887	702
Guatemala	GTM	3,519	1,328	263	Seychelles	SYC	385	75	34
Guyana	GUY	506	115	34	Slovak Rep.	SVK	1,320	334	105
Honduras	HND	2,493	772	183	Slovenia	SVN	1,229	322	65
Hungary	HUN	2,887	705	176	Spain	ESP	7,696	2,746	569
India	IND	8,722	4,456	851	Sri Lanka	LKA	3,275	1,541	295
Indonesia	IDN	6,272	3,834	638	St Kitts and Nevis	KNA	313	71	24
Iran	IRN	4,139	1,882	424	Sweden	SWE	5,851	1,395	418
Ireland	IRL	3,016	757	218	Switzerland	CHE	17,306	6,351	1,425
Italy	ITA	9,636	3,597	700	Tanzania	TZA	1,842	558	157
Jamaica	JAM	1,824	523	167	Thailand	THA	9,272	4,301	836
Japan	JPN	16,838	6,261	1,283	Trinidad and Tobago	TTO	2,066	669	158
Jordan	JOR	3,033	1,023	218	Tunisia	TUN	4,107	1,579	304
Kazakhstan	KAZ	5,135	1,288	439	Turkey	TUR	11,431	4,877	997
Kenya	KEN	2,377	848	184	USA	USA	30,869	10,829	2,508
Korea	KOR	11,419	5,316	936	Ukraine	UKR	8,088	2,752	631
Latvia	LVA	1,287	408	128	Yemen	YEM	799	183	66
Lebanon	LBN	4,789	1,443	309	**Total**		**391,773**	**142,239**	**31,255**

Note: n.c. refers to products not classified as homogenous or differentiated (and as such disregarded in estimations where the dummy for homogenous products is included). The number of observations refers to imports by the reporting country; it includes only observations included in the estimation sample, which requires *inter alia* that a flow above $10,000 be reported by both the importer and the exporter. See text for more details. Out of the 75 countries in this table, 66 also report data for 2001.

Appendix 3: Additional estimation results

Appendix Table A.2: Determinants of customs duty evasion, estimates in differences (2001-04)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ Tariff	0.99 **	0.56	0.53	0.67 **	0.72 ***	0.63 ***	0.72 **
	(2.41)	(1.54)	(1.42)	(2.53)	(2.80)	(2.75)	(2.48)
Δ Tariff, homogenous prod.	-0.10	-0.13	-0.14	-0.09	-0.06	-0.09	-0.11
	(-1.01)	(-1.22)	(-1.51)	(-0.93)	(-0.62)	(-0.96)	(-1.00)
Δ [Tariff * ln(GDPpc)]	-0.19 **			-0.21 *	-0.25 **	-0.19 **	-0.23 **
	(-2.10)			(-1.92)	(-2.43)	(-2.39)	(-2.29)
Δ Tariff * contiguity	0.20	0.23 *	0.24 **	0.19 *	0.17	0.19	0.41 ***
	(1.54)	(1.65)	(1.99)	(1.65)	(1.43)	(1.63)	(2.90)
Δ [Tariff * WTO membership]	-0.37	-0.33	-0.28				
	(-0.99)	(-0.84)	(-0.71)				
Δ [Tariff * MFN variance]	0.21	-0.13	-0.22				
	(0.20)	(-0.20)	(-0.24)				
Δ [Tariff * rule of law]		-0.10					
		(-0.64)					
Δ [Tariff * gov't eff.]			-0.09				
			(-1.35)				
Δ [Tariff * orthog. rule of law]				0.09			
				(0.33)			
Δ [Tariff * orthog. gov't eff.]					0.19		
					(1.55)		
Δ [Tariff] * exporter's BPI							-0.20 ***
							(-3.43)
Adj. R-squared	0.0138	0.0138	0.0138	0.0139	0.0139	0.0139	0.0144
Observations	303,689	303,689	303,689	303,689	303,689	303,689	255,174

Note: As in Table 4.