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**Discussion Papers in**
**Economics and Econometrics**


# Import Tariffs Enforcement with Low Administrative Capacity


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No. 1016





ISSN 0966-4246

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October 23, 2010

**Abstract**

Import tariff receipts represent an important share of government revenues in many developing countries and there has recently been a surge in empirical studies showing how evasion in this field is a pervasive phenomenon. In the case of import tariffs, the tax base is the product of quantity and unit value, both of which have to be reported and need to be assessed by the custom authority during an audit. I show that when the fiscal authority has an imperfect detection technology, there is an additional incentive for the taxpayer to underdeclare, as a greater declaration in one dimension actually increases the fine when evasion in the other dimension is detected, and a tax base presenting this feature is subject to more evasion compared to a tax base that can be assessed directly. Also, when enforcement capacity is low, voluntary compliance is higher when the importer is required to declare only the total value of imports.

*JEL Codes*: F13, H26, H27, K42, O17, O24
*Keywords*: tariff, tax evasion, multiplicative tax base, imperfect detection, low administrative capacity

*I would like to thank György Molnár and the Institute of Economics - Hungarian Academy of Sciences, where I conducted part of this research, for the hospitality. I am grateful to seminar participants at the University of Southampton, and in particular to Jackie Wahba, for helpful comments and discussions.

# 1 Introduction

Import tariff receipts represent an important share of government revenues in many developing countries and there has recently been a surge in empirical studies showing how evasion in this field is a pervasive phenomenon. One peculiar feature of import tariffs is that evasion can take place through "underreporting of unit value, underreporting of taxable quantities, and the mislabelling of higher taxed products as lower-taxed products" (Fisman and Wei, 2004). In particular, in the case of import tariffs, the tax base is the *product* of quantity and unit value. The aim of this paper is to explore the implications of this feature for the tariff evasion decision by importers and for government revenues.

The importance of tariff receipts for developing countries is highlighted by the data collected by Baunsgaard and Keen (2010). As reported in Jean and Mitaritonna (2010), "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". Recent empirical studies have found tariff evasion to be widespread. This literature usually exploits discrepancies in trade flows as recorded by the exporting and the importing country and interprets the correlation between these trade gaps and tariff rates as evidence of tariff evasion taking place. Fisman and Wei (2004) look at trade between Hong Kong and China in 1997-1998 and find that a "one-percentage-point increase in the tax rate is associated with a 3 percent increase in evasion". Javorcik and Narciso (2008) use data on trade between Germany and ten Eastern European countries during 1992-2003 and find that a "one-percentage-point increase in the tariff rate is associated with a 0.4% increase in the trade gap in the case of homogeneous products and a 1.7% increase in the case of differentiated products". Mishra et al. (2008) exploit a major tariff reform in India in the 1990s and find a "robust positive elasticity of evasion with respect to tariffs". Jean and Mitaritonna (2010) use a large panel dataset including observations for 75 countries in 2001 and 2004 and find that "evasion of custom duties in larger in poorer countries" and that in the poorest countries "a one percentage point higher tariff is found to be associated on average with import understatement by one percent or more". They also report the results of several studies showing how in many African countries collection of custom duties is very poor (the worst reported case is the Democratic Republic of Congo, with "80% of custom taxes *not* being collected"). Thus, tariff receipts are an important source of revenues for the public finances of developing countries and, at the same time, tariff evasion seems to be particularly significant in these countries.[1]

Since the seminal contribution by Allingham and Sandmo (1972), the theoretical analysis of tax evasion has mainly been focused on individual decision makers dealing with personal income tax, with some more recent studies looking at tax noncompliance by businesses (for a review of this vast literature see Andreoni, Erard and Feinstein, 1998; Slemrod and Yitzhaki, 2002; Slemrod, 2007). Generally, the assumption is that the tax base is represented by a number, $y$, and the taxpayer's report by a possibly different number, $x$, with evasion being the difference between the two. I will refer to this as the "unitary tax base" case. This way of modelling the tax base is problematic when dealing with tariff evasion given that, as mentioned above, one distinctive feature of import tariffs is that the tax base is the product of quantity and unit value and that evasion can concern each of the two dimensions, plus the misclassification of goods.

To the best of my knowledge, no theoretical analysis of the tax evasion when tax liability is the product of several independently reported variables has been conducted so far. This overlook of the literature may be due to the fact that generally tax evasion has been modelled by assuming perfect detection of the true tax liability in case of an audit by the tax authority. In this case, whether the tax base is unitary or the product of several independently reported variables is indeed irrelevant. I will show that it does however matter when detection is imperfect, i.e. when the tax authority does not discover for sure the true tax liability in case of an audit.[2] In particular, with a standard unitary tax base, a greater declaration has the advantage of reducing the expected fine, but the disadvantage of paying a higher tax and the taxpayer trade-offs these two effects when

[1] Evidence of tariff evasion has been found also for developed countries with a low level of corruption: Stoyanov (2009) analyzes trade between Canada and the US in 1989 and find that "tariff rates have a strong and significant effect on the apparent trade gap among the two".

[2] There is a related literature considering the implications of the fact that the tax base is not perfectly observed. See Slemrod and Traxler (2010) for a recent contribution.

optimally deciding how much to declare. In case of a multiplicative tax base, there is an additional disadvantage of a greater declaration in one dimension in that it increases the fine when evasion in *the other* dimension is detected. This additional effect is not present when the full extension of evasion is discovered in case of an audit, as is usually assumed.

Clearly, the assumption of perfect detection is problematic: as Slemrod (2007) puts it, "any given examination is not perfect". This is supported by the empirical studies by Feinstein (1991) and Erard (1997), who have shown that nondetection is indeed a serious issue. Andreoni et al. (1998), in their review on tax compliance, summarize these findings by stating that during TCMP[3] audit "IRS examiners detect approximately one out of every two dollars of evasion". Given the intensive nature of TCMP audits, the problem is likely to be even more serious in other cases. Feldman and Slemrod (2007) motivate their use of unaudited tax returns to estimate tax noncompliance by the fact that "there are sources of income that even the most intensive audit would have difficulty in detecting" and cite an IRS study that found that "for every dollar of underreported income detected by TCMP examiners without the aid of third-party information documents, another $2.28 went undetected". The issue of imperfect detection is plausibly even more relevant for developing countries, where administrative capacity is generally low.

In this paper, I use a model of evasion with imperfect detection and study the implications of having a multiplicative tax base. What I find is that a tax base that is the product of two different parameters is subject to higher underreporting compared to a tax base that can be assessed directly. I also show that requiring an unitary declaration of a multiplicative tax base, i.e. requiring the importer to declare only the total value of imports, even if quantity and unit value need to be separately assessed during an audit, increases voluntary compliance when enforcement capacity is low as this mitigates the impact of the additional incentive to underreport described in the previous paragraph. Clearly, this also reduces the enforcement ability of the tax authority, but may be optimal for a revenue-maximizing government when the penalty faced by the taxpayer in case evasion is detected does not translate one-to-one into higher government revenues.

[3]Taxpayer Compliance Measurement Program, a program of intensive audits conducted by the Internal Revenue Service (IRS) on a stratified random sample of returns.

This paper deals with import tariffs, however, the applicability of the model is more general as the tax liability is the product of several independently reported variables in other situations. For instance, the base for property taxes is often determined, in particular in developing countries, according to an area-based approach, where the tax base is the product of the taxable area of the property and unit values (e.g. rental or capital value per square meter) based on factors such as location, services available, and quality of the structure (Bahl et al., 2008). Similar issues arise with regard to the enforcement of individual transferable quota (ITQ) in fisheries, in which "[f]ishers may fail to report their harvest, or misreport its weight. When a report is filed, they may attempt to report the species taken as some other species with a lower quota value." (Johnson, 1995). Thus, also in this case underreporting may concern unit value (quota value) and taxable quantities (weight).

The next section outlines the imperfect detection model with an unitary tax base. The following section extends the model to the multiplicative case, while in section 4 the two are compared. Section 5 analyzes the case of an unitary declaration of a multiplicative tax base. The last section concludes.

## 2 Unitary tax base

Here, I model tariff evasion using the "standard" approach, i.e. considering that import value has to be declared as a single number. This is, for instance, the approach taken by Mishra et al. (2008) and by Jean and Mitaritonna (2010). Beside introducing the imperfect detection technology (see also Tonin, 2010), the results obtained here can be compared to the multiplicative case, analyzed in next section, where import value is declared as the product of quantity and unit value.

Consider a firm who faces an ad valorem tariff duty $t \in (0, 1)$ on an exogenously given import $y$. The importer declaration to the custom authority is denoted by $x$. If $x = y$, there is full compliance; if $x = 0$, there is full evasion, i.e. outright smuggling, and if $x \in (0, y)$, there is partial evasion.

The custom authority may perform an audit to find out whether the importing firm complies with custom regulation. I assume there to be an exogenously given probability of an audit being performed, $\gamma \in [0, 1]$. A fine proportional to the amount evaded is imposed in case evasion is detected. However, the fact that an audit is performed does not imply that the authority with certainty discovers the true liability. Instead, it may find evidence to impute an import value of $\hat{y} \in [0, y]$, where $y$ is the true value of the shipment.

I assume that $\hat{y}$ is distributed over the support $[0, y]$ according to pdf $h(\cdot)$ and cdf $H(\cdot)$, so that $H(0) = 0$ and $H(y_i) = 1$, and $H(\cdot)$ does not depend on $x$.[4] To simplify the discussion, I assume that $h(\cdot) > 0$ within the support, so that $H(\cdot)$ is invertible within $[0, y]$.

Given a declaration of $x$ and collected evidence of an import value of $\hat{y}$, the custom authority imposes, in case $\hat{y} > x$, the payment of $\theta t\,(\hat{y} - x)$, consisting of tariff duties plus an additional fine proportional to the assessed evasion, thus $\theta > 1$. This specification of the fine, proportional to the amount evaded, follows Yitzhaki (1974). In case $\hat{y} \leq x$, the custom authority cannot prove any evasion, so no fine is imposed.[5] Given a true import value $y$ and a reported one $x \in [0, y]$, the expected fine in case of auditing, $f$, is

$$f = t\theta \int_{x}^{y} (\hat{y} - x) h(\hat{y}) d\hat{y}. \tag{1}$$

The firm is risk-neutral and maximizes its expected profits. For simplicity, I disregard other costs unrelated to custom duties. Therefore, the optimal declaration is given by

$$x^* \quad s.t. \quad \max_{x \in [0,y]} y - \gamma f - tx. \tag{2}$$

[4]The assumption is that the authority cannot assess and upheld in court a liability higher than the true one. To extend the model to situations where this may not be the case, due for instance to ambiguity in the law, would be straightforward.

[5]An equivalent narrative is that in an audit, the custom authority may find no evidence at all of evasion with probability $H(x)$, which is increasing as the liability declared to the authorities increases. Conditional on detection taking place, the density for any given level of import value $\hat{y} \in [x, y]$ being discovered is given by $h\,(\hat{y})\,/\,[1 - H\,(x)]$.

After substituting (1) into (2), the first-order condition is

$$H(x^*) = 1 - \frac{1}{\gamma\theta} \Longleftrightarrow x^* = H^{-1}\left(1 - \frac{1}{\gamma\theta}\right).$$

The second-order condition, $-t\gamma\theta h(x) < 0$, is always satisfied. The boundary condition $x \leq y$ is always satisfied. Notice that full compliance (i.e. $x = y$) does not take place unless $\gamma\theta \to +\infty$. The condition $x \geq 0$ implies that full evasion will take place, i.e. $x = 0$, when enforcement is very weak, i.e. $\gamma\theta \leq 1$. To simplify the notation, the two enforcement parameters are summarized by $\alpha \equiv 1/(\gamma\theta)$. To summarize, the solution to the reporting problem is given by

$$x^* = \begin{cases} H^{-1}(1-\alpha) & \text{if} \quad \alpha < 1 \\ 0 & \text{if} \quad \alpha \geq 1 \end{cases}. \tag{3}$$

As $\partial\alpha/\partial\gamma < 0$ and $\partial\alpha/\partial\theta < 0$, in an interior solution, the fraction of the value of the shipment that is evaded decreases as enforcement improves either because of more frequent audits or heavier penalties. The equilibrium fine, $f^*$, is given by substituting (3) into (1). Expected profits in equilibrium are then given by

$$\Pi^* = y - \gamma f^* - tx^*. \tag{4}$$

To obtain a closed form solution, from now on I will assume $h(\cdot)$ to be uniform in the support $[0, y]$, i.e. $\hat{y} \sim U_{[0,y]}$. The expression for the expected fine becomes

$$\gamma f = \gamma t\theta(y - x)^2 / (2y). \tag{5}$$

Thus, the cost of evasion is quadratic in the amount of evasion, $y - x$. The optimal reporting behavior given by (3) becomes

$$x^* = \begin{cases} (1-\alpha)\, y & \text{if} \quad \alpha < 1 \\ 0 & \text{if} \quad \alpha \geq 1 \end{cases}. \tag{6}$$

So, the model implies that what is revealed to the authorities is a fraction of the true import value that depends on the enforcement parameters. Using (5), the expected fine is given in equilibrium by

$$\gamma f^* = \begin{cases} yt\alpha/2 & \text{if} \quad \alpha < 1 \\ yt/\left(2\alpha\right) & \text{if} \quad \alpha \geq 1 \end{cases} \tag{7}$$

and thus, substituting (6) and (7) into (4), I get the equilibrium expected profits

$$\Pi^* = \begin{cases} y(1-t) + \alpha yt/2 & \text{if} \quad \alpha < 1 \\ y\left[1 - t/\left(2\alpha\right)\right] & \text{if} \quad \alpha \geq 1 \end{cases}. \tag{8}$$

Given the detection technology, the expected fraction of unreported liability, $y - x^*$, that is discovered in case of auditing is

$$\int_x^y (\hat{y} - x^*)h(\hat{y})d\hat{y}/\left(y - x^*\right) = \alpha/2, \tag{9}$$

i.e. a fraction corresponding to half the ratio of evaded value over true import value. The assumption is thus that it is relatively easy to get away with evasion, as an audit is quite ineffective. For example, when 30% of import value is concealed, only 15% of evasion is, on average, detected in case of auditing. This captures the low administrative capacity that characterizes many developing countries.

# 3 Multiplicative tax base

Here I take into account the fact that in case of trade tariffs the tax base, i.e. the import value, is the product of two parameters, unit value and quantity, and each of them has to be reported to the tax authority. The detection technology in each dimension is the same as the one outlined in the previous section.

The true values of the two parameters are $y_1$ and $y_2$. For each of them, the firm has to decide how much to report to the custom authority, so that $x_1 \in [0, y_1]$ is the declared value of the first parameter and $x_2 \in [0, y_2]$ is the declared value of the second one. In case of an audit, the custom authority manages to impute $\hat{x}_1 \in [0, y_1]$ and $\hat{x}_2 \in [0, y_2]$. The probabilities of detection are assumed to be independent and uniformly distributed over the relevant intervals, so that $g_{\hat{x}_1}(\hat{x}_1) = 1/y_1$ and $g_{\hat{x}_2}(\hat{x}_2) = 1/y_2$ and the corresponding cdf. are indicated as $G_{\hat{x}_1}$ and $G_{\hat{x}_2}$. These assumptions allow to get closed form solutions. The assumption of independence is reasonable when the two parameters are import quantity and unit value, as the evidence to be produced by the custom authority to prove a higher import quantity (e.g. container inspection) is likely to be unrelated to evidence needed to prove higher unit value (e.g. comparison with listed prices). I will discuss in the last section the uniform distribution assumption.

The imposed fine, $f$, depends on the detected and declared values of both parameters. In particular, it is possible to distinguish four cases:

1. $\hat{x}_1 < x_1$ and $\hat{x}_2 < x_2 \Rightarrow f = 0$
2. $\hat{x}_1 < x_1$ and $\hat{x}_2 > x_2 \Rightarrow f = t\theta\left(\hat{x}_2 - x_2\right)x_1$
3. $\hat{x}_1 > x_1$ and $\hat{x}_2 < x_2 \Rightarrow f = t\theta\left(\hat{x}_1 - x_1\right)x_2$
4. $\hat{x}_1 > x_1$ and $\hat{x}_2 > x_2 \Rightarrow f = t\theta\left(\hat{x}_1\hat{x}_2 - x_1x_2\right)$.

In the first case, no evasion is discovered in either dimension and, thus, no penalty is imposed. In cases 2 and 3, underreporting is discovered in one dimension only and the fine is imposed on assessed underreporting in that dimension multiplied by the declared value on the other dimension. In the last case, evasion is discovered in both dimensions. Notice that when evasion is unidimensional, a greater declaration has the advantage of reducing the expected fine, but the disadvantage of paying a higher tax. When a second dimension is involved, there is a further disadvantage in that a higher declaration in one dimension increases the fine when evasion in the *other* dimension is detected. This is evident in cases 2 and 3 above. This means that an importer will take into account, when deciding about the declared unit value of the goods, that, if evasion about the quantity of imported goods is detected by custom officials, while the unit value declaration goes unchallenged, then the value of discovered evasion, and therefore the fine, will be assessed using the declared unit value.

Given a declaration $(x_1, x_2)$, the expected fine is

$$f = t\theta \left[ \begin{array}{c} \int_{x_1}^{y_1}\int_{x_2}^{y_2} (\hat{x}_1\hat{x}_2 - x_1x_2)\, g(\hat{x}_1, \hat{x}_2) d\hat{x}_1 d\hat{x}_2 + x_2 G_{\hat{x}_2}(x_2) \int_{x_1}^{y_1} (\hat{x}_1 - x_1)\, g_{\hat{x}_1}(\hat{x}_1) d\hat{x}_1 + \\ +x_1 G_{\hat{x}_1}(x_1) \int_{x_2}^{y_2} (\hat{x}_2 - x_2)\, g_{\hat{x}_2}(\hat{x}_2) d\hat{x}_2 \end{array} \right], \quad (10)$$

where $g(\hat{x}_1, \hat{x}_2) = g_{\hat{x}_1}(\hat{x}_1) g_{\hat{x}_2}(\hat{x}_2)$. Given the assumption that the distributions are uniform, the expected fine is equal to:

$$f = t\theta \left[ \left(y_2^2 + x_2^2\right) \left(y_1^2 + x_1^2\right) - 4y_1x_1y_2x_2 \right] / \left(4y_1y_2\right). \quad (11)$$

I can rewrite the expression above as

$$\frac{f}{y_1y_2} = \frac{t\theta}{4} \left[ \left(1 - \frac{x_1x_2}{y_1y_2}\right)^2 + \left(\frac{x_1}{y_1} - \frac{x_2}{y_2}\right)^2 \right], \quad (12)$$

where it is evident how the fine depends on the total amount of evasion and on the difference between evasion in the two dimensions. If the firm chooses to declare $x_1$ and $x_2$, then expected profits are

$$\Pi = y_1y_2 - x_1x_2t - \gamma f, \quad (13)$$

where $f$ is given by (11). Therefore, the optimal declaration is given by:

$$(x_1^*, x_2^*) \qquad s.t. \max_{x_1 \in [0, y_1], x_2 \in [0, y_2]} y_1y_2 - x_1x_2t - \gamma f. \quad (14)$$

The first-order conditions are simultaneously satisfied if and only if

$$x_1^* = y_1 \sqrt[2]{1 - 2\alpha} \qquad x_2^* = y_2 \sqrt[2]{1 - 2\alpha}, \quad (15)$$

where $\alpha = 1/\left(\gamma\theta\right)$. To have an interior solution, it is necessary that $\alpha < 1/2$, otherwise full evasion in both dimensions takes place. In what follows, it is assumed that $\alpha < 1/2$, i.e. enforcement is sufficiently strong to avoid full evasion. The maximand is locally concave at $(x_1^*, x_2^*)$; however, it is not globally concave. In the Appendix it is shown that $(x_1^*, x_2^*)$ is indeed the global maximum point. The same portion $\sqrt[2]{1-2\alpha}$ of the true product is declared in both dimensions. Given the total amount of evasion, it is evident from (12) and (13) that the only effect of declaring an unequal portion along the two dimensions is to increase the expected fine and, therefore, the optimal behavior is to equalize them. This property is due to the assumption of an uniform distribution for the probability of detection along the two dimensions, but it is not important for any of the results.

The fraction of unreported liability that is discovered in equilibrium is $\alpha/2$ and the expected fine is given by

$$\gamma f = \alpha t y_1 y_2 \tag{16}$$

giving expected profits of

$$\Pi^* = y_1 y_2 (1-t) + \alpha y_1 y_2 t. \tag{17}$$

As underlined at the beginning of this section, with a multiplicative tax base there is an additional incentive to underreport along one dimension as a higher declaration increases the fine when evasion in the other dimension is detected. Too see how this is indeed the case, consider what would happen if the taxpayer disregarded the fact that the two dimensions of the tax base are linked and instead considered them in isolation. Then, evasion along each dimension would equal evasion in the unitary case, giving a total declaration of $(1-\alpha)^2 y_1 y_2$. As $(1-\alpha)^2 > 1-2\alpha$, it is evident that taking into account the fact that the two dimensions are related increases underreporting.

# 4 Comparison

In this section, I investigate the implications of a multiplicative tax base by comparing the results derived above to the unitary case. I will first look at the firm decision and then at the impact on government revenues.

Table 1 summarizes the comparison between the two cases. The proportion of the tax liability that is declared, the voluntary compliance rate, is clearly higher in case of an unitary tax base. The proportion of tax liability that is paid through enforcement, the fine rate, is instead higher for a multiplicative tax base. Taking both voluntary compliance and enforcement into account, a taxpayer manages to reduce total payments to the fiscal authority more effectively with a multiplicative tax base than with an unitary one. Indeed, with a multiplicative tax base, the taxpayer succeeds through tax evasion to reduce the proportion of the tax base that is paid to fiscal authorities, the effective tax rate, by a factor of $\alpha$ compared to what he should have paid, the statutory tax rate. In the unitary case this reduction is only by a factor of $\alpha/2$.

Table 1: Comparison

| | Unitary | Multiplicative |
|---|---|---|
| Voluntary compliance rate | $1-\alpha$ | $1-2\alpha$ |
| Fine rate | $\alpha/2$ | $\alpha$ |
| Effective tax rate/Statutory tax rate | $1-\alpha/2$ | $1-\alpha$ |

As underlined above, given the same enforcement parameters, in an audit more evasion is uncovered on average with a multiplicative tax base than with an unitary one. This does not imply that a multiplicative tax base is easier to detect than an unitary one, maybe because two parameters instead of one have to be reported to the tax authority. Actually, the opposite is true. In the unitary case, from (5) we have

$$\frac{f}{y}=\frac{t\theta}{2}\left(1-\frac{x}{y}\right)^2,$$

comparing it with (12) when the same proportion is evaded along the two dimensions, it is evident that for a given proportion of undeclared income, more is uncovered in the unitary case compared to the multiplicative one. The higher fine rate in the multiplicative case is simply due to higher evasion.

To look at the impact of a multiplicative tax base on public finances, consider that net revenues include both revenues due to voluntary compliance, $x$, and revenues due to enforcement, $f$. While it may be reasonable to assume that 1 USD paid by the importing firm through voluntary compliance translates into 1 USD net revenue for the custom authority, in the case of revenues due to enforcement this is less likely to be the case. Indeed, part of the costs that are labelled as a fine may be of nonpecuniary nature, like, for instance, reputational costs (Gordon, 1989), or part of the payments in case some evasion is detected may not translate into increased revenues for the tax authority, e.g. when bribes are paid to custom inspectors to reduce or eliminate the liability. Therefore, I will assume that only a portion $\beta \in [0,1]$ of the fine represents a net revenue for the custom authority.[6] Alternatively, the authority may have an objective function such that revenues due to voluntary compliance may be preferred to revenues due to enforcement, due for instance to some underlying government social welfare function that emphasize the "carrot" over the "stick" (Frey and Holler, 1998). Therefore, net revenues for the custom authority are given by

$$T = tx + \beta\gamma f. \tag{18}$$

When $\beta = 1$ net revenues for the custom authority are given by the tax base minus profits. To compare the unitary and multiplicative tax bases in terms of their budgetary implications, consider that voluntary compliance is lower with a multiplicative tax base than with an unitary one. Moreover, profits for the importer are higher with a multiplicative tax base than with an unitary one, so, even when $\beta = 1$, the increase in fines is not enough to compensate for the decrease in voluntary compliance in terms of net revenues. Therefore, in general net revenues are lower with a multiplicative tax base than with an unitary one. I summarize these results in the following proposition

**Proposition 1** *In an environment with imperfect detection of tax evasion, a tax base that is the product of two different parameters is subject to higher underreporting compared to a tax base that can be assessed directly. As a result, expected fines are greater and expected net revenues are*

[6] Of course, costs associated with compliance, like time spent on filling returns and money spent on professional assistance may be relevant (Slemrod and Sorum, 1984). However, evasion may require these activities to even a greater extent. For what follows, it would be immaterial to consider that only a portion of voluntary compliance translates into net revenues for the custom authority, while $1 - \beta$ is the *additional* loss associated with collecting revenues through enforcement.

*lower.*

To summarize, from the previous analysis it emerges that a tax whose base is the product of different factors, each of them declared to and assessed by the tax authority, is more difficult to enforce for the tax authority compared to a tax whose base is directly assessed. This should be taken into consideration when deciding on which base to levy a tax. Yet, whether a given base can be directly assessed or not could be seen as a "technological" constraint over which the tax authority has no control. One possibility, however, is to require an unitary declaration of a multiplicative tax base. This amounts to ask the taxpayer to report not the different factors, but only their product. For the case of import tariffs, this implies that instead of asking the importer to declare both the unit value and the taxable quantities, the custom authority requires only the declaration of the total value of the merchandise. Clearly, an unitary declaration of a multiplicative tax base reduces the amount of information available to the tax authority and, thus, should make enforcement less effective. However, it also counter the disincentive to declare represented by the fact that a higher declaration in one dimension increases the fine when evasion in the other dimension is detected. In what follows, I will investigate the equilibrium when a multiplicative tax base is subject to an unitary declaration and compare it to the other cases analyzed above.

# 5 Unitary declaration of a multiplicative tax base

As in the previous section, the tax base is the product of two parameters and their true values are $y_1$ and $y_2$, so that the tax base is $y = y_1 y_2$. However, it is not the case anymore that each of the two parameters making up the tax base has to be reported to the tax authority. Instead, the taxpayer reports directly the tax base, $x$. In case of an auditing, detection takes place along the two dimensions, so that the tax authority manages to impute $\hat{x}_1 \in [0, y_1]$ and $\hat{x}_2 \in [0, y_2]$, as in section 3. Now, instead of (10), the fine is given by

$$f = t\theta \int_0^{y_1} \int_0^{y_2} \max\left[\hat{x}_1 \hat{x}_2 - x, 0\right] g(\hat{x}_1, \hat{x}_2) d\hat{x}_1 d\hat{x}_2. \tag{19}$$

This captures the fact that, given the assessed values along the two dimensions, the tax authority imposes a fine only if their product is greater than the declared amount. An equivalent expression for the fine is

$$f = t\theta \int_{\frac{x}{y_2}}^{y_1} \int_{\frac{x}{\hat{x}_1}}^{y_2} (\hat{x}_1\hat{x}_2 - x)\, g(\hat{x}_1, \hat{x}_2) d\hat{x}_1 d\hat{x}_2, \tag{20}$$

that gives rise to the following expression, where $y_1y_2$ has been replaced by $y$,

$$f = \frac{t\theta}{y}\left[\frac{y^2}{4} - xy - \frac{x^2}{2}\left(\ln\frac{x}{y}\right) + \frac{3}{4}x^2\right]. \tag{21}$$

Then, the optimal declaration is given by

$$x^* \quad s.t. \quad \max_{x\in[0,y]} y - \gamma f - tx, \tag{22}$$

where the expression for the fine is given by (21). The first order condition is

$$\frac{x}{y} - \frac{x}{y}\left(\ln\frac{x}{y}\right) = (1-\alpha). \tag{23}$$

The second order condition, $\left(\ln\frac{x}{y}\right) < 0$, is always satisfied. The expression above does not have an analytical solution. It is possible, however, to compare the proportion of the tax base that is declared in the different cases. To do this, notice that the left-hand side of expression (23) is increasing in $\frac{x}{y}$ at a decreasing rate. The function is plotted in figure (1). The point on the x-axis corresponding to the intersection between this curve and the horizontal line representing $(1-\alpha)$ is the equilibrium declaration. We will indicate this point as $x^{**}$.

**Comparison to an unitary tax base** Recall from (6) that in case of an unitary tax base $\frac{x}{y} = (1-\alpha)$. As $-\frac{x}{y}\left(\ln\frac{x}{y}\right) > 0$, then the solution to (23) has to be strictly smaller than $(1-\alpha)$, i.e. the share of the tax base that is declared is less than in the case of an unitary tax base. Graphically (see figure 1), the solution to the unitary case is the intersection between the horizontal line and the "unitary line" and this is always to the right of $x^{**}$.

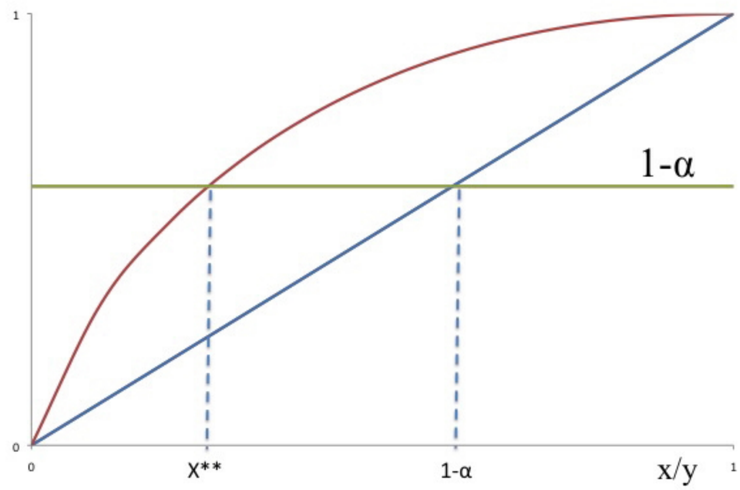


Figure 1: Comparison to an unitary tax base

**Comparison to a standard two dimensional tax base** Recall that in case of a standard two dimensional tax base $\frac{x}{y} = 1 - 2\alpha$. To know how this compare to $x^{**}$, we can calculate the value of the left-hand side of expression (23) when $\frac{x}{y} = 1 - 2\alpha$ and see if it is smaller or bigger than $(1 - \alpha)$. If it is smaller, it means that $x^{**} > 1 - 2\alpha$, if it is bigger it means that $x^{**} < 1 - 2\alpha$. The comparison

$$1 - 2\alpha - (1 - 2\alpha) \ln (1 - 2\alpha) > 1 - \alpha$$

gives the following condition

$$\alpha < -(1 - 2\alpha) \ln (1 - 2\alpha)$$

In figure (2), the two sides are plotted.

Let's indicate as $\alpha^* \simeq 0.36$ the point on the x-axis corresponding to the intersection between the two curves. Then,

$$\begin{array}{l} x^{**} < 1 - 2\alpha \quad if \quad \alpha < \alpha^* \\ x^{**} \geq 1 - 2\alpha \quad if \quad \alpha \geq \alpha^* \end{array}.$$

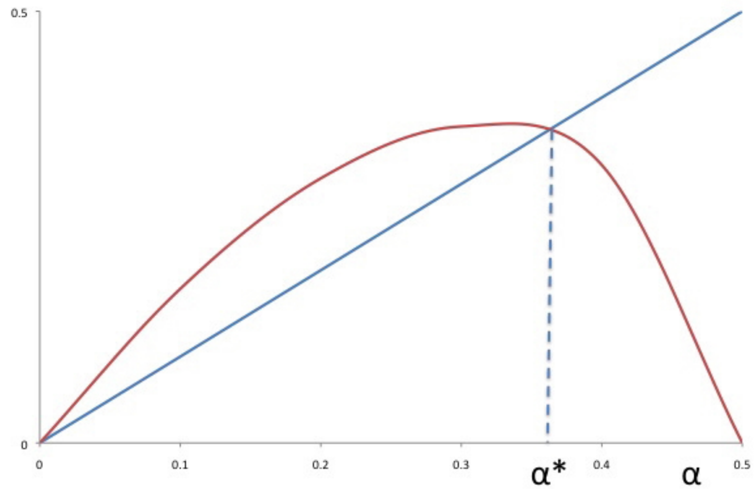


Figure 2: Comparison to a multiplicative tax base

This implies that in an environment with low enforcement, i.e. high $\alpha$, voluntary compliance with taxation of a multiplicative tax base is higher when only the product of the two parameters needs to be declared compared to the case when both parameters need to be declared. To give an example, consider the case with $\alpha = 0.4$. Then, declaration in the standard multiplicative case is given by $1 - 2\alpha = 0.2$, while declaration in case of an unitary declaration of a multiplicative tax base is given by $x^{**} \simeq 0.25$.

From the point of view of the tax authority, the relevant comparison is between net revenues, as defined in (18), or equivalently, the ratio of net revenues over the true tax liability, $T/(ty)$, provided by the two possible institutional arrangements. By using (15) and (16), we get

$$\frac{T}{ty} = (1 - 2\alpha) + \beta\alpha$$

for the case of a multiple declaration, while for the case of an unitary declaration it is possible to

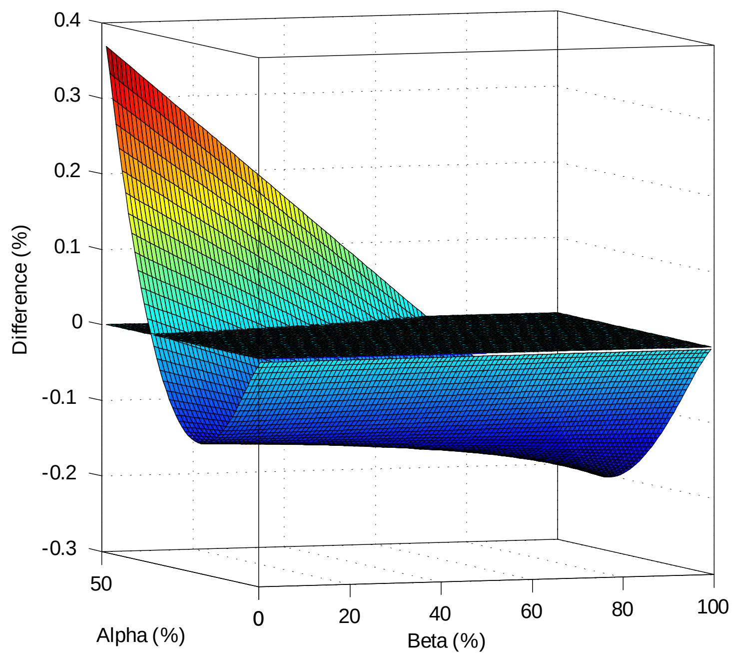


Figure 3: Difference in Revenues

show that

$$\frac{T}{ty} = \frac{x}{y}(1-\beta/2) + \frac{\beta}{4\alpha}\left(1-\frac{x}{y}\right)^2, \qquad (24)$$

where $x/y$ solves (23). Figure 3 plots $\frac{T}{ty}$ with an unitary declaration minus $\frac{T}{ty}$ with a multiple declaration and reveals that for high enough $\alpha$ and low enough $\beta$, net revenues are indeed greater with an unitary declaration compared to a multiple declaration. For instance, when $\alpha = 0.4$ and $\beta = 0.1$, 24% of the true tax liability translates into tax revenues with a multiple declaration, while this is 27.5% in case of an unitary declaration.

I summarize the results in the following proposition

**Proposition 2** *Given a tax base that is the product of two different parameters, in an environment with low enforcement voluntary compliance is higher when only the product of the two parameters needs to be declared compared to the case when both parameters need to be declared. Moreover, if penalties paid by the taxpayer translate into budgetary revenues at a low enough rate, then net revenues are higher with an unitary declaration.*

# 6 Discussion and conclusions

In this paper, I have analyzed the implications of a feature of import tariffs that has not been considered so far, i.e. the fact that the tax base is the product of two factors, unit value and quantity, each of them to be reported by the importer and to be assessed by the custom authority in case of an audit. What I have shown is that when the tax base presents this characteristic instead of being assessed directly, as in the unitary case, then evasion is higher. I have also shown under which circumstances a revenue maximizing custom authority may not require the importer to declare both factors, but only their product. As mentioned in the introduction, tariff evasion can also take place trough mislabelling of higher taxed products as lower-taxed products. The model can be easily reinterpreted as studying evasion through mislabelling and either underreporting of quantity or underreporting of unit price, with the caveat that mislabelling is better modelled as a discrete rather than continuous choice. [7]

For analytical tractability, the probabilities of detection have been assumed to be uniformly distributed over the relevant intervals. In reality, it may well be the case that detection along some dimensions is relatively easy, so that the probability of detection is skewed toward zero, while in other dimensions detection may be relatively difficult, with a probability skewed toward the true value. In this case, the proportion of evasion along each dimension would no longer be identical. The empirical evidence concerning the relative importance of the different channels through which tariff evasion takes place, i.e. quantity, unit price, misclassification, is rather mixed: Fisman and Wei (2004) find evidence of misclassification and underreporting of unit values, but not of quantities. Javorcik and Narciso (2008) find that evasion takes place through misrepresentation of import prices, but not through misclassification or undereporting of quantities, while Mishra et al. (2008) find evasion in quantities to be significant. Jean and Mitaritonna (2010) find that

[7] Moreover, at the cost of losing analytical tractability, the analysis can be extended to a tax base that is the product of three independently reported parameters. In this case, the f.o.c. for each of the three dimensions is given by

$$\left(\frac{x_i}{y_i}\right)^2 + 1 = 2\sqrt{(1-\alpha)}\sqrt{\frac{x_i}{y_i}} \qquad i = 1, 2, 3.$$

underreporting of both quantities and unit price are "widespread modalities of custom evasion, with comparable importance". The generally bad quality of quantity data in trade statistics[8] makes the identification of the different channels difficult. However, the lack of symmetry in evasion along different dimensions would not hinder the intuition behind the main results of the paper, namely that with a multiplicative tax base there is an additional incentive to underreport due to the fact that a higher declaration in one dimension increases the expected fine when evasion in the other dimension is detected, and that an unitary declaration may improve voluntary compliance as it mitigates this disincentive to underreport.

The additional incentive to underreport in case of a multiplicative tax base highlighted in this paper has implications for the issue of crime displacement, i.e. the tendency of higher enforcement along one dimension to increase criminal activity in alternative dimensions. In the context of tariffs, Yang (2008) has shown that increased enforcement in the Philippinnes (preshipment inspection of imports for a subset of countries) led to an increase in an alternative method of duty evasion (shipping via duty-exempt export processing zones), so that total duty avoidance did not change. In terms of the decision analyzed in this paper, improving compliance along one dimension, say unit price, through higher enforcement, increases the expected fine when evasion along the other dimension, quantity, is detected, thus encouraging a higher declaration. Thus, with a multiplicative tax base, the interdependence between the different dimensions actually generates a positive feedback instead of displacement.

From a policy perspective, tariffs have been used by developing countries to raise revenues because they benefit from low collection costs compared to other taxes (Riezman and Slemrod, 1987) and it has been argued that they may be part of the optimal tax structure in developing countries, where tax enforcement is more difficult (Gordon and Li, 2009). However, what has been underlined in this paper is that, in environments with low administrative capacity, custom duties may be actually more difficult to enforce than other taxes and this should be taken into

[8]Quantities are often indicated for information only (Jean and Mitaritonna, 2010) and the unit of measurements reported by different statistical agencies may be non-convertible, e.g. units vs. kilograms (Stoyanov, 2009). See also Rozanski and Yeats (1994) for a comprehensive analysis of the reliability of trade statistics.

account when thinking about the optimal tax structure for developing countries.

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# 7 Appendix

To establish whether $(x_1^*, x_2^*)$ is indeed the global maximum point, it is necessary to check the value of the function along the boundaries.

First, I analyse the boundaries within the axes, i.e. with full evasion in at least one dimension.

1 . Substituting $x_1 = 0$ in (13), I get $\Pi|_{x_1=0} = y_1 y_2 - t\left(y_2^2 + x_2^2\right) y_1 / \left(4\alpha y_2\right)$, that is maximized for $x_2 = 0$;

2. Substituting $x_2 = 0$ in (13), I get $\Pi|_{x_2=0} = y_1 y_2 - t(y_1^2 + x_1^2) y_2 / \left(4\alpha y_1\right)$, that is maximized for $x_1 = 0$;

Thus, when there is total evasion in one dimension, then it is also optimal to have total evasion in the other dimension. A positive declaration would only represent a lower bound on the fine to be paid. Therefore, we need to compare $\Pi^*$ given by (17) with profits corresponding to total evasion given by substituting $x_1 = 0, x_2 = 0$ in (13):

$$\Pi_{bm}^* = y_1 y_2 - \gamma t\theta y_1 y_2 / 4. \tag{25}$$

For $\alpha < 1/2$, we always have that $\Pi^* > \Pi^*_{bm}$.

The case with full compliance in at least one dimension is parallel to the case analyzed in the unitary case.

3. In case $x_1 = y_1$, then $\Pi$ is maximized for $x_2 = (1-\alpha)y_2$, resulting in profits $\Pi^*|_{x_1=y_1} = y_1 y_2(1-t) + \alpha t y_1 y_2/2$;

4. In case $x_2 = y_2$, then $\Pi$ is maximized for $x_1 = (1-\alpha)y_1$, resulting in the same profits as in the previous case.

Thus, profits when there is total compliance in one dimension are given by $\Pi^*_{fc} = \Pi^*|_{x_1=y_1} = \Pi^*|_{x_2=y_2}$. It is straightforward to show that $\Pi^* > \Pi^*_{fc}$.

So, the analysis at the boundaries shows that $(x_1^*, x_2^*)$ is indeed the global maximum point.