Determinants and pervasiveness of the evasion of custom duties

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Abstract: Evasion of custom duties is a serious concern in developing countries, where tariff receipts are often important while their collection is 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 they are available for both partners. We conclude that evasion of custom duties is larger in poorer countries, especially when the rule of law is limited. The consequences are likely to be serious in the poorest countries, where a one percentage point higher tariff is found to be associated on average with imports understatement by one percent or more. We also assess policy remedies and conclude in particular that automated custom data treatment may be useful.

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Because they are collected in specific places –the place of custom clearance-, tariff receipts are generally considered to benefit from lower collection costs than most other taxes. This might explain why tariffs are frequently used by low-income countries as revenue devices, despite their suboptimality (Aizenman, 1985): according to Baunsgaard and Keen's data (2009), the share of trade tax revenue in total tax receipt over the period 2001-2006 amounted on average to 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 tax revenue in at least one year during this period. While almost anecdotal for rich countries, collection of tariff duties is thus a serious matter for most developing countries, and the available evidence suggests that these are precisely the countries where collection is far from perfect: the tariff collection rate, computed by comparing assessed collected taxes to what imports should have originated given statutory protection, are frequently lesser than 70% in Africa, and in some cases they do not reach one half.[2] Even these figures may be overstated, to the extent that they are based on trade statistics, which may themselves be erroneous. For instance, an official United Nations' (UN) letter cites the figure of 80% of custom taxes *not* being collected in the Democractic Republic of Congo, as a result of an undisclosed study by a private company (UN, 2005, p. 16).

As a matter of fact, custom duties can be evaded through a number of ways, from fallacious declarations to bribery or smuggling, meaning that the actual collection cost can easily be understated. A number of features are likely to influence tax evasion, for instance the quality of law enforcement or the level and distribution of tariffs. This raises questions about the effectiveness of custom duties collection, and about its change with tariff liberalisation. Should tariff revenue losses associated with tariff changes be computed "at face value", i.e. based on statutory protection, or may the relationship be more complex? Would specific reforms be likely to improve custom duty collection?

The double declaration of trade flows, by both the importer and the exporter, offers an opportunity to gauge the importance of these unlawful practices: while evading custom duties generally requires the importer to sidestep due registration upon importing, the same does not apply to the exporter. Using discrepancies between mirror declarations at the product level to reveal custom duties evasion was pioneered by Baghwati (1964, 1967), whose results hinted about 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

[1] Assessing tariff receipts in developing countries is difficult. The main statistical source is IMF's *Government Finance Statistics* but for many countries the tariff receipts item in this database actually includes other tax resources such as excise duties, sales taxes, or so-called "phytosanitary" or "statistical" taxes. Baunsgaard and Keen (2009) complement this data with information drawn from IMF's periodic consultations with member countries. We are grateful to them for making these data available to us. The figures reported here are 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 the average tariff collection rate to be 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 & Laborde (2007) report tax collection rates of 44% for Cameroon and 62% for the Central African Republic. Decaluwe 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 countries include Ghana 84%, Guinee 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.

higher tariffs are statistically associated with a lower declaration by the importing country, in comparison to the mirror declaration by the exporter. The relationship is not negligible, since they find that a one percentage point increase in the tax rate is associated with a 3 percent increase in evasion.

Arndt and van Dunem (2005) find comparable results in the case of Mozambique, based on the same approach, with an elasticity half as a large as in the Chinese case. Applying the same approach to trade between Germany and ten Eastern European countries during 1992-2003, Javorcik and Narciso (2008) also find support for the hypothesis that higher product-level tariffs spur stronger tariff evasion, again with estimated elasticities which tend to be weaker than those found by Fisman and Wei. They 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 already suggested by Baghwati (1967). Mishra et al. (2008) show that a comparable relationship between tariffs and discrepancies in reported trade flows held in India during the nineties; they find its magnitude to be lesser than the one found by Fisman and Wei for China, although the gap appears to be declining over time. Bouët and Roy (2010) study in a comparable framework Nigeria, Kenya and Mauritius and find a positive and significant elasticity of substitution in the three countries.

Although these case studies suggest that the phenomenon is not specific to a few countries, it is difficult to evaluate how pervasive it is. A further interesting question is how it compares across countries: Mishra et al. (2008) and Bouët and Roy (2010) hint at the quality of institutions as being a likely determinant of custom evasion, but the subject deserves further scrutiny. Recent works (Johnson, 2001; Keen, 2003; De Wulf and Sokol, 2005) emphasize that specific strategies implemented to reduce corruption are unlikely to be successful, unless they are supported by an improved broader legal environment. Based on the numerous attempts to reform custom administration and on the most relevant tools and principles put forward by experts in this area, targeted measures should also be considered.

This paper addresses these questions by studying discrepancies in mirror trade declarations in relation with tariff duties in all countries for which relevant data were available in 2001 and 2004. It endeavours understanding what the determinants of custom duties evasion may be, trying to relate it to economic and institutional variables. The effectiveness of targeted policy measures aimed at fighting corruption in customs administration is also studied.

The paper is organized as follows. Section 1 presents a simple model, sketching the determinants of customs duties evasion and their interaction with the institutional framework and product characteristics. The empirical approach is introduced in Section 2, before describing the data and giving descriptive statistics. Sections 3 and 4 present the econometric analysis of determinants and possible remedies. Extensions and robustness checks are discussed in Section 5.

1 Theoretical analysis: evasion, tariffs and institutions

We present here a simple model sketching the determinants of custom duties evasion and their interaction with the institutional framework. Mishra et al. (2008) offer a useful general analysis of this issue, based on the simple hypothesis that there is a positive cost of smuggling or avoiding taxes, increasing in the fraction of imports smuggled and in the quality of enforcement by the government, with a marginal cost of smuggling also increasing in the fraction smuggled

and in enforcement. In this context, they show (for usual cost functions) that the elasticity of evasion with respect to tariffs is a decreasing function of the quality of enforcement.

Since our analysis covers different types of policy measures aimed at fighting customs duties evasion, we develop further 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 (1995) analysis of corruptible law enforcers, we explicitly model the interaction between custom 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 $0 \leq \gamma \leq 1$. 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 emphasised 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 avert for differentiated than for homogenous products. For short, we refer to ϵ as ease of enforcement in what follows. The probability of disclosure is thus assumed to be increasing and convex in the share of import smuggled, reflecting the fact that concealing the true value of the shipment is increasingly difficult (in average and marginal terms) as the share smuggled increases.[5]

If the custom officer unveils the true value of the shipment, assuming it has actually 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 that custom officers are rewarded with a bonus proportional to the tariff revenue recovered, $\mathrm{B} = \beta^O t\gamma M$ where $0 \leq \beta^O \leq 1$, as in Anson et al. (2006).[6] However, the custom officer may also accept a bribe from the importer to overlook the understatement. In this case, the custom officer is exposed to an administrative control. The probability that such control is carried out *and* reveals the bribery depends on a variety of factors, including the effort devoted by the government to such controls, as well as measures specifically aimed at improving customs administration (see Section 5).[7] For simplicity, we identify this probability to an index summarizing such measures, τ, referred to as transparency in what follows. When bribery is unveiled, the custom 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).

[3] We assume this amount to be given exogenously, as for instance in Mishra et al. (2008), but assuming otherwise would not change most of the results below.

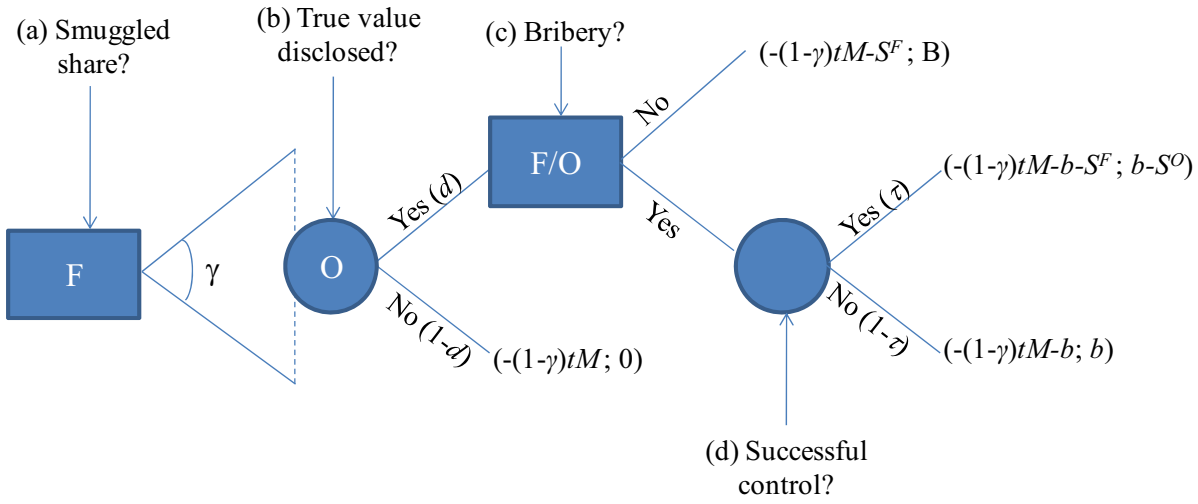
[4] In the simple specification used here, ϵ is the probability of complete smuggling being unveiled (i.e., the probability for $\gamma = 1$). However, using $f(\epsilon)$ instead of ϵ, where f is any function such that $f > 0, f' > 0$, would not alter the results below, meaning that this interpretation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

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

[6] As Anson et al. (2006) point out, this type of positive incentive remains the most widespread.

[7] For simplicity, we assume that this probability does not depend on the share smuggled, for instance because the control technology is the same for the custom officer and for the administrative controller. The success of the control then only depends on the possibility to check the reality and honesty of the custom officer's work.

Figure 1: Sequence of decisions and events



Note: F refers to the importing firm, O to the custom officer. In each case, the payoffs for the importer and the custom officer are shown in parenthesis. The figure describes cases where the importer does understate 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 only involve an economic dimension. As suggested by Allingham and Sandmo (1972), nonpecuniary factors would be worth taking into account in agents' utility functions. For the sake of simplicity, we overlook this dimension and focus exclusively in what follows on purely economic incentives, assuming agents to be risk neutral. We solve the model backward, by first assessing under which conditions bribery might take place. In the event of the true shipment value being disclosed, the importer expect to gain $-b + (1-\tau)S^F$ from bribing the custom 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 for both agents, i.e.

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

If bribery takes place, we assume for simplicity that the bribe is set as the Nash bargaining solution between the importer and the custom officer, assuming equal bargaining power.[8] This means that the benefits they draw from bribery equalize, with a bribe defined as

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

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

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

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

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

As already emphasized for instance by Yitzhaki (1974) about tax income avoidance, the form taken by the penalty to which agents are exposed is important. It may depend upon the value understatement or the tax understatement. A simple form encompassing these two cases 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), all the components are unlikely to be simultaneously nonzero, but this general form allows discussing various cases in a unified framework. For 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 is here the product of the probability of 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 tariffs. The last property reflects the fact that sanctions are at most proportional to tariffs.[9]

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 one, this condition characterizes an interior solution γ^* for γ.[10] Derivating this condition with respect to t implies

(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, noted here 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 the tariff increases more strongly the benefit than the cost of evasion. Moreover we find this effect to be non linear: $\partial\sigma/\partial t \leq 0$ (see Appendix 1, case I). Derivating the FOC with respect to ϵ shows that

(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 (for instance for homogenous products). Because we cannot directly measure the share smuggled but rather its slope with regards to tariffs, we are interested to know whether the ease of enforcement also modifies this slope. As we demonstrate in Appendix 1 (case

[9] 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.

[10] The second order condition is obviously satisfied and the derivative is positive in zero.

I), derivating equation (5) with respect to ϵ shows that $\partial^2\gamma^*/\partial\epsilon\partial t \leq 0$, i.e. $\partial\sigma/\partial\epsilon \leq 0$: easier enforcement also reduces the evasion elasticity.

A similar analysis demonstrates that the share smuggled and the evasion elasticity both decline when transparency is increased ($\partial\gamma^*/\partial\tau \leq 0$ and $\partial\sigma/\partial\tau \leq 0$, see Appendix 1).[11] In addition, $\partial^2\gamma^*/\partial\tau\partial\epsilon \geq 0$ and $\partial^2\sigma/\partial\tau\partial\epsilon \geq 0$, meaning that benefits from improved 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 custom 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 custom officers interact. The importer usually has to declare the shipment value before undergoing custom's examination, hence the sequence considered so far. However, it cannot be ruled out that the importer offers the custom officer a bribe beforehand, and decides jointly with him the value declared for the shipment. The share smuggled is then jointly set by both agents so as to maximize their joint profit. In such case, the question of the ability of the custom 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.

Finally, it is questionable whether the inspection effort of custom officers is exogenous or not (Anson et al., 2006). Since evasion is more likely for high-tariff products, custom officers may choose to devote more effort to control these products. We study the case of endogenous effort in Appendix 1 (case IV), where custom 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, custom 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.[12] 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 evasion elasticity with respect to ease of enforcement is of the opposite sign then the elasticity itself.

This theoretical analysis leads to several testable predictions about the determinants of customs evasion. In our base model, the main predictions are that the evasion elasticity should decrease with the ease of enforcement and with transparency, with a negative second derivative with regards to these two aspects. Alternative settings cannot be ruled out a priori. If collusion dominates, then the ease of enforcement should not matter. If the endogeneity of custom officers is important, then paradoxical results cannot be ruled out. The bottom line is that the question needs an empirical assessment.

[11] An additional restriction on the parameters needs to be made in order to be able to conclude on the elasticity, but it is likely to hold in most practical cases.

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

2 Empirical approach

Since evasion cannot be directly measured, the first empirical issue is to define the form the dependant variable should take. Once this is done, we present the methodology followed to analyse evasion. Data sources and treatments are then discussed.

2.1 Methodology

Custom duties evasion takes place through four main channels: underreporting of unit value; underreporting of taxable quantities; misclassification, by shifting toward a product classification for which the tariff duty is lower; and smuggling, generally defined as imports crossing the border without being registered by custom officers (see for instance Fisman and Wei, 2004; Javorcik and Narciso, 2008). In each case, evasion is reflected in understated import value at custom clearance, i.e. as reported by the importer—even though even a correct declaration of imports' value does not prevent fraud from occurring.[13] In contrast, evading custom duties does not require faking the exporter's declaration in its own country, which are made separately and not available to the importing country's authorities.[14]

As a result, custom duty evasion should lead to shipments registered by the importer being lower than those registered by the exporter. Accordingly, the gap between the shipment values reported by trading partners can be used as an indirect measure of the extent of evasion. In practice, Fisman and Wei (2004) and subsequent studies use the log-difference between the value reported by the exporting and the importing country, for the same flow, as a proxy for tariff evasion. In addition to being standard, this practice is convenient: any constant margin between the valuation of exports and imports (such as the CIF-FOB margin, as commented below, or a constant proportion of misclassified imports, as assumed by Fisman and Wei) would show up as a constant. We thus 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 treading partners:

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

Where X and M refer respectively to the value reported by the exporter and the importer, for exports of product k, from country i (the "partner") to country j (the "reporter"). X and M are frequently referred to as mirror declarations, since they both refer to the same actual flow. This definition of trade gaps will also be used with quantities and unit values instead to values in extensions below. Since such dependent variable is not defined as soon as one out of the two mirror declarations is zero, we will consider as a robustness check extending the definition so as to take these cases into account.

In practice, statistical records use to report import values including cost-insurance and freight (CIF), which corresponds to their actual value at custom clearance. In contrast, exports

[13] The assessment of tax liabilities by customs officers can be purportedly wrong. And even when taxes are correctly assessed, the goods can also be released without the importer actually paying these taxes (Stasavage and Daubrée, 1998).

[14] Smuggling may not be registered even in the exporter's statistics, though, in which case official statistics are of little help, as emphasized for instance by Deardorff and Stolper (1990).

values *X* are usually reported free-on-board (FOB). This difference may drive a systematic wedge between reported exports and imports, unrelated to tax-induced evasion. Getting rid of this wedge is not straightforward, since its magnitude is very difficult to assess (see e.g. Hummels and Lugovskyy, 2006, or 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 useless, because differences in CIF-FOB margins could not be disentangled from misstatements. If appropriately controlled, however, these margins do not prevent from studying the evasion elasticity. This is true in particular if, as we assume in what follows, the residual term ν has zero mean and is independent from the corresponding tariff duty t_{ijk}.

We thus focus on the determinant of the 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 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 value by the importer and the exporter, either 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 theoretical model above predicts that the 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 is problematic based on this specification, given the very large number of products and countries. We therefore impose restrictions on the pattern of evasion elasticities, assuming γ to be constant within two categories of products, homogenous and non-homogenous, and to vary across countries as a linear function of countrywide variables, Z^n_i (n=1, … N, where N is the total number of variables taken into account). The specification to be estimated is accordingly:

(9) $$trade\ gap_{ijk} = \alpha_k + \beta_{ij} + \sigma\, t_{ijk} + \sigma_h homog_k\, t_{ijk} + \textstyle\sum_n \sigma_n Z^n_i t_{ijk} + u_{ijk}$$

Where $homog_k$ is a dummy variable equal to one if product k is classified as homogenous. Some products may be intrinsically more prone to misstatement than others, for example because they are less voluminous for a given value (diamonds are an extreme case), possibly originating a specific form of heteroskedasticity. This is accounted for using standard errors clustered at the product level.

This specification raises concerns about dimensionality. As we will argue below, it is worth in the present context working with as detailed data as possible. We thus make use, for all countries reporting sufficiently reliable statistics (75 in our estimation sample, see below), of data on bilateral trade by six-digit level product (more than 5,000 in the Harmonized System—HS). Equation (9) should thus include more than 10,000 fixed effects (number of products plus number of country pairs), which would make estimation intractable for a sample of more than half a million observations like ours. A within transformation would solve this problem, since the parameters of interest could then be estimated on the transformed regression, without the fixed effects. Unfortunately, this transformation cannot be applied in the context of two-way error-

components model with unbalanced panels. Still, the model can be transformed in a way 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., others than fixed effects) on a full model such as the one laid out in equation (9) can be equivalently obtained 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.[15] While full development of the corresponding algebra is impossible given dimensionality, tailor-made programming taking advantage of the structure of the sparse matrices involved makes the transformation tractable. In what follows, all estimates in level are based on this "within" transformation.

2.2 Data and descriptive statistics

The method described so far relies on the analysis of gaps between trading partners' declarations to infer information about custom duty evasion. 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 part of these discrepancies to reflect evasion, and we already acknowledged the need to control for the CIF-FOB margin. Beyond these two aspects, however, there are many other reasons why trade statistics may be plagued with measurement error, including: unintentional incorrect identification of importer or exporter; unintentional product misclassification; currency conversion; time lag and yearly classification; confidentiality, when the number of firms concerned is too low; reporting error; different customs valuation practices (see e.g. De Wulf, 1981; Yeats, 1995).

As a result, our dependent variable is measured with potentially large measurement errors. We argue that this does not prevent from using this data to infer information about evasion, because there is no serious reason why measurement errors should be correlated with tax evasion. As long as the measurement error in the dependent variable is unrelated to the error term, it makes the estimation less efficient, but without introducing any bias. This is why we deem it important to work with the most detailed data, for all countries for which reliable data are available—even though this entails burdensome treatment, as already mentioned: we rely on a large sample so as to be able identify accurately the variables of interest, despite the noise linked to measurement errors.

The main limitation to the extension of the sample is the need to measure bilateral applied protection at the product level. This is possible at a large scale for 2001 and 2004 based on MAcMap-HS6 (ITC and Cepii), which provides ad-valorem equivalents of most-favored nation (MFN) and preferential applied data 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. Bilateral trade data at the HS-6 level are sourced from the United Nations' (UN) Comtrade database. The analysis is only possible when both countries report their trade statistics

[15] In Davis' notation, the transformation requires pre-multiplying the model by the orthogonal projection on the null-space of the matrix $\Delta = (\Delta_{prod}, \Delta_{countries}), \mathrm{Q}_{[\Delta]}$, where Δ_{prod} is a N by K matrix (N the total number of observations, K the number of products), with element (n,k) equal to one if observation n concerns product k, and zero otherwise. $\Delta_{countries}$ is defined equivalently for country pairs instead of products.

in this database, as do 152 countries for imports and 150 for exports. The sources for other variables are described in Appendix 2.

Limiting measurement errors to the extent possible is important to improve estimates' efficiency. We thus cross-check and filter the data in several ways. We first focus on the homogeneity of reporting practices, by only retaining data from countries following UN's 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[16]); 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's recommendation italicized); Do you classify exports by country of last known destination? (Question 62); Do you use customs declarations as a source? (Question 106). This filter results in significant downsizing of the sample, but it is likely to improve substantially data quality (see Gaulier et al., 2008). Another concern is that some countries do not report in their statistics values under a minimum threshold, often set to $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 raise to specific incentives to fake import declarations (see e.g. Bagwhati, 1964). In addition, only fully independent territories are taken into account, and countries with de facto autonomous regions are disregarded.[17] Re-exports may also originate problems, since they are frequently subject to ambiguous or misleading declarations. We deal with this concern by only relying 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 also revealed massive problems with a series of countries, which although officially considered declaring countries seem to report only occasionally their data. This is the case of countries members of the Economic Community of West African States (ECOWAS), as well as the United Arab Emirates and Syria. For a few other countries, the trade flows are very frequently not reported by the partners, probably because they are included in an aggregate in the partner's geographical classification. This is the case of ex-Yugoslavian countries (except Slovenia), Albania, Andorra, Belarus, Luxembourg and Namibia. Data concerning these countries as reporter or as partner were removed from the sample. Beyond 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.[18] As casual examination confirms, the statistics of

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

[17] Moldova and Georgia are the two countries concerned by this exclusion. The existence of a de facto autonomous region means that the government does not fully control its statistical territory, which is usually an important source of frauds and of declaration problems.

[18] These bounds are chosen based on the prior that a normal ratio is slightly above one 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 exclude St Vincent, Dominica, Cyprus, Syria, Cambodia (the total value reported by partners exceeds 1.5 times the

countries not matching this basic pre-request are unsuitable to proper econometric analysis. As a result of these successive steps of data filtering, we are left with a sample of 75 countries (see list in Appendix 2).

When trade volume data are used, the sample must be further limited to trade flows for which both partners report volume and use the same physical unit. In this case, an additional condition required for a country to be retained in the sample is that it follows UN's recommendations to use a standard unit of weight for quantity measurement of all commodities where applicable, or at least of most commodities (Questions 143 and 144).

Additional concerns may arise for specific products. We exclude from the analysis HS chapters 43 (furskins and furs), 84 (nuclear reactors), 88 (aircrafts), 89 (ships), 93 (arms and ammunitions) and 97 (arts and antiques), as well as HS heading 9601 (worked ivory), since trade is frequently restricted or kept confidential in these sectors (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.[19] Finally, we exclude ores and oil trade (Chapters 26 and 27), for which origin and destination of shipping are frequently unknown.

When comparing partner-country trade data, one would normally expect an excess of values reported by the importer over corresponding mirror declarations by the exporter, due to the CIF-FOB margin. In addition, countries are usually considered to monitor better imports than exports. Accordingly, following the words of Baghwati (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 imports under-invoicing.[20]

The general pattern uncovered by Table 1 is consistent with these priors: on average across all countries and products, reported imports exceed reported exports, although by a mere 3 percent of the total (average ratio of exports reported by partners over reported imports equal to 0.97, column 1, row 1). Meanwhile, 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; for low- and lower-middle-income countries, the average ratio even exceeds 1.7 in this case, a very large discrepancy by any standard. Another striking observation is that the level of this ratio is lower for high-income countries, in most cases by a substantial extent. More generally, the whole table exhibits a clear pattern of increasingly "perverse" average discrepancy between reported imports and exports, as countries get poorer and MFN duties get larger (the large discrepancy for duty-free products for low-income countries is an exception, though). A similar picture emerges when countries are grouped by corruption level. This preliminary evidence is consistent with the assumption that

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value reported by the country for these five countries), as well as St-Lucia, Zambia, Uganda (the ratio is below 0.75 for these three countries).

[19] Short of relevant information on these excise duties, our estimates would suffer from the omission of this variable, potentially important in explaining frauds in these sectors.

[20] Over-reporting of exports is not excluded, in particular when a form of subsidy is attached to exporting, or when currency conversion is not free, but there are far less incentives to bias invoicing in this respect than to cheat with imports value.

discrepancies in trade declarations reflect to some extent tax evasion, which is more widespread the lesser the quality of the importer's institutions, and the higher the tariff rate.

Table 1 – Exports reported by partners, as a share of reported imported (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. The ratio is computed country by country. The figures presented here are unweighted, cross-country averages.

3 Estimating cross-country patterns of custom duties evasion

Since trade gap is an indirect measurement of custom duty evasion, checking its consistency through several straightforward tests is a useful step to begin the analysis with. Cross-country patterns of custom duty evasion can then be studied.

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 once applied the "within" transformation proposed by Wansbeek and Kapteyn (1989) and extended by Davis (2002), as described above. We first check 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 estimated evasion elasticity is 0.24 on average 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).[21] We will use the conservative in what

[21] Using instead a dummy for differentiated products (which is not exactly a complementary category) also makes little difference for other variables. Mishra et al. (2008) suggest building an alternative product classification

follows, but using instead the liberal definition does not alter the results. We then check whether the intensity of this relationship is positively correlated with other measurements of corruption. This is done introducing interaction terms with the control of corruption index developed by the World Bank Institute. We find that stronger control of corruption (i.e., lower corruption—see Appendix 2 on definition and sources) is indeed associated with a weaker link between tariffs and trade gaps, as witnessed by the negative and significant estimated coefficient for the interaction term. Because the intensity of this link may depend upon products' nature, an additional term is considered, whereby the interaction is allowed to differ for homogenous products. This term is found to be positive and significant, a result consistent with the model's insight according to which 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	0.24 ***	0.35 ***	0.37 ***	0.41 ***	0.42 ***	0.46 ***	0.44 ***	0.29 ***	0.26 ***
	(5.21)	(5.36)	(5.33)	(6.09)	(6.10)	(6.86)	(5.70)	(4.98)	(4.48)
Tariff, homogenous prod.		-0.27 ***		-0.11	-0.18 **	-0.16 *	-0.11	-0.08	-0.08
		(-3.48)		(-1.47)	(-2.11)	(-1.77)	(-1.11)	(-1.21)	(-1.21)
Tariff, hom. prod. (liberal dummy)			-0.27 ***						
			(-3.53)						
Tariff * control of corruption				-0.20 ***	-0.28 ***	-0.26 ***	-0.27 ***		
				(-6.46)	(-6.18)	(-5.04)	(-4.23)		
Tariff * ctrl corruption, hom. prod.					0.14 ***	0.14 ***	0.17 **		
					(2.86)	(2.79)	(2.51)		
Squared tariff						-0.05	-0.02		
						(-1.44)	(-0.26)		
Squared tariff, homog. prod.							-0.04		
							(-0.61)		
Tariff * CPI index								-0.12 ***	-0.18 ***
								(-7.13)	(-6.72)
Tariff * CPI index, homog. prod.									0.09 ***
									(3.03)
Adj. R-squared (within)	0.0004	0.0005	0.0006	0.0008	0.0009	0.0009	0.0009	0.0007	0.0007
Observations	565,267	534,012	534,012	534,012	534,012	534,012	534,012	532,258	532,258

Note: The dependant variable is the trade gap in value as defined in equation (7). The specification follows equation (9). All estimates in level, for year 2004. Fixed effects by pair of reporter-partner and by HS6 product are included in all estimations. Within estimator reported, based on the transformation for unbalanced panels proposed by Wansbeek and Kapteyn (1989) and further 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 one. 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 the 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 about the non-linearity in

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 also found to be significant and does not alter much the other results.

the impact of tariffs upon evasion, which is found to be significant by Fisman and Wei (2004) for China, but not by Mishra et al. (2008) in 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 an alternative measurement of control of corruption, namely the Corruption Perceptions Index compiled by Transparency International. The results are comparable to the previous ones, in particular as regards the evasion elasticity and its link with corruption. The very low adjusted R-squared found in all estimates is not very surprising given the very noisy nature of the data, and the within transformation.

On the whole, these results confirm the relevance and consistency of trade gaps as indirect indicators of the extent of custom duty evasion. By the same token, they suggest that the phenomenon is not only widespread, as is evident from anecdotal evidence, but also substantial, in particular for differentiated products. Investigating this phenomenon more in depth requires accounting better for its cross-country heterogeneity.

3.2 Cross-country differences in and institutional determinants of evasion

Since corruption indices are likely to cover *inter alia* custom administration corruption, they cannot be meaningfully considered as independent variables. Still, cross-country differences in institutional quality must be taken into account, given their obvious relevance. A usual concern when trying to do so is the strong collinearity between institutional variables, which makes it difficult to identify the separate influence of each dimension. In addition, an extensive literature has shown the close links between institutions and income per capita, resulting from two-way causality. Since disentangling these relationships is beyond the scope of this paper, we rely on Kaufman et al. (2008) database and focus on two institutional dimensions of particular relevance here. The first one 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). The rule of law should be important in determining to what extent potential penalties are credible threats in case of unlawful practices. The second dimension if 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" (*ibid.*). Government effectiveness may influence the thoroughness and chances of success of customs control, but also the reality of the control custom officers are themselves 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. WTO membership is another potential determinant, since GATT's Article VII states principles aimed at harmonizing custom valuation practices and 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 for frauds 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.[22] The estimates show that, out of these three variables, only contiguity makes a significant difference, increasing the evasion elasticity by approximately 0.15 on average (Table 3, column 1). WTO membership and tariff variance are not found to be significant.[23] For the sake of parsimony, these two variables are not included in subsequent estimations.

Measures more specifically targeted at fighting customs fraud might also be considered. Given their strong specificity, however, country practices with regards to these measures are bound to depend on the extent of custom fraud. This means that such variables would suffer from significant endogeneity. To avoid the ensuing bias, we do not include them in these estimations in level, and delay the analysis of these measures until the next section, based on estimates in differences.

To assess the influence of institutions, we first introduce the interaction between tariffs and log GDP per capita (measured in 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 the log GDP is lower for homogenous products, although the correspondent dummy variable is insignificant.

Testing separately a similar interaction with the two above-mentioned institutional variables gives very similar results (unreported estimates). This similarity 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 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 instead of the index itself the residual of a cross-country regression of the index over a constant and the log GDP per capita.[24]

Even when orthogonalized to income level, an improved rule of law is found to reduce significantly (at the 10% level) the evasion elasticity (Table 3, column 2). This influence is lesser 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 are not statistically significant (column 3).[25] Estimation (4), based on the assumption that the influence of income level and of rule of law is the same for homogenous and differentiated products, gives

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

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

[24] For the RL index, for instance, the orthogonalized index (ORL) 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 is available.

[25] Actually, the results found for both variables do not differ strongly, 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.

very similar results, although the orthogonalized index of rule of law does not reach statistical significance in this case.

The bottom line is that in each case the evasion elasticity is positive (although lower for homogenous products), but it declines with "institutional quality" (although less so for homogenous products). Institutional dimensions are difficult to disentangle from one another, although 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. Noteworthily, the estimated evasion elasticity at sample mean is also remarkably stable across estimations, around 0.4 for non-homogenous products.[26]

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

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Tariff	1.04 ***	0.95 ***	0.94 ***	0.86 ***	0.87 ***	0.78 ***	0.75 ***
	(5.38)	(6.27)	(6.26)	(6.56)	(6.55)	(4.98)	(4.82)
Tariff, homogenous prod.	-0.32 *	-0.34 **	-0.33 **	-0.10	-0.10	-0.14 *	-0.14 *
	(-1.90)	(-1.97)	(-1.97)	(-1.27)	(-1.30)	(-1.70)	(-1.68)
Tariff * ln(GDPpc)	-0.27 ***	-0.28 ***	-0.28 ***	-0.23 ***	-0.23 ***	-0.18 ***	-0.18 ***
	(-4.32)	(-4.78)	(-4.93)	(-4.95)	(-4.93)	(-3.19)	(-3.15)
Tariff * ln(GDPpc), homogenous prod.	0.10	0.09	0.10				
	(1.63)	(1.51)	(1.60)				
Tariff * contiguity	0.16 **	0.16 **	0.17 ***	0.20 ***	0.20 ***	0.14 **	0.15 **
	(2.49)	(2.50)	(2.70)	(3.14)	(3.14)	(2.41)	(2.51)
Tariff * WTO	-0.14						
	(-0.98)						
Tariff * MFN variance	-0.24						
	(-0.49)						
Tariff * orthog. rule of law		-0.15 *		-0.09	-0.09	-0.15 **	-0.14 **
		(-1.93)		(-1.38)	(-1.36)	(-2.00)	(-1.98)
Tariff * orthog. rule of law, homogenous pr.		0.12					
		(1.27)					
Tariff * orthog. gov't eff.			-0.13				
			(-1.38)				
Tariff * orthog. gov't eff., homogenous prod.			0.07				
			(0.65)				
Tariff - tariff on similar prod.					-0.03		
					(-0.34)		
Tariff * exporter's BPI						-0.11 **	-0.19 **
						(-2.55)	(-2.14)
Tariff * ln(exporter's GDPpc)							0.131
							(1.20)
Adj. R-squared (within)	0.0010	0.0010	0.0010	0.0009	0.0009	0.0010	0.0010
Observations	534,012	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.

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

As Fisman and Wei (2004) pointed out, a low level of tariffs for similar products may create an incentive to mislabel the imported product. Based on the average tariff for the four-digit category the product belongs to, 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 for the product and the mean tariff applied by the country within the four-digit product classification (column 5).[27] This variable is not found to be significant.

An additional concern, not accounted for in the model above, is that the likeliness of the exporter being smuggling and/or being ready to consider paying a bribe may 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.[28] Since this index is not available for 2004, we use instead the country-mean over 2002 and 2006 when both years are available (when only one of these two years is available, we use it directly). Any partner effect constant across products is absorbed by the fixed effects, but the interaction between BPI and tariffs can be estimated. We find this interaction to be negative and significant, suggesting that evasion depends also significantly on the partner country's practices (column 6). The incomplete coverage of this variable reduces the number of observations, but the results for other variables are not significantly changed.[29] An additional interaction term between tariffs and the log GDP per capita of the exporter is not significant and does not modify significantly other coefficients, suggesting that BPI does a good job in summarizing exporters' practices.[30]

3.3 Estimating country-specific evasion elasticities

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

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

As before, this equation accounts for pairwise country fixed effects and product fixed effects. It also takes into account the potential influence of product homogeneity and of contiguity between trading partners upon the evasion elasticity, consistently with the previous estimation results. Estimated country-specific evasion elasticities ($\hat{\sigma}_i$) are plotted in Figure 2, where the

[27] Because the tariff for similar product is strongly correlated to the tariff for the product itself, we prefer to specify this variable as the difference with respect to the tariff applied to the product, instead of the tariff for similar products itself, to ease readability. In unreported estimates, we tested including an interaction between this difference with tariff for similar products and income level. It did not retain significance. Using the minimum or the first decile instead of the mean to characterize tariffs for similar products did not make a significant difference either.

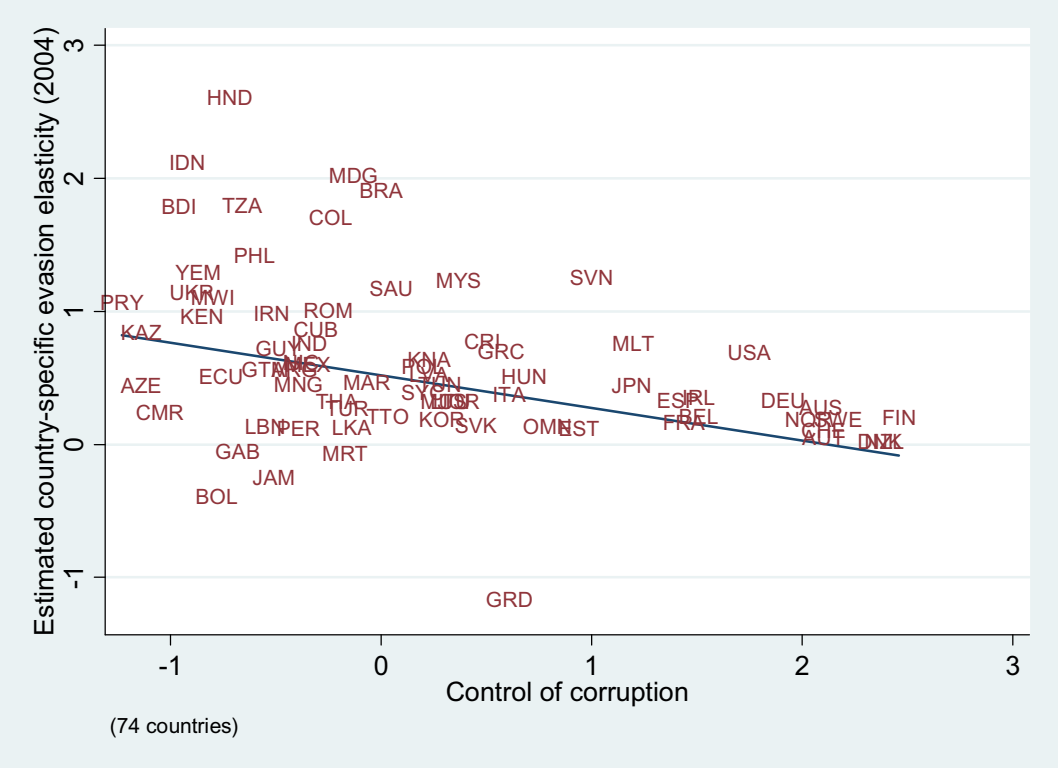
[28] See http://www.transparency.org/policy_research/surveys_indices/bpi. The index ranges theoretically between 0 and 10, a higher score indicating that engaging in bribery is perceived to be less common among the country's exporters. Before computing the interaction with tariffs, we demean this variable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

[29] The statistical significance of the orthogonalized index of rule of law is increased, however, which may reflect the usefulness of controlling for exporters' practices.

[30] The same is true of interactions with the exporter's institutional variables (rule of law, government effectiveness, control of corruption) instead of the log GDP per capita.

horizontal axis features Kaufman's et al. (2008) index of control of corruption. The negative correlation between evasion elasticity and control of corruption appears clearly, although it is looser for countries with a high corruption level. This is not surprising given the limited quality of trade statistics in many of these countries, which also seems to be the reason underlying the odd estimate found for Grenada. On the whole, these country-specific estimates are consistent and confirm that custom 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), centered 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 one. The control of corruption index is sourced from Kaufman et al. (2008). The solid line materializes the fitted values from an unweighted regression.

3.4 Estimates in differences

Although the specifications estimated so far include a number of controls, including fixed effects by pair of trading partners and by product, two main concerns may arise. The first one is that product specificities may materialize differently depending on the trading partner. If this is the case, the fixed effects accounted for so far would not allow controlling fully for unobserved heterogeneity. The second concern has to do with endogeneity, which would arise if policy

makers set higher tariffs for products more prone to custom duty evasion, in order to increase bribery opportunities. Noteworthily, the estimations above already include product fixed effects. Still, if country specificities interact with product specificities, potential rents might differ across countries for the same product, with a consequence for tariff levels.

Taking advantage of the availability to us of complete data for another year, 2001, we overcome both these concerns by relying on differences rather than on levels to estimate evasion elasticities. This can be done based on the difference over time of 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 disturbance linked for instance to exchange rates movements or to changing transportation costs (resulting for instance from improved infrastructures).[31] Time-invariant unobserved heterogeneity is thus fully controlled for, and there is little reason to expect this unobserved heterogeneity to change substantially over the period under study. Even if that would be the case, it is unlikely that policy makers would have the opportunity to measure this change and to adapt accordingly tariff levels during this short period, so that we do not consider endogeneity to be likely in this case. This approach has an obvious cost, however: it strongly reduces the information available to identify the relationship under study, due to the requirement that data be available for both 2001 and 2004, and most of all because the variance of tariff changes over the period 2001-04 is relatively small compared to the variance of tariff levels in 2004.

The accuracy of estimates is reduced accordingly, as reflected in the lower statistical significance found for all variables (Table 4). In contrast with estimates in level, the influence of the rule of law index and of government effectiveness is not found to be significant, either alone of when combined (and orthogonalized) to the log GDP per capita. This insignificance likely reflects the inaccuracy of estimates for variables with limited variance in the differences over the short period under study.[32] It also points to the log GDP per capita as the most robust synthetic index of aggregate determinants of custom duty evasion, since this variable is still found to significantly influence the evasion elasticity. Since the BPI is not available for years 2001 and 2004 specifically, its change over time cannot be tested. Still, it makes sense introducing in the specification the product of the average BPI level by the change in tariff. Consistent with estimates in levels, the corresponding interaction term is found to be negative and strongly significant (column 4). Note in addition that, as for estimates in level, contiguity between trading partners is found to increase the evasion elasticity, while WTO membership and variance in MFN tariffs are statistically insignificant.

The values found are consistent with those obtained from estimates in levels. Both the evasion elasticity and its interaction with income level are lower when estimated in differences, but confidence intervals at standard significance level overlap. In addition, delayed adjustment (in particular with regards to changes in income level) may explain why short-term changes exhibit lower elasticities.

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[31] Maintaining in addition partner fixed effects may also be considered. It does not influence significantly the results.

[32] For each observation, the change in the product of the tariff by the institutional measure can be decomposed as the sum of the product of the average tariff across the period by the change in the institutional measure, and of the product of change in the tariff by the average institutional measure. When this decomposition is used, the first term is found to be statistically insignificant, while the second one is significant.

Table 4: Determinants of custom 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: The dependant variable in the change in trade gaps in value, 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 one. t statistics, based on standard errors clustered on six-digit products, reported in parenthesis. See text and Appendix 2 for details.

4 Which remedies?

Evasion of custom duties has long been identified as a serious concern in numerous developing countries, prompting in many cases the investment of conspicuous resources to reform and modernize custom administration. These efforts often benefited from financial and technical support from the donors community and were frequently carried out in the context of adjustment programs. There is no quick fix to the problem of custom corruption, but a number of lessons can been learnt out of these experiences, as is clear from in-depth analyses such as Hors (2001), Keen (2003) and de Wulf and Sokol (2005). We first discuss how these policy measures can be accounted for in our analysis. The econometric analysis follows.

4.1 Measurable dimensions of customs reforms

Core principles of custom reform include the necessity to simplify rules and procedures, to minimize the scope for discretion, to streamline the organization and management of the custom administration and to enhance transparency. This process raises a number of complex questions well above the scope of this paper, discussed in depth in the above-cited references. A comprehensive and consistent approach is needed, involving a number of policy measures that cannot be included in an aggregate, quantitative analysis like ours. Still, a few important policy measures can be tracked down and accounted for:

- *Implementation of the ACV agreement*: as mentioned above, WTO membership may matter to the extent that harmonization of custom valuation practices is among the objectives pursued in the GATT (Article VII).[33] WTO membership is not found to be per se a significant determinant of custom duty evasion in the estimations above, perhaps because the corresponding commitments remain fairly loose. The Agreement on Implementation of Article VII of the GATT (now generally referred to as the Agreement on Custom Valuation, or ACV), signed in 1979 as a result of the Tokyo Round, clarifies the form these harmonized valuation practices should take, by establishing that custom value should be based on transaction value, that is the price actually paid or payable for goods being valued (see Goorman and de Wulf, in de Wulf et al. 2005). Five alternative methods, to be used in a well defined order, are listed for cases where the transaction value cannot be used. Methodologies deemed more arbitrary, such as minimum values, are prohibited by the agreement. The Uruguay Round appended the agreement by stating that, in case of disagreement, the custom officer could require the importer to establish the accuracy of the value declared (the "shifting the burden of the proof" decision). This agreement thus contains rather specific commitments. However, its implementation was not mandatory until the Uruguay Round agreement, and it remained problematic for developing countries afterwards, despite the five-year implementation delay granted under the special and differential treatment provisions of the agreement. According to Goorman and de Wulf (De Wulf et al., 2005, p. 158), among the developing countries requesting the five-year implementation delay, only two fully implemented the ACV by 2000, while fifteen more applied it with reservations; 22 requested the extension of the initial delay, while 23 countries, mostly among the poorest ones, neither invoked the five-year delay, nor notified the WTO about the adoption of the corresponding legislation. While the effectiveness of this agreement in improving customs administration in developing countries is questionable (Finger and Schuler, 2000), the implementation of the agreement is an interesting variable to take into account in the analysis, given the commitments it entails. This is done here based on issues of WTO's *Annual Report of the Committee on Customs Valuations*.
- *Use of the Asycuda system*: Information and communication technologies are powerful tools to ensure the transparency of custom procedures, but the development of well-suited systems is complex and costly. This is why, since the early eighties, the UN Conference on Trade and Development (UNCTAD) has made available to developing

[33] The initial agreement was followed up by the 1950 Convention on the Valuation of Goods for Customs Purposes, establishing the Brussels Definition of Value.

countries the Automated System for Custom Data (Asycuda).[34] Now adopted by more than 85 countries, Asycuda is an automated custom management system that can handle all customs clearance-related processes. This is done by implementing simplified and harmonized procedures, using standardized trade documents (e.g. UN Layout key, or Single Administrative Document) and international classifications (e.g. the use of Commodity description and coding systems). The system is adapted to suit each country's needs. Compared to paper-based procedures, Asycuda facilitates and accelerates clearance of goods, it improves the quality of statistics on foreign trade and revenue and it makes the control of customs operations easier. While the program is provided at no cost, its implementation and subsequent updates require substantial (often co-financed) financial effort. The data available on Asycuda website allows each country's efforts in this area to be measured.

- *Pre-Shipment Inspection (PSI)*: Many developing countries willing to improve the collection of custom 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, year in which PSI was first adopted in Zaire, the number of countries hiring a PSI company has strongly increased, encouraged by private donors and the WTO's recommendations (see the WTO agreement on pre-shipment inspection). Since the beginning, PSI was conceived as a second-best solution for countries lacking the institutional capacities and the power to engage in full-fledged reforms. However, studying the case of the Philippines, Yang (2008) argues that PSI introduced as an isolate initiative is unlikely to have much effect on collected tax revenue, since smugglers often sidestep controls by splitting up the shipment to stay below the threshold set for PSI inspection[35] or by importing through exporting processing zones. The theoretical analyses in Johnson (2001) and in Anson et al. (2006) also question the effectiveness of PSI in deterring evasion, emphasizing the key role played by the way the 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 be able to take into account, but while indicators exist in that domain, none of them is readily available at a large scale for the period studied.[36] Note however that the variance of MFN tariffs, included in previous estimations, deals with a specific dimension of simplification, to the extent that tariffs heterogeneity is relevant to rent-seeking opportunities, as emphasized by Gatti (1999). As mentioned in the theoretical analysis above, information about the penalties faced by custom

[34] For more details, see www.asycuda.org.

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

[36] The World Bank's Doing Business indicators related to trade costs and delays are only available starting from 2006.

officers and importers would also be important, as well as about custom officers' salaries. Short of relevant data on these aspects, we cannot include them in the quantitative analysis.

4.2 Econometric assessment

The initial state of customs administration is an obvious determinant of the likeliness of specific policy actions such as the ones described above being undertaken. This means that attempting to assess the impact of such specific actions upon custom evasion based on estimates in level would suffer from an endogeneity bias. This problem can be solved by relying instead on estimates in differences, assessing whether a policy change is reflected in a change in the evasion elasticity. Estimates in differences carried out so far relied on the differentiation over time of equation (10), assuming the coefficients to remain unchanged: we now drop this assumption. The difference over time of the generic term for the 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. While the second term on the right-hand side has been disregarded so far based on the assumption of unchanged evasion elasticity over time, we now take it into account considering that policy actions may have influenced the evasion elasticity. 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 custom duty evasion.

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 of the investment over the 2000-03 period[37] (in million USD), or a dummy variable indicating that significant investment in such systems is initiated during this period.[38] Using either measure, investment in Asycuda systems is estimated to reduce significantly and substantially the evasion elasticity (Table 5, columns 1 and 2).

We then assess whether ratifying the ACV agreement over the period makes a significant difference. While our previous estimates suggest that being a member of the WTO does not have *per se* a significant influence on custom duty evasion, the Uruguay Round's ACV agreement is more specifically aimed at streamlining the custom valuation of products, and the ratification of this agreement by developing countries has not been simultaneous nor even systematic so far. Out of 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).

Hiring a PSI company is another way to fight custom duty evasion,[39] but a change in this regard during the period under study is not associated to any significant impact over the evasion

[37] A one-year lag is introduced, assuming that investment in year *n* are effective starting from year *n*+1. Out of our estimation sample, 15 countries have a non-zero investment in Asycuda systems over 2000-03.

[38] Only investments exceeding 100,000 USD (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.

[39] Nine countries in the estimation sample were hiring a PSI company in 2004. Two countries (India and Indonesia) started doing so between 2001 and 2004, while two other countries (Argentina and Bolivia) ceased doing so.

elasticity (column 4). Because the heterogeneity of the impact of PSI has already been emphasized, we test the significance of the interaction between PSI and income level. 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.[40]

Table 5: Policy remedies to custom 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: As in Table 4.

It is impossible to control for all 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. However, in this case, we would expect to observe a positive correlation between the policy measures studied. This is not the case, since none of the pairwise correlation between 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 change significantly the assessed impact of each single 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 is found significant (results available on request). Taking into account exporters' practices, based as before on the BPI index, proves useful, and does not alter significantly the estimated coefficients of other variables (columns 7 and 8).

[40] Removing this interaction term from subsequent estimations does not affect significantly other variables, apart from PSI itself.

5 Extensions and robustness checks

Further light can be shed on custom 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.[41]

Table 6: Determinants of quantity and unit value trade gaps, estimates in levels (2004)

	Quantity gaps			Unit value gaps		
	(1)	(2)	(3)	(4)	(5)	(6)
Tariff	0.46 ***	0.45 ***	0.34 *	0.53 ***	0.54 ***	0.55 ***
	(2.71)	(2.67)	(1.71)	(4.55)	(4.60)	(3.92)
Tariff, homogenous prod.	0.03	0.03	0.03	-0.07	-0.08	-0.06
	(0.34)	(0.38)	(0.28)	(-1.51)	(-1.62)	(-1.00)
Tariff * ln(GDPpc)	-0.20 ***	-0.20 ***	-0.14 *	-0.16 ***	-0.16 ***	-0.20 ***
	(-2.89)	(-2.90)	(-1.75)	(-3.54)	(-3.50)	(-3.34)
Tariff * contiguity	0.16 ***	0.16 ***	0.09	0.04	0.04	0.07
	(2.60)	(2.60)	(1.36)	(1.35)	(1.33)	(1.46)
Tariff, specific component	0.13	0.13	0.08	0.10	0.10	0.18 **
	(1.34)	(1.35)	(0.63)	(1.44)	(1.45)	(2.06)
Tariff - tariff on similar prod.		0.05	-0.08 *		-0.07	-0.01
		(0.46)	(-1.84)		(-1.19)	(-0.38)
Tariff * exporter's BPI						
Adj. R-squared (within)	0.0002	0.0002	0.0002	0.0013	0.0013	0.0013
Observations	317,192	317,192	245,463	246,625	246,625	189,075

Note: As in Table 2.

The analysis in level, based on the most representative specifications used in the analysis above, shows that the qualitative results found for gaps in value are also valid for both quantity and unit value gaps (Table 6): the coefficient of the applied tariff level is positive and significant

[41] 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.

in both cases, exhibiting as before a negative interaction with income level. 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. The rule of law index, orthogonalized with log GDP per capita, is still estimated to reduce the evasion elasticity, but it only significant for unit values. In addition to ad-valorem equivalent tariffs, we consider separately the ad-valorem equivalent of their specific component, since there is no incentive to cheat on unit values when tariffs are defined in specific terms. Except in one case, this term is not found to be significant. Product homogeneity reduces the extent of gaps in unit values but not in quantities: this (insignificant) effect is consistent with the assumption that concealing the true unit value is more difficult for homogenous products. Exporters' practices, as measured through the BPI, is only found to matter for quantities, for which better practices reduce the evasion elasticity. For unit values, exporters' practices are not found to matter. In sum, these results point to both underreporting and undervaluation as being widespread modalities of custom duty evasion, with comparable importance. Similar estimations in differences give less accurate, but consistent results (see Appendix 3).

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. 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.

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:[42] 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 that the flow is not 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.

[42] 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.

The relevance of these controls is confirmed by the estimates (Table 7): 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.

Table 7: 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:[43]

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

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 8). The main noteworthy difference is

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

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

Table 8: Determinants of custom 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

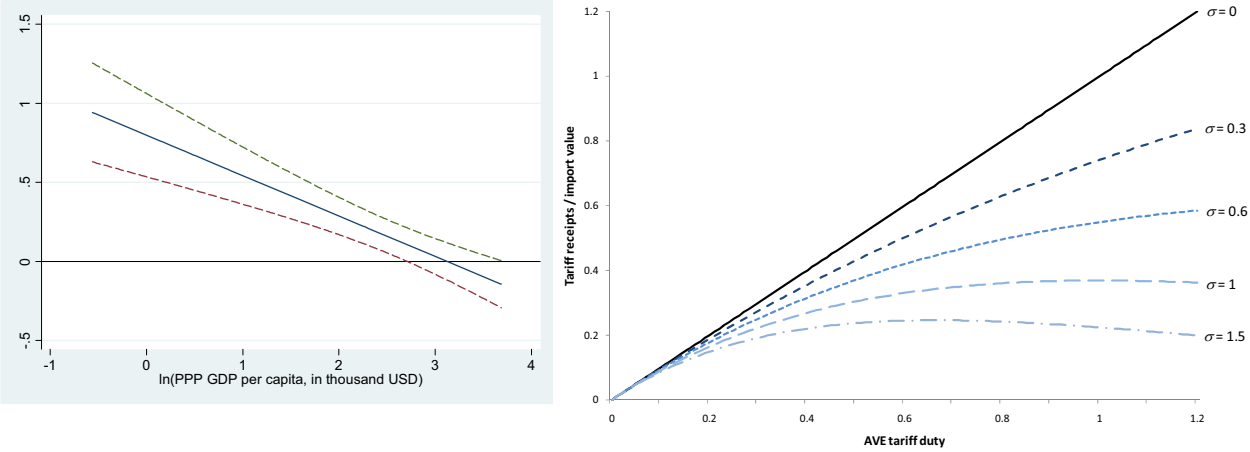
A simple yet natural question at this stage is: Does it really matter? The answer is not straightforward given the strong heterogeneity observed across countries. Since income level appears as the main cross-country determinant of the extent of tariff evasion, we first address this question by computing the estimated evasion elasticity conditional on the countries income level, 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 level above approximately $16,000, it is strongly significant for poor countries, with a confidence interval centred on one 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 illustrates authors computations based on estimate reported in Table 3, column 4. 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 materialize 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 used implies that, for an actual trade flow worth one dollar (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 $te^{-\sigma t}$. Maximum receipts are thus collected for $t = 1/\sigma$ when the 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. Would this tariff be cut by half, the decrease in tariff receipt, at constant imports, would not amount to the 25% resulting from calculation at face value: it would be respectively 20, 16, 11 or only 6% for an evasion elasticity worth respectively 0.3, 0.6, 1 and 1.5. Neglecting custom 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 made clear that avoiding taxation also involves costs.

6 Concluding remarks

Anecdotal evidence abound about custom duty evasion, and a few recent case studies proved its relevance in specific countries, by studying gaps in reported trade flows. By extending the analysis to all countries for which suitable data is available to do so, this study allows gauging the pervasiveness and magnitude of this phenomenon, as well as its determinants. Our results show that custom duty evasion is widespread and uneven. Differences across products matter, because the value of homogenous products is more easily assessed, 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 also tend to have weaker institutions. Even controlling for income level, though, a higher degree of rule of law is found to limit the extent of evasion. In contrast, we could not find any significant influence of WTO membership nor 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: exporters practices are thus another important determinant of evasion.

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

The quality of trade data is known to be low at the detailed level. While measurement error in the dependent variable is not a source of bias in a linear model like ours, it reduces the efficiency of estimates. The large number of observations allows overcoming this problem here, as confirmed by the robustness of the findings to a variety of controls and of changes in specifications, including the use of differences instead of 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 one (or more) is common in poor countries, meaning that the share of imports evading taxation is one percent 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 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 overstate significantly the fiscal consequences of liberalizations in poor countries, where concerns about replacement are precisely most serious (Baunsgaard and Keen, 2009). More generally, given the pervasiveness of evasion, thinking about tariff receipts based on "face values" may be highly misleading in the case of low-income countries.

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Appendix 1: Theoretical analysis—details and additional cases

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 $2ts_1^O s_2^F \geq 2t\left[s_1^F s_2^O + \beta^O(s_1^O + s_1^F)\right] + \left[\tau s_1^O + (1+\tau)s_1^F\right]\left[s_1^O + s_2^O t + s_1^F + s_2^F t\right]$.

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 custom officer's penalty is more dependent in the tariff rate than the

importer's penalty.[44] 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 custom 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 custom 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)

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

[44] If the importer's penalty is far more dependent on the tariff rate than the custom 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.

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 custom 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 custom 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,[45] and we write it as $\tau\gamma^2$. Assuming penalties to take the same form as previously, the joint benefit for the custom 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.

Case IV: Corruption, endogenous inspection effort

Let us assume that custom 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 custom 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 custom 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 custom 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 custom 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 custom 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

[45] 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 custom officer disclosed it.

$s_j^F = \alpha s_j,\ j = 1, 2$, 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 custom 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 custom 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 custom 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: custom officers and importers take the behaviour of each others as given. In the equilibrium, these two equations jointly determine e^* and γ^*:

(A.14)

$$\gamma^* = \left[\frac{4t}{3\epsilon^2[(\alpha-\tau)(s_1 + s_2 t) + \beta^O t][(\alpha+\tau)(s_1 + s_2 t) + \beta^O t]}\right]^{\frac{1}{5}}$$

(A.15)

$$e^* = \frac{1}{2\epsilon^5}\left[\frac{4t}{3(\alpha+\tau)(s_1 + s_2 t) + \beta^O t}\right]^{\frac{3}{5}}\left[(\alpha-\tau)(s_1 + s_2 t) + \beta^O t\right]^{\frac{2}{5}}$$

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 custom officers devote to control when transparency is high. The way the tariff influences evasion is characterized by

(A.16)

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

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, custom 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 then the elasticity itself.

Appendix 2: Data—Sources and definitions

Appendix 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 only includes 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 the 75 countries in this table, 66 also report data for 2001.

Appendix Table A.2: Variables definition and sources

Variables Definition	Source
Evasion: Gap between the declared export and import for a given product at the HS6 level by country pairs.	Comtrade Database
Tariff: Detailed protection (MFN and preferential Tariff) at the HS6 level for 166 importing countries and 208 partners.	MAcMap databases http://www.cepii.fr/anglaisgraph/bdd/macmap.htm
Institutional quality measures	
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.	Kaufman et al., 2008
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, the index is centered and rescaled, with a final scale between -2.5 and +2.5.	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).	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.	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.	Kaufman et al., 2008
Specific measures of custom reforms	
Gatt Valuation Agreement (ACV): adoption by a WTO member of uniform rules for the evaluation of goods at customs.	Annual Report of the Committee on Customs Valuations (WTO)
Automated System for custom data (ASYCUDA) software: Detailed schedules by country, amount invested, donor financing the project and type of investment (e.g. software release, or providing training).	UNCTAD (www.asycuda.org)
Pre-Shipment Inspection (PSI): hiring a private company which inspects the	Johnson (2001) for 2001 ,

value of requiring imports, before shipments to the importing country.	and World Bank (2005) for 2004
Other Variables	
Contiguity: geographical contiguity of country pairs.	http://www.cepii.fr/anglaisgraph/bdd/distances/htm
WTO membership	www.wto.org
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 arrange possible ambiguities when classifying products into the three categories.	Rauch, J. (1999)

Appendix 3: Additional estimation results

Appendix Table A.3: Disentangling quantities from unit values, estimates in differences (2001-04)

	Quantity gaps			Unit value gaps		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Tariff	0.49	0.36	0.46	-0.12	0.01	0.01
	(1.47)	(1.07)	(0.99)	(-0.60)	(0.03)	(0.05)
Δ Tariff, homogenous prod.	-0.19	-0.20	-0.06	-0.14 **	-0.14 **	-0.10
	(-1.32)	(-1.25)	(-0.36)	(-2.05)	(-1.96)	(-1.07)
Δ [Tariff * ln(GDPpc)]	-0.18	-0.13	-0.18	0.10	0.05	0.03
	(-1.36)	(-0.96)	(-0.97)	(1.42)	(0.66)	(0.25)
Δ Tariff * contiguity	0.22	0.20	0.41 **	-0.01	0.00	-0.06
	(1.42)	(1.20)	(2.26)	(-0.17)	(-0.06)	(-0.85)
Δ Tariff, specific component	0.29 **	0.26 **	0.17	-0.08	-0.05	0.00
	(2.32)	(2.10)	(1.12)	(-1.36)	(-0.79)	(-0.04)
Tariff * Δ Asycuda		-1.69 **	-1.75 ***		0.15	0.17
		(-2.57)	(-2.67)		(0.38)	(0.42)
Tariff * ACV ratified 2001-04		0.03	-0.01		0.74 ***	0.42 *
		(0.14)	(-0.05)		(3.22)	(1.83)
Tariff * PSI initiated 2001-04		0.70 *	0.82 *		0.10	0.27
		(1.67)	(1.67)		(0.33)	(0.92)
Tariff * PSI initiated 2001-04 * ln(GDPpc)		-0.59 ***	-0.67 ***		-0.15	-0.21
		(-2.80)	(-2.89)		(-1.14)	(-1.53)
Δ Tariff * exporter's BPI			-0.14 **			0.03
			(-2.09)			(0.95)
R-squared	0.030	0.038	0.029	0.032	0.034	0.031
Observations	154,533	154,533	127,192	103,179	103,179	84,078

Note: As in Table 4.