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IN THE PRESENCE OF TARIFF EVASION

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YOON SANG KIM

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Charles L Ballard
Major professor

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By

Yoon Sang Kim

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ABSTRACT

THE MARGINAL COST OF PUBLIC FUNDS IN THE PRESENCE
OF TARIFF EVASION

By

Yoon Sang Kim

In this paper, I examine the major determinants of tariff evasion and calculate the marginal cost of public funds (*MCF*) associated with various policy tools, using micro data for 1998 in Korea. I show that, if we incorporate the tariff evasion and concealing costs incurred by firms in calculating *MCF*s, different values are measured than those derived without considering evasion.

I find that tariff evasion increases with tariff rates in all commodity categories. Estimates of the elasticity of tariff evasion with respect to a tariff rate are in the range of 0.102 and 1.026, depending on the commodity categories. This wide range of elasticities is due to the differences in the slope of evasion in terms of the tariff rate and the ratio of the tariff rate to evasion. However, the probability of detection has no significant effects on evasion in any of the categories. Only for Consumer Goods does the probability of audit have deterrent effects, with the elasticity of -0.416.

I also calculate *MCF*s of tariff rates without evasion, which vary from 1.1446 to 1.3064 for three commodity categories. Surprisingly, for all commodities, *MCF*s of tariff rates in the presence of evasion are found to be smaller than those derived without considering evasion, although the differences are usually small. Overall, an increase in the probability of audit, an increase in the penalty rate, and an increase in the probability

of detection are found to be more efficient policy tools for raising additional revenues than tariff rates, if these enforcement variables have deterrent effects on evasion (with negative values of the partial effects of enforcement variables).

As novel results, the main contributions of this paper are an estimation of the major determinants of tariff-evasion behavior and customs fraud and the provision of numerical values of *MCF*s associated with different government policy tools.

To my family

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I dedicate this dissertation to all of those whom I love and to all of those who have loved me, throughout my life.

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CHAPTER I

INTRODUCTION

There has been a substantial amount of public finance literature on the marginal cost of public funds (*MCF*) per additional dollar of tax revenue, such as Campbell (1975), Stuart (1984), Wildasin (1984), Ballard, Shoven, and Whalley (1985), and Ballard and Fullerton (1992). The *MCF*, which accounts for the distortionary effects of taxes necessary to finance additional government spending, can be calculated by taking the loss in consumers' welfare brought about by a tax change, and dividing it by the amount of additional tax revenue collected. The traditional method of analyzing the *MCF* ignores the existence of tax evasion, compliance costs, evading costs, administrative costs, and enforcement expenditures. They usually focus only on an efficiency loss from a wedge between the relative prices for the calculation of the *MCF*.

However, it is widely believed that tax evasion and direct resource costs, such as concealing costs incurred by taxpayers and enforcement costs, can also affect the *MCF*.[1] That is, all the indirect costs and direct resource costs should be considered in identifying the *MCF*. Thus, the literatures on the *MCF* that fail to consider the existence of these costs may overstate or understate the true value of the *MCF*.

Until recently, only a few economists have been concerned with this issue, and those who have been concerned with it have used unrealistic assumptions about the probability

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[1] Slemrod and Yitzhaki (1996) refer to the costs incurred by society in the process of transferring purchasing power from the taxpayers to the government as the social costs, which include the cost of administering the law, compliance costs, and the deadweight losses and expenditures caused by taxpayers' activities to reduce the tax burden, such as evasion, avoidance, and switching to more lightly taxed, but otherwise less attractive, consumption. They argue that conclusions from models of the costs of taxation that ignore these social costs can be misleading.

of detection, enforcement expenditures, and the penalty rates, and have failed to show the corresponding empirical evidence.

Usher (1986) develops the formulas for the *MCF*s of an income tax and an excise tax, incorporating the distortionary effect of tax evasion. His study is the first theoretical work on the *MCF* of taxes in the presence of evasion. He argues that the *MCF* should include allowances for marginal deadweight loss and marginal cost of tax evasion per dollar of public revenue acquired.

Yitzhaki (1987) argues that, if we ignore the income effect, then the excess burden of tax evasion and the excess burden of the tax rate can be added to estimate the total excess burden of a tax. Basically, he uses a differential analysis, which should be distinguished from the balanced-budget analysis adopted to calculate the *MCF*.[2] Although Yitzhaki recognizes that tax evasion leads to welfare losses and tries to formulate the excess burden of tax evasion, he does not consider the *MCF* caused by an increase in tax rates to finance additional public spending.

Kaplow (1990) examines the relationship between optimal taxation and optimal tax enforcement, and argues that some expenditures on enforcement may be optimal despite their resource costs, their distortionary effects, and the availability of other revenue sources having no enforcement costs. Although he does not focus on the *MCF*, he indicates that measures of the efficiency cost of raising government revenue may differ in

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[2] Ballard (1990) points out that if the question is whether to undertake an additional tax-financed government project, and if that project cannot be considered as equivalent to a lump-sum transfer, then it is appropriate to use a balanced-budget analysis for the calculation of the *MCF*, in which income effects and uncompensated elasticities must be considered. However, Browning (1976, 1987) uses a differential analysis to calculate the *MCF*, in which distortionary taxes are replaced with lump-sum taxes, holding government spending constant. As indicated by Ballard (1990), methodologically, it is incorrect to calculate the *MCF* using a differential experiment, unless one believes that the relevant marginal government expenditures are very close substitutes for cash.

the presence of tax evasion and enforcement costs.

Falkinger (1991) shows that tax evasion may lead to less public expenditure, but may also imply a higher optimal level of public-good provision.[3] He also proves that if public goods have zero income effects, which means that the marginal rate of substitution, U_G/U_X, is independent of X, tax evasion has no impact on the optimal level of public good provision, where U_G ($=\partial U/\partial G$) and U_X ($=\partial U/\partial X$) denote the derivatives of the taxpayer's utility with respect to the level of public good provision, G, and private consumption, X, respectively.

Fortin and Lacroix (1994) compute not only the *MCF* associated with tax rates, but also the *MCF* with respect to enforcement instruments, such as penalty rates and the probability of detection, using a simultaneous model of labor supply in the regular and irregular sectors. In this respect, despite some limitations[4], their work is a pioneer study in this area, since it is the first study that makes empirical measurements of the *MCF* of tax rates in the presence of tax evasion and the *MCF*s of revenue sources other than tax rate increases.

Cremer and Gahvari (1999) show that ignoring tax evasion may lead to

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[3] Falkinger (1991) argues that the optimal level of public goods depends on the derivative of evasion with respect to government spending E_G ($= \partial E/\partial G$) and the derivative of evasion with respect to the tax rate E_t ($=\partial E/\partial t$) respectively. For instance, $E_t > 0$ means that a higher tax rate leads to a less-than-proportionate increase in expected tax yields, since tax evasion increases with t. Thus, the marginal rate of transformation is higher than that in the no-tax evasion case, which indicates less public expenditure. On the contrary, $E_t<0$ implies a higher optimal level of public goods.

[4] For example, they assume that enforcement expenditures by the government are an increasing function of the exogenously determined probability of detection. As I explain in detail later, it is more appropriate and intuitively appealing to assume that the probability of detection is a function of the fraction of undeclared income or import (evasion), concealing costs, and enforcement expenditures. In addition, their empirical results are based on a survey of taxpayers' evasion behavior. However, the results from surveys, especially on evasion, may not be reliable, since individuals have an incentive to hide information on their illegal behavior.

underestimating as well as overestimating the *MCF* of commodity taxes. In the presence of evasion, an increase in the legislated tax rate may increase, as well as decrease, the size of the marginal tax revenue (*MTR*) and the marginal utility loss (*MUL*) of taxation. The intuition for the ambiguity in the *MTR* is that, although the new equilibrium value of the effective tax rate will be less with tax evasion than without, the equilibrium value of quantity demanded will be more (because price will increase by less). For the *MUL*, increasing the legislated tax increases the consumer price by a lesser amount with evasion, resulting in a smaller increase in the utility loss, while the additional loss due to concealment increases the value of the *MUL*. Therefore, tax evasion may decrease, as well as increase, the $MCF = MUL/MTR$. Only if the taxed good is perfectly inelastic in demand can one be certain that tax evasion causes the *MCF* to increase and exceed its value in the absence of evasion, since desired effects of tax evasion on the *MCF* (smaller changes in price) wash out.

Recently, Poapongsakorn et al. (2000) compare the *MCF* of additional tax enforcement with the *MCF* of tax rate changes in the presence of income-tax evasion, using data for the 1993 taxpayer survey in Thailand. Their empirical analysis indicates that, in their base case, an increase in income-tax rates on wage earners is a more attractive policy than devoting more resources to tax enforcement.

However, most studies of the *MCF* with evasion have been focused on the *MCF* of the income tax. No work has been done to measure empirically the *MCF* of indirect taxes, such as commodity taxes and tariffs, in the presence of evasion. Furthermore, I am not aware of any theoretical or empirical works that consider the *MCF*s of other revenue sources, such as the penalty and the enforcement activities, when they attempt to analyze the *MCF* of indirect taxes.

The purpose of this paper is to provide numerical measures of the *MCF*s of tariffs (including internal taxes on imported goods) and other enforcement instruments, in the presence of evasion, for the case of Korea. For the calculation of the *MCF*s, I use detailed data on import declarations in 1998, randomly selected for inspection by the Korea Customs Service (KCS) at the time of import.

It is meaningful to quantify the *MCF* of tariffs in the presence of evasion in Korea. First, the tariff and tax revenues collected by the KCS are a large share of total Korean government revenues. The pure tariff revenue is 3,836 billion Korean won (*W*) in 1998, which is only 5.66% of total tax revenues (including tariffs) collected by the central government agencies in Korea. However, Article 26-2 of Korea Customs Act prescribes that internal taxes on import goods, such as value-added tax, special consumption tax, liquor tax, education tax, etc., shall be collected by the customs house along with the customs duty. If we include all internal taxes collected by the KCS, the total tariff revenues (including internal taxes) are 15,956.3 billion *W*, 23.54% of the total Korean tax and tariff revenues in 1998.

Second, most countries (including Korea) have adopted simplified clearance procedures to keep up with rapidly changing international trade environments and the growing need for a prompt customs clearance, to reduce customs-clearance-related costs. However, the simplified clearance procedures, such as the self-declaration system, are frequently abused in efforts to claim lower duty rates, falsify country-of-origin markings, infringe trademarks, etc. According to the KCS (1999), in the year 1998, the total number of customs offences had reached 1,550 cases (about 198 billion *W* in value). This may seem like a relatively small amount of fraud. However, even if the total value of customs fraud is only a little part of the total trade volume, without considering the other costs associated with these illegal activities, our results on the measure of the *MCF* may be misleading. It is shown that the *MCF* can be changed in the presence of tariff evasion, private costs of evasion, and administrative costs on enforcement.

Third, we can determine whether a government project should be financed through higher tariff rates (higher commodity tax rates) or greater enforcement activities to detect evasion, by comparing the *MCF* of each of the government policy tools to raise revenues. This comparison has important policy implications, which are neglected in most of the theoretical and empirical literature on the *MCF*.

In chapter II, I use a simple model of tariff evasion to predict how tariff evasion can be affected by changes in tariff rates, penalty rates, and enforcement expenditures by the government. In chapter III, I derive the formulas for the *MCF* associated with each of the government policy tools, and compare them with each other as well as with the *MCF* without evasion. In chapter IV, I estimate the major determinants of tariff evasion by a Tobit model, using the most detailed data sets from the KCS. In chapter V, I examine the major determinants of customs fraud by a Probit model. In chapter VI, I measure the *MCF*s, using the formulas derived from chapter III and the parameter values from chapter IV. In addition, it is shown how the values of the *MCF* are sensitive to changes in parameter values. In chapter VII, I discuss policy implications for cost-benefit analysis, choice of policy tools, and the optimal tax design or tax reform. In the last chapter, I point out some limitations of this study, and suggest areas for future work.

CHAPTER II

THE MODEL

1. Theoretical Framework[5]

Consider a small open economy with a large number of identical importers. Imports are subject to an *ad valorem* tariff at a rate t, and are sold in a competitive market at a given price of P. We assume that imports are the only source of a firm's profit, and that domestic production is zero. Now suppose that a firm may attempt to evade tariff payment by declaring only a portion, $(1-\alpha)$, of its true per-unit import price, P^*[6], or its true quantity, X, to the customs authority, in the presence of the probability of getting caught, β, and the penalty rate, θ, when caught. Interpreting this assumption in another way, such that the importer may declare a fraction of its true tariff payment, $(1-\alpha)tP^*X$, we can also include another type of smuggling, false declaration of items so that a lower tariff rate would apply.[7]

In this model, we mainly focus on legally disguised smuggling, such as the

[5] This model is an extension and generalization of the excise-tax framework of Cremer and Gahvari (1993, 1999). Their model is amended to a tariff-evasion framework. I also generalize their model, making the probability of detection endogenous, explicitly including enforcement expenditures, etc. For these generalized assumptions and comparative static analysis, I am greatly influenced by Martin and Panagariya (1984), which is the pioneer work in the analysis of the uncertain nature of smuggling, introducing the risk and uncertainty into the firm's smuggling decision framework for the first time.

[6] The world price, P^*, is fixed, since we assume a small open economy.

[7] There are two methods of determining the duty amount: *Declaration & Payment* and *Notice of Assessment*. For the general case in Korea, *Declaration & Payment System* is practiced, in which a firm which desires to import goods makes a declaration on payment of the customs duties, upon making a declaration of import, to the customs authority. In this context, declaration of tariff payment may be a more appropriate interpretation than declaration of unit price and quantity. It may be the case that the importers can intentionally claim lower duty rates through false invoicing of items, even if they report the true unit price and quantity.

undervaluation, the underdeclaration of a quantity (weight), the declaration of false items, etc., so that we rule out the possibility of smuggling through illegal points of entry without declaring anything to the customs.[8]

The probability of getting caught, β, consists of a two-part process by which the authorities detect evaders. One part is the probability that the taxpayer is audited, A. The other part is the probability that evasion is detected, conditional on the occurrence of an audit, D. Suppose that there are 1,000 import declarations, from which 100 declarations are selected for inspections. From the 100 declarations audited by customs, 30 declarations are detected for fraud. Then, the probability of audit, A, is 10% (= 100/1,000), and the probability of detection given the audit, D, is 30% (= 30/100). In this case, the probability of getting caught, β, equals the probability of audit multiplied by the probability of detection, conditional on the occurrence of the audit, $A \times D$, which is 3% (= 0.1×0.3). Both the probability of audit and the probability of detection given the audit are functions of the proportion of imports unreported, α, concealing costs per dollar of imports by the firm to escape detection, c, and the government expenditures per dollar of imports to detect tariff evasion, d. If follows that $A = A(\alpha, c, d)$ and $D = D(\alpha, c, d)$. Therefore, $\beta = \beta(\alpha, c, d)$, where $\beta_\alpha > 0$, $\beta_c < 0$, and $\beta_d > 0$. In general, inspection of imported goods, which leads to detection of evasion or illegal trade, is conducted to determine: (i) The value of the goods for customs purposes and their dutiable status; (ii) Whether the goods must be marked with the country of their origin or are in need of

[8] According to the Korea Customs Service (1999), legally disguised importation accounts for about 80% of total customs offences in Korea. The other 20% includes direct smuggling by air and by sea, drug trafficking, money laundering, etc.

special marking or labeling. If so, whether they are marked in the manner as prescribed; (iii) Whether the shipment contains prohibited articles; (iv) Whether the goods are correctly invoiced; (v) Whether the goods are in excess of the invoiced quantities.

The concealing cost incurred by the firm is an increasing and convex function of the undeclared portion of imports, so that $c_\alpha > 0$ and $c_{\alpha\alpha} > 0$. These costs can be real resource costs for legally disguised smuggling goods, such as costs of special packaging, costs of misinvoicing (undervaluing, underweighing, false items, etc.) paid to foreign exporters or professional counterfeiters, extra costs (premium) of purchasing the foreign exchange in the black market, etc.

Government expenditures, d, can be thought of administrative costs or efforts to detect tariff evasion. These may include the development of an information-management system, the integration of computer systems among law-enforcement agencies, the introduction of advanced techniques (e.g., financial transaction tracing techniques), the modernization of inspection equipment (e.g., X-ray inspection machines, wiretapping devices), and, after inspection equipment is modernized, it has to be operated, training of investigators, and, after investigators are trained, they have to be paid, etc. The penalty for tariff evasion is assumed to be proportional to the amount of evaded tariffs.

Compared with Cremer and Gahvari (1999), first of all, I generalize the structure of the probability of getting caught, and account explicitly for enforcement expenditures by the government. They assume that the probability of getting caught is exogenously determined, and they do not consider enforcement expenditures. In this paper, the probability of getting caught is an increasing function of the proportion of imports unreported and the enforcement expenditures per dollar of imports, and a decreasing function of concealing costs per dollar of imports by the firm to escape detection. Furthermore, I explicitly recognize that the probability of getting caught consists of a two-part process, the probability of audit and the probability of detection, given an audit. Each part of the two-part process will be considered as a separate policy variable in the next chapter. In addition, their model is in a unit-excise-tax evasion framework, while this model is in an *ad-valorem*-tariff evasion framework.

The firm chooses α to maximize its expected profit, given t, θ, and d, which are determined by the government. Thus, the firm maximizes

$$E\pi = \{(1-A)[P-P^{*}-(1-\alpha)tP^{*}-cP^{*}]$$
$$+ A[(1-D)(P-P^{*}-(1-\alpha)tP^{*}-cP^{*}) + D(P-(1+t)P^{*}-\theta\alpha tP^{*}-cP^{*})]\}X.$$

The first term in {} is unit profit if the firm is not audited, and the second term is unit profit if the firm is audited. The second term is divided into two parts. One part is the unit profit if the firm is not detected, and the other is the unit profit if the firm is detected, both of which are conditional on the occurrence of an audit. The firm pays concealing costs (c) regardless of whether it is audited or detected. The penalty (θ) is only assessed on tariff payments which the firm tried to evade.

Simplifying the firm's expected profit, we get

$$E\pi = \{(P-P^{*}-(1-\alpha)tP^{*}-cP^{*}) - AD(1+\theta)\alpha tP^{*}\}X,$$
$$= \{(P-P^{*}-(1-\alpha)tP^{*}-cP^{*}) - \beta(1+\theta)\alpha tP^{*}\}X. \qquad (1)$$

The first- and second-order conditions are as follows.

$$\{t - c_\alpha - \beta_1(1+\theta)\alpha t - \beta(1+\theta)t\}P^*X = 0 \tag{2}$$

$$\{-c_{\alpha\alpha} - \beta_1'(1+\theta)\alpha t - 2\beta_1(1+\theta)t\}P^*X < 0, \tag{3}$$

where $\beta_1 = \beta_\alpha + \beta_c c_\alpha$ and $\beta_1' = \beta_{\alpha\alpha} + \beta_{cc} c_{\alpha\alpha}$ denote the first and second derivatives of β with respect to α, respectively. It should be noted that both β_1 and β_1' are positive for an interior solution. Without this condition, nothing will be declared to customs, such that $\alpha = 1$. These assumptions are also intuitively appealing. As the deviation from the true imports or tariff gets greater, it is more likely that the customs authority will be able to detect the legally disguised smuggling. This implies that the slope of β in terms of α, β_1, is positive, and increases with the fraction of undeclared imports or tariffs.

If we further assume $P^* > 0$ and $X > 0$, then equation (2) can be rewritten as follows.

$$t - \beta_1(1+\theta)\alpha t - \beta(1+\theta)t = c_\alpha. \tag{2)'$$

From (2)', it is clear that the firm chooses the optimal value of α so that the marginal benefits or profits from an underdeclaration of imports are equal to the marginal cost of tariff evasion. The left-hand side of (2)' shows the net increase in the firm's profit from an underdeclaration. One dollar of undeclared imports increases the firm's profits by the tariff rate, t. However, at the same time, it both increases the probability of detection and the expected penalty, which have negative impacts on profits. The right-hand side of (2)' represents the additional resource costs incurred by the firm to evade tariff payments. From equations (1) and (2)', we know that the fraction of imports undeclared, α, is independent of the firm's imports, X. Thus, the amount of imports, X, is separable from the evasion decision, and will be solely determined by the demand side. This separability arises because total evasion costs, $cP^{*}X$, are assumed to be proportional to the amount of imports, $P^{*}X$.

It should be noted that tariff evasion takes place if the derivative of the importer's expected profit with respect to α, $\partial E\pi/\partial\alpha$, is positive when evaluated at $\alpha = 0$. At $\alpha = 0$, an increase in α would increase the importer's expected profit. When evaluating $\partial E\pi/\partial\alpha = \{t - c_{\alpha} - \beta_1(1+\theta)\alpha t - \beta(1+\theta)t\}P^{*}X > 0$ at $\alpha = 0$, assuming that $P^{*} > 0$ and $X > 0$, we derive the following condition:

$$t - \beta(1+\theta)t > 0 \text{ or } \beta(1+\theta) < 1.$$

This condition has important implications for choosing policy variables to detect evasion and to increase government revenues. This will be discussed in more detail in later sections.

2. Comparative Static Analysis

Now we examine the effects of a change in each of the policy variables (t, θ, and d) on the fraction of imports undeclared, α. From the firm's profit-maximization problem, we can implicitly derive the optimal value of $\alpha = \alpha(t, \theta, d)$.

First, substituting the optimal choice of α into the first-order condition and differentiating it with respect to t, we obtain

$$\partial\alpha/\partial t = [-1 + \beta_1(1+\theta)\alpha + \beta(1+\theta)] \,/\, [-c_{\alpha\alpha} - \beta_1'(1+\theta)\alpha t - 2\beta_1(1+\theta)t]. \tag{4}$$

It can be shown that $\partial\alpha/\partial t$ is positive, so that an increase in tariff rates will increase (decrease) tariff evasion (tariff compliance). This effect is intuitively appealing, in particular, at $t = 0$. In the neighborhood of $t = 0$, we can expect full compliance, since there is no incentive at all to evade tariffs incurring concealing costs. Then, it is obvious that an increase in the tariff rate from zero leads to evasion. The interesting thing about this comparative-static derivative is that the result holds for any value of t. From the first-order condition, the numerator of the right-hand side of equation (4), $[-1 + \beta_1(1+\theta)\alpha + \beta(1+\theta)] = -c_\alpha/t$ is negative, since c_α is positive. The denominator of equation (4), $[-c_{\alpha\alpha} - \beta_1'(1+\theta)\alpha t - 2\beta_1(1+\theta)t]$ is negative because it is just the second-order condition. Thus, the sign of $\partial\alpha/\partial t$ is positive. This implies that, as tariff rates increase, the proportion of imports undeclared increases, since the additional benefit, 1, from an underdeclaration outweighs an increase in the expected penalty, $[\beta(1+\theta) + \beta_1(1+\theta)\alpha]$. The first term, $\beta(1+\theta)$, represents a direct increase in the expected penalty, and the second term,

$\beta_1(1+\theta)\alpha$, is an indirect increase via an increase in the probability of getting caught. It should be noted that an increase in concealing costs, c_α, is already included in β_1, since $\beta_1 = \beta_\alpha + \beta_c c_\alpha$.

Second, substituting the optimal choice of α into the first-order condition and differentiating it with respect to θ, we obtain

$$\partial\alpha/\partial\theta = [\beta_1\alpha t + \beta t] / [-c_{\alpha\alpha} - \beta_1'(1+\theta)\alpha t - 2\beta_1(1+\theta)t]. \tag{5}$$

The sign of $\partial\alpha/\partial\theta$ can be shown to be negative, so that an increase in the penalty rate decreases the fraction of true imports undeclared. Since β_1 is assumed to be positive, the numerator of the right-hand side of (5) is positive. It follows that the sign of $\partial\alpha/\partial\theta$ is negative, since the denominator is negative, while the numerator is positive. This implies that an increase in the penalty rate has a deterrent effect on tariff evasion, since the expected net profit from an additional dollar of tariff evasion, $-[\beta_1\alpha t + \beta t]$, is negative, other things being equal.

Third, substituting the optimal choice of α into the first-order condition and differentiating it with respect to d, we obtain

$$\partial\alpha/\partial d = [\beta_{1d}(1+\theta)\alpha t + \beta_d(1+\theta)t] / [-c_{\alpha\alpha} - \beta_1'(1+\theta)\alpha t - 2\beta_1(1+\theta)t], \tag{6}$$

where $\beta_{1d} = \beta_{\alpha d} + \beta_{cc}c_{\alpha d}$, which is assumed to be non-negative. The sign of $\partial\alpha/\partial d$ is negative, so that an increase in government expenditures on the detection of tariff evasion will decrease the fraction of imports unreported. This result is based on the reasonable assumption that β_{1d} is non-negative. We view government spending, d, as administrative costs or efforts to enhance the effectiveness of an existing investigation or a surveillance system, such as the introduction of new techniques or equipment to increase the efficiency, β_1 (the slope of β in terms of α) of a detecting system. Therefore, β_1 can be assumed to be an increasing function of d, or at least be constant, so that β_{1d} is non-negative. It thus follows that the numerator of (6) is positive, since β_d is assumed to be positive. Thus, the sign of $\partial\alpha/\partial d$ is negative.

Both an increase in the penalty rate and an increase in the probability of getting caught by raising government expenditures have deterrent effects on evasion. If they have positive effects on raising government revenues (i.e., if the marginal tariff revenues of these instruments are positive), they can be used as substitutes for each other, other things being the same. The government would choose policy instruments to eliminate the incentive of tariff evasion so that they ensure the following condition,

$$t - \beta(1+\theta)t < 0 \text{ or } \beta(1+\theta) > 1.$$[9]

There can be many combinations of the penalty rate, θ, and the probability of getting caught, β, (actually government expenditures, d), that would satisfy this condition. The optimal value of the penalty rate is infinity, while the optimal level of the probability of getting caught is zero by setting the government expenditures to zero. This is because an increase in the probability of getting caught requires government resources, while the

[9] This condition comes from the previous section.

penalty rate can be increased without limit incurring no costs to the government (from our assumptions given in early this section), and an increased penalty rate would result in additional government revenues transferred from the evaders, other things being the same. It seems that an increase in the penalty rate is a more attractive policy tool for the government.

However, as noted by many economists, such as Cullis and Jones (1998), Myles (1995), Tanzi and Shome (1993), etc., the penalty rate cannot be raised without limit. Cullis and Jones (1998, p. 205) point out that "justice requires that 'the punishment should fit the crime' and fines must increase with extent of the crime to preserve marginal deterrence". In addition, Tanzi and Shome (1993, pp. 812-3) note that "many societies feel uncomfortable about singling out and punishing particular individuals, almost by lottery, when many others have committed the same offenses", and "if the individual who gets caught can bribe some tax officials, and if the bribe is less than the penalty, then the theory becomes ambiguous".

When we consider the optimal policy in the presence of evasion, a tariff rate should also be considered as one of the policy variables. In addition, all the policy tools should be evaluated in the context of maximizing the social welfare or minimizing the welfare loss of society from raising additional revenues for public spending. They should not be confined solely to deterrence of evasion or maximization of government revenues.

CHAPTER III

THE MARGINAL COST OF PUBLIC FUNDS WITH TARIFF EVASION

Now consider the policy tools available to the government to finance an additional dollar for a certain public project. The government can raise revenues for public spending by increasing tariff rates, by increasing the probability of getting caught by allocating more resources to tracking down customs fraud, or by raising penalty rates. The marginal cost of public funds (*MCF*) may have a different value in each case. This is neglected in Usher (1986) and Cremer and Gahvari (1999). They only consider an increase in tax rates as a government revenue source. As a result, they do not propose the formulas for the *MCF*s of revenue sources other than tax rate changes, such as the *MCF*s of the penalty rate and the enforcement activities. This is summarized in Table 1.

In the following sections, we examine the additional government revenue and the consumer's utility losses from each of these government policy tools. Then, we derive the MCF_i, where $i = t$, θ, and d, using the well-known formula,

$$MCF_i = -\text{ (change in consumer welfare) / (additional government revenue).}$$

1. Marginal Tariff Revenues in the Absence of Evasion[10]

Without evasion, the total tariff revenue, TR^*, is given by,

[10] We assume that the economy is on the left-hand side of the Laffer curve, so that the marginal tariff revenue is positive.

$$TR^* = tP^*X.^{11} \tag{7}$$

Differentiating (7) with respect to t, we get the marginal tariff revenue (MTR),

$$MTR_t^* = P^*X + tP^*(\partial X/\partial P^\wedge)(\partial P^\wedge/\partial t), \tag{8}$$

where $P^\wedge = (1 + t)P^*$ is the market equilibrium price without evasion. We can rewrite $(\partial P^\wedge/\partial t)$ as P^*. Thus, equation (8) can be simplified as follows.

$$\begin{aligned} MTR_t^* &= P^*X + tP^*P^*(\partial X/\partial P^\wedge)(P^\wedge/X)(X/P^\wedge) \\ &= P^*X + tP^*(\varepsilon_{XP^\wedge}/P^\wedge)P^*X \\ &= [1 + tP^*(\varepsilon_{XP^\wedge}/P^\wedge)]P^*X, \end{aligned} \tag{8)'$$

where $\varepsilon_{XP^\wedge}$ is the uncompensated elasticity of demand with respect to the price, $P^\wedge$.

In the presence of evasion, the market equilibrium price differs from the price that would obtain in the absence of evasion. In addition, as the tariff rate increases, the consumer price with evasion increases by a smaller amount. These can easily be shown as follows. Let

$$t^e \equiv [(1-\alpha) + \beta(1+\theta)\alpha]t \tag{9}$$

[11] I am describing a situation in which the government is certain, *ex ante*, that no evasion will be attempted at all, so that no enforcement expenditures are needed.

denote the firm's expected tariff payment per dollar of imports. The first term in equation (9), $(1-\alpha)t$, shows payment on declared imports, regardless of whether caught. The second term, $\beta(1+\theta)\alpha t$, represents penalty payment on undeclared imports, which is only incurred if caught. The market equilibrium occurs at

$$P = P^{*} + cP^{*} + t^{e}P^{*} = \{1 + c + t^{e}\}P^{*}, \tag{10}$$

where both c and t^e are evaluated at the firm's optimal value of α.[12] At this price, the firm's expected profits are equal to zero. At any other price, the firm would import either $X = 0$ or $X = \infty$, and no other price is consistent with the conditions of equilibrium.

From (1), it is clear that $c + t^e < t$. Otherwise, the firm would be better off declaring honestly. This condition has two important implications. First, t is greater than t^e, such that $[(1-\alpha) + \beta(1+\theta)\alpha] < 1$. This is intuitively obvious in that if $t \leq t^e$, then, there is no incentive at all to evade tariff by incurring concealing costs. Second, the consumer price without evasion is greater than in its presence, such that $P = \{1 + c + t^e\}P^{*} < (1 + t)P^{*} = P^{\wedge}$.

Differentiating (10) with respect to t, θ, and d, and using equation (2)', we get,

$$\begin{aligned}\partial P/\partial t &= c_{\alpha}(\partial\alpha/\partial t)P^{*} + \{[(1-\alpha)+\beta(1+\theta)\alpha] + [-1+\beta_{1}(1+\theta)\alpha+\beta(1+\theta)]\,(\partial\alpha/\partial t)t\}P^{*}\\ &= c_{\alpha}(\partial\alpha/\partial t)P^{*} + \{[(1-\alpha)+\beta(1+\theta)\alpha] - c_{\alpha}(\partial\alpha/\partial t)\}P^{*}\\ &= [(1-\alpha) + \beta(1+\theta)\alpha]\,P^{*}\end{aligned} \tag{11}$$

[12] In the absence of tariff evasion, the market equilibrium occurs at the tariff-inclusive world price, $P^{\wedge} = (1 + t)P^{*}$.

$$\partial P/\partial\theta = c_\alpha(\partial\alpha/\partial\theta)P^* + [\beta\alpha t - c_\alpha(\partial\alpha/\partial\theta)]P^*$$

$$= \beta\alpha t P^* \qquad (12)$$

$$\partial P/\partial d = c_\alpha(\partial\alpha/\partial d)P^* + [\beta_d(1+\theta)\alpha t - c_\alpha(\partial\alpha/\partial d)]P^*$$

$$= \beta_d(1+\theta)\alpha t P^*. \qquad (13)$$

From (11), we can see that $\partial P/\partial t = [(1-\alpha) + \beta(1+\theta)\alpha]P^*$ is less than $\partial \hat{P}/\partial t = P^*$, since $[(1-\alpha) + \beta(1+\theta)\alpha]$ is less than one. Comparing $\partial P/\partial t$ and $\partial P/\partial\theta$, the latter is smaller than the former. From (11) and (12), it is clear that $\beta\alpha t$ is less than $[(1-\alpha) + \beta(1+\theta)\alpha]$, so that $[(1-\alpha) + \beta(1+\theta)\alpha] - \beta\alpha t = (1-\alpha) + \beta\alpha(1+\theta-t)$ is positive. However, without specifying parameter values, we cannot determine whether $\partial P/\partial d$ is greater or smaller than the others. So far, we see that $\partial \hat{P}/\partial t > \partial P/\partial t > \partial P/\partial\theta > 0$ and $\partial P/\partial d > 0$. These results have very important implications for comparisons of the changes in consumer welfare from each of the policy variables as well as of the changes in the marginal tariff revenue.

2. Marginal Tariff Revenues in the Presence of Evasion

In the presence of tariff evasion, total tariff revenue net of enforcement expenditures, TR, is given by

$$TR = t^e P^* X - dP^* X$$

$$= \{[(1\text{-}\alpha) + \beta(1+\theta)\alpha]t - d\}P^* X. \quad (14)$$

Comparing (7) and (14), total tariff revenues in the presence of evasion are less than those in its absence. This is what we expect from the condition, $t > t^e$. Differentiating (14) with respect to t, θ, and d, and using derivatives of the equilibrium price (equations (11), (12), and (13)), we can derive formulas for the marginal tariff revenue from each of the policy variables.

First, the MTR from an increase in the tariff rate is given by

$$MTR_t = \{[(1\text{-}\alpha) + \beta(1+\theta)\alpha] - c_\alpha(\partial\alpha/\partial t)\}P^* X + (t^e\text{-}d)P^*(\partial X/\partial P)(\partial P/\partial t)$$

$$= \{[(1\text{-}\alpha) + \beta(1+\theta)\alpha] - c_\alpha(\partial\alpha/\partial t)\}P^* X + (t^e\text{-}d)P^*(\partial X/\partial P)(P/X)[(1\text{-}\alpha) + \beta(1+\theta)\alpha]$$
$$\times P^*(X/P)$$

$$= \{[(1\text{-}\alpha) + \beta(1+\theta)\alpha] - c_\alpha(\partial\alpha/\partial t)\}P^* X + (t^e\text{-}d)P^*(\varepsilon_{XP}/P)[(1\text{-}\alpha) + \beta(1+\theta)\alpha]\, P^* X$$

$$= \{1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - c_\alpha(\partial\alpha/\partial t)/[(1\text{-}\alpha) + \beta(1+\theta)\alpha]\}[(1\text{-}\alpha) + \beta(1+\theta)\alpha]P^* X, \quad (15)$$

where ε_{XP} is the uncompensated elasticity of demand with respect to the price with evasion, P. Comparing (8)′ and (15), we see that, whereas total tariff revenues are unambiguously lower if there is evasion, it is ambiguous whether the same is true for marginal revenues: MTR_t^* may be greater than or less than MTR_t. If $\varepsilon_{XP^\wedge} = \varepsilon_{XP} \geq 0$, then the marginal tariff revenues without evasion, MTR_t^*, are unambiguously greater than those with evasion. However, in case of $\varepsilon_{XP^\wedge} \neq \varepsilon_{XP} < 0$, we cannot get clear-cut results. That is, it is possible that $MTR_t^* < MTR_t$. This ambiguity may be explained if we account for two opposite effects of raising the tariff rate on the MTR_t in the presence of evasion. An increase in the tariff rate will increase the firm's expected tariff payment per dollar of imports, t^e, by a smaller amount. This effect works toward a lower MTR_t. However, the amount of imports will decrease by a smaller amount, since the market price with evasion will increase by less than 1. Thus, this effect works toward a higher MTR_t. The net effect depends on the relative strength of these two effects.

Second, the MTR from an increase in the penalty rate can be shown as

$$\begin{aligned}
MTR_\theta &= [-c_\alpha(\partial\alpha/\partial\theta) + \beta\alpha t]P^*X + (t^e\text{-}d)P^*(\partial X/\partial P)(\partial P/\partial\theta) \\
&= [-c_\alpha(\partial\alpha/\partial\theta) + \beta\alpha t]P^*X + (t^e\text{-}d)P^*(\partial X/\partial P)(P/X)(X/P)[\beta\alpha t P^*] \\
&= \{-c_\alpha(\partial\alpha/\partial\theta) + \beta\alpha t + (t^e\text{-}d)P^*(\varepsilon_{XP}/P)[\beta\alpha t]\}P^*X \\
&= \{1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - c_\alpha(\partial\alpha/\partial\theta)/[\beta\alpha t]\}\ [\beta\alpha t]P^*X\,. \qquad (16)
\end{aligned}$$

We cannot explicitly compare the MTR_θ with the MTR_t^* or the MTR_t, even in the case when $\varepsilon_{XP^\wedge} = \varepsilon_{XP} = 0$, without specifying the magnitudes of $[\beta\alpha t]$ and $[(1\text{-}\alpha) + \beta(1+\theta)\alpha]$. For example, when $\varepsilon_{XP^\wedge} = \varepsilon_{XP} = 0$, the value of $\{\cdot\}$ in MTR_θ is unambiguously greater than those in MTR_t^* and MTR_t. However, since $[\beta\alpha t]$ is less than 1 and $[(1\text{-}\alpha) + \beta(1+\theta)\alpha]$, we cannot determine whether MTR_θ is greater than MTR_t^* or MTR_t.

Third, the MTR_d is given as

$$MTR_d = [-c_\alpha(\partial\alpha/\partial d) + \beta_d(1+\theta)\alpha t\text{-}1]P^*X + (t^e\text{-}d)P^*(\partial X/\partial P)(\partial P/\partial d)$$

$$= [-c_\alpha(\partial\alpha/\partial d) + \beta_d(1+\theta)\alpha t\text{-}1]P^*X + (t^e\text{-}d)P^*(\partial X/\partial P)(P/X)(X/P)\beta_d(1+\theta)\alpha t P^*$$

$$= [-c_\alpha(\partial\alpha/\partial d) + \beta_d(1+\theta)\alpha t + (t^e\text{-}d)P^*(\varepsilon_{XP}/P)\beta_d(1+\theta)\alpha t - 1]P^*X.$$

$$= \{[1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - [c_\alpha(\partial\alpha/\partial d)+1] / [\beta_d(1+\theta)\alpha t]\}[\beta_d(1+\theta)\alpha t]P^*X. \qquad (17)$$

For reasons similar to those given for MTR_θ, we cannot explicitly compare MTR_d with MTR_t^*, MTR_t, or MTR_θ.

3. Consumer Welfare Losses

Consider an economy with identical individuals, whose utility depends on their consumption of imported goods, X, supply of labor, L, which is assumed to be exogenously fixed and treated as the numeraire, and public goods, G, maximizing the utility function,

$$U(X) + V(G),$$

subject to his budget constraint,

$$\boldsymbol{P}X = L,$$

where $\boldsymbol{P}$ equals P in the presence of evasion and $P^{\wedge}$ in its absence. By assuming identical consumers, we can ignore distributional issues. Since the utility function is separable between imported goods, X, and public goods, G, public goods have no effects on demands for imported goods.

Without tariff evasion, the marginal utility loss (MUL) from an increase in a tariff rate is given by

$$MUL_t^* = (\partial P^{\wedge}/\partial t)X = P^*X.\text{[13]} \tag{18}$$

[13] Mayshar (1990) shows that, in the absence of evasion, the MUL of raising unit tax on any commodity equals the consumption level of that commodity such that $MUL = X$, assuming exogenous income.

In the presence of tariff evasion, the marginal utility losses from each of the government policy tools are as follows:

$$MUL_t = (\partial P/\partial t)X$$

$$= [(1\text{-}\alpha) + \beta(1+\theta)\alpha]P^*X \quad (19)$$

$$MUL_\theta = (\partial P/\partial\theta)X$$

$$= \beta\alpha tP^*X \quad (20)$$

$$MUL_d = (\partial P/\partial d)X$$

$$= \beta_d(1+\theta)\alpha tP^*X. \quad (21)$$

Comparing (18) and (19), the marginal utility loss from an increase in a tariff rate in the presence of evasion is smaller than in its absence, since the consumer price with evasion will increase by a smaller amount. That is, $(\partial P/\partial t) = [(1\text{-}\alpha) + \beta(1+\theta)\alpha]P^*$ is less than $(\partial P^\wedge/\partial t) = P^*$. The marginal utility loss from an increase in the penalty rate is less than the loss from an increase in the tariff rate, since $(\partial P/\partial\theta)$ is smaller than $(\partial P/\partial t)$. However, it is not clear whether the marginal utility loss from an increase in the government expenditures to detect evasion is greater or smaller.

We examine different effects on consumer price, government revenue, and the consumer's utility losses from each of the government policy tools. These results are summarized in Table 2.

4. The Marginal Cost of Public Funds of Major Policy Changes

The *MCF*s can be obtained as the absolute value of the ratio of the marginal utility losses of the consumer to the additional government revenue, so that the MCF_i = MUL_i/MTR_i, where $i = t$, θ, and d. We can also get the same formula of the MCF_i from the government maximization problem. The government chooses t, θ, d, and G to maximize the indirect utility function, which is derived from the individual problem,

$$U(X(t, \theta, d)) + V(G),$$

subject to the per-capita government budget constraint,

$$(t^e - d)P^*X = P_G G/H,$$

where P_G is the price of public goods, and H is the number of identical consumers. After some algebra[14], we can derive the well-known condition of the optimal provision of public goods,

$$\Sigma MRS = MCF_i \times MRT,$$

where $\Sigma MRS = HV_G/U_X$ is the sum of the marginal rates of substitution,[15] $MCF_i = \lambda_i/\mu$ is

[14] The algebra is given in Appendix A.

[15] U_X $(=\partial U/\partial X)$ and V_G $(=\partial V/\partial G)$ denote the derivative of the individual's utility with respect to private consumption of imported goods, X and the derivative of the individual's utility with

the marginal cost of public funds associated with each policy variable,[16] and $MRT = P_G/\boldsymbol{P}$ is the marginal rate of transformation. The $MCF_i = \lambda_i/\mu$ can easily be shown to be equal to MUL_i/MTR_i, where $i = t$, θ, and d.[17]

4-1. The *MCF* of a Tariff Rate Increase in the Absence of Evasion

Without evasion, from (8)' and (18), we can derive

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\begin{aligned}
MCF_t^{*} &= [P^{*}X] \,/\, \{[1 + tP^{*}(\varepsilon_{X\hat{P}} / \hat{P})]P^{*}X\} \\
&= 1 \,/\, [1 + tP^{*}(\varepsilon_{X\hat{P}} / \hat{P})] \\
&= 1 \,/\, \{1 + [t/(1+t)]\varepsilon_{X\hat{P}}\}. \qquad (22)
\end{aligned}
$$

In this case, the MCF_t^{*} depends on the uncompensated elasticity of demand. From the above formula, it is clear that when an increase in t leads to an increase in P, the demand for X is reduced, and the *MCF* is greater than 1. In this case, the government project is less attractive than it would be if the government's revenue constraint could be met with lump-sum taxes only. It is clear from (22) that the MCF_t^{*} is greater as imported goods are more elastically demanded. Not surprisingly, this is in accord with most of the *MCF* literature. However, as indicated by Ballard and Fullerton (1992), we should not *a priori* conclude that the *MCF* is always greater than 1.[18] When the taxed good is perfectly

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respect to the level of public goods, G, respectively.

[16] λ is the social marginal cost of raising revenue, and μ is the marginal utility of income to the consumer.

[17] This is shown in Appendix A.

[18] They suggest that no general conclusion can be drawn about the marginal costs of taxation used

inelastic in demand, so that $\varepsilon_{XP^{\wedge}}=0$, then the *MCF* is equal to 1. If the quantity demanded of imported goods increases (e.g., the income effect dominates the substitution effect) with price, then the MCF_t^* can actually be less than one. We may not rule out this possibility in the presence of (import) commodity taxes. For Giffen goods, by definition, an increase in price induces an increase in quantity demanded, and *vice versa*, although the Giffen case has to be considered very unusual. For some luxury goods (domestic or imported), it may be the case that the demands for high-priced goods, such as cosmetics and fur coats, tend to increase with price because of some psychological effects, such as bandwagon effects, Veblen effects, etc.

4-2. The *MCF* of Major Policy Changes in the Presence of Evasion

In the presence of tariff evasion, the MCF_t may take on a different value from the value without evasion, since the market equilibrium price differs from the price that would obtain in the absence of evasion. In addition, each of the government policy tools affects the price by a different amount. Thus, the MCF_i may have a different value for each government policy tool.

4-2-1. The *MCF* of a Tariff Rate Increase in the Presence of Evasion

First, suppose that the government increases a tariff rate. From (15) and (19), we get,

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to finance a marginal public project. For example, for negative uncompensated labor supply elasticities, the *MCF* of a proportional income tax increase is less than one.

$$MCF_t = \{[(1\text{-}\alpha) + \beta(1+\theta)\alpha]P^*X\} \,/\, \{\{1+(t^e\text{-}d)P^*(\varepsilon_{XP}/P)\text{-}c_\alpha(\partial\alpha/\partial t)/[(1\text{-}\alpha) + \beta(1+\theta)\alpha]\} \times [(1\text{-}\alpha) + \beta(1+\theta)\alpha]P^*X\}$$

$$= 1 \,/\, \{1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - c_\alpha\alpha_t \,/\, [(1\text{-}\alpha) + \beta(1+\theta)\alpha]\}$$

$$= 1 \,/\, \{1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - \varepsilon_{c\alpha}\varepsilon_{\alpha t}(c/t) \,/\, [(1\text{-}\alpha) + \beta(1+\theta)\alpha]\}$$

$$= 1 \,/\, \{1 + [(t^e\text{-}d) \,/\, (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha t}(c/t) \,/\, [(1\text{-}\alpha) + \beta(1+\theta)\alpha]\}$$

$$= 1 \,/\, \{1 + [(t^e\text{-}d) \,/\, (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha t}(c/t^e)\}, \tag{23}$$

where $\varepsilon_{c\alpha}$ is the elasticity of concealing costs with respect to the proportion of imports undeclared, and $\varepsilon_{\alpha t}$ is the elasticity of the proportion of imports undeclared with respect to a tariff rate. The MCF_t depends not only on ε_{XP}, but also on $\varepsilon_{c\alpha}$ and $\varepsilon_{\alpha t}$. In this case, even if $\varepsilon_{XP} = 0$, the MCF_t is greater than 1, because the importer incurs direct resource costs to evade the tariff. From equation (4), as a tariff rate increases, the proportion of declared imports decreases (i.e., tariff evasion increases). It thus follows that, as tariff evasion increases, concealing costs incurred by the importer will be increased, since we assume $c_\alpha > 0$. To finance a certain amount of additional revenue in the presence of evasion, a tariff rate will be increased by a larger amount than in its absence to offset the revenue loss, which further increases the distortions of the tariff, other things being equal. The importer again incurs additional concealing costs. Thus, with evasion, we have another source of distortions, costs of concealment, which tend to increase the value of the MCF_t.

However, except for the unusual case when $\varepsilon_{XP^\wedge} = \varepsilon_{XP} \geq 0$, we cannot explicitly compare the MCF_t with the MCF_t^*. If $\varepsilon_{XP^\wedge} = \varepsilon_{XP} \geq 0$, the MCF_t with evasion is unambiguously greater than in its absence, since the second term of the denominator of equation (22), $[t/(1+t)]\varepsilon_{XP\hat{}}]$, is greater than in (23), $[(t^e\text{-}d) / (1+c+t^e)]\varepsilon_{XP}$. It should be noted that, in general, $\varepsilon_{XP\hat{}} \neq \varepsilon_{XP}$, and $\varepsilon_{XP\hat{}}$, $\varepsilon_{XP} < 0$, so that we cannot say that the MCF_t with evasion is always greater than in its absence. Even if we assume $\varepsilon_{XP\hat{}} = \varepsilon_{XP} < 0$, this result holds, since $[t/(1+t)] > [(t^e\text{-}d) / (1+c+t^e)]$. In the presence of evasion, we have a different value of the consumer price, and thus a different amount of demand. Distortionary effects on the demand for taxed goods will be different, since an increase in tariff rates has a different effect on the price and thus on the quantity demanded. These results can be explained in terms of the marginal tax revenue. With evasion, t^e is less than t, which lowers the marginal tax revenue. However, in the presence of evasion, the tax base (the quantity demanded for imported goods) decreases by a smaller amount than in its absence, other things being equal. Therefore, it is not clear whether the MCF_t with evasion is greater or smaller.

4-2-2. The *MCF* of a Penalty Rate Increase in the Presence of Evasion

Second, if the government uses penalty rates as an instrument, from (16) and (20),

$$\begin{aligned} MCF_\theta &= [\beta\alpha t P^* X] / \{1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - c_\alpha(\partial\alpha/\partial\theta)/[\beta\alpha t]]\ [\beta\alpha t]P^* X\} \\ &= 1 / \{1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - c_\alpha\alpha_\theta/[\beta\alpha t]\} \\ &= 1 / \{1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - \varepsilon_{c\alpha}\varepsilon_{\alpha\theta}(c/\theta)/[\beta\alpha t]\} \\ &= 1 / \{1 + [(t^e\text{-}d) /(1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha\theta}(c/\theta)/[\beta\alpha t]\}, \qquad (24) \end{aligned}$$

where $\varepsilon_{\alpha\theta}$ is the elasticity of the proportion of imports undeclared with respect to the penalty rate. In this case, the MCF_θ depends on ε_{XP}, $\varepsilon_{c\alpha}$, and $\varepsilon_{\alpha\theta}$. Unlike the MCF_t, the third term in the denominator of equation (24) works toward a lower *MCF*. From equation (5), we know that an increase in θ lowers tariff evasion. Then, costs of concealment decrease. We cannot explicitly compare the MCF_θ with the MCF_t^* except in the case when $\varepsilon_{XP^\wedge} = \varepsilon_{XP} = 0$, in which the MCF_θ has a lower value than the MCF_t^*. However, comparing it with the MCF_t, it is clear that the MCF_θ has a lower value, since the third term in the denominator in the MCF_θ is negative, whereas it is positive in the MCF_t. This is intuitively appealing, considering that an increase in θ lowers concealing costs through a decrease in evasion, while an increase in t increases these costs through an increase in evasion. This can be also explained in terms of the marginal tax revenue. In the case of an increase in the penalty rate, the tax base (the quantity demanded for imported goods) decreases by a smaller amount than in the case of an increase in the tariff rate, other things being equal. This is because an increase in the consumer price in response to an increase in the penalty rate is smaller than in the case of an increase in the tariff rate. We know that $\partial P/\partial\theta$ is less than $\partial P/\partial t$. This result is quite natural, in the sense that $\partial P/\partial t$ includes additional concealing costs, while $\partial P/\partial\theta$ includes the decreased amount of these costs. Therefore, the government project will be more attractive when we use the penalty rate to raise additional revenue.

4-2-3. The *MCF* of an Enforcement Expenditure Increase in the Presence of Evasion

Third, when the government enhances the probability of detection by increasing expenditures on detection, then from (17) and (21),

$$MCF_d = [\beta_d(1+\theta)\alpha t P^* X] \,/\, \{[1+(t^e\text{-}d)P^*(\varepsilon_{XP}/P) - [c_\alpha(\partial\alpha/\partial d)+1]/[\beta_d(1+\theta)\alpha t]\}$$

$$\times\, [\beta_d(1+\theta)\alpha t]P^* X$$

$$= 1 \,/\, \{1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - [c_\alpha\alpha_d+1]/[\beta_d(1+\theta)\alpha t]\}$$

$$= 1 \,/\, \{1 + (t^e\text{-}d)P^*(\varepsilon_{XP}/P) - [\varepsilon_{c\alpha}\varepsilon_{\alpha d}(c/d)+1]/[\beta_d(1+\theta)\alpha t]\}$$

$$= 1 \,/\, \{1 + [(t^e\text{-}d) \,/(1+c+t^e)]\varepsilon_{XP} - [\varepsilon_{c\alpha}\varepsilon_{\alpha d}(c/d)+1]/[\beta_d(1+\theta)\alpha t]\}, \qquad (25)$$

where $\varepsilon_{\alpha d}$ is the elasticity of the proportion of imports undeclared with respect to administrative costs. The MCF_d depends on ε_{XP}, $\varepsilon_{c\alpha}$, and $\varepsilon_{\alpha d}$. Unlike those in the MCF_t and the MCF_θ, the sign of the third term in the denominator of the MCF_d is ambiguous. Because of this ambiguous sign of the third term, it is not easy to compare the MCF_d with the others. As enforcement expenditures increase, the portion of undeclared imports will decrease. Then, an increase in tariff compliance lowers the amount of direct resource costs per unit of undeclared imports that are incurred by the importer to evade the tariff (slope of c in terms of α). These effects may work toward lowering the *MCF*. However, unlike the other government policy tools, the government must use its own direct resources on enforcement in this case. This makes enforcement spending less attractive, compared with the other policy variables that have no enforcement costs.

Because of these counteracting effects, we cannot explicitly compare MCF_d with MCF_t or MCF_θ, unless we make very specific assumptions about the effectiveness of the government efforts to detect evasion. The MCF_d can have a lower value only when the third term in the denominator is negative, which depends on the sign of $[c_\alpha\alpha_d+1]$ = $[\varepsilon_{c\alpha}\varepsilon_{\alpha d}(c/d)+1]$. The first term in the bracket, $c_\alpha\alpha_d$, shows a decrease in concealing costs from a one-dollar increase in government spending, and the second term, 1, is the additional government spending to detect evasion. We can consider three cases regarding the sign of $[c_\alpha \alpha_d + 1]$, which represents the relative effectiveness of additional government spending on tracking down customs fraud. First, the additional government spending can be so effective that the resulting decrease in concealing costs is greater than the increase in the government expenditures, such that $-c_\alpha \alpha_d > 1$. In this case, MCF_d is unambiguously smaller than MCF_t. However, it is still unclear whether MCF_d is greater or smaller than MCF_θ, without specifying the parameter values. Second, if the decrease in concealing costs is exactly equal to the increase in government expenditures, such that $-c_\alpha \alpha_d = 1$, then MCF_d is smaller than MCF_t, whereas it is greater than MCF_θ. Third, it is possible that additional expenditure to detect customs offenses may not be so effective, so that the direct resource costs incurred by the importer decrease by a smaller amount than the additional government spending, such that $-c_\alpha \alpha_d < 1$. In this case, MCF_d is greater than MCF_θ. However, it is ambiguous whether MCF_d is greater or smaller than MCF_t. Relative magnitudes of the *MCF*s that do change according to the effectiveness of enforcement are summarized in Table 3. It should be noted that the relationships among some *MCF*s, $MCF_t^* \gtrless MCF_t$, $MCF_t^* > MCF_\theta$, and $MCF_t > MCF_\theta$, do not change, regardless of the effectiveness of enforcement.

Table 1. Comparison of the Models of the *MCF* in the Presence of Evasion

		Usher (1986)	Fortin and Lacroix (1994)	Cremer and Gahvari (1999)	This Study
Model	Type of Tax	Excise tax (*ad valorem*)	Income tax	Excise Tax (unit tax)	Tariff (*ad valorem*)
	Audit (β)	—	Exogenous	Exogenous	$\beta = \beta\ (\alpha, c, d)$
	Concealing Cost (c)	$c = c\ (\alpha, d)$	—	$c = c\ (\alpha)$	$c = c\ (\alpha)$
	Enforcing Cost (d)	Exogenous	$d = d\ (\alpha, \theta)$	—	Exogenous
Formula for *MCF*	*MCF* of Tax Rate	Yes	Yes	Yes	Yes
	MCF of Penalty	No	Yes	No	Yes
	MCF of Audit Rate	No	Yes	No	Yes

Note: A measure of evasion, α, is different across models.

Table 2. Different Effects on Price, Utility, and Tariff Revenue

Factor	Relative Order
Consumer Price	$\partial P^{*}/\partial t > \partial P/\partial t > \partial P/\partial \theta > 0,\ \partial P/\partial d > 0$
Marginal Utility Loss (*MUL*)	$MUL_t^{*} > MUL_t > MUL_\theta > 0,\ MUL_d > 0$
Total Tariff Revenue (*TR*)	$TR^{*} > TR$
Marginal Tariff Revenue (*MTR*)	*Ambiguous*

Table 3. Relationships among *MCF*s

$[c_\alpha \alpha_d + 1]$	Comparison of the *MCF*
Effective Enforcement	$MCF_t^* > MCF_d$
$(-c_\alpha \alpha_d > 1)$	$MCF_t > MCF_d$, $MCF_\theta \gtrless MCF_d$
Neutral Enforcement	$MCF_t^* > MCF_d$
$(-c_\alpha \alpha_d = 1)$	$MCF_t > MCF_d > MCF_\theta$
Ineffective Enforcement	$MCF_t^* \gtrless MCF_d$
$(-c_\alpha \alpha_d < 1)$	$MCF_\theta < MCF_d$, $MCF_t \gtrless MCF_d$

CHAPTER IV

THE MARGINAL COST OF PUBLIC FUNDS ASSUMING EXOGENOUS AUDIT AND DETECTON

1. Theoretical Framework for Tariff Evasion

We modify the theoretical framework for tariff evasion in chapter II, by assuming that the probability of inspection (audit), A, and the probability of detection given the inspection, D, are exogenously determined. This modification is in accordance with our empirical analysis in chapter V, since we use lagged values for these two variables. With an explicit consideration of the detection rate given audit separately from the audit rate, we implicitly assume that customs officials may select the wrong imported goods for inspection, which are not actually involved in any of customs fraud. All the other assumptions and notations are the same as those in chapter II and III.

The importer chooses α to maximize its expected profit, given t, θ, A, and D, which are determined by the government. Thus, the firm maximizes

$$E\pi = \{(1\text{-}A)[P\text{-}P^{*}\text{-}(1\text{-}\alpha)tP^{*}\text{-}cP^{*}]$$

$$+ A[(1\text{-}D)(P\text{-}P^{*}\text{-}(1\text{-}\alpha)tP^{*}\text{-}cP^{*}) + D(P\text{-}(1+t)P^{*}\text{-}\theta\alpha tP^{*}\text{-}cP^{*})]\}X.$$

Simplifying the firm's expected profit, we get

$$E\pi = \{P - P^{*} - (1\text{-}\alpha)tP^{*} - cP^{*} - AD(1+\theta)\alpha tP^{*}\}X. \tag{26}$$

The first- and second-order conditions are as follows.

$$[t - c_\alpha - AD(1+\theta)t]P^*X = 0 \tag{27}$$

$$-c_{\alpha\alpha}P^*X < 0. \tag{28}$$

If we further assume $P^* > 0$ and $X > 0$, then equation (27) can be rewritten as follows.

$$[1 - AD(1+\theta)]t = c_\alpha. \qquad (27)'$$

Tariff evasion takes place if the derivative of the importer's expected profit with respect to α, $\partial E\pi/\partial\alpha$, is positive when evaluated at $\alpha = 0$. At $\alpha = 0$, an increase in α would increase the importer's expected profit. When evaluating $\partial E\pi/\partial\alpha = [t - c_\alpha - AD(1+\theta)t]P^*X > 0$ at $\alpha = 0$, assuming that $P^* > 0$ and $X > 0$, we derive the following condition for interior solution,

$$t - AD(1+\theta)t > 0 \text{ or } AD(1+\theta) < 1. \tag{29}$$

Now we examine the effects of a change in each of the policy variables (t, θ, A, and D) on the fraction of imports undeclared, α. From the firm's profit maximization problem, we can implicitly derive the optimal value of $\alpha = \alpha(t, \theta, A, D)$.

First, substituting the optimal choice of α into the first-order condition and differentiating it with respect to t, we obtain

$$\partial\alpha/\partial t = [1 - AD(1+\theta)] / c_{\alpha\alpha}. \tag{30}$$

It can be easily shown that $\partial\alpha/\partial t$ is positive, so that an increase in tariff rates will stimulate tariff evasion. The numerator of the right-hand side of equation (30), $[1 - AD(1+\theta)]$ is positive from equation (27)′. The denominator, $c_{\alpha\alpha}$ is positive from the second-order condition. Thus, the sign of $\partial\alpha/\partial t$ is positive. This implies that, as tariff rates increase, the proportion of imports undeclared increases, since the additional benefit, 1, from an underdeclaration outweighs an increase in the expected penalty, $AD(1+\theta)$.

Second, substituting the optimal choice of α into the first-order condition and differentiating it with respect to θ, we obtain

$$\partial\alpha/\partial\theta = -ADt / c_{\alpha\alpha}. \tag{31}$$

The sign of $\partial\alpha/\partial\theta$ can be shown to be negative, so that an increase in the penalty rate decreases the fraction of true imports undeclared. This implies that an increase in the penalty rate has a deterrent effect on tariff evasion, since the expected net profit from an additional dollar of tariff evasion, $-ADt$, is negative, other things being equal.

Third, substituting the optimal choice of α into the first-order condition and differentiating it with respect to A, we obtain

$$\partial\alpha/\partial A = -D(1+\theta)t / c_{\alpha\alpha}. \tag{32}$$

From equation (32), it is clear that the sign of $\partial\alpha/\partial A$ is negative, so that an increase in the inspection rate will decrease tariff evasion.

Fourth, substituting the optimal choice of α into the first-order condition and differentiating it with respect to D, we obtain

$$\partial\alpha/\partial D = -A(1+\theta)t \,/\, c_{\alpha\alpha}. \tag{33}$$

As with an increase in the inspection rate, it is predicted that an increase in the detection rate would decrease tariff evasion.

2. The Marginal Cost of Public Funds in the Presence of Tariff Evasion

Now the government has four policy options available in the presence of evasion. The government can raise revenues for public spending by increasing tariff rates, by increasing the probability of inspection or audit, by increasing the probability of detection given audit, or by raising penalty rates. First, we examine the additional government revenue and the consumer's utility losses from each of these government policy tools. Then, we derive the MCF_i, where $i = t, \theta, A$ and D, using the formula,

$$MCF_i = - \text{(change in consumer welfare) / (additional government revenue).}$$

2-1. Marginal Tariff Revenues

Let

$$t^e \equiv [(1-\alpha) + AD\,(1+\theta)\alpha]t \quad . \quad (34)$$

denote the firm's expected tariff payment per dollar of imports. The market equilibrium occurs at

$$P = P^* + cP^* + t^eP^* = [1 + c + t^e]P^*, \quad (35)$$

where both c and t^e are evaluated at the firm's optimal value of α.

Differentiating (35) with respect to t, θ, A, and D, and using equation (27)', we get,

$$\partial P/\partial t = c_\alpha(\partial\alpha/\partial t)P^* + \{[(1-\alpha)+AD(1+\theta)\alpha] + [-1+AD(1+\theta)]\,(\partial\alpha/\partial t)t\}P^*$$

$$= c_\alpha(\partial\alpha/\partial t)P^* + \{[(1-\alpha)+AD(1+\theta)\alpha] - c_\alpha(\partial\alpha/\partial t)\}P^*$$

$$= [(1-\alpha) + AD(1+\theta)\alpha]\, P^* \qquad (36)$$

$$\partial P/\partial\theta = c_\alpha(\partial\alpha/\partial\theta)P^* + [AD\alpha t - c_\alpha(\partial\alpha/\partial\theta)]P^*$$

$$= AD\alpha tP^* \qquad (37)$$

$$\partial P/\partial A = c_\alpha(\partial\alpha/\partial A)P^* + [D(1+\theta)\alpha t - c_\alpha(\partial\alpha/\partial A)]P^*$$

$$= D(1+\theta)\alpha tP^*. \qquad (38)$$

$$\partial P/\partial D = c_\alpha(\partial\alpha/\partial D)P^* + [A(1+\theta)\alpha t - c_\alpha(\partial\alpha/\partial D)]P^*$$

$$= A(1+\theta)\alpha tP^*. \qquad (39)$$

In the presence of tariff evasion, total tariff revenue (TR) is given by

$$TR = t^e P^* X$$

$$= [(1-\alpha) + AD(1+\theta)\alpha]tP^*X. \qquad (40)$$

Differentiating (40) with respect to t, θ, A and D, and using derivatives of the equilibrium price (equations (36), (37), (38) and (39)), we can derive formulas for the marginal tariff revenue (MTR) from each of the policy variables.

First, the MTR from an increase in the tariff rate is given by

$$MTR_t = \{[(1-\alpha) + AD(1+\theta)\alpha] - c_\alpha(\partial\alpha/\partial t)\}P^*X + t^eP^*(\partial X/\partial P)(\partial P/\partial t)$$

$$= \{[(1-\alpha) + AD\,(1+\theta)\alpha] - c_\alpha(\partial\alpha/\partial t)\}P^*X + t^eP^*(\partial X/\partial P)(P/X)[(1-\alpha) + AD(1+\theta)\alpha]$$

$$\times\, P^*(X/P)$$

$$= \{[(1-\alpha) + AD(1+\theta)\alpha] - c_\alpha(\partial\alpha/\partial t)\}P^*X + t^eP^*(\varepsilon_{XP}/P)[(1-\alpha) + AD(1+\theta)\alpha]\, P^*X$$

$$= \{1 + t^eP^*(\varepsilon_{XP}/P) - c_\alpha(\partial\alpha/\partial t)/[(1-\alpha) + AD(1+\theta)\alpha]\}[(1-\alpha) + AD(1+\theta)\alpha]P^*X. \quad (41)$$

Second, the *MTR* from an increase in the penalty rate can be shown as

$$MTR_\theta = [-c_\alpha(\partial\alpha/\partial\theta) + AD\alpha t]P^*X + t^eP^*(\partial X/\partial P)(\partial P/\partial\theta)$$

$$= [-c_\alpha(\partial\alpha/\partial\theta) + AD\alpha t]P^*X + t^eP^*(\partial X/\partial P)(P/X)(X/P)[\, AD\alpha tP^*]$$

$$= \{-c_\alpha(\partial\alpha/\partial\theta) + AD\alpha t + t^eP^*(\varepsilon_{XP}/P)[\, AD\alpha t]\}P^*X$$

$$= \{1 + t^eP^*(\varepsilon_{XP}/P) - c_\alpha(\partial\alpha/\partial\theta)/[\, AD\alpha t]\}\, [AD\alpha t]P^*X. \quad (42)$$

Third, the *MTR* from an increase in the inspection rate is given as

$$MTR_A = [-c_\alpha(\partial\alpha/\partial A) + D(1+\theta)\alpha t]P^*X + t^eP^*(\partial X/\partial P)(\partial P/\partial A)$$

$$= [-c_\alpha(\partial\alpha/\partial A) + D(1+\theta)\alpha t]P^*X + t^eP^*(\partial X/\partial P)(P/X)(X/P)D(1+\theta)\alpha tP^*$$

$$= [-c_\alpha(\partial\alpha/\partial A) + D(1+\theta)\alpha t + t^eP^*(\varepsilon_{XP}/P)D(1+\theta)\alpha t]P^*X.$$

$$= \{[1 + t^eP^*(\varepsilon_{XP}/P) - [c_\alpha(\partial\alpha/\partial A)] \,/\, [D(1+\theta)\alpha t]\}[D(1+\theta)\alpha t]P^*X. \quad (43)$$

Fourth, the *MTR* from an increase in the detection is derived as

$$MTR_D = [-c_\alpha(\partial\alpha/\partial D) + A(1+\theta)\alpha t]P^*X + t^eP^*(\partial X/\partial P)(\partial P/\partial A)$$

$$= [-c_\alpha(\partial\alpha/\partial D) + A(1+\theta)\alpha t]P^*X + t^eP^*(\partial X/\partial P)(P/X)(X/P)A(1+\theta)\alpha tP^*$$

$$= [-c_\alpha(\partial\alpha/\partial D) + A(1+\theta)\alpha t + t^eP^*(\varepsilon_{XP}/P)A(1+\theta)\alpha t]P^*X.$$

$$= \{[1 + t^eP^*(\varepsilon_{XP}/P) - [c_\alpha(\partial\alpha/\partial A)] \,/\, [A(1+\theta)\alpha t]\}[A(1+\theta)\alpha t]P^*X. \quad (44)$$

2-2. Consumer Welfare Losses

In the presence of tariff evasion, the marginal utility losses (MUL) of the representative consumer from each of the government policy tools are as follows:

$$MUL_t = (\partial P/\partial t)X$$

$$= [(1-\alpha) + AD(1+\theta)\alpha]P^*X \tag{45}$$

$$MUL_\theta = (\partial P/\partial \theta)X$$

$$= AD\alpha tP^*X \tag{46}$$

$$MUL_A = (\partial P/\partial A)X$$

$$= D(1+\theta)\alpha tP^*X. \tag{47}$$

$$MUL_D = (\partial P/\partial D)X$$

$$= A(1+\theta)\alpha tP^*X. \tag{48}$$

2-3. The Marginal Cost of Public Funds of Major Policy Changes

The MCFs can be obtained as the absolute value of the ratio of the marginal utility losses of the consumer to the additional government revenue, so that the MCF_i = MUL_i/MTR_i, where i = t, θ, A and D. In the presence of tariff evasion, each of the government policy tools affects the price by a different amount. Thus, the MCF_i may have a different value for each government policy tool.

First, suppose that the government increases a tariff rate. From (41) and (45), we get,

$$MCF_t = \{[(1\text{-}\alpha) + AD(1+\theta)\alpha]P^*X\} \;/\; \{[1+t^eP^*(\varepsilon_{XP}/P)\text{-}c_\alpha(\partial\alpha/\partial t)/[(1\text{-}\alpha) + AD(1+\theta)\alpha]]$$

$$\times\, [(1\text{-}\alpha) + AD(1+\theta)\alpha]P^*X\}$$

$$= 1 \,/\, \{1 + [t^e \,/\, (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha t}(c/t^e)\}. \qquad (49)$$

Second, if the government uses penalty rates as an instrument, from (42) and (46),

$$MCF_\theta = [AD\alpha tP^*X] \,/\, \{[1 + t^eP^*(\varepsilon_{XP}/P) - c_\alpha(\partial\alpha/\partial\theta)/[AD\alpha t]]\; [AD\alpha t]P^*X\}$$

$$= 1 \,/\, \{1 + [t^e \,/\, (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha\theta}(c/\theta)/[AD\alpha t]\}. \qquad (50)$$

Third, the MCF of the inspection rate in the presence of evasion is derived, using (43) and (47),

$$MCF_A = [D(1+\theta)\alpha tP^*X] \,/\, \{[1+t^eP^*(\varepsilon_{XP}/P) - c_\alpha(\partial\alpha/\partial A)/[D(1+\theta)\alpha t]]$$

$$\times\, [D(1+\theta)\alpha t]P^*X\}$$

$$= 1 \,/\, \{1 + [t^e \,/\, (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha A}c/[AD(1+\theta)\alpha t]\}, \qquad (51)$$

where $\varepsilon_{\alpha A}$ is the elasticity of the proportion of imports undeclared with respect to the inspection rate.

Fourth, the formula for the MCF associated with the detection rate is derived, using (44) and (48),

$$MCF_D = [A(1+\theta)\alpha tP^*X] \,/\, \{[1+t^eP^*(\varepsilon_{XP}/P) - c_\alpha(\partial\alpha/\partial D)/[A(1+\theta)\alpha t]]$$

$$\times\, [A(1+\theta)\alpha t]P^*X\}$$

$$= 1 / \{1 + [t^e / (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha D}c/[AD(1+\theta)\alpha t]\}, \tag{52}$$

where $\varepsilon_{\alpha D}$ is the elasticity of evasion with respect to the detection rate given inspection.

CHAPTER V

THE EMPIRICAL ANALYSIS OF TARIFF EVASION

1. Empirical Framework

An econometric model to explain tariff evasion behavior can be specified as

$$\begin{aligned} EVASION_i = {} & \beta_0 + \beta_1\, TARIFF_i + \beta_2\, DETECTION_i + \beta_3\, AUDIT_i + \beta_4\, RAWFUELS_i \\ & + \beta_5\, CAPGOODS_i + \beta_6\, \mathrm{LOG}(IMPORT_i) + \beta_7\, EXCHANGE_i + \beta_8\, NONPROFIT_i \\ & + \beta_9\, INDIVIDUAL_i + \beta_{10}\, FIRMAGE_i + \beta_{11}\, BRANCH_i + \beta_{12}\, OECD_i + u_i, \qquad (53) \end{aligned}$$

where:

EVASION = A measure of tariff evasion,

TARIFF = An effective tariff rate including internal taxes levied on imports,

DETECTION = The probability of detection, conditional on the occurrence of audit,

AUDIT = The probability of audit for the firm,

RAWFUELS = A dummy variable equal to 1 when the imported good belongs to Raw Materials & Fuels,

CAPGOODS = A dummy variable equal to 1 when the good belongs to Capital Goods,

LOG(*IMPORT*) = The logarithm of an amount of imports in U.S. dollars,

EXCHANGE = An exchange rate of Korean won to U.S. dollar expressed in *W* 100,

NONPROFIT = A dummy variable equal to 1 when the importer belongs to the non-profit organization group,

INDIVIDUAL = A dummy variable equal to 1 when the importer belongs to the individual group,

FIRMAGE = Years after the establishment of the firm,

BRANCH = A dummy variable equal to 1 when the importer is a branch,

OECD = A dummy variable equal to 1 when the imported good is originated from a well-developed country[19], and

u = The disturbance term.

Equation (53) describes the major determinants of tariff evasion, where i denotes each import declaration.

In specifying an empirical framework of tariff evasion, it should be noted that a substantial portion of import declarations is not involved in tariff evasion. Thus, like most empirical works on tax evasion, such as Clotfelter (1983), Feinstein (1991), and Erard (1997), I use a Tobit estimation method to account for the large portion of imports with non-evasion.[20] The Tobit model for tariff-evasion behavior can be formulated using a latent variable as follows.

$$y_i^* = \mathbf{x}_i\beta + u_i \tag{54}$$

$$y_i = \max(0, y_i^*), \tag{55}$$

where $\mathbf{x}_i$ is a vector of exogenous variables, such as tariff and enforcement variables,

[19] We measure "well-develop country" by OECD membership.
[20] Detailed explanations and econometric treatments of variables like this, called *corner solution outcomes*, are given in Wooldridge (2001, Chapter 16). Amount of life insurance coverage chosen by an individual, charitable contributions, family contributions to an individual retirement account, and firm expenditures on research and development are examples of *corner solution outcomes*.

commodity classes, firm-specific characteristics, and a country variable for each declaration i, β is a vector of coefficients, and y_i^* is a latent variable for the propensity of the importer to evade tariff payments when he or she files an import declaration i. In equation (27), u_i is assumed to be distributed $N(0, \sigma^2)$. Equation (28) implies that the observed variable (actual tariff payment or the ratio of evaded tariff to true tariff payment), y_i, equals y_i^* when $y_i^* > 0$, and $y_i = 0$ otherwise.

One problem in the econometric analysis of evasion is that our measure of tariff evasion, explained in the next section, includes not only understatements of tariff payments, but also overstatements of tariff payments. Table 4 provides statistics on underreporting and overreporting of tariff payments.

For Consumer Goods and Materials & Fuels, the frequency and the average amount of understated tariff payments far exceed the corresponding statistics for overstatements of tariffs. Thus, the overreporting of tariffs in these two categories can be neglected. However, for Capital Goods, the average amount of understated tariff payments are slightly less than the overstatements of tariffs. Thus, one may argue that some part of the underdeclarations of tariffs in Capital Goods are due to unintentional mistakes rather than attempting to evade tariffs.[21]

However, it may not be the case that unintentional mistakes are included in understatements of tariffs. Thus, there may not be a symmetric relationship between underreporting and overreporting. Furthermore, overstatements may not always be

[21] However, our estimation results for total tariff evasion behavior in a later section rarely change, even if we exclude Capital Goods in the estimation of the Tobit model for tariff evasion behavior. The significance of each variable does not change. Only the magnitudes of some coefficients change a little bit.

related to unintentional mistakes.

First, in most cases, professional customs brokers assist the importers in preparing import declaration forms, including commodity classification.[22] In addition, more than 88% of importers belong to for-profit corporations, which have some experience and skills in filing imports. Most of them may well try to maximize their profits in the legal system. Thus, there is little possibility that the importers are involved in unintentional mistakes by overreporting their true tariff payments, and that they just throw their money out of pockets by pure mistakes. In addition, most importers (especially for-profit corporations) understand the possible disadvantages they will face when caught for underreporting, even if it is just due to unintentional errors, since it is very difficult for customs officers to distinguish an intentional understatement from an unintentional one. Thus, as with overreporting, it is less likely that unintentional errors are included in the underreporting.

Second, sometimes, even for-profit corporations and customs brokers may have difficulties in understanding customs regulations or clearance procedures, because they require specific technical knowledge in trade. When they are not sure about the Customs Law or other regulations, including commodity classification, they tend to be conservative in declaring imports. That is, when there is confusion about the classification or tariff rates, they may tend to declare the item in a category for which a higher tariff rate applies, or to overstate their tariff payments. By doing so, the importers

[22] Article 137-3 of Korea Customs Act prescribes that Customs declaration for import or export can be submitted under the name of the owner of goods or customs brokers. According to KCS, about 95% of all export & import declarations are made in the name of customs brokers. It is more likely that almost all import declarations are submitted under the name of customs brokers. This is because imports are typically involved in tariff payments and, thus, professional knowledge of commodity classifications and import regulations is required.

and customs brokers can avoid unnecessary conflict with the customs service (e.g., being named in the black list) or sanctions.[23] In addition, these mistakes of overstatements can be corrected without any difficulty, when they (or customs officials) finally figure out the true Harmonized Commodity Description and Coding System (HS) code or tariff rates, which are favorable to them. In most cases, these corrections are made by the customs before the settlement of the import declaration (or right after the declaration), when the importers raise questions to verify the appropriateness of the commodity code or tariff rates. Thus, when they are not sure about the commodity classification or tariff payments, they may take the safe way, since there is nothing to lose.

Therefore, it is less likely that unintentional mistakes are included in the understatements of tariffs. In addition, we may not rule out the possibility of intentional overstatements. For these reasons, the measured level of tariff evasion (y_i) is set equal to zero for import declarations that overstate tariff payments.[24]

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[23] When the importers are found to be involved in customs fraud, customs brokers who assist the importers also face various kinds of disadvantages, such as being required to get additional education, and an increased rate of audit for the imports assisted by that broker. This is often the case, even if the brokers do not know of the fraud of their customers when they assist the importers. In particular, an increase in the audit rate for import declarations that are assisted by specific brokers is considered to be a serious problem for those brokers. When the importers realize this situation, no one will get assistance from those brokers, and, as a result, brokers may not continue to do business.

[24] In most of the literature on tax evasion, for example, Clotfelter (1983) and Feinstein (1991), the measure of tax evasion is set to zero for income-tax returns that overstate tax payments, to maintain the Tobit structure.

2. Data Description

In the empirical analysis, I use the most detailed and reliable data sources for customs fraud, including tariff evasion, from the Korea Customs Service, which is described as follows.

First, I get the total number of 13,695 forms of the import declarations randomly selected for investigation at the time of import in 1998. Each observation is a particular transaction of import, which includes

(i) Firm code including the 'type of firm' and 'year of establishment',

(ii) Date of import,

(iii) Amount of import in Korean won and U.S. dollars,

(iv) Declared commodity code (HS) and corresponding pure tariff rate,

(v) Corrected commodity code (HS) and its tariff rate after investigation,

(vi) Country code for origin,

(vii) Type of actions taken by the KCS when detecting violations of the Customs Law, and

(viii) Final tariff payment (including internal taxes).

Second, I use the data for 4,881 firms on the import and audit records in 1997, of those who have been randomly selected for inspection in 1998. This firm data will be used to calculate the audit rate in the preceding year and the perceived penalty rate for each firm. The data include,

(i) Number of import declarations by the importer,

(ii) Number of inspections on the importer, and

(iii) Number of detections for the importer after inspections.

I now describe how the variables in (26) are measured.

Dependent Variable: *EVASION*

For a measure of evasion, I use the ratio of the undeclared tariff (the difference between the true tariff and the declared tariff) to the true amount of tariff. These declared and true amounts of tariff incorporate not the only pure tariff, but also all relevant internal taxes levied on imports at the time of import, such as VAT, special excise tax, liquor tax, education tax, etc. We should not rule out the possibility that some importers may have an incentive to evade internal tax payments, even if they declare pure tariff payments honestly. For some importers, internal taxes on imports are heavier than the pure tariff.[25] In addition, evasion of pure tariff payment affects the amount of internal taxes on imports as well, since internal taxes (e.g., VAT) are imposed on the sum of the imports (CIF valuation) and pure tariff payments.[26] Thus, it is more appropriate to include all evaded internal taxes in a measure of evasion, as well as pure tariff.

However, data for tariff and internal taxes are available only for the final payment. Thus, I use an indirect way to measure evasion using an effective tariff rate. I calculate an effective tariff rate for each imported good, by dividing the final tariff payment

[25] The rate of VAT is uniformly set to 10%. In addition to VAT, some goods are subject to special excise tax, which varies from 7 ~ 30%. For example, a special excise tax of 30% shall be levied on the jewelry (on the sum of the customs value and the related duty). VAT is not included in the tax base for special excise tax.

[26] Suppose Integrated Circuit (IC) is subject to a pure tariff at a rate of 8% and VAT at a rate of 10%. The firm imports IC with CIF valuation of $100,000. Then, pure tariff and VAT payment are $8,000 and $10,800 respectively. If the firm declares IC as another item with a tariff rate of 4%, the pure tariff payment can be reduced to $4,000. In addition, the amount of VAT also decreases to $10,400. Thus, the total tax and tariff payment is reduced from $18,800 to $14,400.

including internal taxes by the amount of imports. In the case of false declaration of items, so that a lower tariff rate would apply, the difference between the true and the declared effective tariff rate, divided by the true effective tariff rate, can be a good measure of evasion. However, this measure cannot capture other types of legally disguised smuggling, such as the importation of undeclared items, undervaluation, underdeclaration of a quantity or weight, etc.[27] For the importation of undeclared items, I set the evasion rate to 100 %, since all tariff and tax payments on these items are totally evaded. This is considered to be the most serious violation of Customs Law. For the other types of evasion, I can calculate an evasion ratio or propensity to evade only when the actual amount of the undervaluation or the underdeclaration are identified from the descriptions of actions taken by the KCS after detecting customs fraud.[28]

Tariff Variable: *TARIFF*

The calculation of the effective tariff rates is mentioned in the description of the dependent variable, *EVASION*. Except for some elastic tariffs (special customs duties), there is little room for each government to adjust a pure tariff rate to raise revenue or to protect the domestic industry.

(Pure) Tariffs in effect in Korea are as follows: (1) Statutory Tariff, (2) Conventional

[27] One typical example of the importation of the undeclared items is hiding smuggling goods in the declared items to disguise their illegal activities. Some importers attempt to evade tariff by not declaring the cost of transportation and/or insurance or by underreporting its unit price or quantity (weight).

[28] Only three observations can be identified by this method. Thus, our estimation of tariff evasion is focused mainly on evasion of tariff payments by declaring false description or HS code of imported goods.

Tariff, and (3) Elastic Tariff. Statutory Tariff includes the Basic Tariff and the Temporary Tariff, which are both regulated by national legislation. Conventional Tariff includes World Trade Organization (WTO) Conventional Tariff and Preferential Tariff for developing member countries. Elastic Tariffs can be used to regulate foreign trade or to stabilize the domestic market. For example, when there is deemed to be an urgent need to regulate foreign trade for protection of domestic industry, anti-dumping duty, retaliatory duty, emergency duty, countervailing duty, and beneficial duty are levied on some designated import goods by Presidential Decree. These Elastic Tariffs have the first priority in applying tariff rates. However, these adjustments of basic duty rates can only be allowed in very limited and special situations under the guidance of WTO.[29]

In most cases, pure tariff rates for imported goods are determined by multilateral or bilateral trade agreements rather than determined solely by the government alone. Statutory Tariff regulated by the national legislation is dominated by Conventional Tariff in priority of tariff application. Table 5 provides data on the amounts and percentage of total tax and tariff revenue collected from Statutory, Conventional, and Elastic Tariff in the year 1998.

Thus, the effective tariff rate including internal taxes may be the more relevant independent variable in estimating tariff evasion behavior, which is a plausible government instrument in raising additional revenues. An effective tariff rate is

[29] For example, Article 12 I of Korea Customs Act prescribes initial conditions for imposing Emergency Duty as follows. 'If it is confirmed through an investigation, that increased imports of any specified product cause or threaten to cause serious injury to the domestic industry that produces like or directly competitive products, and if it is deemed necessary to protect such domestic industry, the customs duties may be imposed additionally in the limit necessary to prevent or remedy such serious injury and to facilitate adjustment'. The following sections (II ~ VIII) prescribe complicated conditions and procedures for Emergency Duty.

calculated as follows. Suppose that an imported car is subject to pure tariff at a rate, 8%, and VAT at a rate, 10%. Then, an effective tariff rate, [pure tariff rate + VAT rate (1 + pure tariff rate)], for the car is 18.8%.

Enforcement Variables: *AUDIT* and *DETECTION*

Probability of Audit (*AUDIT*): I use the ratio of the number of import declarations by the importer selected for inspection to the total number of declarations by the importer in 1997 as the probability of audit. That is, (number of inspections /number of declarations) for each importer is used. The number of inspections includes import declarations selected by customs officers according to certain criteria, as well as those randomly selected. It should be noted that not only actual inspection of goods, but also reviews of declared documents by customs officers, such as import-declaration forms, invoices, and relevant certificates, are included in the number of inspections. However, due to the data availability, we neither account for post-audits of imports by the Audit Bureau nor comprehensive investigations by the Investigation and Surveillance Bureau. Here, we mainly focus on the results from review of import-documents and inspection of goods by the Clearance Facilitation Bureau, which are done at the time of import.

Probability of Detection (*DETECTION*): I use the actual detection rate given audit in 1997 for each importer. Thus, the detection rate is calculated by dividing the number of detections by the number of inspections. The number of detections includes all kinds of customs fraud, including actual tariff evasion detected after investigation. In addition, the number of inspections includes not only import declarations by the importer randomly selected for inspection, but also those selected by customs officials in local customhouses and by the pre-specified criteria determined by the KCS headquarters.

Penalty Rate (*PENALTY*): Another important policy tool to enforce compliance is a penalty rate change. Although the penalty rate for evasion of customs duty varies case by case, in our data set, all cases except for one are subject to a penalty of 10% of the duties evaded.[30] Thus, we cannot directly estimate the effects of the penalty rate on tariff evasion, since there are no variations in the penalty rates faced by the importers. It is fixed to 10% of the evaded tariffs and taxes by legislation. Accordingly, the penalty rate is excluded from the explanatory variables in the empirical estimation.

Firm-Specific Variables: *IMPORT*, *NONPROFIT*, *INDIVIDUAL*, *FIRMAGE*, and *BRANCH*

Amount of Imports (*IMPORT*): I consider the amount of imports valued at transaction value (unit price × quantity or weight) plus the cost of transportation and insurance to the frontier of Korea (CIF valuation) in U.S. dollars.[31]

Type of the Importers (*NONPROFIT*, *INDIVIDUAL*): The Korea Customs Service classifies importers into six types according to their nature: (1) for-profit corporations, (2)

[30] Article 180 I (i) of Korea Customs Act prescribes that any person who files a false or no report on the customs value or the rate of customs duties with the intention of affecting the determination of taxes shall be punished by imprisonment not exceeding three years, or by a fine equivalent to the amount not exceeding the larger amount of money between five times the duties evaded and the cost of the goods. However, due to the difficulty and related costs in proving intentional evasion in court, most firms detected at the time of import are subject to a penalty of 10% of undeclared tariffs.

[31] In most countries including Korea, imports are valued at transaction value plus the cost of transportation and insurance to the frontier of the importing country or territory.

non-profit corporations, (3) government agencies including public enterprises, (4) foreign corporations, (5) self-employed individuals, and (6) individuals with exemption from internal taxes. I recategorize these 6 types into 3 broad groups: (1) for-profit and foreign corporations, (2) non-profit organizations, and (3) individuals. This is because some of types drop when I estimate the equation for tariff evasion (customs fraud) by commodity categories.[32] I include 2 dummies for each group of the firms, making the for-profit corporations as the basis.

Years After Establishment of The Firm (*FIRMAGE*): We can examine the effect of years after the establishment by including the variable, (1999 – year of establishment).

Branch (*BRANCH*): Some firms have branch offices other than their headquarters. From the importer-code, we can differentiate the headquarters from its branch, for each importer who has at least one branch. Except for the 1 digit in the code, the branch has the same firm code as its headquarters. I include a dummy variable for the branch to examine the difference in tariff evasion behavior between the headquarters and its branches.

Country Variable: *OECD*

I divide countries into two categories, developed countries and developing countries, using OECD countries as criteria for developed countries. However, among the 29 OECD countries, I exclude 5 countries that recently joined the OECD: Mexico, the Czech

[32] Some types of firms drop because they perfectly predict tariff evasion or perfectly do not predict evasion.

Republic, Hungary, Poland, and Korea. In general, these countries are not considered as developed countries. The dummy variable is equal to one when the imported good is originated or produced in one of the OECD countries excluding those 5 countries, and zero when the good originates in one of the non-OECD countries including those 5 countries.[33]

It should be noted that the country of origin is a different concept from the country of the last shipment. Suppose that the U.S. exports products originated in the U.S. to Hong Kong, and Hong Kong re-exports these goods to Korea. In this case, the KCS regards the U.S. as the country of origin and Hong Kong as the country of the last shipment. This is the often the case for *via third country trade*.

Commodity Classification

Commodity Category (*CONGOODS*, *RAWFUELS*, and *CAPGOODS*): As recommended by the World Customs Organization (WCO), the KCS classifies imported goods on the basis of the Harmonized Commodity Description and Coding System (HS), which consists of 97 2-digit, 1,241 4-digit, 5,113 6-digit, and 11,096 10-digit codes. However, HS codes are designed mainly to make imposition of tariff easy, so that it may not be easy to understand the item descriptions of HS codes, which are too detailed.

[33] The OECD countries that are considered as developed countries in this paper include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States. The original 20 member-countries that established the OECD in the year 1961 are located in Western countries of Europe and North America. After the year 1961, Japan (1964), Finland (1969), Australia (1971), and New Zealand (1973) joined the OECD.

Thus, it may not be useful to use HS codes directly to classify goods for our analysis, even at the 2-digit level.

Instead, I use Import End-Use codes from the KCS, which are designed for the publication of trade statistics. I match Korea HS codes to these Import End-Use codes on the basis of HS 10-digit codes.[34] Imported goods are classified into the categories and classes given in Table 6.

Other Variables

Foreign Exchange Rate (*EXCHANGE*): Article 9-13 of Korea Customs Act prescribes that, in order to determine the customs value in Korean currency of the value expressed in foreign currency, the Administrator shall determine the exchange rate on the average of the selling rate of foreign exchange applied during the immediately preceding calendar week. Thus, various foreign exchange rates are applied to each of the imported goods, such as exchange rates of Korean won to Japanese yen. I unify these foreign exchange rates into that of Korean won to U.S. dollar, which is calculated by dividing imports valued in Korean won by imports in U.S. dollars.

Table 7 provides short descriptions of the variables. In the estimation of tariff-evasion behavior and customs fraud in later sections, a dummy variable for Consumer Goods (*CONGOODS*) and a dummy variable for for-profit corporations (*FORPROFIT*) are excluded as the basis.

[34] HS 6-digit codes are unified over all the countries, under the guidance of the WCO. For the remaining digits, each country makes and uses its own codes for specific purposes.

From summary statistics given in Table 8, an average fraction of undeclared tariffs is 0.28%. More than 10% of import declarations are involved in various kinds of customs fraud, including tariff evasion. In terms of the number of import declarations, the shares of Consumer Goods, Crude Materials & Fuels, and Capital Goods are 16.8%, 35.0%, and 48.1%, respectively. For-profit corporations are responsible for 88.6% of the total number of imports. More than 72% of the total number of imports are originated or produced in developed countries.

The mean value of each variable by commodity category is presented in Table 9. These values are quite different across commodities, especially between the mean values for Consumer Goods and those for the other two categories. On average, it is more likely that Consumer Goods are involved in evasion and customs fraud than the other two categories. The average audit rate on Consumer Goods is more than 20%, while those on Materials & Fuels and Capital Goods are around 10%. Thus, despite a relatively higher audit rate in the previous year, the evasion ratio and the fraction of customs fraud are higher in the case of Consumer Goods, on average.

Self-employed individuals import 19.44% of Consumer Goods, while they import less than 10% of the other goods. On average, the years of establishment of importers that import Consumer Goods are relatively short, about 13 years, while those that import Materials & Fuels and Capital Goods are about 18 and 19 years, respectively.

3. Empirical Results

3-1. Total Estimation

3-1-1. Estimation Results

I estimate the Tobit model for tariff-evasion behavior of importers for all observations. The estimation results for the Tobit model are presented in Table 10. For comparison, OLS and Probit estimates are reported along with Tobit. However, the magnitudes of the coefficients are not directly comparable across models. Thus, I compute adjustment factors for unconditional expectation, by evaluating the standard normal cumulative distribution function (*cdf*) at the mean values of the x_j, $\Phi(x\hat{\beta}/\hat{\sigma})$, which is about 0.0065. By multiplying the Tobit coefficients by the estimated scale factor, 0.0065, they are made roughly comparable to the OLS estimates. That is, the partial effect of x_j on $E(y \mid x)$ is obtained from $\partial E(y \mid x)/\partial x_j = \beta_j \Phi(x\hat{\beta}/\hat{\sigma}) = 0.0065\beta_j$.[35] For the Probit estimates, I also derive the partial effects of the variables x_j's on the response probabilities using the sample averages of the x_j's, which are comparable to the OLS estimates. The scaled coefficients for Probit and Tobit are also reported in Table 10.

There are big differences in the magnitudes and statistical significance of the coefficients across models, while they show the same signs of coefficients. We compare and discuss the estimation results in detail in the following sub-sections.

[35] Wooldridge (2001, Chapter 16) points out that, in corner-solution applications, interest centers on $E(y \mid x, y>0)$ and $E(y \mid x)$, while, in data censoring applications, interest lies in $E(y^* \mid x)$. Thus, I mainly focus on the partial effects on $E(y \mid x)$ rather than $E(y^* \mid x)$.

It should be noted that each firm can be viewed as a cluster, since firms make more than one import declaration. The observations within a cluster are likely to be correlated, due to unobserved cluster effects. Thus, I correct the standard errors of the above estimates, specifying that the observations are independent across firms (clusters), but not necessarily independent within firms (clusters). However, even if we assume that all observations are independent with each other, so that there is no clustering effect, it does not make much difference to the standard errors, and the significance levels of the coefficients do not change. This may be because we have so many clusters (5713 firms out of 13695 observations) in our data. Thus, although the number of observations within a cluster usually differs across clusters, varying from 1 to 472, the average number of import declarations per firm is only 2.40. The estimation results without considering the cluster effect are reported in table 11 for comparison.

3-1-2. Specification Tests

An informal diagnostic to test the appropriateness of the Tobit model, especially for corner-solution applications, is to compare the Probit estimates (β) to the Tobit estimates (β/σ).[36] As shown in Table 10, the estimates from the Tobit and the Probit are the same in their signs, and, except for *BRANCH*, the same variables are statistically significant in both models.[37] Furthermore, the magnitudes of the Tobit estimates are almost the same as those of the Probit estimates. Thus, we can roughly verify the appropriateness of the

[36] $\hat{\sigma}$ in the Tobit model is 0.9801.
[37] The t-statistic and p-value for the coefficient of *BRANCH* in the Probit model is –1.608 and 0.108 respectively.

Tobit model, since there are no statistically significant sign changes between the two models. However, there are some differences between the OLS estimates and the Tobit and Probit estimates in the statistical significance of the corresponding variables. One of the major differences is that the coefficient of *TARIFF* is insignificant in OLS, while it is statistically significant in the Tobit and the Probit model. In addition, the coefficient of log(*IMPORT*) is significant in OLS, while it is not statistically different from zero in the Tobit and the Probit model.

The Tobit model relies crucially on assumptions of normality and homoskedasticity in the latent variable model. In the presence of heteroskedasticity or nonnormality, the Tobit estimator $\hat{\beta}$ is inconsistent for β. Furthermore, in corner-solution applications, heteroskedasticity or nonnormality will entirely change the functional forms for $E(y \mid x)$ and $E(y \mid x, y>0)$.

First, the Lagrange multiplier (LM) statistic is used to test the null hypothesis of homoskedasticity, assuming $\mathrm{Var}(u \mid x) = \sigma^2 \exp(z\delta)$, where z is a $1 \times Q$ subsector of x. The LM test can be carried out without estimating the unrestricted model. As shown in Table 12, the hypothesis of homoskedasticity is rejected, based on the LM statistic. However, based on the LR test, we cannot reject the hypothesis. The log-likelihood from the restricted model (a standard Tobit model) is –608.725, while that from the unrestricted model (a Tobit model with heteroskedasticity) is –601.570. Then, the LR statistic is 2[-601.570 - (-608.725)] = 14.310, which is less than the critical value.

As shown in Table 12, the test results from the LM and LR statistics for homoskedasticity in our Tobit model are contradictory.[38] This result may not be surprising. Numerous Monte Carlo experiments suggest that the outer product of the score LM statistic has severe size distortions.[39] Typically, the null hypothesis is rejected much more often than the nominal size of the test. That is, these LM tests often have a size far in excess of their nominal asymptotic size. Thus, we can reasonably argue that the homoskedasticity assumption is satisfied based on the LR test. Nevertheless, the estimation results of the Heteroskedatic Tobit model are shown in Table 13 for reference.[40]

Second, the conditional moment-based test (Pagan and Vella, 1989) is used to evaluate the nonnormality in the latent-variable model. The test result is presented in Table 12. Based on the LM statistic, which is chi-squared with 2 degrees of freedom, the null hypothesis of normality cannot be rejected.

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[38] The LM and LR statistics are both calculated with respect to the full set of regressors except a constant. They are asymptotically distributed as chi-squared with 12 degrees of freedom.

[39] Wooldridge (2001) and Davidson and Mackinnon (1993) provide several references for this problem. Davidson and Mackinnon (p.477, 1993) suggest that, in most cases, it is safe to conclude that a restriction is compatible with the data if a test statistic computed using the outer product of the gradient estimator fails to reject the null hypothesis. However, they also indicate that it is generally not safe to conclude that a restriction is incompatible with the data if this statistic rejects the null.

[40] It should be noted that the standard errors for Heteroskedastic Tobit estimates are not adjusted to account for cluster effect. However, it does make any problem, since the maginitudes of the coefficients are the same with and without cluster effect.

3-1-3. Implications

Tariff and Enforcement Variables

First, the tariff and enforcement variables, *TARIFF* and *AUDIT*, are found to be significantly different from zero at the 5% level, while *DETECTION* is insignificant.

As the tariff rate increases by 1% point, tariff evasion increases by 0.00002. In other words, a one-percentage-point increase in the tariff rate increases the fraction of the undeclared tariff payment by 0.002% point. This is a relatively small amount, since the average of the dependent variable, *EVASION*, is 0.00279. In other words, the average value of the fraction of the undeclared tariff payment is 0.279%. The elasticity of the expected tariff evasion with respect to the tariff rate is 0.114 at the average value of both variables. Thus, for the importer with an average tariff rate for the sample, 18.70%, a one-percent increase in the tariff rate (to 18.89%) would result in an expected 0.114% increase in tariff evasion. In other words, if the tariff were to increase from 18.70% to 18.89%, these estimates suggest that tariff evasion would increase from 0.279% to about 0.2793%. This finding is consistent with the prediction of our theoretical framework.

Although there are no empirical works at all for the effect of a tariff rate on tariff evasion, we can get some rough idea of the elasticity through comparison with the estimates of Clotfelter (1983).[41] He finds that the elasticities of income tax evaded with

[41] There is an extensive review on the theoretical and empirical studies of income-tax evasion in Andreoni, Erard, and Feinstein (1998). Almost all major issues in tax compliance are fully described and discussed in this paper. However, they focus mainly on the individual income-tax evasion problem.

respect to the income-tax rate varies from about 0.515 to 0.844 for three classes of taxpayers (Non-Business, Non-Farm Business, and Farm), by estimating a standard Tobit model of tax evasion using data from the 1969 Taxpayer Compliance Measurement Program. Although the overall elasticity of evasion with respect to the tariff rate, 0.114, is much smaller than Clotfelter (1983), as shown in a later section, some of the elasticities for the three commodity categories (Consumer Goods, Raw Materials & Fuels, and Capital Goods), which vary from 0.102 to 1.026, are not far from his estimates. However, his estimates of elasticities for ten audit classes show greater variation, ranging from about 0.5 to over 3.0, which are much larger than our estimates for three commodity categories.

Tobit estimates for *AUDIT* show that as the probability of audit or inspection increases by 1% point, tariff evasion decreases by 0.00005. However, considering the average value of the expected tariff evasion, 0.00279, practically, an increase in the probability of inspection has only a small deterrent effect on tariff evasion. The elasticity of this variable is –0.232 at the average values, implying that, for the importer with an average probability of being inspected for the sample, 11.994%, a one-percent increase in the inspection rate would decrease tariff evasion by 0.232% in the following year. In other words, if the audit rate were to increase from 11.994% to 12.114%, these estimates suggest that tariff evasion would decrease from 0.279% to about 0.278%. This finding is also consistent with the prediction of our theoretical framework as well as the general notion that a higher probability of audit discourages evasion.

However, unlike our expectation, the probability of detection, given audit, has no significant effects on tariff evasion. The implication seems to be that being audited is costly, whereas being detected and penalized is not so costly. This is plausible, considering the fact that the penalty rate is so low, 10% of the evaded tariff payments in most cases. Thus, whether the importer has the previous experience of being detected, conditional on the occurrence of audit, does not make any difference, when they decide to undertake tariff evasion or when they choose the amount of evasion. On the contrary, importers are likely to care more about being audited, since being audited by customs is pretty costly. When imports are selected for inspection, importers have to bear all necessary expenses, such as costs of loading and unloading, costs of unpacking and repacking, etc. In addition, an inspection of goods can delay the settlement of import declaration, which may lead to delay of imports to be used as elements of production or to be sold to another firms or consumers.

Commodity Categories

Second, according to our estimates, all dummy variables for commodity categories are significantly different from zero. That is, Crude Materials & Fuels and Capital Goods are less likely to be the target of evasion, compared with Consumer Goods. This may be caused by relative differences in the degree of ease in evasion according to the nature and the characteristics of imported goods. In particular, for some agricultural products (Cereal or Direct Consumer Goods), compared with manufactured consumer goods or Capital Goods, it is relatively easier to hide the true nature of products. Thus, these items are more likely to be involved in illegal activities, such as false item declaration so that a lower tariff rate applies.

Firm-Specific Variables

Third, except for LOG(*IMPORT*) and *FIRMAGE*, all the other firm-specific variables are found to be significant.

Compared with for-profit corporations, individuals have a greater tendency to evade the tariff payment. The intuition behind this result is that corporations may care more about their reputations than individuals do. It is likely that those individuals who are involved in importing are usually risk-loving. On the contrary, firms will not take the risk of evasion, since their reputation would be greatly damaged in the case of detection by customs. Unlike our expectations, non-profit organizations are more likely to be involved in evasion than for-profit corporations.

The amount of imports valued in U.S. dollars and years after the establishment have no significant effects on evasion decision. These results suggest that there are no differences in evasion behavior between the firms that import a relatively large volume in CIF valuation and those that import a small volume, other things being the same. Thus, the amount of import, unit import-price × quantity or weight, does not influence the evasion decision. Rather, it is the objectives of import, such as Consumer Goods, Raw Materials & Fuels, and Capital Goods, that affect the level of tariff evasion. In addition, the firms with a relatively long history do not show any differences in the evasion decision from the newly established firms.

However, branches are found to have different attitudes from their headquarters in evasion behavior. They have less tendency to evade tariff or tax payments on their imports.

Country of Origin

Fourth, the country-of-origin variable is found to be significantly different from zero. This implies that goods originated or produced from the well-developed countries (OECD) have significant differences in evasion pattern, when compared with less affluent countries. We usually expect that it is relatively easier for importers to evade tariff payments for goods imported from the less-developed countries by misinvoicing (undervaluing, underweighing, false items, etc.) with the collusion of exporters. Foreign exporters of the less-developed countries would be rarely detected in their home countries because these countries usually have weak internal control, less-developed information technology system in customs procedures, etc.

However, the coefficient on the country of origin variable is positive, implying that goods from the well-developed countries are more likely to be involved in evasion, an opposite finding to our general expectation. This may be because, for some goods (e.g., complicated machines) newly designed and manufactured in the well-developed countries, it may be relatively easy to declare the good to be another item, to evade tariffs or some internal taxes. For some customs officials with little knowledge about the new product, this false declaration of items or description or goods can be often overlooked, and import declarations may be settled without detecting anything.[42]

I also estimate tariff evasion, using the G7 countries as criteria for developed

[42] The Central Customs Laboratory and four regional customs laboratories of the KCS are responsible for technical services necessary for effective customs administration, such as tariff classification. Thus, when customs officials have difficulties in deciding the commodity classifications of imports, they can ask the laboratories to provide comprehensive and technical analyses on these goods based on the International Agreement on the Harmonized Commodity Description and Coding System.

countries, which include Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. However, there is no change in the sign and significance of the country-of-origin variable (a dummy variable). The magnitude of the coefficient is almost the same. In addition, the signs and significance of the other variables do not change, and the magnitudes of the other coefficients rarely change. It is not surprising that the results for G7 are similar to the results for OECD, since G7 is a subset of OECD. When I use top three importing countries of Korea in 1998 (the United States, Japan, and China), as dummy variables, I get the same results.[43] That is, there are no changes in the signs and significance of the other variables, and the magnitudes of the other variables are almost the same.

Foreign Exchange Rate

An increase in the foreign exchange rates implies an increase in the unit import price, other things being the same. That is, equation (10) in part III can be expressed in terms of Korean won, $P^w = \{1 + c + t^e\}P^* \times \textit{exchange rate}$. Thus, it is predicted that, as the unit import price increases, importers are more likely to commit tariff evasion to reduce their increased financial burden.

The coefficient on the foreign exchange rate is significantly different from zero. A one-hundred won increase in the exchange rate of won to dollar increases tariff evasion by 0.00064. The elasticity of the expected tariff evasion with respect to the foreign

[43] The amount of imports from these three countries accounts for about half of total Korea imports in the year 1998. The share of imports from the United States, Japan, and China is 21.9%, 18.1%, and 7.0%, respectively.

exchange rate is 3.162 at the average value of both variables. Thus, for the importer with an average foreign exchange rate for the sample, *W*1,380.414 per U.S. dollar, a one-percent increase in the foreign exchange rate (to *W*1,394.218) would result in an expected 3.162% increase in tariff evasion. In other words, if the exchange rate were to increase from *W*1,380.414 to *W*1,394.218, these estimates suggest that tariff evasion would increase from 0.279% to about 0.288%.

3-2. Estimation by Commodity Categories

3-2-1. Estimation Results

I divide the imported goods into 3 categories (Consumer Goods, Raw Materials & Fuels, and Capital Goods) and estimate a Tobit model for each of the categories separately. The Tobit estimates for each of the commodity categories are given in Table 14, 15, and 16. For comparison, OLS and Probit estimates are reported along with those of the Tobit. As in the previous section, I compute adjustment factors for the unconditional expectations for each of the commodity categories, evaluating the standard normal *cdf* at the mean values of the x_j's, $\Phi(x\hat{\beta}/\hat{\sigma})$. The estimated scale factors for Consumer Goods, Raw Materials & Fuels, and Capital Goods are 0.0102, 0.0064, and 0.0047 respectively. For the Probit estimates, I also derive the partial effects of the variables x_j on the response probabilities using the sample averages of the x_j's. The scaled coefficients for Probit and Tobit are also reported in each of these tables. The standard Tobit estimates by commodity categories are rearranged in Table 17.

It should be noted that the standard errors of above estimates are also adjusted for cluster sampling, allowing that the observations are independent across firms (clusters), but not necessarily independent within firms (clusters). The average number of observations within a cluster usually differs across commodity categories, varying from 1.5 to 2.8, as shown in Table 18. However, the standard errors are very similar to those computed without accounting for the cluster effect. The estimation results without considering the cluster effect are reported in table 18 for comparison.

3-2-2. Specification Tests

The results of specification tests for homoskedasticity and normality by commodity categories are presented in Table 20.

First, both the LM and LR statistics are used to test the null hypothesis of homoskedasticity against the alternative hypothesis of multiplicative heteroskedasticity.[44] As in the previous section, the test results for heteroskedasticity are contradictory. Based on the LR test, we cannot reject the null hypothesis in any of the commodity categories. However, based on the LM test, the hypothesis can be rejected. Considering that the outer product of the score LM statistic tends to reject much more often than the nominal size of the test, we can reasonably argue that the homoskedasticity assumption is satisfied in each of the categories. The estimates of the heteroskedastic Tobit model by commodity categories are given in Table 21, 22, and 23 for comparison with those of the homoskedastic Tobit model.

Second, based on the LM statistic (Pagan and Vella, 1989), which is chi-squared with 2 degrees of freedom, the null hypothesis of normality cannot be rejected for any of the commodities.

[44] Both the LM and LR statistics are calculated with respect to the full set of regressors except a constant. They are asymptotically distributed as chi-squared with 10 degrees of freedom.

3-2-3. Implications

As indicated in Table 17, the Tobit estimates show almost consistent signs among commodity categories. However, except for the effective tariff rate, the statistical significance of the coefficients is quite different across commodity categories.

Tariff and Enforcement Variables

The coefficients for effective tariff rates are found to be significantly different from zero at the 10% level for all commodity categories. The elasticities of expected tariff evasion with respect to the effective tariff rate in Consumer Goods, Crude Materials & Fuels, and Capital Goods are 0.102, 0.852, and 1.026, respectively, at the average values of the relevant variables. Comparing these values with the overall elasticity of evasion with respect to the effective tariff rate, 0.114, imported goods falling into Crude Materials & Fuels and Capital Goods have relatively higher elasticities, while the elasticity for Consumer Goods is actually very close to the overall elasticity.

These different levels of elasticities across commodity categories can be explained in terms of the slope of evasion in terms of the tariff rate (the derivative of α with respect to t) and the ratio of the tariff rate to evasion (t/α). For the case of Consumer Goods, the slope of evasion and the ratio of the tariff rate to evasion are 0.000025 and 4109.84 (=25.07/0.0061), respectively, both of which are far smaller than those of Crude Materials & Fuels (0.000111 and 7804.35 (=17.95/0.0023), respectively) and Capital Goods (0.000117 and 8957.89 (=17.02/0.0019), respectively). This is because, for certain range of α and t, α is a concave function of t so that $\alpha_t > 0$ and $\alpha_{tt} < 0$. It thus follows that Consumer Goods has the lowest elasticity of evasion with respect to the tariff rate, $\varepsilon_{\alpha t} = (\partial\alpha/\partial t)(t/\alpha)$, and Capital Goods has the greatest elasticity of evasion. Table 24 shows the slope of evasion with respect to the tariff rate, the ratio of the tariff rate to evasion, and the elasticity of evasion with respect to the tariff rate for each of the commodity categories.

Unlike the prediction of the theoretical model in chapter IV, the Tobit estimates of *DETECTION* imply that an increase in the probability of detection would have no significant deterrent effects on evasion in any of the commodity categories, although it is of the predicted sign.

The probability of inspection is found to be statistically significant at the 5% level only in Consumer Goods. The Tobit estimate for *AUDIT* shows that, as the probability of inspection increases by a one-percentage point, tariff evasion in Consumer Goods decreases by 0.0001. The elasticity of tariff evasion with respect to the probability of audit is -0.416 at the average values. Thus, for firms which import goods classified in Consumer Goods with an average probability of being inspected for this sample, 21.307%, a one-percent increase in the inspection rate would decrease tariff evasion by 0.416% in the following year. In other words, if the audit rate were to increase from 21.307% to 21.520%, these estimates suggest that tariff evasion would decrease from 0.615% to about 0.612%.

Firm-Specific Variables

For the firm-specific variables, we find that there are big differences in the statistical significance of the independent variables across commodity categories.

The amount of import is found to have no significant effects on evasion behavior in any of the commodity categories.

The Tobit estimates show that individuals have a higher tendency to evade tariff payments than for-profit corporations in Raw Materials & Fuels. However, in Consumer Goods and Capital Goods, there are no differences in evasion behavior between individuals and for-profit corporations. In all categories, the evasion behaviors of non-profit organizations are not statistically different from those of for-profit corporations.

Only in Crude Materials & Fuels does the number of years after establishment of the firm have a significant effect on evasion behavior. The positive coefficient of this variable implies that firms with a relatively long history have a greater tendency to commit illegal activities in this category.

However, *BRANCH* is insignificant in all categories. This implies that branches have no differences in evasion behavior from their headquarters.

Country of Origin

Only for Capital Goods does the country of origin have significant effects on the evasion decision. Tobit estimates for this variable show that items classified in Capital Goods originated from or produced in one of the OECD countries are more likely to be involved in evasion. For Consumer Goods and Crude Materials & Fuels, there are no differences in evasion propensities, whether they are imported from the well-developed countries or from the less-developed countries.

Foreign Exchange Rate

In both Consumer Goods and Crude Materials & Fuels, the foreign exchange rates are significantly different from zero. Thus, as the unit import price increases, firms who import goods in these categories are more likely to commit evasion to reduce their financial burden. The elasticities of the expected tariff evasion with respect to the foreign exchange rate for Consumer Goods and Crude Materials & Fuels are 4.010 and 3.163 at the average value of both variables, respectively. Thus, for the importer with an average foreign exchange rate for the sample, a one-percent increase in the foreign exchange rate would result in an expected 4.010% increase in tariff evasion when importing Consumer Goods and an expected 3.163% increase in tariff evasion when importing Crude Materials & Fuels. However, for Capital Goods, an increase in the foreign exchange rates and, thus, an increase in the unit price, has no significant effects on evasion.

When we compare the elasticity of evasion with respect to the foreign exchange rate with the elasticity with respect to the tariff rate, the former far exceeds the latter in all commodities, as summarized in Table 25. Thus, the importers seem much more sensitive to exchange rates than to tariff rates.

This is because an increase in the foreign exchange rate would give importers additional incentives of evasion. When the exchange rate increases, not only do firms make higher tariff payments, but they also pay more for the good itself. As a result, the firm suffers more financial pressure from an increase in the exchange rate than from an increase in the tariff rate. A one-percent increase in the tariff rate raises tariff payments by a one-percent. So does the foreign exchange rate. There is no difference in the amount of changes in tariff payments between an increase in the foreign exchange rate and an increase in the tariff rate. However, when the foreign exchange rate increases, importers incur additional costs of imports, since they have to buy the same amount of foreign currency in exchange for more Korean Won.

This can be illustrated with a simple example. Suppose that the firm imports the goods of $1000 in the presence of the foreign exchange rate, ₩1,000 per U.S. dollar and the tariff rate of 10% of imports. If a tariff rate increases by 10% (from 10% to 11%), then the tariff payment would increase by ₩10,000. If a foreign exchange rate increases by 10% (from ₩1,000 to ₩1,100), the total additional burden to the firm is ₩110,000. It is the sum of the increased tariff payment, ₩10,000, and the additional cost of buying the foreign currency in the foreign exchange market, ₩100,000. Thus, it is most likely that the importer is more sensitive to an increase in the foreign exchange rate than to an increase in the tariff rate, other things being the same.

Table 4. Understatements and Overstatements of Tariff Payments by Commodity

Category	Understatements			Overstatements		
	Observation	Under-tariff	Avg. Import	Observation	Over-tariff	Avg. Import
Consumer goods	35	1,496	15,331	6	369	14,678
Materials & Fuels	39	3,037	36,303	12	316	9,839
Capital goods	39	583	22,776	26	766	26,382
Overall average	—	1,713	25,139	—	589	20,274
Total	113	193,533	2,840,670	44	25,930	892,063

Note: Observation is the number of cases of under- or over-statements. Understatements or overstatements of internal taxes levied on imported goods are included in these statistics. Under-tariff (Over-tariff) denotes the average understated (overstated) tariff payments. Avg. import denotes the average amount of imports (CIF valuation). The unit of Under- and Over-tariffs and Avg. import is one thousand Korean won.

Table 5. Tax and Tariff Revenue from Statutory, Conventional, and Elastic Tariff

	Revenue		
	Tariff (%)	VAT (%)	Total (%)
Statutory tariff	5,089 (75.5)	8,747 (67.8)	13,836 (70.4)
Conventional tariff	902 (13.4)	2,554 (19.8)	3,456 (17.6)
Elastic tariff	748 (11.1)	1,608 (12.4)	2,356 (12.0)
Total	6,739 (100)	12,909 (100)	19,648 (100)

Note: The unit of Tariff and VAT is one billion Korean won.

Table 6. Commodity Classification

Variable	*Commodity Description*	*Sub Commodity*
• Category 1	• Consumer Goods	
- Class 1	- Cereal	wheat, rice, soya bean, corn & fodder
- Class 2	- Direct Consumer Goods	tobacco, beverages, meat, fish, etc.
- Class 3	- Durable Consumer Goods	electro-machine for home use, car, etc.
- Class 4	- Non-Durable Consumer Goods	printed book & product, clothing, etc.
• Category 2	• Crude Materials & Fuels	
- Class 5	- Fuels	crude oil, coal & coke, gas, oil products
- Class 6	- Minerals	crude mineral, iron ore, etc.
- Class 7	- Light-Industrial Crude Materials	raw sugar, rubber, wood, pulp, raw cotton
- Class 8	- Oil & Fat	oil & fat of cattle, vegetable oil & fat
- Class 9	- Fibre	textile yarn & thread, woven fabrics, etc.
- Class 10	- Chemicals	(in)organic compounds, fertilizer, etc.
- Class 11	- Iron & Steel Products	pig iron, coil, lump, plates & sheets, etc.
- Class 12	- Non-Ferrous Metal	copper, aluminum, lead, zinc, tin, nickel
- Class 13	- Others	cement, glass & glassware, paper board
• Category 3	• Capital Goods	
- Class 14	- Machinery & Precision Equipment	machinery, precision equipment
- Class 15	- Electric & Electronic Machinery	generator, computer, semi-conductor, etc.
- Class 16	- Transport Equipment	railway vehicles, aircraft, ships & boats
- Class 17	- Others	

Note: Passenger cars are classified into Durable Consumer Goods. Road motor vehicles excluding passenger cars are included in Transport Equipment.

Table 7. Variable Descriptions

Variable	Description
EVASION	the ratio of undeclared amount of tariff to true tariff payment
FRAUD	1 if detected for customs fraud after investigation, 0 otherwise.
TAFIFF	an effective tariff rate which includes all internal taxes levied on imported goods at the time of import as well as a pure tariff
DETECTION	the actual detection rate for each importer in 1997, conditional on the audit
AUDIT	the ratio of the number of import declarations inspected to the total number of declarations by the importer in 1997
CONGOODS	1 if the imported good is classified as Consumer Goods (category1), 0 otherwise
RAWFUELS	1 if the imported good is classified as Crude Materials & Fuels (category2), 0 otherwise
CAPGOODS	1 if the imported good is classified as Capital Goods (category3), 0 otherwise
IMPORT	amount of imports valued in U.S. dollars
EXCHANGE	foreign exchange rate of Korean won for U.S. dollars
FORPROFIT	1 if the importer falls into either the for-profit corporation category or the foreign corporation category
NONPROFIT	1 if the importer falls into either the category of non-profit corporation or government agency including public enterprise
INDIVIDUAL	1 if the importer falls into either the category of self-employed individuals or an individual exempted from internal taxes
FIRMAGE	years after establishment of the firm, making 1999 as the base year
BRANCH	1 if the importer is a branch, 0 otherwise
OECD	1 if the country of origin of the imported good is one of the OECD countries (except for Mexico, the Czech Republic, Hungary, Poland, or Korea), 0 otherwise

Table 8. Summary Statistics

Variable	Mean	Std. Deviation	Minimum	Maximum
EVASION	0.0028	0.0413	0	1
FRAUD	0.1043	0.3057	0	1
TARIFF (%)	18.700	16.656	0	584.500
DETECTION (%)	11.865	13.957	0	100
AUDIT (%)	11.994	15.270	0	100
CONGOODS	0.168	0.374	0	1
RAWFUELS	0.350	0.477	0	1
CAPGOODS	0.481	0.500	0	1
IMPORT ($)	33,216	213,011	1	7,900,819
EXCHANGE (*W*)	1,380	124.80	638	2,217
FORPROFIT	0.886	0.318	0	1
NONPROFIT	0.012	0.110	0	1
INDIVIDUAL	0.102	0.302	0	1
FIRMAGE (year)	17.780	13.042	1	80
BRANCH	0.238	0.426	0	1
OECD	0.721	0.448	0	1

Table 9. Mean Values by Commodity Category

Variable		Consumer Goods	Materials & Fuels	Capital Goods
EVASION		0.0061	0.0023	0.0019
FRAUD		0.144	0.096	0.096
TARIFF	(%)	25.072	17.954	17.015
DETECTION	(%)	14.186	10.276	12.210
AUDIT	(%)	21.307	10.975	9.478
IMPORT	($)	21,548	55,299	21,214
EXCHANGE	(*W*)	1,383	1,381	1,379
FORPROFIT	(%)	78.959	89.019	91.701
NONPROFIT	(%)	1.605	1.021	1.244
INDIVIDUAL	(%)	19.436	9.960	7.055
FIRMAGE	(year)	12.674	18.439	19.085
BRANCH	(%)	10.152	22.901	29.313
OECD	(%)	60.0	73.536	75.376

Note: The mean values for dummy variables are calculated by multiplying average values of these variables by 100%. Thus, for these variables, each mean value represents its fraction in total sample.

Table 10. Regression Results of Tariff-Evasion Behavior with Cluster Effect

Independent Variable	Dependent variable: *EVASION*				
		Probit		Tobit	
	OLS × 100	$\beta \times 100$	$g(x\beta)\beta \times 100$	$\beta \times 100$	$\beta\,\Phi(x\beta/\sigma) \times 100$
TARIFF	0.0085	0.267***	0.0049***	0.264***	0.0017***
	(0.0063)	(0.081)	(0.0015)	(0.081)	(0.0005)
DETECTION	-0.0006	-0.291	-0.0053	-0.256	-0.0017
	(0.0022)	(0.252)	(0.0046)	(0.245)	(0.0016)
AUDIT	-0.0069***	-0.876***	-0.0161***	-0.828**	-0.0054**
	(0.0025)	(0.302)	(0.0053)	(0.291)	(0.0019)
RAWFUELS	-0.3656**	-24.622**	-0.4171**	-25.303***	-0.1655***
	(0.1515)	(9.768)	(0.1538)	(9.881)	(0.0642)
CAPGOODS	-0.4219***	-35.645***	-0.6602***	-35.707***	-0.2335***
	(0.1466)	(9.686)	(0.1806)	(9.961)	(0.0647)
LOG(*IMPORT*)	-0.0366**	-1.081	-0.0198	-1.507	-0.0099
	(0.0180)	(1.711)	(0.0312)	(1.658)	(0.0108)
EXCHANGE	0.0624**	10.420***	0.1910***	9.769***	0.0639***
	(0.0298)	(2.231)	(0.0423)	(2.177)	(0.0142)
NONPROFIT	0.7785	46.628**	1.5184**	45.776**	0.2994**
	(0.6865)	(22.803)	(1.1621)	(22.829)	(0.1484)
INDIVIDUAL	0.3037*	22.498**	0.5181**	22.214**	0.1453**
	(0.1734)	(10.445)	(0.2896)	(10.40)	(0.0676)
FIRMAGE	0.0047	0.146	0.0027	0.207	0.0014
	(0.0039)	(0.354)	(0.0065)	(0.347)	(0.0023)
BRANCH	-0.1933**	-17.092	-0.2819	-18.182*	-0.1189*
	(0.0852)	(10.679)	(0.1579)	(10.706)	(0.0696)
OECD	0.2105***	20.920**	0.3447**	21.428**	0.1402**
	(0.0650)	(9.403)	(0.1377)	(9.340)	(0.0607)
CONSTANT	-0.2359	-364.523***	—	-348.692***	-2.2807***
	(0.4245)	(34.582)	—	(39.853)	(0.2590)
Observations	13,695	13,695		13,695	
Clusters	5,713	5,713		5,713	
Log-Likelihood value	N/A	-618.542		-608.725	
Pseudo R^2	0.005	0.048		0.050	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables in the Probit estimation are for discrete changes from 0 to 1. The values in parentheses below the estimates are the corrected standard errors for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The pseudo R-squared for the OLS is the usual R^2. For the Probit and Tobit, the pseudo R^2 is the measure based on the log likelihoods.

Table 11. Regression Results of Tariff-Evasion Behavior without Cluster Effect

Independent Variable	Dependent variable: *EVASION*				
	OLS × 100	Probit		Tobit	
		$\beta \times 100$	$g(x\beta)\beta \times 100$	$\beta \times 100$	$\beta\,\Phi(x\beta/\sigma) \times 100$
TARIFF	0.0085	0.267^{***}	0.0049^{***}	0.264^{***}	0.0017^{***}
	(0.0062)	(0.10)	(0.0019)	(0.098)	(0.0007)
DETECTION	-0.0006	-0.291	-0.0053	-0.256	-0.0017
	(0.0022)	(0.305)	(0.0056)	(0.296)	(0.0019)
AUDIT	-0.0069^{***}	-0.876^{***}	-0.0161^{***}	-0.828^{***}	-0.0054^{***}
	(0.0026)	(0.308)	(0.0056)	(0.304)	(0.0020)
RAWFUELS	-0.3656^{**}	-24.622^{**}	-0.4171^{**}	-25.303^{***}	-0.1655^{***}
	(0.1490)	(9.679)	(0.1534)	(9.598)	(0.0627)
CAPGOODS	-0.4219^{***}	-35.645^{***}	-0.6602^{***}	-35.707^{***}	-0.2335^{***}
	(0.1433)	(9.632)	(0.1822)	(9.756)	(0.0629)
LOG(*IMPORT*)	-0.0366^{**}	-1.081	-0.0198	-1.507	-0.0099
	(0.0181)	(1.90)	(0.0348)	(1.844)	(0.0121)
EXCHANGE	0.0624^{**}	10.420^{***}	0.1910^{***}	9.769^{***}	0.0639^{***}
	(0.0285)	(2.466)	(0.0444)	(2.556)	(0.0164)
NONPROFIT	0.7785	46.628^{**}	1.5184^{**}	45.776^{**}	0.2994^{**}
	(0.6721)	(22.428)	(1.1467)	(21.990)	(0.1444)
INDIVIDUAL	0.3037^{*}	22.498^{**}	0.5181^{**}	22.214^{**}	0.1453^{**}
	(0.1732)	(10.659)	(0.3021)	(10.495)	(0.0688)
FIRMAGE	0.0047	0.146	0.0027	0.207	0.0014
	(0.0040)	(0.325)	(0.0060)	(0.316)	(0.0021)
BRANCH	-0.1933^{**}	-17.092	-0.2819	-18.182^{*}	-0.1189^{*}
	(0.0867)	(10.631)	(0.1568)	(10.495)	(0.0680)
OECD	0.2105^{***}	20.920^{**}	0.3447^{**}	21.428^{**}	0.1402^{**}
	(0.0656)	(8.808)	(0.1294)	(8.779)	(0.0565)
CONSTANT	-0.2359	-364.523^{***}	—	-348.692^{***}	-2.2807^{***}
	(0.4102)	(38.955)	—	(48.875)	(0.3522)
Observations	13,695	13,695		13,695	
Log-Likelihood value	N/A	-618.542		-608.725	
Pseudo R^2	0.005	0.048		0.050	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables in the Probit estimation are for discrete changes from 0 to 1. For the OLS estimates, the values in parentheses below the estimates are heteroskedasticity-robust standard errors. For Probit and Tobit, the values in parentheses are the usual standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The pseudo R-squared for the OLS is the usual R^2. For the Probit and Tobit, the pseudo R^2 is the measure based on the log likelihoods.

Table 12. Results of Specification Tests in the Tobit Model

	Homoskedasticity		Normality
	LM test	LR test	LM test
Test statistic	28.156	14.310	0.617
P-value	0.005	0.281	0.735
Critical value	21.026	21.026	5.991
Test result	rejected	not rejected	not rejected

Note: The critical values for the LM and LR tests of homoskedasticity are derived from the 95th percentile in the chi-squared distribution with 12 degrees of freedom. The critical value for the LM test of normality is derived from the 95th percentile in the chi-squared distribution with 2 degrees of freedom.

Table 13. Tobit Estimates of Tariff-Evasion Behavior

Independent Variables	Dependent variable: *EVASION*			
	Homoskedastic Tobit		Heteroskedastic Tobit	
	$\beta \times 100$	$\beta\, \Phi(x\hat{\beta}'/\hat{\sigma}) \times 100$	$\beta \times 100$	$\beta\, \Phi(x\hat{\beta}'/\hat{\sigma}) \times 100$
TARIFF	0.264***	0.0017***	0.071	-0.0315
	(0.081)	(0.0005)	(0.550)	(0.0623)
DETECTION	-0.256	-0.0017	-1.501	-0.1014
	(0.245)	(0.0016)	(2.704)	(0.2219)
AUDIT	-0.828**	-0.0054**	-3.114	-0.1795
	(0.291)	(0.0019)	(2.060)	(0.1627)
RAWFUELS	-25.303***	-0.1655***	-14.048	0.6085
	(9.881)	(0.0642)	(26.206)	(2.4942)
CAPGOODS	-35.707***	-0.2335***	-50.715	-1.8022
	(9.961)	(0.0647)	(37.259)	(3.5899)
LOG(*IMPORT*)	-1.507	-0.0099	-0.821	0.1005
	(1.658)	(0.0108)	(8.376)	(0.7345)
EXCHANGE	9.769***	0.0639***	12.036	0.2379
	(2.177)	(0.0142)	(9.965)	(0.6286)
NONPROFIT	45.776**	0.2994**	41.182	-0.3550
	(22.829)	(0.1484)	(102.175)	(9.4369)
INDIVIDUAL	22.214**	0.1453**	58.090*	4.4031
	(10.40)	(0.0676)	(35.003)	(3.8738)
FIRMAGE	0.207	0.0014	-1.164	-0.1240
	(0.347)	(0.0023)	(1.656)	(0.1334)
BRANCH	-18.182*	-0.1189*	2.732	0.1711
	(10.706)	(0.0696)	(54.607)	(4.5254)
OECD	21.428**	0.1402**	23.614	0.2609
	(9.340)	(0.0607)	(36.057)	(2.8815)
CONSTANT	-348.692***	-2.2807***	-339.481**	-1.8487
	(39.853)	(0.2590)	(171.686)	(9.1004)
σ	0.9801		0.9175	
Observations	13,695		13,695	
Log-Likelihood value	-608.725		-601.570	
Pseudo R^2	0.05		—	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The values in parentheses below the Homoskedastic Tobit estimates are the standard errors, corrected for cluster effect. The values in parentheses below the Heteroskedastic Tobit estimates are the standard errors, not corrected for cluster effect. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 14. Regression Results of Tariff-Evasion Behavior for Consumer Goods

Independent variable	Dependent variable: *EVASION*				
		Probit		Tobit	
	OLS × 100	$\beta \times 100$	$g(x\beta)\beta \times 100$	$\beta \times 100$	$\beta\ \Phi(x\beta/\sigma) \times 100$
TARIFF	0.0076	0.221*	0.0058*	0.245*	0.0025*
	(0.0067)	(0.101)	(0.0027)	(0.112)	(0.0011)
DETECTION	-0.0027	-0.350	-0.0092	-0.338	-0.0035
	(0.0049)	(0.432)	(0.0109)	(0.453)	(0.0046)
AUDIT	-0.0099**	-1.153**	-0.0302**	-1.175**	-0.0120**
	(0.0047)	(0.443)	(0.0104)	(0.446)	(0.0045)
LOG(*IMPORT*)	-0.0319	-0.714	-0.0187	-1.10	-0.0113
	(0.0447)	(2.475)	(0.0652)	(2.665)	(0.0272)
EXCHANGE	0.1682*	17.118***	0.4488***	17.419***	0.1783***
	(0.0953)	(4.588)	(0.1343)	(4.450)	(0.0454)
NONPROFIT	0.6474	67.151*	3.7665*	65.697	0.6724
	(1.2485)	(37.437)	(3.6622)	(38.713)	(0.3949)
INDIVIDUAL	0.2870	29.501*	0.9647*	29.162	0.2985
	(0.3452)	(18.020)	(0.7049)	(18.825)	(0.1920)
FIRMAGE	0.0087	0.093	0.0024	0.162	0.0017
	(0.0179)	(0.735)	(0.0192)	(0.830)	(0.0085)
BRANCH	-0.6597	-27.453	-0.5630	-31.971	-0.3272
	(0.5067)	(35.313)	(0.5330)	(38.973)	(0.3975)
OECD	0.4601*	21.939	0.5514	25.286	0.2588
	(0.2354)	(16.053)	(0.3789)	(17.612)	(0.1796)
CONSTANT	-1.7713	-458.515***	—	-482.764***	-4.9411***
	(1.3221)	(66.898)	—	(75.976)	(0.7750)
Observations	2,305	2,305		2,305	
Clusters	1,551	1,551		1,551	
Log-Likelihood value	N/A	-162.019		-166.699	
Pseudo R^2	0.007	0.085		0.076	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables in Probit are for discrete changes from 0 to 1. The values in parentheses below the estimates are the standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The pseudo R-squared for the OLS is the usual R^2. For Probit and Tobit, the pseudo R^2 is the measure based on the log likelihoods.

Table 15

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Table 15. Regression Results of Tariff-Evasion Behavior for Raw Materials & Fuels

Independent variable	Dependent variable: *EVASION*				
		Probit		Tobit	
	OLS × 100	$\beta \times 100$	$g(x\beta)\beta \times 100$	$\beta \times 100$	$\beta\ \Phi(x\beta/\sigma) \times 100$
TARIFF	0.0254	2.141**	0.0390**	1.729**	0.0111**
	(0.0178)	(0.879)	(0.0169)	(0.720)	(0.0046)
DETECTION	-0.0008	-0.415	-0.0076	-0.299	-0.0019
	(0.0041)	(0.428)	(0.0077)	(0.348)	(0.0022)
AUDIT	-0.0021	-0.749	-0.0137	-0.541	-0.0035
	(0.0044)	(0.657)	(0.0116)	(0.506)	(0.0032)
LOG(*IMPORT*)	-0.0466	-3.024	-0.0551	-2.915	-0.0188
	(0.0421)	(2.956)	(0.0528)	(2.573)	(0.0165)
EXCHANGE	0.1107*	9.766***	0.1779***	8.322**	0.0536**
	(0.0605)	(3.665)	(0.0660)	(3.267)	(0.0209)
NONPROFIT	0.2705	48.916	1.6334	37.619	0.2422
	(0.3830)	(44.454)	(2.3785)	(34.594)	(0.2214)
INDIVIDUAL	0.5606*	38.216**	1.0335**	33.053**	0.2128**
	(0.3239)	(17.095)	(0.6172)	(15.082)	(0.0965)
FIRMAGE	0.0094	0.867	0.0158	0.754*	0.0049*
	(0.0061)	(0.528)	(0.0093)	(0.454)	(0.0029)
BRANCH	-0.1977*	-15.625	-0.2574	-14.428	-0.0929
	(0.1166)	(17.277)	(0.2547)	(14.282)	(0.0914)
OECD	0.1162	11.865	0.2022	9.944	0.0640
	(0.1005)	(14.755)	(0.2351)	(11.947)	(0.0765)
CONSTANT	-1.5702*	-407.323***	—	-334.621***	-2.1547***
	(0.9021)	(64.614)	—	(69.069)	(0.4420)
Observations	4,799	4,799		4,799	
Clusters	2,560	2,560		2,560	
Log-Likelihood value	N/A	-214.957		-204.360	
Pseudo R^2	0.007	0.051		0.057	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables in Probit are for discrete changes from 0 to 1. The values in parentheses below the estimates are the standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The pseudo R-squared for the OLS is the usual R^2. For Probit and Tobit, the pseudo R^2 is the measure based on the log likelihoods.

Table 16. Regression Results of Tariff-Evasion Behavior for Capital Goods

Independent variable	Dependent variable: *EVASION*				
		Probit		Tobit	
	OLS × 100	$\beta \times 100$	$g(x\beta)\beta \times 100$	$\beta \times 100$	$\beta\,\Phi(x\beta/\sigma) \times 100$
TARIFF	0.0307*	2.406***	0.0334***	2.457***	0.0117***
	(0.0175)	(0.678)	(0.0107)	(0.772)	(0.0036)
DETECTION	-0.0003	-0.181	-0.0025	-0.170	-0.0008
	(0.0026)	(0.455)	(0.0064)	(0.453)	(0.0021)
AUDIT	-0.0079*	-0.690	-0.0096	-0.810	-0.0038
	(0.0043)	(0.617)	(0.0085)	(0.662)	(0.0031)
LOG(*IMPORT*)	-0.0240	-0.090	-0.0013	-0.601	-0.0029
	(0.0161)	(2.857)	(0.0397)	(2.716)	(0.0128)
EXCHANGE	-0.0143	5.728*	0.0795*	4.864	0.0231
	(0.0210)	(3.446)	(0.0486)	(3.221)	(0.0151)
NONPROFIT	1.4020	48.699	1.2711	59.038	0.2803
	(1.3807)	(41.846)	(1.7692)	(45.869)	(0.2156)
INDIVIDUAL	0.0421	-18.459	-0.2099	-15.595	-0.0740
	(0.2265)	(25.597)	(0.2378)	(25.586)	(0.1203)
FIRMAGE	-0.0003	-0.569	-0.0079	-0.494	-0.0023
	(0.0041)	(0.510)	(0.0072)	(0.495)	(0.0023)
BRANCH	-0.0890	-10.096	-0.1331	-11.298	-0.0536
	(0.0928)	(13.560)	(0.1713)	(13.819)	(0.0650)
OECD	0.1527*	35.268*	0.3993*	37.034*	0.1758*
	(0.0780)	(18.369)	(0.1673)	(19.536)	(0.0918)
CONSTANT	-0.0436	-381.645***	—	-369.878***	-1.7561***
	(0.4662)	(58.304)	—	(68.312)	(0.3211)
Observations	6,591	6,591		6,591	
Clusters	2,339	2,339		2,339	
Log-Likelihood value	N/A	-229.251		-224.849	
Pseudo R^2	0.004	0.041		0.041	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables in Probit are for discrete changes from 0 to 1. The values in parentheses below the estimates are the standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The pseudo *R*-squared for the OLS is the usual R^2. For Probit and Tobit, the pseudo R^2 is the measure based on the log likelihoods.

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Table 17. Tobit Estimates of Tariff Evasion by Commodity Category

Independent variables	Dependent variable: *EVASION*					
	Consumer Goods		Raw Materials & Fuels		Capital Goods	
	β × 100	β Φ(xβ/σ) × 100	β × 100	β Φ(xβ/σ) × 100	β × 100	β Φ(xβ/σ) × 100
TARIFF	0.245*	0.0025*	1.729**	0.0111**	2.457***	0.0117***
	(0.112)	(0.0011)	(0.720)	(0.0046)	(0.772)	(0.0036)
DETECTION	-0.338	-0.0035	-0.299	-0.0019	-0.170	-0.0008
	(0.453)	(0.0046)	(0.348)	(0.0022)	(0.453)	(0.0021)
AUDIT	-1.175**	-0.0120**	-0.541	-0.0035	-0.810	-0.0038
	(0.446)	(0.0045)	(0.506)	(0.0032)	(0.662)	(0.0031)
LOG(*IMPORT*)	-1.10	-0.0113	-2.915	-0.0188	-0.601	-0.0029
	(2.665)	(0.0272)	(2.573)	(0.0165)	(2.716)	(0.0128)
EXCHANGE	17.419***	0.1783***	8.322**	0.0536**	4.864	0.0231
	(4.450)	(0.0454)	(3.267)	(0.0209)	(3.221)	(0.0151)
NONPROFIT	65.697	0.6724	37.619	0.2422	59.038	0.2803
	(38.713)	(0.3949)	(34.594)	(0.2214)	(45.869)	(0.2156)
INDIVIDUAL	29.162	0.2985	33.053**	0.2128**	-15.595	-0.0740
	(18.825)	(0.1920)	(15.082)	(0.0965)	(25.586)	(0.1203)
FIRMAGE	0.162	0.0017	0.754*	0.0049*	-0.494	-0.0023
	(0.830)	(0.0085)	(0.454)	(0.0029)	(0.495)	(0.0023)
BRANCH	-31.971	-0.3272	-14.428	-0.0929	-11.298	-0.0536
	(38.973)	(0.3975)	(14.282)	(0.0914)	(13.819)	(0.0650)
OECD	25.286	0.2588	9.944	0.0640	37.034*	0.1758**
	(17.612)	(0.1796)	(11.947)	(0.0765)	(19.536)	(0.0918)
CONSTANT	-482.764***	-4.9411***	-334.621***	-2.1547***	-369.878***	-1.7561***
	(75.976)	(0.7750)	(69.069)	(0.4420)	(68.312)	(0.3211)
$\hat{\sigma}$	1.0960		0.8141		1.0060	
Observations	2,305		4,799		6,591	
Clusters	1,551		2,560		2,339	
Log-Likelihood	-166.699		-204.360		-224.849	
Pseudo R^2	0.076		0.057		0.041	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The values in parentheses below the estimates are the standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 18. Observations per Firm across Commodity

Category	Minimum	Average	Maximum
Consumer Goods	1	1.5	33
Raw Materials	1	1.9	41
Capital Goods	1	2.8	472
Overall	1	2.4	472

Table 19. Tobit Estimates of Tariff Evasion by Commodity without Cluster Effect

Independent variables	Dependent variable: *EVASION*					
	Consumer Goods		Raw Materials & Fuels		Capital Goods	
	$\beta \times 100$	$\beta\,\Phi(x\beta/\sigma) \times 100$	$\beta \times 100$	$\beta\,\Phi(x\beta/\sigma) \times 100$	$\beta \times 100$	$\beta\,\Phi(x\beta/\sigma) \times 100$
TARIFF	0.245*	0.0025*	1.729***	0.0111***	2.457***	0.0117***
	(0.127)	(0.0013)	(0.638)	(0.0043)	(0.821)	(0.0041)
DETECTION	-0.338	-0.0035	-0.299	-0.0019	-0.170	-0.0008
	(0.577)	(0.0059)	(0.429)	(0.0027)	(0.542)	(0.0026)
AUDIT	-1.175**	-0.0120**	-0.541	-0.0035	-0.810	-0.0038
	(0.528)	(0.0050)	(0.498)	(0.0032)	(0.657)	(0.0031)
LOG(*IMPORT*)	-1.10	-0.0113	-2.915	-0.0188	-0.601	-0.0029
	(4.098)	(0.0419)	(2.625)	(0.0168)	(3.112)	(0.0148)
EXCHANGE	17.419***	0.1783***	8.322**	0.0536**	4.864	0.0231
	(6.056)	(0.0609)	(3.559)	(0.0226)	(4.338)	(0.0204)
NONPROFIT	65.697	0.6724	37.619	0.2422	59.038	0.2803
	(42.292)	(0.4381)	(35.589)	(0.2294)	(40.348)	(0.1936)
INDIVIDUAL	29.162	0.2985	33.053**	0.2128**	-15.595	-0.0740
	(19.438)	(0.1998)	(14.715)	(0.0944)	(26.175)	(0.1237)
FIRMAGE	0.162	0.0017	0.754*	0.0049*	-0.494	-0.0023
	(0.747)	(0.0076)	(0.405)	(0.0026)	(0.580)	(0.0027)
BRANCH	-31.971	-0.3272	-14.428	-0.0929	-11.298	-0.0536
	(32.344)	(0.3301)	(13.911)	(0.0890)	(16.205)	(0.0766)
OECD	25.286	0.2588	9.944	0.0640	37.034*	0.1758**
	(17.639)	(0.1784)	(11.892)	(0.0763)	(18.960)	(0.0836)
CONSTANT	-482.764***	-4.9411***	-334.621***	-2.1547***	-369.878***	-1.7561***
	(112.982)	(1.2944)	(73.802)	(0.5348)	(85.991)	(0.4566)
σ^{*}	1.0960		0.8141		1.0060	
Observations	2,305		4,799		6,591	
Log-Likelihood	-166.699		-204.360		-224.849	
Pseudo R^2	0.076		0.057		0.041	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The values in parentheses below the estimates are the usual standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 20. Results of Specification Test in the Tobit Model by Commodity Categories

Commodity		Homoskedasticity		Normality
		LM test	LR test	LM test
Consumer Goods	Test statistic	58.772	10.528	0.618
	P- value	0.000	0.395	0.734
	Critical value	18.307	18.307	5.991
	Test result	rejected	not rejected	not rejected
Raw Materials & Fuels	Test statistic	81.703	13.750	4.695
	P- value	0.000	0.185	0.096
	Critical value	18.307	18.307	5.991
	Test result	rejected	not rejected	not rejected
Capital Goods	Test statistic	61.373	17.798	3.580
	P- value	0.000	0.058	0.167
	Critical value	18.307	18.307	5.991
	Test result	rejected	not rejected	not rejected
Total	Test statistic	28.156	14.310	0.617
	P- value	0.005	0.281	0.735
	Critical value	21.026	21.026	5.991
	Test result	rejected	not rejected	not rejected

Note: The critical values for LM and LR tests of homoskedasticity in commodity categories are derived from the 95th percentile in the chi-squared distribution with 10 degrees of freedom. The critical values for LM tests of normality in commodity categories are derived from the 95th percentile in the chi-squared distribution with 2 degrees of freedom.

Table 21. Heteroskedastic Tobit Estimates of Tariff Evasion for Consumer Goods

Independent variables	Dependent variable: *EVASION*			
	Homoskedastic Tobit		Heteroskedastic Tobit	
	$\beta \times 100$	$\beta\, \Phi(x\beta^*/\sigma^*) \times 100$	$\beta \times 100$	$\beta\, \Phi(x\beta^*/\sigma^*) \times 100$
TARIFF	0.245*	0.0025*	0.011	-0.0282
	(0.112)	(0.0011)	(1.006)	(0.1095)
DETECTION	-0.338	-0.0035	-3.066	-0.2412
	(0.453)	(0.0046)	(6.020)	(0.7371)
AUDIT	-1.175**	-0.0120**	-2.766	-0.1736
	(0.446)	(0.0045)	(4.203)	(0.4187)
LOG(*IMPORT*)	-1.10	-0.0113	6.480	0.8961
	(2.665)	(0.0272)	(21.174)	(2.9525)
EXCHANGE	17.419***	0.1783***	22.742	0.6490
	(4.450)	(0.0454)	(22.122)	(1.7582)
NONPROFIT	65.697	0.6724	42.512	-1.3994
	(38.713)	(0.3949)	(132.857)	(16.7105)
INDIVIDUAL	29.162	0.2985	70.005	6.7044
	(18.825)	(0.1920)	(84.846)	(12.3777)
FIRMAGE	0.162	0.0017	-0.022	-0.0629
	(0.830)	(0.0085)	(4.088)	(0.4325)
BRANCH	-31.971	-0.3272	-199.822	-13.1926
	(38.973)	(0.3975)	(570.305)	(41.6823)
OECD	25.286	0.2588	14.482	1.1692
	(17.612)	(0.1796)	(64.765)	(9.0899)
CONSTANT	-482.764***	-4.9411***	-570.611	-3.7640
	(75.976)	(0.7750)	(367.028)	(42.8390)
σ	1.0960		1.5004	
Observations	2,305		2,305	
Log-Likelihood value	-166.699		-161.435	
Pseudo R^2	0.076			

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The values in parentheses below the Homoskedastic Tobit estimates are the standard errors, adjusted for cluster effect. The values in parentheses below the Heteroskedastic Tobit estimates are the standard errors, not adjusted for cluster effect. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The computed adjustment factor for Heteroskedastic Tobit is about 0.0158.

Table 22. Heteroskedastic Tobit Estimates of Tariff Evasion for Raw Materials & Fuels

Independent variables	Dependent variable: *EVASION*			
	Homoskedastic Tobit		Heteroskedastic Tobit	
	$\beta \times 100$	$\beta\,\Phi(x\beta/\sigma) \times 100$	$\beta \times 100$	$\beta\,\Phi(x\beta/\sigma) \times 100$
TARIFF	1.729**	0.0111**	1.337	-0.1385
	(0.720)	(0.0046)	(1.873)	(0.1923)
DETECTION	-0.299	-0.0019	-0.737	-0.0274
	(0.348)	(0.0022)	(2.524)	(0.1934)
AUDIT	-0.541	-0.0035	-2.098	-0.0811
	(0.506)	(0.0032)	(3.183)	(0.2306)
LOG(*IMPORT*)	-2.915	-0.0188	-1.416	0.0642
	(2.573)	(0.0165)	(13.902)	(1.0008)
EXCHANGE	8.322**	0.0536**	-2.346	-0.6322
	(3.267)	(0.0209)	(27.737)	(1.9918)
NONPROFIT	37.619	0.2422	-77.581	-7.1104
	(34.594)	(0.2214)	(1885.730)	(102.3258)
INDIVIDUAL	33.053**	0.2128**	43.172	-3.9426
	(15.082)	(0.0965)	(143.443)	(7.1280)
FIRMAGE	0.754*	0.0049*	-1.791	0.0887
	(0.454)	(0.0029)	(1.625)	(0.1849)
BRANCH	-14.428	-0.0929	12.980	-0.0430
	(14.282)	(0.0914)	(51.955)	(4.8545)
OECD	9.944	0.0640	-83.320	-7.3637
	(11.947)	(0.0765)	(81.611)	(11.8204)
CONSTANT	-334.621***	-2.1547***	-110.418	-0.1385
	(69.069)	(0.4420)	(470.943)	(6.7234)
σ	0.8141		0.2009	
Observations	4,799		4,799	
Log-Likelihood value	-204.360		-197.485	
Pseudo R^2	0.057			

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The values in parentheses below the Homoskedastic Tobit estimates are the standard errors, adjusted for cluster effect. The values in parentheses below the Heteroskedastic Tobit estimates are the standard errors, not adjusted for cluster effect. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The computed adjustment factor for Heteroskedastic Tobit is about 0.0005.

Table 23. Heteroskedastic Tobit Estimates of Tariff Evasion for Capital Goods

Independent variables	Dependent variable: *EVASION*			
	Homoskedastic Tobit		Heteroskedastic Tobit	
	$\beta \times 100$	$\beta\ \Phi(x\beta/\sigma) \times 100$	$\beta \times 100$	$\beta\ \Phi(x\beta/\sigma) \times 100$
TARIFF	2.457***	0.0117***	1.587	0.0119
	(0.772)	(0.0036)	(2.215)	(0.1424)
DETECTION	-0.170	-0.0008	-0.161	-0.0002
	(0.453)	(0.0021)	(2.151)	(0.0961)
AUDIT	-0.810	-0.0038	0.759	0.0926
	(0.662)	(0.0031)	(1.897)	(0.1318)
LOG(*IMPORT*)	-0.601	-0.0029	-1.997	-0.0641
	(2.716)	(0.0128)	(17.837)	(0.9623)
EXCHANGE	4.864	0.0231	5.992	0.1895
	(3.221)	(0.0151)	(18.014)	(0.8966)
NONPROFIT	59.038	0.2803	-53.729	-3.9493
	(45.869)	(0.2156)	(4402.850)	(142.8151)
INDIVIDUAL	-15.595	-0.0740	-132.547	-4.5809
	(25.586)	(0.1203)	(237.817)	(10.1305)
FIRMAGE	-0.494	-0.0023	-1.882	-0.0711
	(0.495)	(0.0023)	(3.875)	(0.1831)
BRANCH	-11.298	-0.0536	-28.260	-0.4649
	(13.819)	(0.0650)	(152.349)	(6.4055)
OECD	37.034*	0.1758*	-107.286	-8.2191
	(19.536)	(0.0918)	(76.504)	(7.5435)
CONSTANT	-369.878***	-1.7561***	-182.696	-0.4804
	(68.312)	(0.3211)	(278.052)	(6.1346)
σ	1.0060		0.4497	
Observations	6,591		6,591	
Log-Likelihood value	-224.849		-215.950	
Pseudo R^2	0.041			

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The values in parentheses below the Homoskedastic Tobit estimates are the standard errors, adjusted for cluster effect. The values in parentheses below the Heteroskedastic Tobit estimates are the standard errors, not adjusted for cluster effect. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The computed adjustment factor for Heteroskedastic Tobit is about 0.0001.

Table 24. Different Elasticity of Evasion across Commodities

Classification	$\partial\alpha/\partial t$	t/α	$\varepsilon_{\alpha t}$
Consumer Goods	0.000025	4109.84 (=25.07/0.0061)	0.102
Raw Materials	0.000111	7804.35 (=17.95/0.0023)	0.852
Capital Goods	0.000117	8957.89 (=17.02/0.0019)	1.026

Table 25. Elasticity of Evasion with Respect To the Foreign Exchange Rate

Classification	Tariff Elasticity	Exchange Elasticity
Consumer Goods	0.102	4.010
Raw Materials	0.852	3.163
Capital Goods	1.026	1.642
Overall	0.114	3.162

CHAPTER VI

THE EMPIRICAL ANALYSIS OF CUSTOMS FRAUD

1. Empirical Framework

I use a similar econometric model explaining tariff-evasion behavior to examine the major determinants of customs fraud as follows.

$$
\begin{aligned}
FRAUD_i = {} & \beta_0 + \beta_1\, TARIFF_i + \beta_2\, DETECTION_i + \beta_3\, AUDIT_i + \beta_4\, RAWFUELS_i \\
& + \beta_5\, CAPGOODS_i + \beta_6\, \mathrm{LOG}(IMPORT_i) + \beta_7\, EXCHANGE_i + \beta_8\, NONPROFIT_i \\
& + \beta_9\, INDIVIDUAL_i + \beta_{10}\, FIRMAGE_i + \beta_{11}\, BRANCH_i + \beta_{12}\, OECD_i + u_i, \qquad (56)
\end{aligned}
$$

where $FRAUD$ is a dummy variable set to 1 if import declaration is involved in customs fraud. For the other variables, I use the same data as in the estimation of tariff evasion in the previous chapter. Equation (29) describes the major determinants of customs fraud, where i denotes each import declaration.

One problem with using a Tobit model to estimate tariff evasion in the preceding chapter is that we cannot capture all types of customs fraud, other than the case where import declarations are involved in actual evasion of tariff payments. For some imported goods, the importers must have a permit or approval relating to the importation of goods under laws and regulations other than the Customs Law. Importers may avoid these regulations by declaring false items. In addition, some importers tend to be wrongly benefited by falsely or not marking the country of origin, which may lead to a confusion or misunderstanding among ultimate consumers. The effects of these customs frauds are not directly measured in terms of the amount of tariff evaded or money value.

Thus, accounting for other types of customs fraud, I also estimate the behaviors of importers that are associated with committing customs fraud, using a binary dependent model, such as the following Probit model.

$$
\begin{aligned}
y_i^* &= x_i\beta + u_i \\
y_i &= 1 \text{ (customs fraud) if } y_i^* > 0 \\
y_i &= 0 \text{ (compliance) otherwise,}
\end{aligned}
\tag{57}
$$

where customs fraud ($y_i = 1$) accounts for all import declarations involving the violation of Customs Law as well as other regulations, which include false description of imported goods to avoid the import regulations, false marking of the country of origin, etc.

2. Data Description

Except for the dependent variable, I use the same data set used in the estimation of tariff evasion. Table 26 provides major types of customs fraud occurring at the time of import.

The total number of customs frauds detected after random inspection in 1998 is 1,475. The most frequent type of customs fraud is the violation of the country-of-origin rule, which includes differences in country of origin between actual marks on goods and those on declaration forms, and false marking of country of origin (681 observations).

It should be noted that the total number of customs frauds includes declaration of wrong items, which, to my knowledge, neither affects the tariff payment nor is related to any of the import restrictions or regulations (299 observations). These may be regarded as minor mistakes, which may not be serious violations of the Customs Laws and other relevant regulations. Sometimes, however, these mistakes cause serious problems in the calculation of trade statistics for imports by item and by country. These incorrect trade statistics can lead to inappropriate international trade policies, or to wrong decision-makings for business. In this respect, the KCS has put much emphasis on the need for correct declaration of commodity description and HS code to collect reliable and useful trade statistics. Thus, we include these figures in the estimation of customs fraud.

3. Empirical Results

3-1. Total Estimation

3-1-1. Estimation Results

I estimate the Probit model for customs fraud committed by importers. For comparison, OLS and Logit estimates are reported along with those of the Probit in Table 27. Since the magnitudes of the coefficients are not directly comparable across the models, I derive the partial derivatives comparable to the OLS estimates. The effects of the variables x_j on the response probabilities $P(y=1 \mid x)$ are estimated at the average values of the independent variables in the sample. The scaled coefficients for Logit and Probit are also reported in Table 27.

The estimates from the three models are the same in their signs, and the same variables are statistically significant in all models. In addition, the OLS estimates, the partial effects in the Logit model, and the partial effects in the Probit model are very similar in their magnitudes. Comparing with estimates of the Tobit model for tariff evasion, we find some interesting results. The effective tariff rates are found to have no effects on customs fraud, while they are significant in the tariff-evasion equation. It is not surprising that fraud is not affected by tariff rates, since fraud is often motivated for reasons other than tariff evasion. It is predicted that an increase in the probability of detection has deterrent effects on fraud, while they are not statistically different from zero in the tariff-evasion model. More detailed interpretations and implications of these estimates are discussed in a later section.

As with the estimation of tariff evasion in the previous chapter, the standard errors of the above estimates are adjusted for cluster sampling, allowing that the observations are independent across firms (clusters), but not necessarily independent within firms (clusters). However, even if we assume that all observations are independent with each other so that there is no clustering effect, it does not make much difference in the standard errors, and the significance levels of the coefficients do not change. The estimation results without considering cluster effect are reported in table 28 for comparison.

3-1-2. Tests for Homoskedasticity

To test the hypothesis of homoskedasticity against the alternative hypothesis of heteroskedasticity in the Probit and Logit model, both the LM and LR statistics are used. The more general model (unrestricted model) is assumed to be the model with multiplicative heteroskedasticity in which $Var(u) = [exp(z\delta)]^2$. The test results for homoskedasticity are presented in Table 29. Based on the LR and LM statistics, the hypothesis of homoskedasticity in the Probit can be rejected. In addition, we can also reject the assumption of homoskedasticity in the Logit based on these two statistics. In contrast to the test statistics for the Tobit model in the previous chapter, the LM statistics are much smaller than the LR statistics. Considering the general notion that the outer product of the score LM statistic has severe size distortions, it is interesting that LM statistics are much smaller than LR statistics.

We can compare the estimates of the standard Probit (Logit) model to those of the Probit (Logit) model with multiplicative heteroskedasticity in order to determine the extent to which heteroskedasticity in the latent variable model affects the partial derivatives. As shown in Table 30 (for the Probit) and Table 31 (for the Logit), the effects of heteroskedasticity on β are extremely large in both models. However, comparing the effects of the variables x_j on the response probabilities $P(y=1 \mid x)$, they are not much different. Especially, the presence of heteroskedasticity does not have huge impacts on the partial effects in the Probit model. Except for *TARIFF* and *FIRMAGE*, there are no huge differences between the partial effects of explanatory variables in the homoskedastic Probit model and those in the heteroskedastic Probit model. For the Logit model, the partial effects in the heteroskedastic Logit model are not far from those in the standard Logit model either, except for a few variables, such as *TARIFF*. In addition, the introduction of the more complicated model (heteroskedastic Probit and Logit Model) does not improve the percentage correctly predicted. Instead, due to the large standard errors, all the partial effects in the heteroskedastic Probit and Logit models are not statistically different from zero.

Despite test results from the LM and LR statistics, we may not reject the hypothesis, since the effects of heteroskedasticity on the partial effects are not so huge. Based on this reasoning, I mainly focus on the estimation results of the standard Probit model hereafter.

3-1-3. Implications

Tariff and Enforcement Variables

DETECTION and *AUDIT* are found to be significantly different from zero at the 5% level, while *TARIFF* is insignificant.

Unlike the estimation results of tariff evasion, in which an increase in tariff rates has significant effects on tariff-evasion behavior, the coefficients are not statistically different from zero. The intuition behind this difference in the statistical significance of effective tariff rates is that the importer who commits customs fraud can be wrongly benefited by misleading consumers and avoiding other regulations, rather than by evading actual tariff payments. As noted in the previous section, customs fraud includes not only tariff evasion, but also falsely marking or not marking the country of origin, avoidance of regulations, infringement of trademark, etc. Thus, from the types of customs fraud, it is obvious that importers who commit fraud have different incentives compared with those who are attempting to evade tariffs.

The Probit estimate shows that, unlike the Tobit estimate in tariff evasion, an increase in the probability of detection has statistically significant effects on customs fraud. As the detection rate increases by 1% point, the probability of committing customs fraud decreases by 0.0012. Thus, an increase in the detection rate has deterrent effects. However, the effect is relatively small, since the average of the dependent variable, *FRAUD*, is 0.1043. The elasticity of customs fraud with respect to the detection rate is -0.133 at the average value of both variables. Thus, for the importer with an average detection rate for the sample, 11.865%, a one-percent increase in the detection rate would result in an expected 0.133% decrease in the probability of committing customs fraud. In other words, if the detection rate were to increase from 11.865% to 11.984%, these estimates suggest that the probability of customs fraud would decrease from 0.1043 to about 0.1042.

The Probit estimate for *AUDIT* shows that, as the inspection rate increases by 1% point, customs fraud decreases by 0.0020. As with *DETECTION*, considering the average value of the probability of committing customs fraud, practically, an increase in the probability of inspection has only a small deterrent effect on fraud. The elasticity of customs fraud with respect to the audit rate is -0.230 at the average value of both variables. Thus, for the importer with an average audit rate for the sample, 11.994%, a one-percent increase in the penalty rate would result in an expected 0.230% decrease in the probability of committing customs fraud. In other words, if the audit rate were to increase from 11.994% to 12.114%, these estimates suggest that the probability of customs fraud would decrease from 0.1043 to about 0.1041.

Commodity Categories

All dummy variables for commodity categories are significantly different from zero with negative signs. Thus, in most cases, it is predicted that Raw Materials & Fuels and Capital Goods are less likely to be the target of customs fraud, compared with Consumer Goods. In particular, imported goods classified in Cereal, Direct Consumer Goods, Durable Consumer Goods, or Non-Durable Consumer Goods have a higher probability of committing fraud compared with the other imported goods.

It may be the case that Cereal (e.g., wheat, rice, corn) and agricultural products in Direct Consumer Goods (e.g., garlic, sesame seed) are goods for which it is relatively easy to disguise their true nature or to undervalue quantity or weight. Durable or Non-Durable Consumer Goods, such as domestic electro-machines, household appliances, etc., tend to be the target of false marking of origin, as well as declaration of false items. For these consumer goods, the country of origin is one of the most important factors in attracting consumers. It may also have great impact on consumer price. Thus, some importers may well attempt to be wrongly benefited by falsely marking or not marking the country of origin on these Durable or Non-Durable Consumer Goods, which leads to a confusion or misunderstanding among the ultimate consumers.

For example, in many cases, the Foreign Trade Act of Korea requires each imported good to be marked in a conspicuous place as legibly, indelibly, and permanently, and the country of origin should appear preceded by "made in", "product of", or other words of similar meaning. However, some importers would mark with adhesive stickers or tags, in attempt to purposely destroy or alter the country of origin after the customs clearance. They can also mark the origin in a manner intentionally leading to confusion among consumers, using obscure words, such as "stylized in". In this case, the name of country preceded by "stylized in" is different from true country of origin.[45]

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[45] For example, consumers who buy cloth think that they are imported from Italy, when "stylized in Italy" is marked on each cloth in a place easily seen, from which true country of origin is different.

Firm-Specific Variables

The coefficient on the amount of imports is not statistically different from zero. Thus, the probability of committing customs fraud is not affected by the amount of imports. Compared with for-profit corporations, it is predicted that importing individuals have a higher probability of committing customs fraud. Years after the establishment of the firm are shown to be negatively related to the probability of fraud. Thus, when the firm has a long history of its business, it is less likely to commit fraud at the time of import.[46] In addition, compared with their headquarters, branches have a lower probability of committing fraud.

Country of Origin

The country-of-origin variable has significant effects on customs fraud. This implies that goods originated from or produced in developed countries (OECD countries) are more likely to be the target of fraud.

Foreign Exchange Rate

The coefficient on the foreign exchange rate is found to be significantly different from

[46] In the previous chapter, for Raw Materials & Fuels, the years-after-establishment of the firm has a positive effect on evasion, which is a counter-intuitive result. As with the estimation results here, it is more likely that the history of the firm is negatively related to the prospensity to commit customs fraud as well as to evasion.

zero. That is, a one-hundred Korean won increase in the exchange rate of won to dollar increases the probability of customs fraud by 0.025. The elasticity of customs fraud with respect to the foreign exchange rate is 3.309 at the average value of both variables. Thus, for the importer with an average foreign exchange rate for the sample, *W*1,380.414 per U.S. dollar, a one-percent increase in the foreign exchange rate would result in an expected 3.309% increase in the probability of committing customs fraud. In other words, if the exchange rate were to increase from *W*1,380.414 to *W*1,394.218, these estimates suggest that the probability of customs fraud would increase from 0.1043 to about 0.1078.

3-2. Estimation by Commodity Categories

3-2-1. Estimation Results

I divide the imported goods into 3 categories (Consumer Goods, Raw Materials & Fuels, and Capital Goods) and estimate a Probit model for each of the categories separately. The Probit estimates for each of the commodity categories are given in Table 32.

When we compare the signs and significances of the estimates across commodity categories, most variables are consistent in their signs and significance. In particular, *DETECTION*, *AUDIT*, and *EXCHANGE* are significant in all commodity categories and have the same signs across the categories. It is shown that an increase in the probability of detection given audit is predicted to have significant deterrent effects on customs fraud in all categories. The probability of audit also has significant deterrent effects on fraud. In addition, an increase in the exchange rate would induce more customs fraud in all categories.

The standard errors of Probit estimates are also adjusted for cluster sampling, allowing that the observations are independent across firms (clusters), but not necessarily independent within firms (clusters). However, the standard errors are very similar to those computed without accounting for cluster effect. The estimation results without considering the cluster effect are also reported in table 33 for comparison.

3-2-2. Tests of Homoskedasticity

Both the LM and LR statistics are used to test the hypothesis of homoskedasticity against the heteroskedasticity in the Probit model by commodity categories. As shown in Table 34, based on the LR and LM statistics, the hypothesis of homoskedasticity can be rejected in all categories at the 95% level.

However, for Consumer Goods, the hypothesis cannot be rejected at the 99% level with the critical value of 23.21 based on LM statistic. In addition, the statistical tests may not be sufficient to determine whether the homoskedasticity assumption is satisfied. Thus, we compare the estimates of the standard Probit model to those of the Probit model with multiplicative heteroskedasticity to examine the effects of heteroskedasticity in the latent variable model on the partial derivatives. As presented in Table 35, 36, and 37, the effects of heteroskedasticity on β seem to be extremely large in all commodity groups. However, comparing the effects of the independent variables on the response probabilities, they are not much different except in the case of Consumer Goods.[47] Especially, there are no huge differences in the partial effects of our key variables, such as *TARIFF*, *PENALTY*, and *AUDIT* in Raw Materials & Fuels and Capital Goods. Despite test results from the LM and LR statistics at the 95% level, we may not reject the hypothesis, since the effects of heteroskedasticity on the partial effects are not so large. Based on this reasoning, I mainly focus on the estimates of the standard Probit to interpret the estimation results.

[47] The estimates ($\hat{\beta}$ and $g(x\hat{\beta})\hat{\beta}$) in the heteroskedastic Probit model for Consumer Goods may not be reliable, since there is abnormal exit from initial iterations during the estimation. However, based on the LM statistic at the 99%, the homoskedasticity assumption can still be supported.

3-2-3. Implications

Tariff and Enforcement Variables

The coefficients on effective tariff rates are found to be significantly different from zero at the 10% level in Raw Materials & Fuels and Capital Goods, while insignificant in Consumer Goods. Thus, as the tariff rate increases by 1% point, the probability of committing customs fraud increases by 0.0016 in Crude Materials & Fuels and 0.0029 in Capital Goods. The elasticities of customs fraud with respect to the tariff rate in Raw Materials & Fuels and Capital Goods are 0.299 and 0.514, respectively. Thus, for importers of Raw Materials & Fuels, if the tariff rate were to increase from 17.954% to 18.124%, these estimates suggest that the probability of committing customs fraud would increase from 0.096 to about 0.0963. For Capital Goods, if the tariff rate were to increase from 17.015% to 17.185%, these estimates suggest that the probability of committing customs fraud would increase from 0.096 to about 0.0965.

The Probit estimate for *DETECTION* shows that an increase in the probability of detection has deterrent effects on customs fraud in all commodity groups. A 1% point increase in the detection rate is predicted to decrease the probability of committing customs fraud by 0.0021 in Consumer Goods, 0.0007 in Crude Materials & Fuels and 0.0012 in Capital Goods. Thus, an increase in the detection rate can be a relatively effective tool to deter fraud for Consumer Goods, although the overall deterrent effects of the detection rate are small. The elasticities of customs fraud with respect to the penalty rate in Consumer Goods, Raw Materials & Fuels, and Capital Goods are -0.207, -0.075, and -0.152, respectively. Thus, for importers of Consumer Goods, if the detection rate were to increase from 14.186% to 14.328%, these estimates suggest that the probability of committing customs fraud would decrease from 0.144 to about 0.1437. For importers of Raw Materials & Fuels, if the detection rate were to increase from 10.276% to 10.379%, these estimates suggest that the probability of committing customs fraud would decrease from 0.096 to about 0.0959. For Capital Goods, if the detection rate were to increase from 12.210% to 12.332%, these estimates suggest that the probability of committing customs fraud would decrease from 0.096 to about 0.0959.

Like the probability of detection, the probability of inspection also has deterrent effects on customs fraud. The Probit estimate for *AUDIT* shows that as the inspection rate increases by 1% point, customs fraud decreases by 0.0021 in Consumer Goods, 0.0022 in Crude Materials & Fuels and 0.0024 in Capital Goods. The effects of this instrument on fraud are very similar across commodities. The elasticities of customs fraud with respect to the inspection rate in Consumer Goods, Raw Materials & Fuels, and Capital Goods are -0.311, -0.252, and -0.237, respectively. Thus, for importers of Consumer Goods, if the audit rate were to increase from 21.307% to 21.520%, these estimates suggest that the probability of committing customs fraud would decrease from 0.144 to about 0.1436. For importers of Raw Materials & Fuels, if the audit rate were to increase from 10.975% to 11.085%, these estimates suggest that the probability of committing customs fraud would decrease from 0.096 to about 0.0958. For Capital Goods, if the audit rate were to increase from 9.478% to 9.573%, these estimates suggest that the probability of committing customs fraud would decrease from 0.096 to about 0.0958.

Firm-Specific Variables

For the firm-specific variables, we can find that there are some differences in the statistical significance and signs of the independent variables across commodity categories.

The amount of import is found to have significant effects on customs fraud in Raw Materials & Fuels and Capital Goods, while its effect is insignificant in Consumer Goods. However, the amount of imports is negatively related to the probability of committing customs fraud in Raw Materials & Fuels, while positively related in Capital Goods.

The Probit estimates show that individuals are more likely to be involved in fraud only for Raw Materials & Fuels, compared with the for-profit corporations and non-profit organizations. For Consumer Goods and Capital Goods, there are no differences in the probability of committing fraud between the individuals and the for-profit corporations. In any of the categories, the possibilities of customs frauds of the non-profit organizations are not statistically different from those of the for-profit corporations.

The number of years after establishment of the firm has significant effects on fraud in all commodities. The negative coefficient of this variable implies that firms with relatively long histories have a smaller tendency to commit illegal activities when they import.

In addition, compared with their headquarters, branches have a lower probability of committing fraud in all commodity categories.

Country of Origin

Except in the case of Consumer Goods, the country of origin has significant effects on customs fraud. Probit estimates for this variable show that items classified in Raw Materials & Fuels or Capital Goods originated from or produced in one of the OECD countries are more likely to be involved in illegal activities at the time of import.

Foreign Exchange Rate

In all commodity groups, the foreign exchange rates are significantly different from zero. That is, a one-hundred Korean won increase in the exchange rate of won to dollar increases the probability of committing customs fraud by 0.050 in Consumer Goods, by 0.015 in Raw Materials & Fuels, and by 0.022 in Capital Goods. Thus, as the unit import price increases, firms are more likely to commit fraud to make compensation for their additional financial burden. The elasticities of customs fraud with respect to the foreign exchange rate in Consumer Goods, Raw Materials & Fuels, and Capital Goods are 4.802, 2.158, and 3.160, respectively. Thus, for the importer with an average foreign exchange rate for the sample, a one-percent increase in the foreign exchange rate would result in an expected 4.802% increase in the probability of committing customs fraud in Consumer Goods, a 2.158% increase in Raw Materials & Fuels, and a 3.160% increase in Capital Goods.

Table 26. Types of Customs Fraud

Type	Reason	Method (related to type)
• Undervaluation	- To evade customs duty	Reduction of the quantity or unit price
• False Declaration of Items	- To claim lower duty rates - To claim lower special excise taxes - To avoid import regulations	False description of items False declaration of HS code
• Violation of Country-of - Origin Rule	- To claim lower duty rates - To deceive final consumers - To avoid import regulations	Not marking of origin False marking of origin False declaration of origin
• Infringed Trademarks	- To deceive final consumers	False marking of trade mark

Table 27. OLS, Logit, and Probit Estimates of Customs Fraud with Cluster Effect

Independent variable	Dependent variable: *FRAUD*				
		Logit		Probit	
	OLS × 100	$\beta^* \times 100$	$g(x\beta^*)\beta^* \times 100$	$\beta^* \times 100$	$g(x\beta^*)\beta^* \times 100$
TARIFF	0.0171	0.147	0.0121	0.098	0.0163
	(0.0158)	(0.115)	(0.0094)	(0.069)	(0.0114)
DETECTION	-0.1146***	-1.423***	-0.1170***	-0.708***	-0.1173***
	(0.0176)	(0.275)	(0.0226)	(0.133)	(0.0223)
AUDIT	-0.1983***	-2.415***	-0.1985***	-1.195***	-0.1981***
	(0.0197)	(0.318)	(0.0261)	(0.148)	(0.0247)
RAWFUELS	-5.6715***	-55.585***	-4.5672***	-28.624***	-4.7441***
	(0.9263)	(8.654)	(0.7112)	(4.641)	(0.7106)
CAPGOODS	-5.4144***	-51.599***	-4.2397***	-27.541***	-4.5647***
	(0.8826)	(8.238)	(0.6770)	(4.433)	(0.7151)
LOG(*IMPORT*)	-0.1492	-1.593	-0.1309	-0.913	-0.1514
	(0.1424)	(1.594)	(0.1310)	(0.840)	(0.140)
EXCHANGE	2.8096***	27.432***	2.2540***	14.959***	2.4793***
	(0.2724)	(2.108)	(0.1733)	(1.160)	(0.2011)
NONPROFIT	2.0527	18.206	1.4959	9.506	1.5755
	(2.4502)	(26.266)	(2.1586)	(13.851)	(2.5806)
INDIVIDUAL	3.3633***	24.208***	1.9891***	13.373***	2.2164***
	(1.0385)	(9.079)	(0.7461)	(4.892)	(0.9285)
FIRMAGE	-0.1480***	-1.698***	-0.1396***	-0.834***	-0.1382***
	(0.0317)	(0.420)	(0.0345)	(0.209)	(0.0331)
BRANCH	-3.3147***	-44.832***	-3.6837***	-22.561***	-3.7392***
	(0.8037)	(11.376)	(0.9349)	(5.607)	(0.7826)
OECD	2.4948***	30.516***	2.5074***	16.226***	2.6893***
	(0.5875)	(7.315)	(0.6012)	(3.803)	(0.5603)
CONSTANT	-17.8058***	-492.369***	-40.4564***	279.999***	—
	(3.9747)	(33.414)	(2.7460)	(18.072)	—
Observations	13,695	13,695		13,695	
Clusters	5,713	5,713		5,713	
Correctly Predicted	—	89.57%		89.57%	
Log-Likelihood	—	-4326.393		-4328.337	
Pseudo R^2	0.037	0.056		0.055	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables in the Logit and the Probit model are computed at the mean values. The values in parentheses below the estimates are the standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The pseudo R-squared is the usual R^2 for the OLS and the measure based on the log likelihoods for Logit and Probit.

Table 28. OLS, Logit, and Probit Estimates of Customs Fraud without Cluster Effect

Independent variable	Dependent variable: *FRAUD*				
		Logit		Probit	
	OLS × 100	$\beta^* \times 100$	$g(x\beta^*)\beta^* \times 100$	$\beta^* \times 100$	$g(x\beta^*)\beta^* \times 100$
TARIFF	0.0171	0.147	0.0121	0.098	0.0163
	(0.0148)	(0.137)	(0.0113)	(0.079)	(0.0132)
DETECTION	-0.1146***	-1.423***	-0.1170***	-0.708***	-0.1173***
	(0.0176)	(0.260)	(0.0212)	(0.127)	(0.0210)
AUDIT	-0.1983***	-2.415***	-0.1985***	-1.195***	-0.1981***
	(0.0182)	(0.256)	(0.0206)	(0.124)	(0.0203)
RAWFUELS	-5.6715***	-55.585***	-4.5672***	-28.624***	-4.7441***
	(0.8829)	(8.244)	(0.6741)	(4.414)	(0.7306)
CAPGOODS	-5.4144***	-51.599***	-4.2397***	-27.541***	-4.5647***
	(0.8602)	(7.878)	(0.6449)	(4.252)	(0.7037)
LOG(*IMPORT*)	-0.1492	-1.593	-0.1309	-0.913	-0.1514
	(0.1343)	(1.526)	(0.1254)	(0.796)	(0.1319)
EXCHANGE	2.8096***	27.432***	2.2540***	14.959***	2.4793***
	(0.2462)	(1.988)	(0.1595)	(1.088)	(0.1783)
NONPROFIT	2.0527	18.206	1.4959	9.506	1.5755
	(2.3745)	(25.935)	(2.1310)	(13.597)	(2.2536)
INDIVIDUAL	3.3633***	24.208***	1.9891***	13.373***	2.2164***
	(1.0269)	(8.831)	(0.7262)	(4.810)	(0.7977)
FIRMAGE	-0.1480***	-1.698***	-0.1396***	-0.834***	-0.1382***
	(0.0240)	(0.285)	(0.0232)	(0.143)	(0.0236)
BRANCH	-3.3147***	-44.832***	-3.6837***	-22.561***	-3.7392***
	(0.6434)	(8.875)	(0.7227)	(4.395)	(0.7253)
OECD	2.4948***	30.516***	2.5074***	16.226***	2.6893***
	(0.5593)	(6.758)	(0.5524)	(3.496)	(0.5777)
CONSTANT	-17.8058***	-492.369***	-40.4564***	279.999***	—
	(3.6676)	(31.1682)	(2.5248)	(16.820)	—
Observations	13,695	13,695		13,695	
Clusters	5,713	5,713		5,713	
Correctly Predicted	—	89.57%		89.57%	
Log-Likelihood	—	-4326.393		-4328.337	
Pseudo R^2	0.037	0.056		0.055	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables in the Logit and the Probit model are computed at the mean values. For the OLS, the values in parentheses below the estimates are heteroskedasticity-robust standard errors. For Logit and Probit, the values in parentheses are the usual standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The pseudo R-squared is the usual R^2 for the OLS and the measure based on the log likelihoods for Logit and Probit.

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Table 29. Tests for Homoskedasticity in Probit and Logit

	Homoskedasticity			
	Probit		Logit	
	LM test	LR test	LM test	LR test
Test statistic	93.619	240.460	99.490	253.588
P- value	0.000	0.000	0.000	0.000
Critical value	21.026	21.026	21.026	21.026
Test result	Rejected	Rejected	Rejected	Rejected

Note: The critical values for LM and LR test are derived from the 95th percentile in the chi-squared distribution with 12 degrees of freedom.

Table 30. Heteroskedastic Probit Estimates of Customs Fraud

Independent Variables	Dependent variable: *FRAUD*			
	Homoskedastic Probit		Heteroskedastic Probit	
	$\hat{\beta} \times 100$	$G(x\hat{\beta})\hat{\beta} \times 100$	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$
TARIFF	0.098	0.0163	0.246	0.1670
	(0.069)	(0.0114)	(4.233)	(0.1667)
DETECTION	-0.708***	-0.1173***	-37.444***	-0.0707
	(0.133)	(0.0223)	(11.949)	(0.1937)
AUDIT	-1.195***	-0.1981***	-72.250***	-0.2094
	(0.148)	(0.0247)	(20.690)	(0.3707)
RAWFUELS	-28.624***	-4.7441***	-206.480**	-1.8140
	(4.641)	(0.7106)	(102.306)	(2.3792)
CAPGOODS	-27.541***	-4.5647***	-114.288	-1.7490
	(4.433)	(0.7151)	(86.367)	(2.1027)
LOG(*IMPORT*)	-0.913	-0.1514	-2.939	-0.1930
	(0.840)	(0.140)	(17.709)	(0.3384)
EXCHANGE	14.959***	2.4793***	-21.993	2.5041
	(1.160)	(0.2011)	(37.656)	(2.3329)
NONPROFIT	9.506	1.5755	-452.836	1.5820
	(13.851)	(2.5806)	(542.609)	(9.4005)
INDIVIDUAL	13.373***	2.2164***	153.556**	-1.8205
	(4.892)	(0.9285)	(77.308)	(1.9238)
FIRMAGE	-0.834***	-0.1382***	-11.328**	-0.0234
	(0.209)	(0.0331)	(5.036)	(0.0861)
BRANCH	-22.561***	-3.7392***	-821.657***	-2.2299
	(5.607)	(0.7826)	(310.276)	(5.4526)
OECD	16.226***	2.6893***	30.590	3.0027
	(3.803)	(0.5603)	(63.175)	(2.8549)
CONSTANT	279.999***	—	-78.513	-0.6738
	(18.072)	—	(454.502)	(4.6681)
Observations	13,695		13,695	
Correctly Predicted	89.57 %		89.57 %	
Log-Likelihood value	-4328.337		-4208.107	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables are computed at the mean values. The partial effect of the Heteroskedastic Probit model, $g(x\hat{\beta})\hat{\beta}$, is equal to $\partial P(y=1|x)\ /\ \partial x_j = \phi[x\beta/\exp(z\delta)]\times[(\beta_j-\delta_j x\beta)/\exp(z\delta)]$. The values in parentheses below the Homoskedastic Probit estimates are the standard errors, adjusted for cluster effect. The values in parentheses below the Heteroskedastic Probit estimates are the usual standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 31. Heteroskedastic Logit Estimates of Customs Fraud

Independent variables	Dependent variable: *FRAUD*			
	Homoskedastic Logit		Heteroskedastic Logit	
	$\beta^* \times 100$	$g(x\beta^*)\beta^* \times 100$	$\beta^* \times 100$	$g[x\beta^*/\exp(z\delta)]\beta^* \times 100$
TARIFF	0.147	0.0121	0.750	0.0021
	(0.115)	(0.0094)	(10.111)	(0.0426)
DETECTION	-1.423***	-0.1170***	-102.871***	-0.2846
	(0.275)	(0.0226)	(33.916)	(3.8521)
AUDIT	-2.415***	-0.1985***	-200.278***	-0.5541
	(0.318)	(0.0261)	(59.601)	(7.4953)
RAWFUELS	-55.585***	-4.5672***	-435.111*	-1.2037
	(8.654)	(0.7112)	(233.040)	(16.2559)
CAPGOODS	-51.599***	-4.2397***	-245.695	-0.6797
	(8.238)	(0.6770)	(200.143)	(9.1611)
LOG(*IMPORT*)	-1.593	-0.1309	-6.512	-0.0180
	(1.594)	(0.1310)	(41.578)	(0.2469)
EXCHANGE	27.432***	2.2540***	-65.342	-0.1808
	(2.108)	(0.1733)	(93.232)	(2.2973)
NONPROFIT	18.206	1.4959	-1342.096	-3.7129
	(26.266)	(2.1586)	(1461.849)	(50.3036)
INDIVIDUAL	24.208***	1.9891***	349.80*	0.9677
	(9.079)	(0.7461)	(181.314)	(13.1295)
FIRMAGE	-1.698***	-0.1396***	-20.091*	-0.0556
	(0.420)	(0.0345)	(10.951)	(0.7522)
BRANCH	-44.832***	-3.6837***	-2224.082***	-6.1530
	(11.376)	(0.9349)	(847.899)	(83.2537)
OECD	30.516***	2.5074***	52.807	0.1461
	(7.315)	(0.6012)	(148.916)	(2.0784)
CONSTANT	-492.369***	-40.4564***	16.888	0.0467
	(33.414)	(2.7460)	(1132.738)	(2.6594)
Observations	13,695		13,695	
Correctly Predicted	89.57 %		89.57 %	
Log-Likelihood value	-4326.393		-4199.599	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables are computed at the mean values. The values in parentheses below the Homoskedastic Logit estimates are the standard errors, adjusted for cluster effect. The values in parentheses below the Heteroskedastic Logit estimates are the usual standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

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Table 32. Probit Estimates of Customs Fraud by Commodity Category with Cluster Effect

Independent variables	Dependent variable: *FRAUD*					
	Consumer Goods		Raw Materials & Fuels		Capital Goods	
	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$
TARIFF	0.008	0.0017	0.985*	0.1568*	1.901***	0.2901***
	(0.080)	(0.0162)	(0.530)	(0.0848)	(0.527)	(0.0777)
DETECTION	-1.035***	-0.2097***	-0.439**	-0.070**	-0.782***	-0.1193***
	(0.231)	(0.0470)	(0.215)	(0.0343)	(0.229)	(0.0355)
AUDIT	-1.062***	-0.2150***	-1.368***	-0.2178***	-1.592***	-0.2429***
	(0.199)	(0.0385)	(0.330)	(0.0511)	(0.278)	(0.0432)
LOG(*IMPORT*)	-0.293	-0.0594	-6.284***	-1.0004***	2.733**	0.4169**
	(1.671)	(0.3386)	(1.414)	(0.2277)	(1.185)	(0.1806)
EXCHANGE	24.591***	4.9808***	9.531***	1.5172***	14.482***	2.2093***
	(2.598)	(0.5246)	(1.895)	(0.3027)	(1.679)	(0.2731)
NONPROFIT	6.738	1.4168	28.625	5.4655	18.603	3.2082
	(34.691)	(7.5707)	(23.757)	(5.3093)	(17.654)	(3.3724)
INDIVIDUAL	8.635	1.8032	25.105***	4.5637***	4.893	0.7684
	(8.761)	(1.8834)	(8.047)	(1.6442)	(8.645)	(1.3971)
FIRMAGE	-0.703*	-0.1423*	-0.399	-0.0636	-1.260***	-0.1923***
	(0.374)	(0.0757)	(0.267)	(0.0422)	(0.323)	(0.0449)
BRANCH	-25.595*	-4.5873*	-12.569	-1.9106	-26.225***	-3.7168***
	(13.940)	(2.1865)	(7.680)	(1.1110)	(7.719)	(1.0236)
OECD	6.528	1.3123	13.009**	1.9871**	20.459***	2.9059***
	(7.155)	(1.4288)	(6.381)	(0.9297)	(5.610)	(0.7378)
CONSTANT	-411.249***	—	-210.512***	—	-352.965***	—
	(37.907)	—	(32.489)	—	(28.520)	—
Observations	2,305		4,799		6,591	
Clusters	1,551		2,560		2,339	
CorrectlyPredicted	85.29		90.35		90.34	
Log-Likelihood	-866.252		-1458.680		-1957.361	
Pseudo R^2	0.087		0.041		0.064	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables are for discrete changes from 0 to 1. The values in parentheses below the estimates are the standard errors, adjusted for cluster sampling. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 33. Probit Estimates of Customs Fraud by Commodity without Cluster Effect

Independent variables	Dependent variable: *FRAUD*					
	Consumer Goods		Raw Materials & Fuels		Capital Goods	
	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$
TARIFF	0.008	0.0017	0.985*	0.1568*	1.901***	0.2901***
	(0.092)	(0.0187)	(0.532)	(0.0846)	(0.449)	(0.0684)
DETECTION	-1.035***	-0.2097***	-0.439**	-0.070**	-0.782***	-0.1193***
	(0.259)	(0.0517)	(0.209)	(0.0333)	(0.211)	(0.0321)
AUDIT	-1.062***	-0.2150***	-1.368***	-0.2178***	-1.592***	-0.2429***
	(0.186)	(0.0371)	(0.248)	(0.0390)	(0.250)	(0.0377)
LOG(*IMPORT*)	-0.293	-0.0594	-6.284***	-1.0004***	2.733**	0.4169**
	(1.747)	(0.3539)	(1.387)	(0.2192)	(1.197)	(0.1824)
EXCHANGE	24.591***	4.9808***	9.531***	1.5172***	14.482***	2.2093***
	(2.489)	(0.4961)	(1.929)	(0.3047)	(1.593)	(0.2408)
NONPROFIT	6.738	1.4168	28.625	5.4655	18.603	3.2082
	(27.127)	(5.9152)	(24.357)	(5.4508)	(21.874)	(4.2223)
INDIVIDUAL	8.635	1.8032	25.105***	4.5637***	4.893	0.7684
	(8.818)	(1.8978)	(8.110)	(1.6625)	(8.406)	(1.3585)
FIRMAGE	-0.703**	-0.1423**	-0.399*	-0.0636*	-1.260***	-0.1923***
	(0.342)	(0.0692)	(0.228)	(0.0363)	(0.219)	(0.0332)
BRANCH	-25.595*	-4.5873*	-12.569*	-1.9106*	-26.225***	-3.7168***
	(13.577)	(2.1249)	(7.206)	(1.0438)	(6.201)	(0.8101)
OECD	6.528	1.3123	13.009**	1.9871**	20.459***	2.9059***
	(7.179)	(1.4312)	(6.145)	(0.8988)	(5.534)	(0.7268)
CONSTANT	-411.249***	—	-210.512***	—	-352.965***	—
	(37.040)	—	(31.685)	—	(24.932)	—
Observations	2,305		4,799		6,591	
Clusters	1,551		2,560		2,339	
Correctly Predicted	85.29		90.35		90.34	
Log-Likelihood	-866.252		-1458.680		-1957.361	
Pseudo R^2	0.087		0.041		0.064	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables are for discrete changes from 0 to 1. The values in parentheses below the estimates are the usual standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 34. Tests for Homoskedasticity in the Probit Model by Commodity Categories

	Homoskedasticity					
	Consumer Goods		Raw Materials & Fuels		Capital Goods	
	LM test	LR test	LM test	LR test	LM test	LR test
Test statistic	19.943	65.926	65.970	123.224	50.698	83.208
P- value	0.030	0.000	0.000	0.000	0.000	0.000
Critical value	18.307	18.307	18.307	18.307	18.307	18.307
Test result	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected

Note: The critical values for LM and LR tests are derived from the 95th percentile in the chi-squared distribution with 10 degrees of freedom.

Table 35. Heteroskedastic Probit Estimates of Customs Fraud for Consumer Goods

Independent variables	Dependent variable: *FRAUD*			
	Homoskedastic Probit		Heteroskedastic Probit	
	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$
TARIFF	0.008	0.0017	-7.317	0.0037
	(0.080)	(0.0162)	(14.473)	(0.4694)
DETECTION	-1.035***	-0.2097***	-77.60	-0.0031
	(0.231)	(0.0470)	(56.680)	(0.7818)
AUDIT	-1.062***	-0.2150***	-260.053	0.0197
	(0.199)	(0.0385)	(162.938)	(1.5405)
LOG(*IMPORT*)	-0.293	-0.0594	-70.384	0.0357
	(1.671)	(0.3386)	(131.276)	(4.5829)
EXCHANGE	24.591***	4.9808***	130.295	0.8514
	(2.598)	(0.5246)	(206.360)	(117.3061)
NONPROFIT	6.738	1.4168	-482803.0	-88.3565
	(34.691)	(7.5707)	(23523500.0)	(9070.4524)
INDIVIDUAL	8.635	1.8032	-150.763	-0.2444
	(8.761)	(1.8834)	(481.876)	(34.1802)
FIRMAGE	-0.703*	-0.1423*	-53.647	0.0147
	(0.374)	(0.0757)	(47.236)	(1.7688)
BRANCH	-25.595*	-4.5873*	-1580.240	-0.1452
	(13.940)	(2.1865)	(2393.31)	(27.1630)
OECD	6.528	1.3123	-514.802	0.5656
	(7.155)	(1.4288)	(589.405)	(75.2271)
CONSTANT	-411.249***	—	-1947.970	-0.4188
	(37.907)	—	(2733.410)	(66.2810)
Observations	2,305		2,305	
Clusters	1,551		1,551	
Correctly Predicted	85.29 %		85.64 %	
Log-Likelihood value	-866.252		-833.289	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables are computed at the mean values. The partial effect of the Heteroskedastic Probit model, $g(x\hat{\beta})\hat{\beta}$, is equal to $\partial P(y=1|x) / \partial x_j = \phi[x\beta/\exp(z\delta)] \times [(\beta_j - \delta_j x\beta)/\exp(z\delta)]$. The values in parentheses below the Homoskedastic Probit estimates are the standard errors, adjusted for cluster effect. The values in parentheses below the Heteroskedastic Probit estimates are the usual standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 36. Heteroskedastic Probit Estimates of Customs Fraud for Raw Materials & Fuels

Independent Variables	Dependent variable: *FRAUD*			
	Homoskedastic Probit		Heteroskedastic Probit	
	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$
TARIFF	0.985*	0.1568*	-0.899	0.2244
	(0.530)	(0.0848)	(7.265)	(0.4749)
DETECTION	-0.439**	-0.070**	-26.740*	-0.0142
	(0.215)	(0.0343)	(14.528)	(0.2170)
AUDIT	-1.368***	-0.2178***	-66.218**	-0.2139
	(0.330)	(0.0511)	(30.608)	(0.6856)
LOG(*IMPORT*)	-6.284***	-1.0004***	-14.869	-0.8379
	(1.414)	(0.2277)	(19.751)	(1.3414)
EXCHANGE	9.531***	1.5172***	-27.461	1.5996
	(1.895)	(0.3027)	(39.613)	(3.0695)
NONPROFIT	28.625	5.4655	162.549	0.4344
	(23.757)	(5.3093)	(229.561)	(7.3121)
INDIVIDUAL	25.105***	4.5637***	110.754	-0.2718
	(8.047)	(1.6442)	(79.674)	(2.3875)
FIRMAGE	-0.399	-0.0636	-1.736	0.0356
	(0.267)	(0.0422)	(3.335)	(0.1031)
BRANCH	-12.569	-1.9106	-343.796	-0.1188
	(7.680)	(1.1110)	(209.807)	(3.9810)
OECD	13.009**	1.9871**	99.751	1.7922
	(6.381)	(0.9297)	(70.228)	(4.2168)
CONSTANT	-210.512***	—	124.107	1.4534
	(32.489)	—	(500.651)	(3.5391)
Observations	4,799		4,799	
Clusters	2,560		2,560	
Correctly Predicted	90.35 %		90.37 %	
Log-Likelihood value	-1458.680		-1397.068	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables are computed at the mean values. The partial effect of the Heteroskedastic Probit model, $g(x\hat{\beta})\hat{\beta}$, is equal to $\partial P(y=1|x) / \partial x_j = \phi[x\beta/\exp(z\delta)]\times[(\beta_j-\delta_j x\beta)/\exp(z\delta)]$. The values in parentheses below the Homoskedastic Probit estimates are the standard errors, adjusted for cluster effect. The values in parentheses below the Heteroskedastic Probit estimates are the usual standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

Table 37. Heteroskedastic Probit Estimates of Customs Fraud for Capital Goods

Independent variables	Dependent variable: *FRAUD*			
	Homoskedastic Probit		Heteroskedastic Probit	
	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$	$\hat{\beta} \times 100$	$g(x\hat{\beta})\hat{\beta} \times 100$
TARIFF	1.901***	0.2901***	9.680	0.3453
	(0.527)	(0.0777)	(11.469)	(0.5805)
DETECTION	-0.782***	-0.1193***	-33.538**	-0.0760
	(0.229)	(0.0355)	(17.068)	(0.3119)
AUDIT	-1.592***	-0.2429***	-59.454**	-0.1930
	(0.278)	(0.0432)	(27.118)	(0.5601)
LOG(*IMPORT*)	2.733**	0.4169**	25.360	0.240
	(1.185)	(0.1806)	(25.762)	(0.7986)
EXCHANGE	14.482***	2.2093***	-1.822	2.2833
	(1.679)	(0.2731)	(46.608)	(3.5012)
NONPROFIT	18.603	3.2082	104.152	0.3364
	(17.654)	(3.3724)	(514.544)	(11.9146)
INDIVIDUAL	4.893	0.7684	190.798	-4.2105
	(8.645)	(1.3971)	(122.483)	(4.8427)
FIRMAGE	-1.260***	-0.1923***	-14.289*	-0.0802
	(0.323)	(0.0449)	(8.355)	(0.1972)
BRANCH	-26.225***	-3.7168***	-927.616*	-3.4954
	(7.719)	(1.0236)	(537.041)	(10.9984)
OECD	20.459***	2.9059***	-0.337	3.5305
	(5.610)	(0.7378)	(92.588)	(4.9972)
CONSTANT	-352.965***	—	-773.360*	-7.5661
	(28.520)	—	(427.756)	(18.8249)
Observations	6,591		6,591	
Clusters	2,339		2,339	
Correctly Predicted	90.34 %		90.34 %	
Log-Likelihood value	-1957.361		-1915.757	

Note: All the estimates are reported after multiplying by 100 to avoid the confusion from rounding. The partial effects of the dummy variables are computed at the mean values. The partial effect of the Heteroskedastic Probit model, $g(x\hat{\beta})\hat{\beta}$, is equal to $\partial P(y=1\,|\,x) / \partial x_j = \phi[x\beta/\exp(z\delta)]\times[(\beta_j-\delta_j x\beta)/\exp(z\delta)]$. The values in parentheses below the Homoskedastic Probit estimates are the standard errors, adjusted for cluster effect. The values in parentheses below the Heteroskedastic Probit estimates are the usual standard errors. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively.

CHAPTER VII

COMPUTATION OF THE MARGINAL COST OF PUBLIC FUNDS

1. The Empirical Studies on the *MCF*s

Until recently, little work has been done to measure the *MCF* of tariff rates, not to mention the MCF_t in the presence of tariff evasion. The only study done in this area, Clarete and Whalley (1987), finds that the *MCF* of tariffs on import substitutes in the Philippines are in the range of 1.28 to 6.99 for the tariff rates of 5 ~ 30%.[48] We can also get some idea of the MCF^*_t of tariffs by comparing it with the *MCF* with internal taxes, such as sales taxes. Clarete and Whalley (1987) calculate the *MCF* of commodity taxes on import substitutes in the Philippines, which is in the range of 0.93 to 1.11 for the tax rates of 5 ~ 30%. Ballard, Shoven, and Whalley (1985) calculate the *MCF* associated with consumer sales taxes, which is in the range of 1.256 to 1.388.[49]

There are only two studies to compute the *MCF* in the presence of evasion, Fortin and Lacroix (1994) and Poapongsakorn, et. al (2000). However, both of these empirical studies of the *MCF* with evasion have been focused on the *MCF* of the income tax. No work has been done to measure empirically the *MCF* of indirect taxes, such as commodity taxes and tariffs, in the presence of evasion.

Fortin and Lacroix (1994) find that the *MCF* of an income-tax rate in the presence of

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[48] For their case, when a tariff rate is 10%, the *MCF* is 1.46.

[49] Their central case is the value of 1.388 with elasticities of 0.4 for saving and 0.15 for labor supply. It should be noted that they use a Cobb-Douglas utility function that imposes the assumption of unitary elasticities. This may overstate the demand elasticity for many goods, especially for alcohol, tobacco, and gasoline, which are the goods with the highest tax rates. Thus, they may overstate the *MCF* for sales taxes.

evasion is in the range of 1.444 and 1.529, using a simultaneous model of labor supply in the regular and irregular sectors. These values are greater than the corresponding values of the *MCF* in the absence of evasion (no irregular market), which ranges from 1.393 to 1.508. Fortin and Lacroix (1994) also explicitly consider the penalty as one of the effective policy tools to raise revenues in the presence of evasion. They find that the *MCF* with respect to penalty rates is 1.33, which is far lower than *MCF*s of tax rates with and without evasion. Fortin and Lacroix (1994) find that the *MCF* associated with a probability of audit is 1.47, assuming that it could be raised at no cost to the government and is determined exogenously. As they point out, taking enforcement expenditures into account is likely to increase the *MCF*.

Recently, Poapongsakorn et al. (2000) find that the *MCF* from raising income-tax rates is 1.043 at their base case labor supply elasticitiy, 0.02. They also compute the *MCF* from additional tax enforcement (taxpayer survey). With intermediate risk aversion, the *MCF* of an increase in the taxpayer survey is in the range of 1.40 and 11.60, depending on the survival rates of firms.

Previous studies on the *MCF* in the presence of income-tax evasion and the related studies on the *MCF* of commodity tax or tariff in the absence of evasion are summarized in Table 38.

2. The *MCF* in the Absence of Tariff Evasion

We can get a numerical value of the *MCF* without tariff evasion, MCF_t^*, using the average effective tariff rate and the elasticity of import demand with respect to the price for each of the commodity categories given in Tables 38 and 39.

First, I calculate the average effective tariff rate for each of the commodity categories, by just summing up all the rates and dividing them by the number of observations in each commodity category. These are not weighted-average tariff rates, since I do not account for the amount of imports. However, despite their limitations, considering the data availability, they can still give some useful information about average tariff rates. In addition, this problem can be solved by sensitivity analysis, using different values of effective tariff rates and elasticities. Actual amount of imports and average effective tariff rates by commodity categories in 1998 are presented in Table 39.

Second, according to a trade index published by the KCS, the average import price in U.S. dollars was 17.82% lower in 1998 than in 1997. The average quantity or weight also decreased by 21.51%. As a result, the total amount of imports (unit import price × quantity or weight) decreased by 35.5% in U.S. dollars in 1998. However, if we convert the measurement of the unit price from U.S. dollar to Korean won, using an average exchange rate in each year, the average import price in terms of Korean won increases by 16.65%. This is mainly due to an increase in the exchange rate.[50] In terms of the Korean won, the import volume decreases only by 8.42%. Then, dividing percentage quantity changes by percentage price changes in the Korean won, we can roughly estimate

[50] The average exchange rate used to determine the customs value was 1,011 Korean won per U.S. dollar in 1997 and 1,435 *W*/$ in 1998. Thus, the exchange rate increased by 41.94%.

elasticities of demands for imported goods with respect to the price, $\varepsilon_{XP^{\wedge}} = (\Delta X/X) / (\Delta P/P)$, other things being the same. Import price elasticities by commodity categories are provided in Table 40.

It should be noted that, in calculating demand elasticities based on observations from 1997 and 1998, I control for the change in income (e.g., Gross National Product), since the observed changes in the quantity of imports are accounted for not only changes in import prices, but also changes in income. The GNP in Korea decreased by 5.8% in 1998 compared with that in 1997. Thus, I adjust the 1998 quantities by 5.8% to account for a decrease in income.[51] If I do not consider the reduction in income, I would have higher elasticities in absolute terms, other things being equal. This adjustment may not reflect the true effects of the income decrease on quantities on import, since I adjust changes in quantities by the same proportions for all commodities, without accounting for the different effects of a decrease in income on different commodities. However, despite this limitation, our adjustment may generate price elasticities of imports that are close to the true values, since changes in income affect the quantity of imports, and there is no other way to consider the effects of income except for this method.

It is shown in Table 39 that the overall elasticity of Korean imports is –0.94. The import elasticities for Consumer Goods, Crude Materials & Fuels, and Capital Goods are –1.17, –0.83, and –1.01, respectively. All of these are fairly close to unity. Considering

[51] By adjusting 1998 quantities by 5.8%, I implicitly assume that the elasticity of imports with respect to income is unity. This is not far from existing estimates of the elasticity of Korean imports. For example, Senhadji (1998) finds that the income elasticity of Korean imports is 1.32, using annual data from 1960 to 1993. Giorgianni and Milesi-Ferretti (1997) also find that the income elasticity of Korean imports is in the range of 1.24 – 1.40, using quarterly data for the period of 1973 – 1995. With annual data, the elasticity is estimated to be 1.20. Mah (1993) shows that the income elasticity of Korean imports is 0.658, using quarterly data for the period of 1971-1988.

the Korean import regime (high weight of Raw Materials & Fuels and Capital Goods), these estimates are reasonable. Because of the lack of natural resources, Korea depends heavily on foreign trade, by importing most crude materials and capital goods, assembling and making goods with these raw materials and capital goods, and then exporting these goods.[52] Thus, for the case of Korea, it is not surprising that raw materials and capitals goods account for more than 90% of total imports, which are used mainly for the production of exports. In this context, it can be reasonably argued that imports, especially Crude Materials & Fuels and some of Capital Goods, are not so elastic in demand with respect to the price. In addition, these elasticities are in accordance with studies for the elasticity of imports for Korea, although there are no empirical studies on these elasticities by commodity category using micro data.[53]

It should be noted that, for some commodities, the price elasticities of Korean imports are greater than zero. Non-durable consumer goods, Minerals, and Electric & Electronic machinery have the positive elasticities. For non-durable consumer goods, we can reasonably expect that the demands for high-priced goods, such as cosmetics and fur coats, tend to increase with price because of some psychological effects, such as bandwagon effects, Veblen effects, etc. For Minerals and Electric & Electronic

[52] The shares of Consumer Goods, Crude Materials & Fuels, and Capital Goods in total imports in 1998 are 9.54%, 54.23%, and 36.23%, respectively.

[53] Senhadji (1998) shows that the price elasticity of Korean imports is –0.84, using annual data over the period 1960-1993, where the ratio of the import deflator to the GDP deflator is used as the relative price of imports. Giorgianni and Milesi-Ferretti (1997) find that the price elasticity of Korean imports is -1.07 when the prices are measured using the ratio of the unit value of imports to the domestic wholesale price index, and –0.69 when the CPI-based real effective exchange rate is used, using quarterly data for the period 1973-1995. With annual data, they find that the price elasticity of imports is –1.19, using the ratio of the unit value of imports to the domestic wholesale price index. Mah (1993) shows that the price elasticity of Korea imports is –1.029, using quarterly data for the period of 1971-1988, where the ratio of the import price index to wholesale price index is used. All of these studies show that the elasticity of Korean imports with respect to the price is very close to unity.

machinery, it is hard to give any plausible explanation for the positive elasticities. For Minerals, it is possible that a decrease in income has little effects on the quantity of imports. For Electric & Electronic machinery, it may be the case that the quantity index is mis-measured.

With these parameter values, the MCF_t^* without evasion can be calculated from equation (22), $MCF_t^* = 1 / \{1 + [t/(1+t)]\varepsilon_{XP^\wedge}\}$. Table 41 shows the MCF_t^* for each commodity category. Despite some limitations in the calculation of effective tariff rates and elasticities, our numerical values can still provide us with valuable information about the *MCF*s of effective tariff rates in the absence of evasion. As we expect, the *MCF* in Crude Materials & Fuels has the lowest value, among the commodity categories, at 1.1446. This is because these goods have relatively lower import demand elasticities and effective tariff rates. Accordingly, the Consumer Goods sector, with higher elasticities and tariff rates, has the highest value of the *MCF*, 1.3064. The *MCF* in Capital Goods is 1.1722, which falls between the *MCF*s for Consumer Goods and Crude Materials & Fuels.

Table 42 shows the *MCF* of tariff rate change in the absence of evasion, MCF_t^*, for each of the commodity categories for different import demand elasticities. As indicated above, if we do not consider changes in income, we may have higher import-demand elasticities. However, given the effective tariff rates of each category, there are no dramatic changes in the MCF_t^* for lower elasticities. Our central case in the absence of evasion is an MCF_t^* of 1.1738 with the import demand elasticity of -0.94 and the effective tariff rate of 18.70%. It should be noted that the average pure tariff rate excluding internal taxes is 8.14%. The *MCF* for the pure tariff rate is 1.0761, which is smaller than our central case, 1.1738.

Table 43 gives the MCF_t^* for different demand elasticities and tariff rates. The *MCF*s with higher tariff rates are more sensitive to changes in the demand elasticity than the *MCF*s with lower tariff rates. Similarly, the *MCF*s with higher import-demand elasticities are more sensitive to changes in the tariff rates than the *MCF*s with lower elasticities.

3. The *MCF* in the Presence of Tariff Evasion

Some of the key parameter values in calculating the *MCF* with tariff evasion are the elasticities of evasion. Table 44 gives the elasticities of tariff evasion with respect to the tariff rate, the audit rate, and the detection rate, which are estimated in Chapter V.

For the calculation of the MCF_i, we should also specify the concealing cost, c, incurred by the importer to evade tariff payments, and the elasticity of the concealing cost with respect to the fraction of imports undeclared, $\varepsilon_{c\alpha}$. These values cannot be directly observed or estimated. Thus, I choose concealing costs, which are equal to $c_1 = 0.9(t\text{-}t^e)$ and $c_2 = 0.45(t\text{-}t^e)$, so that they satisfy the condition, $c + t^e < t$, in chapter III. For $\varepsilon_{c\alpha}$, I use various values, such as 0.1, 0.05, and 0.01, to see the sensitivity of the MCF_i.

As mentioned in chapter II, concealing costs include costs of special packaging, costs of misinvoicing, extra costs (premiums) of purchasing foreign exchange in the black market, etc. These concealing costs and elasticities are different from commodity to commodity, depending on their nature and characteristics. Table 45 provides concealing costs per one million Korean Won of imports by commodity categories.

For some agricultural products, concealing costs may be relatively higher and more elastic than those for other imported goods. For example, potato starch is a highly dutied product (customs duty rate, 327.8%). This is often intentionally mixed with bread crumbs to be disguised as prepared potato (duty rate, 20%). After customs clearance, the potato starch is separated from the mixture. The bread crumbs are then discarded, and the potato starch is sold as such. In this case, the concealing costs would not be trivial. They would also increase by a large amount, as the amount of potato starch to be disguised as prepared potato increases. In this case, the importer would need much more bread crumbs. The concealing costs include not only the bread crumbs, but also the necessary expenses or efforts to separate the potato starch from the mixture. Thus, an increase in the tariff rate would increase tariff evasion. An increased amount of evaded tariff payments again would result in an increased concealing costs incurred by the importer. For goods like potato starch, due to its nature and characteristics, the concealing costs per dollar of imports, c, may be relatively large, and the elasticity of the concealing cost with respect to tariff evasion may also be relatively large.

For the other goods, such as Capitals goods and Consumer goods, the amount of concealing costs would be negligible, and these costs would be relatively inelastic with respect to the degree of evasion, since tariff payments are generally evaded by misinvoicing or counterfeiting of related documents.[54] For these goods, the elasticity of the concealing cost with respect to tariff evasion may be close to zero.

Thus, in computing the *MCF*s associated with different policy tools, I choose relatively small parameter values as our base cases, such that the concealing costs = c_2 and the elasticity of concealing costs with respect to evasion = 0.05.

In addition, the firm's expected tariff payments per Korean won of imports, $t^e \equiv [(1\text{-}\alpha) + \beta(1+\theta)\alpha]t$, defined in chapter III, should satisfy the condition, $[(1\text{-}\alpha) + \beta(1+\theta)\alpha] < 1$. As indicated in chapter III, without this condition, there is no incentive at all to evade tariffs by incurring concealing costs. That is, t should be greater than t^e in all commodity categories. To check this condition, the firm's expected tariff payments per import

[54] Because of the continuing deregulation of the foreign exchange market in Korea, the extra costs of selling or purchasing the foreign exchange in the black market will be small. In addition, it is more likely that special packaging, which is relatively expensive and elastic in costs, is used in smuggling of drugs or gold & jewelry, rather than in legally disguised smuggling. The purpose of special packaging in this case is to successfully pass X-ray inspection machines, metal detectors, or sensors for drugs.

(expected tariff rate in the presence of evasion) by category are calculated using the average values of α, β, and θ in each commodity category. These results are presented in Table 46. In all categories, the condition, $[(1-\alpha) + \beta(1+\theta)\alpha] < 1$, is satisfied. Thus, the true tariff rate, t, is greater than the expected tariff rate with evasion, t^e.

For the elasticities of demand for imported goods in the presence of evasion, I assume that they have the same values of elasticities as those without tariff evasion, discussed above. Thus, the elasticities in Table 40 are used for the calculation of the *MCF* with evasion.

3-1. The *MCF* of the Tariff Rate Change in the Presence of Evasion

The *MCF*s of the tariff rate change in the presence of evasion are calculated using the formula, given in equation (49),

$$MCF_t = 1 / \{1 + [t^e / (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha t}(c/t^e)\}.$$

As mentioned in chapter IV, this formula is derived by assuming that the probability of audit and the probability of detection are exogenously determined, and they could be raised at no cost to the government, in accordance with our empirical analysis.

Among the parameters in equation (49), the values of $\varepsilon_{\alpha t} = (\partial\alpha/\partial t)(t/\alpha)$ are derived from the partial effects of tariff rates on evasion $(\partial\alpha/\partial t)$ at the average values of evasion and tariff rates, which are estimated using a Tobit model in chapter V. Thus, in computing the MCF_t, I use the lower and upper bounds of the confidence intervals for the partial effects of tariff rates, as well as the point estimates. In addition, I also consider the case where an increase in the tariff rate has no effect on evasion, so that $\varepsilon_{\alpha t} = 0$ or $(\partial\alpha/\partial t) = 0$. This procedure would provide a range of likely values for the partial effects of tariff rates and, thus, for the *MCF*s of the tariff rate increase in the presence of evasion. Table 47 provides possible values of the MCF_t at corresponging values of $\varepsilon_{\alpha t}$ or $(\partial\alpha/\partial t)$. Our central cases of the MCF_t are in the range of 1.1443 to 1.3044 for three commodity categories, with $\varepsilon_{c\alpha} = 0.05$ and c_2. It is shown that the *MCF*s of the tariff rate increase are very insensitive to different values of $\varepsilon_{\alpha t}$ or $(\partial\alpha/\partial t)$.

I also compute the values of the MCF_t with different parameter values for the elasticities of concealing costs with respect to evasion and concealing costs, to see the sensitivity of the MCF_t. As given in Table 48, the MCF_t's are shown to be insensitive to both the concealing cost and the elasticity of the concealing cost with respect to evasion. They are robust to these parameter values as well as the elasticities of evasion with respect to tariff rate, as shown in Table 47. Thus, variation of the MCF_t in each of the commodity categories is very small. This is because the third term in the denominator of the formula for the MCF_t, $\varepsilon_{c\alpha}\varepsilon_{\alpha t}(c/t^e)$, has very little effect on the values of the MCF_t due to the very small values of the concealing cost, c. The variations in the MCF_t across commodities come mainly from the differences in the expected tariff rates and the elasticity of import demand with respect to the price.

Comparing the MCF_t with the MCF_t^*, we find very interesting results. For all commodity categories, regardless of parameter values, the MCFs of the tariff rate change in the presence of evasion are strictly smaller than the correponding values of the MCFs in the absence of evasion. These results can be explained in terms of the marginal utility loss or the marginal tariff revenue. In the presence of tariff evasion, the marginal utility loss from an increase in a tariff rate is smaller than in its absence, since the consumer price will increase by a smaller amount with evasion, which works toward a lower MCF. An increase in the tariff rate will increase the firm's expected tariff payment, t^e, by a smaller amount. This effect works toward a lower marginal tariff revenue (MTR) and, thus, a higher MCF. However, the amount of imports will decrease by a smaller amount, since the market price with evasion will increase by less than 1. This effect works toward a higher MTR and, thus, a lower MCF. In addition, when the elasticities of concealing costs with respect to evasion are lower, the marginal tariff revenue will have a higher value, which lowers the *MCF*, other things being the same. Thus, with a lower $\varepsilon_{c\alpha}$, it is more likely that the marginal tariff revenue with evasion has a higher value. When combined with a smaller marginal utility loss, it is not surprising that the MCF_t's in the presence of evasion have smaller values than in its absence. Even if the marginal tariff revenue with evasion increases by a smaller amount, it is possible that we may have a lower MCF_t when the marginal utility loss from a tariff rate with evasion is so small.

However, for all commodity categories, the difference between the *MCF* of the tariff rate in the presence of evasion and the *MCF* of the tariff rate in the absence of evasion is very small. They are very similar in their maganitudes. Thus, even if we account for the presence of evasion in calculating the MCF_t, it does not have much of an effect on the values of the MCF_t.

This is partly because the second term in the denominator of the formula for the MCF_t, $[t^e / (1+c+t^e)]\varepsilon_{XP}$, is very close to that for the MCF_t^*,$[t/(1+t)]\varepsilon_{XP\wedge}$, since the expected tariff rate, t^e, is not far from the true tariff rate, t, the concealing cost, c, is small in magnitude, and I assume that the import demand elasticities in the presence of evasion and in the absence of evasion are the same.

Second, the third term in the denominator of the formula for the MCF_t, $\varepsilon_{c\alpha}\varepsilon_{\alpha t}(c/t^e)$, has little effect on the value of the MCF_t, since $[(1-\alpha) + AD(1+\theta)\alpha]$ is very close to 1, and the concealing cost, c, is very small to satisfy the condition, $c < (t - t^e)$.[55]

All of these similarities come from the very small values of evasion, α. Greater

[55] I choose concealing costs, $c_1 = 0.9(t-t^e)$ and $c_2 = 0.45(t-t^e)$, so that they satisfy this condition.

evasion would lead to much smaller values of the expected tariff rate, and, thus, would result in much greater differences between the values of the *MCF* of the tariff rate in the presence of evasion and those in the absence of evasion. When I assume that relatively large amounts of tariffs are evaded, such that $\alpha = 0.1$, the expected tariff rate is far smaller than the true tariff rate in each of the commodity categories ($[(1-\alpha) + AD(1+\theta)\alpha]$ deviates from 1 by a larger amount), as given in Table 49.

Then, as shown in Table 50, the corresponding values of the *MCF*s of the tariff rate in the presence of greater evasion have much smaller values than those derived with little evasion in Table 47. This is because, in the presence of greater evasion, the marginal utility loss from an increase in a tariff rate would be much smaller, since the consumer price would increase by a smaller amount than with little evasion. In addition, the amount of imports would decrease by a smaller amount, since the market price with evasion will increase by smaller amount, than with little evasion. These effects work toward much lower values of the *MCF* in the presence of greater evasion.

Accordingly, the difference between the *MCF* of the tariff rate change with evasion and those without evasion would be greater, as more tariff payments are evaded.

3-2. The *MCF* of the Penalty Rate Change in the Presence of Evasion

The *MCF* associated with the penalty rate in the presence of evasion can be calculated using the following formula, equation (50),

$$MCF_\theta = 1 / \{1 + [t^e / (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha\theta}(c/\theta)/[AD\alpha t]\}.$$

Since the penalty rate is fixed to 10% in most cases, we cannot directly estimate the elasticity of evasion with respect to the penalty rate. Thus, I use several values for the elasticity, such as $\varepsilon_{\alpha\theta}$ = -0.01, -0.05, and -0.1, to see the sensitivity of the values in the MCF_θ. I choose relatively small values of the elasticity of evasion with respect to the penalty rate. This is because an increase in the penalty rate would not have huge impacts on the evasion decision, since the legislative penalty rate is so low, 10% of the evaded tariff and tax payments, in most cases. Thus, most importers would not be so sensitive to a change in the penalty rate. The values of the MCF_θ with different values of $\varepsilon_{\alpha\theta}$s, $\varepsilon_{c\alpha}$s, and the concealing costs are given in Table 51 through 53.

Unlike the *MCF* of the tariff rate with evasion, the MCF_θs are found to be very sensitive to both the concealing cost and the elasticity of the concealing cost with respect to evasion. This is because the third term in the denominator of the formula for the MCF_θ, $\varepsilon_{c\alpha}\varepsilon_{\alpha\theta}(c/\theta)/[AD\alpha t]$ has relatively large impact on the values of the MCF_θ. As expected, an increase in the deterrent effects of the penalty rate (an increase in the absolute values of $\varepsilon_{\alpha\theta}$) reduces the values of the MCF_θ. As shown in chapter III and IV, if an increase in the penalty rate has deterrent effects on evasion, the MCF_θ is always lower than the MCF_t, regardless of the other parameter values. Thus, it is clear that the MCF_θ's are smaller than the MCF_t's in all categories, regardless of parameter values. These results are intuitively obvious. The marginal utility loss from an increase in the penalty rate is less than the marginal utility loss from an increase in the tariff rate, since the consumer price increases by a smaller amount in response to an increase in the penalty rate. That is, $\partial P/\partial\theta$ is less than $\partial P/\partial t$, since $\partial P/\partial t$ implicitly includes additional concealing costs for an increase in evasion, while $\partial P/\partial\theta$ includes the decreased amount of these costs for a decrease in evasion. In addition, when the penalty rate increases, the tax base (the quantity demanded for imported goods) decreases by a smaller amount compared with the case of an increase in the tariff rate. Thus, as shown in Table 51 through Table 53, in the presence of evasion, the values of the MCF of a penalty rate change are always smaller than the MCF of a tariff rate change in all commodities

3-3. The *MCF* of the Audit Rate Change in the Presence of Evasion

The *MCF*'s of the probability of audit in the presence of evasion are calculated using the following formula, equation (51) in chapter IV,

$$MCF_A = 1 / \{1 + [t^e / (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha A}c/[AD(1+\theta)\alpha t]\},$$

The values of the MCF_t in Table 54 are computed at the point estimates of the coefficients of the audit rate variable and the lower and upper bounds of the corresponding confidence intervals. Our central cases of the MCF_A are in the range of 0.6170 and 1.4980, depending on the commodity categories, with $\varepsilon_{c\alpha} = 0.05$ and c_2.

Comparing the MCF_A with the MCF_t^* and the MCF_t, the values of the MCF_A are usually smaller, except for Crude Materials and Capital Goods at the upper bound of the confidence interval for the partial effects of the audit rate on evasion. At the upper bound for these two categories, the partial effect of the audit rate on evasion, and, thus, the elasticities of evasion with respect to the audit rate have positive values. These positive values result in greater values of the MCF_A. If an increase in the audit rate has deterrent effects on evasion (if the partial effect of the audit rate is positive), then the values of the MCF_A are always smaller than the *MCF* of a tariff rate change with and without evasion, with similar reasons to the *MCF* of the penalty rate.

It should be noted that the values of the MCF_A are sometimes less than one. In particular, all values of the MCF_A are smaller than one, at the lower bound in each of the commodity categories. At the lower bound, the partial effect of an audit rate (the elasticities of evasion with respect to the audit rate) has the greatest values in absolute terms. Thus, if an increase in the audit rate effectively deters evasion and the audit rate can be increased without any resource costs to government, then the government can solely depend on an increase in the audit rate to raise revenues in the presence of evasion.

I also compute the values of the MCF_A with different parameter values for the concealing costs and the elasticities of concealing costs with respect to evasion, to see the sensitivity of the MCF_A, which is given in Table 55. Like the MCF_θ, the values of the MCF_A's are found to be sensitive to both the concealing costs and the elasticity of concealing cost with respect to evasion. Compared with the MCF_θ, the values of the MCF_A are shown to be smaller than those of the MCF_θ at the corresponding parameter values, if the penalty rate has only small deterrent effects on evasion, such as $\varepsilon_{\alpha\theta} = -0.01$. With greater deterrent effects of the penalty rate, such as $\varepsilon_{\alpha\theta} = -0.05$ or -0.1, the values of the MCF_A are greater than those of the MCF_θ, at the corresponding parameter values.

Thus, the relative attractiveness of each of the policy variables depends on whether it has greater deterrent effect on tariff evasion. If one policy variable is more effective in discouraging evasion, then it is a more attractive policy tool to raise additional government revenues for a certain public project in the presence of evasion.

If there are relatively much evasion, such that $\alpha = 0.1$, as shown in Table 56, the corresponding values of the MCFs of the audit rate in the presence of evasion have usually much greater values than those derived with little evasion. In the presence of a greater degree of evasion, even if an increase in the audit rate has a deterrent effect on evasion, the marginal revenue would be much smaller than the marginal revenue with little evasion, whcih work toward greater values of the MCFs. If this unfavorable effect on the *MCF* exceeds the favorable effects on the *MCF* with greater evasion, such as the smaller amount of the marginal utility loss and a smaller decrease in the amount of imports, then the *MCF* of the audit rate change in the presence of greater evasion has the greater values than those derived in the presence of little evasion.

3-4. The *MCF* of the Detection Rate Change in the Presence of Evasion

The *MCF*'s of the probability of detection given the audit in the presence of evasion are calculated using the following formula, which was given in equation (52),

$$MCF_D = 1 / \{1 + [t^e / (1+c+t^e)]\varepsilon_{XP} - \varepsilon_{c\alpha}\varepsilon_{\alpha D}c/[AD(1+\theta)\alpha t]\}.$$

The values of the MCF_D in Table 57 are also computed at the point estimates of the partial effect of the detection rate on evasion and the lower and upper bounds of the corresponding confidence intervals.

Our central cases of the MCF_D are in the range of 0.6983 and 2.2998, depending on the commodity categories, with $\varepsilon_{c\alpha} = 0.05$ and c_2. Comparing the MCF_D with the MCF_t^* and the MCF_t, if an increase in the detection rate has deterrent effects on evasion (if the partial effect of the detection rate is negative), then the values of the MCF_D are smaller than those of the MCF_t^* and the MCF_t. However, for all categories, the values of the MCF_D are shown to be greater than those of the MCF_A. This is because the absolute values of the elasticities of evasion with respect to the audit are greater than the elasticities with respect to the detection rate in all commodities.

As with the MCF_A, the MCF_D are sometimes less than one. If an increase in the detection rate effectively deters evasion, and it can be raised without incurring any resource cost to the government, then the detection rate would be an attractive policy tool to raise revenues in the presence of evasion.

I do the sensitive analysis with different parameter values for the concealing costs and the elasticities of concealing costs with respect to evasion as given in Table 58. Like the MCF_θ and the MCF_A, the values of the MCF_D's are sensitive to the elasticity of concealing cost with respect to evasion. In all commodity categories, the values of the MCF_D are greater than those of the MCF_A and the MCF_θ even with $\varepsilon_{\alpha\theta}$ = -0.01 at the corresponding parameter values.

With similar reasons to the MCF_A, greater evasion leads to much higher values than those derived with little evasion, in most cases. This result is provided in Table 59.

Table 38. Empirical Studies on the *MCF* in the Presence of Evasion

Empirical Studies	MCF_t^*	MCF_t	MCF_θ	MCF_A	MCF_D
Ballard et al. (1985)					
- Sales Tax	1.256 ~ 1.388	—	—	—	—
Clarete and Whalley (1987)					
- Tariff	1.28 ~ 6.99	—	—	—	—
- Commodity Tax	0.93 ~ 1.11	—	—	—	—
Fortin and Lacroix (1994)					
- Income Tax	1.393 ~ 1.508	1.444 ~ 1.529	1.33	1.47	—
Poapongsakorn et al. (2000)					
- Income Tax	—	1.043	—	1.40 ~ 11.60	—
This Study					
- Effective Tariff	1.145 ~ 1.306	1.144 ~ 1.304	0.950 ~ 1.304	0.617 ~ 1.498	0.698 ~ 2.30

Note: MCF_t^* denotes the *MCF* of a tax (tariff) rate increase in the absence of evasion. MCF_t denote the *MCF* of a tax (tariff) rate increase in the presence of evasion. MCF_A denotes the *MCF* of an audit rate increase in the presence of evasion. MCF_D denotes the *MCF* of a detection rate increase, given an audit, in the presence of evasion.

Table 39. Effective Tariff Rates by Category

Classification	Import (million $)	Effective Tariff Rate (%)
Consumer Goods	8,896	25.07
Cereal	2,520	45.49
Direct Consumer Goods	2,458	41.86
Durable Consumer Goods	2,800	19.24
Non-durable Consumer Goods	1,089	18.58
Crude Materials & Fuels	50,591	17.95
Fuels	18,165	18.69
Minerals	3,146	11.84
Light-Industrial Crude Materials	3,778	12.58
Oil & Fat	279	18.50
Fibre	2,073	20.90
Chemicals	6,117	18.41
Iron & Steel Products	2,979	17.23
Non-Ferrous Metals	3,317	16.95
Capital Goods	33,795	17.02
Machinery & Precision Equipment	11,227	18.44
Electric & Electronic Machinery	19,961	16.10
Transport Equipment	1,491	18.50
Overall	93,282	18.70

Table 40. Demand Elasticities of Imported Goods by Commodity

Classification	Price Change (A)	Quantity Change (before adjust)	Quantity Change (after adjust, C)	Elasticity (C/A)
Consumer Goods	18.75	-27.79	-21.99	-1.17
Cereal	23.75	-6.80	-1.0	-0.04
Direct Consumer Goods	25.08	-35.20	-29.40	-1.17
Durable Consumer Goods	29.27	-33.07	-27.27	-0.93
Non-durable Consumer Goods	-29.93	-19.49	-13.69	0.46
Crude Materials & Fuels	18.83	-21.48	-15.68	-0.83
Fuels	12.41	-15.71	-9.91	-0.80
Minerals	21.78	-5.04	0.76	0.03
Light-Industrial Crude Material	23.83	-24.94	-19.14	-0.80
Oil & Fat	38.41	-13.72	-7.92	-0.21
Fibre	21.90	-25.95	-20.15	-0.92
Chemicals	19.73	-17.36	-11.56	-0.59
Iron & Steel Products	36.24	-44.72	-38.92	-1.07
Non-Ferrous Metals	23.59	-17.57	-11.77	-0.50
Capital Goods	13.26	-19.19	-13.39	-1.01
Machinery & Precision Equipment	30.95	-44.39	-38.59	-1.25
Electric & Electronic Machinery	3.48	3.54	9.34	2.68
Transport Equipment	40.66	-45.58	-39.78	-0.98
Overall	16.65	-21.51	-15.71	-0.94

Note: Units for price and quantity changes are percentage (%). Quantity change (before adjust) and (after adjust) denote changes in the quantity of imports before and after the adjustment of quantity change accounting for the income decrease, respectively.

Table 41. The *MCF* in the Absence of Tariff Evasion

Classification	Effective Tariff (%)	Elasticity	MCF_t^*
Consumer Goods	25.07	-1.17	1.3064
Cereal	45.49	-0.04	1.0127
Direct Consumer Goods	41.86	-1.17	1.5273
Durable Consumer Goods	19.24	-0.93	1.1766
Non-durable Consumer Goods	18.58	0.46	0.9328
Crude Materials & Fuels	17.95	-0.83	1.1446
Fuels	18.69	-0.80	1.1441
Minerals	11.84	0.03	0.9968
Light-Industrial Crude Materials	12.58	-0.80	1.0982
Oil & Fat	18.50	-0.21	1.0339
Fibre	20.90	-0.92	1.1891
Chemicals	18.41	-0.59	1.1010
Iron & Steel Products	17.23	-1.07	1.1866
Non-Ferrous Metals	16.95	-0.50	1.0781
Capital Goods	17.02	-1.01	1.1722
Machinery & Precision Equipment	18.44	-1.25	1.2416
Electric & Electronic Machinery	16.10	2.68	0.7291
Transport Equipment	18.50	-0.98	1.1806
Overall	18.70	-0.94	1.1738

Table 42. The MCF_t^* by Category for Different Import Demand Elasticities

Category	Import Demand Elasticites						
	-0.59	-0.70	-0.83	-0.94	-1.01	-1.17	-1.25
Consumer Goods	1.1341	1.1632	1.1996	1.2322	1.2538	1.3064*	1.3343
Materials & Fuels	1.0986	1.1192	1.1446*	1.1669	1.1816	1.2166	1.2349
Capital Goods	1.0939	1.1134	1.1373	1.1584	1.1722*	1.2051	1.2222
Overall	1.1025	1.1239	1.1504	1.1738*	1.1892	1.2260	1.2452

Note: * denotes our central case of elasticities and MCF_t^* by category.

Table 43. The MCF_t^* for Different Parameter Values

Tariff Rate	*Import Demand Elasticities*				
	-0.20	-0.70	-1.30	-2.00	-3.00
5%	1.0096	1.0345	1.0660	1.1053	1.1667
8%	1.0150	1.0547	1.1066	1.1739	1.2857
12%	1.0219	1.0811	1.1618	1.2727	1.4737
18%	1.0315	1.1195	1.2474	1.4390	1.8438
25%	1.0417	1.1628	1.3514	1.6667	2.5
40%	1.0606	1.250	1.5909	2.3333	7.0

Table 44. Estimated Elasticities of Tariff Evasion by Category

Classification	Tariff Elasticity	Audit Elasticity	Detection Elasticity
Consumer Goods	0.102	-0.416	-0.081
Crude Materials & Fuels	0.852	-0.164	-0.083
Capital Goods	1.026	-0.186	-0.050
Overall	0.114	-0.232	-0.072

Note: Tariff Elasticity, Audit Elasticity, and Detection Elasticity denote the elasticities of tariff evasion with respect to the tariff rate, the audit rate, and the detection rate, respectively. Only for Consumer Goods are the elasticities of evasion with respect to the audit rate significantly different from zero. The elasticities of tariff evasion with respect to the detection rate in all commodity categories are not significantly different from zero, since the coefficients of the detection rate are insignificant.

Table 45. Concealing Costs per One Million Korean Won of Imports

Classification	$c_1(W)$	$c_2(W)$
Consumer Goods	1,053	527
Crude Materials & Fuels	333	167
Capital Goods	261	131
Overall	405	203

Table 46. Expected Tariff Rates by Category

Classification	$[(1-\alpha) + AD(1+\theta)\alpha]$	*Expected Tariff* (%)	*True Tariff* (%)
Consumer Goods	0.9941	24.924	25.072
Crude Materials & Fuels	0.9977	17.913	17.954
Capital Goods	0.9981	16.983	17.015
Overall	0.9972	18.648	18.70

Table 47. The MCF_t in the Presence of Tariff Evasion with $\varepsilon_{c\alpha} = 0.05$ and c_2

Classification	0	Lower Bound	Point Estimate	Upper Bound
Consumer Goods	1.3043	1.3043	1.3044	1.3044
Crude Materials & Fuels	1.1443	1.1443	1.1443	1.1444
Capital Goods	1.1718	1.1718	1.1719	1.1719
Overall	1.1733	1.1733	1.1733	1.1733

Table 48. Sensitivity Analysis of the MCF_t with Different Parameter Values

Category	MCF_t					
	$\varepsilon_{c\alpha} = 0.1$		$\varepsilon_{c\alpha} = 0.05$		$\varepsilon_{c\alpha} = 0.01$	
	c_1	c_2	c_1	c_2	c_1	c_2
Consumer Goods	1.3043	1.3044	1.3042	1.3044	1.3042	1.3043
Crude Materials	1.1444	1.1444	1.1443	1.1443	1.1443	1.1443
Capitals Goods	1.1720	1.1719	1.1719	1.1719	1.1718	1.1718
Overall	1.1733	1.1733	1.1733	1.1733	1.1733	1.1733

Note: For the sensitive analysis, the partial effect of the tariff rate on evasion in each of the commodity categories is set equal to the point estimate, so that $\varepsilon_{\alpha t} = 0.102$ for Consumer Goods, $\varepsilon_{\alpha t} = 0.852$ for Raw Materials & Fuels, $\varepsilon_{\alpha t} = 1.026$ for Capital Goods, $\varepsilon_{\alpha t} = 0.114$ for Overall, as given in Table 43.

Table 49. Expected Tariff Rates with Higher Evasion Ratio ($\alpha = 0.1$)

Classification	$[(1-\alpha) + AD(1+\theta)\alpha]$	*Expected Tariff* (%)	*True Tariff* (%)
Consumer Goods	0.9033	22.648	25.072
Crude Materials & Fuels	0.9012	16.180	17.954
Capital Goods	0.9013	15.336	17.015
Overall	0.9016	16.860	18.70

Table 50. The MCF_t in the Presence of Tariff Evasion with $\alpha = 0.1$

Classification	0	Lower Bound	Point Estimate	Upper Bound
Consumer Goods	1.2766	1.2766	1.2766	1.2766
Crude Materials & Fuels	1.1309	1.1309	1.1309	1.1310
Capital Goods	1.1553	1.1553	1.1554	1.1554
Overall	1.1572	1.1572	1.1572	1.1572

Note: I use the same parameter values as in Table 46, such that $\varepsilon_{c\alpha} = 0.05$ and c_2.

Table 51. The MCF_θ in the Presence of Tariff Evasion with $\varepsilon_{\alpha\theta} = -0.01$

Category	MCF_θ					
	$\varepsilon_{c\alpha} = 0.1$		$\varepsilon_{c\alpha} = 0.05$		$\varepsilon_{c\alpha} = 0.01$	
	c_1	c_2	c_1	c_2	c_1	c_2
Consumer Goods	1.0069	1.1366	1.1374	1.2152	1.2688	1.2864
Crude Materials	0.6295	0.8122	0.8122	0.9501	1.0580	1.0995
Capitals Goods	0.6449	0.8319	0.8320	0.9731	1.0836	1.1260
Overall	0.7166	0.8898	0.890	1.0122	1.1035	1.1373

Table 52. The MCF_{θ} in the Presence of Tariff Evasion with $\varepsilon_{\alpha\theta} = -0.05$

Category	MCF_{θ}					
	$\varepsilon_{c\alpha} = 0.1$		$\varepsilon_{c\alpha} = 0.05$		$\varepsilon_{c\alpha} = 0.01$	
	c_1	c_2	c_1	c_2	c_1	c_2
Consumer Goods	0.5251	0.7488	0.7492	0.9518	1.1374	1.2152
Crude Materials	0.2248	0.3757	0.3758	0.5658	0.8122	0.9501
Capitals Goods	0.2303	0.3850	0.3850	0.5796	0.8320	0.9731
Overall	0.2801	0.4523	0.4523	0.6530	0.890	1.0122

Table 53. The MCF_θ in the Presence of Tariff Evasion with $\varepsilon_{\alpha\theta} = -0.1$

Category	MCF_θ					
	$\varepsilon_{c\alpha} = 0.1$		$\varepsilon_{c\alpha} = 0.05$		$\varepsilon_{c\alpha} = 0.01$	
	c_1	c_2	c_1	c_2	c_1	c_2
Consumer Goods	0.3286	0.5250	0.5251	0.7488	1.0069	1.1366
Crude Materials	0.1246	0.2248	0.2248	0.3757	0.6295	0.8122
Capitals Goods	0.1277	0.2303	0.2303	0.3850	0.6449	0.8319
Overall	0.1591	0.2801	0.2801	0.4523	0.7166	0.8898

Table 54. The MCF_A in the Presence of Tariff Evasion with $\varepsilon_{c\alpha} = 0.05$ and c_2

Classification	Lower Bound	Point Estimate	0	Upper Bound
Consumer Goods	0.8624	1.0183	1.3043	1.2431
Crude Materials & Fuels	0.6198	0.8769	1.1443	1.4980
Capital Goods	0.6170	0.8709	1.1718	1.4797
Overall	0.7455	0.8781	1.1733	1.0666

Table 55. Sensitivity Analysis of the MCF_A with Different Parameter Values

Category	MCF_A					
	$\varepsilon_{c\alpha}$= 0.1		$\varepsilon_{c\alpha}$= 0.05		$\varepsilon_{c\alpha}$= 0.01	
	c_1	c_2	c_1	c_2	c_1	c_2
Consumer Goods	0.6142	0.8351	0.8351	1.0183	1.1725	1.2350
Crude Materials	0.5155	0.7108	0.7107	0.8769	1.0198	1.0785
Capitals Goods	0.4919	0.6929	0.6929	0.8709	1.0295	1.0960
Overall	0.5003	0.7015	0.7015	0.8781	1.0342	1.0994

Note: For the sensitive analysis, the partial effect of the audit rate on evasion in each of the commodity categories is set equal to the point estimate, so that $\varepsilon_{\alpha A}$ = -0.416 for Consumer Goods, $\varepsilon_{\alpha A}$ = -0.164 for Raw Materials & Fuels, $\varepsilon_{\alpha A}$ = -0.186 for Capital Goods, $\varepsilon_{\alpha A}$ = -0.232 for Overall, as given in Table 43.

Table 56. The MCF_A in the Presence of Tariff Evasion with $\alpha = 0.1$

Classification	Lower Bound	Point Estimate	0	Upper Bound
Consumer Goods	1.2387	1.2555	1.2766	1.2728
Crude Materials & Fuels	1.1095	1.1231	1.1309	1.1370
Capital Goods	1.1362	1.1479	1.1553	1.1598
Overall	1.1391	1.1465	1.1572	1.1540

Note: I use the same parameter values as in Table 53, such that $\varepsilon_{c\alpha} = 0.05$ and c_2.

Table 57. The MCF_D in the Presence of Tariff Evasion with $\varepsilon_{c\alpha} = 0.05$ and c_2

Classification	Lower Bound	Point Estimate	0	Upper Bound
Consumer Goods	1.0562	1.2367	1.3043	1.4929
Crude Materials & Fuels	0.7165	0.9913	1.1443	1.6034
Capital Goods	0.6983	1.0722	1.1718	2.2998
Overall	0.8762	1.0624	1.1733	1.3471

Table 58. Sensitivity Analysis of the MCF_D with Different Parameter Values

Category	MCF_D					
	$\varepsilon_{c\alpha} = 0.1$		$\varepsilon_{c\alpha} = 0.05$		$\varepsilon_{c\alpha} = 0.01$	
	c_1	c_2	c_1	c_2	c_1	c_2
Consumer Goods	1.0701	1.1757	1.1756	1.2367	1.2763	1.2902
Crude Materials	0.7075	0.8744	0.8743	0.9913	1.0777	1.110
Capitals Goods	0.8543	0.9882	0.9882	1.0722	1.1298	1.1504
Overall	0.8278	0.9707	0.9707	1.0624	1.1263	1.1493

Note: For the sensitive analysis, the partial effect of the detection rate on evasion in each of the commodity categories is set equal to the point estimate, so that $\varepsilon_{\alpha D}$ = -0.081 for Consumer Goods, $\varepsilon_{\alpha D}$ = -0.083 for Raw Materials & Fuels, $\varepsilon_{\alpha D}$ = -0.050 for Capital Goods, $\varepsilon_{\alpha D}$ = -0.072 for Overall, as given in Table 43.

Table 59. The MCF_D in the Presence of Tariff Evasion with $\alpha = 0.1$

Classification	0	Lower Bound	Point Estimate	Upper Bound
Consumer Goods	1.2766	1.2589	1.2724	1.2863
Crude Materials & Fuels	1.1309	1.1157	1.1269	1.1383
Capital Goods	1.1553	1.1408	1.1533	1.1660
Overall	1.1572	1.1464	1.1538	1.1613

Note: I use the same parameter values as in Table 56, such that $\varepsilon_{c\alpha} = 0.05$ and c_2.

CHAPTER VIII

POLICY IMPLICATIONS

Our central case of the MCF_t^*'s in the absence of evasion and the MCF_i's associated with different policy instruments in the presence of tariff evasion are summarized in Table 60.

First, if we consider tariff evasion in measuring the *MCF* of a tariff rate, despite concealing costs incurred by the importers, the MCF_t with evasion is smaller than the corresponding value without tariff evasion in all commodity categories, although the differences are usually small. This is mainly because the domestic price of the imported goods in the presence of evasion is shown to be lower than the price without evasion (tariff-inclusive world price). Thus, considering tariff evasion in calculating the *MCF*s, we should not *a priori* conclude that benefits from the government project financed by an increase in tariff rates with evasion must be greater than those which do not consider tariff evasion. For example, in the presence of evasion, when we increase a tariff rate on Consumer goods by one percent, the *MCF* per additional won of tariff revenue is in the range of 1.3043 and 1.3044. This implies that a public project must produce marginal benefits of at least *W* 1.3044 per won of cost if it is to be justified. However, without considering evasion, the marginal benefits from a public spending should be at least *W* 1.3064 per won of its cost.

Second, the government can finance additional dollars of public spending by increasing tax rates, by increasing penalty rates, by increasing the probability of audit, or by increasing the probability of detection. These government policy tools cause distortions in the individual's behavior through various elasticities and through the concealing costs of evaders. Thus, the government should compare the *MCF* of each policy instrument when it chooses one policy tool to raise additional revenues for a certain public project. As discussed in chapter VI and summarized in Table 60, the values of the *MCF*s associated with the penalty rate, the probability of audit, and the probability of detection are usually lower than those of the *MCF*s of tariff rates, with and without evasion. For some commodities, these values are sometimes less than one.

However, although they seem to be attractive policy tools to raise government revenues, the penalty rate as well as the probability of audit and detection cannot be increased by a huge amount. The penalty rate for tariff evasion (legally disguised smuggling) should be compatible with the penalty rates for other crimes, such as tax evasion.[56] Thus, the government cannot resort solely to penalty rates in raising additional revenue for a public project. In addition, if the actual probability of detection is not significantly high, then the effect of higher penalty rates on tariff evasion may be small. In this case, an increase in penalty rates to raise additional government revenues may not be so effective. Furthermore, if an increase in penalty rates has no effect on evasion behavior, then the penalty rate is not a superior policy instrument compared with the tariff rate. As shown in Table 60, with $\varepsilon_{\alpha\theta} = 0$, the *MCF*'s of an increase in penalty rates are actually the same as the *MCF*'s of an increase in tariff rates across commodities.

The audit rate and the detection rate cannot be increased dramatically, and we should be careful when we use these enforcement variables as one of policy tools. For our

[56] For example, we cannot raise the time of imprisonment for *W* 1,000 tariff evasion to 50 years, or increase a fine to *W* 1,000,000. According to IRS, in 1997, the average time of imprisonment for tax violations was 2 years.

empirical analysis, the probability of audit and the probability of detection are assumed to be exogenously determined, since I use lagged values of these variables. Thus, we do not have to consider any government expenditures on enforcement to measure the MCF_A and the MCF_D. However, the government would have to spend its own direct resources to raise audit rates or detection rates, as explained in chapter III. In addition, more importantly, higher rates of audit on goods at the time of imports would impose a great burden on firms in terms of money and waiting costs. Considering the industrial structure of Korea, which heavily depends on foreign trade, it would damage the Korean economy as a whole.[57]

Third, as Ballard, Shoven, and Whalley (1985) point out, the *MCF*'s of different taxes may have substantially different values. Likewise, although I only consider the *MCF*'s with tariff evasion, the *MCF*'s in the presence of other types of tax evasion, such as income-tax evasion, may have a different value. Higher tariff rates and higher income-tax rates do not have the same effect on evasion behavior or on distortions. The penalty rate and the inspection rate may also have different effects on evasion, and thus different values of the *MCF*'s, in the case of income-tax evasion. Thus, they may have totally different values. In addition, if we include income-tax evasion as well as tariff evasion in the same framework to calculate the *MCF*'s, we can reasonably expect to find different values of the *MCF*'s. Therefore, the government should also consider other taxes, which have smaller *MCF*'s in the presence of evasion, as policy tools to raise additional

[57] In order to achieve two contradicting goals, maintaining speedy clearance and detecting illegal trade, the post-audit is conducted after import declarations are accepted to check commodity classification and value determination, as well as legitimacy of impost declaration. In this case, the government and importers would also incur direct resource costs.

revenues. In other words, we can choose those taxes or tariffs which induce less evasion, other things being equal.

Table 60. The *MCF*s in Our Central Case

Category	MCF_t^*	MCF_t	MCF_θ	MCF_A	MCF_D
Consumer Goods	1.3064	1.3043 ~ 1.3044	1.2152 ~ 1.3043	0.8624 ~ 1.3043	1.0562 ~ 1.4929
Raw Materials	1.1446	1.1443 ~ 1.1444	0.9501 ~ 1.1443	0.6198 ~ 1.4980	0.7165 ~ 1.6034
Capital Goods	1.1722	1.1718 ~ 1.1719	0.9731 ~ 1.1718	0.6170 ~ 1.4797	0.6983 ~ 2.2998
Overall	1.1738	1.1733	1.0122 ~ 1.1733	0.7455 ~ 1.1733	0.8762 ~ 1.3471

Note: The values of the MCF_t^*, the MCF_t, the MCF_A, and the MCF_D come from Table 40, Table 46, Table 53, and Table 56, respectively. The values of the MCF_θ are derived with parameter values of $\varepsilon_{c\alpha} = 0.05$, $\varepsilon_{\alpha\theta} = -0.01$ and 0, and c_2.

CHAPTER IX

CONCLUSION

In this paper, I examine the major determinants of tariff evasion and calculate the *MCF*'s associated with various policy tools, using detailed micro data for 1998 in Korea. I show that, if we incorporate tariff evasion and concealing costs incurred by firms in calculating the *MCF*'s, different values are measured than those derived without considering evasion, although the differences are usually small.

I find that tariff evasion increases with tariff rates in all commodity categories. That is, estimates of the elasticity of tariff evasion with respect to a tariff rate are positive and generally significant, in the range of 0.102 and 1.026. For Consumer goods, an increase in the inspection rate has deterrent effects on evasion, with an elasticity of -0.416. However, the detection rate is found to have no significant effects on evasion in any of the commodity categories, although the detection-rate coefficients have the expected signs.

I also calculate the *MCF*'s with and without evasion. Without evasion, the *MCF*'s associated with tariff rates vary from 1.1446 to 1.3064, depending on commodity categories. Surprisingly, with lower values of $\varepsilon_{c\alpha}$ (the elasticity of concealing costs), the MCF_t's in the presence of tariff evasion are found to be smaller than those without evasion. The *MCF*'s of tariff rates in the presence of evasion are in the range of 1.1443 and 1.3044 for three commodity categories. Overall, an increase in the probability of audit, an increase in the penalty rate, and an increase in the probability of detection are found to be more efficient policy tools for raising additional revenues than tariff rates, if these enforcement variables have deterrent effects on evasion (with negative values of the partial effects of enforcement variables). The *MCF*'s of the penalty rate are in the range of 0.9501 and 1.3043, with our base case parameter values. The *MCF*'s of the audit rates vary from 0.6170 to 1.4980, depending on commodity categories. The *MCF*'s of the detection rates are in the range between 0.6983 to 2.2998, depending on commodity categories.

As novel results, the main contributions of this paper are an estimation of the major determinants of tariff-evasion behavior and customs fraud, and the provision of numerical values of the *MCF*'s associated with different government policy tools. I am not aware of any other empirical work on the effects of tariff rates and government enforcement activities on tariff evasion or customs fraud. Furthermore, there is no theoretical or empirical study at all on the *MCF*'s associated with different policy instruments in the presence of tariff evasion.

However, there are some limitations in my analysis, although I use the most detailed and reliable data. First, among other things, in estimating tariff evasion and thus calculating the *MCF*'s, I do not account for all types of legally disguised smuggling, such as the importation of undeclared items, the undervaluation, the underdeclaration of a quantity or weight, etc. Except for the declaration of false items, I can calculate an evasion ratio or propensity to evade only when the actual amount of the undervaluation or the underdeclaration are identified from the descriptions of actions taken by the KCS after detecting customs fraud. Thus, accounting for other types of customs fraud, I also estimate behaviors of importers that are associated with committing customs fraud, using a binary dependent variable model in a separate chapter.

A second limitation of my work is that I do not consider enforcement costs by the government and compliance costs by importers related to inspection on imports. I assume that the audit rate and the detection rate could be raised at no cost to the government, to be consistent with our empirical studies. In addition, importers are assumed not to incur any compliance cost, in response to an increase in each of the policy variables. This is because these costs can be neither directly observed nor estimated. If we include these costs, the *MCF*'s may have different values.

Third, unlike Ballard, Shoven, and Whalley (1985), I do not account for interactions among different taxes. That is, I only focus on the calculation of the *MCF*'s associated with tariffs, ignoring the interaction of tariffs with other taxes, such as the income tax. Thus, this paper does not provide any evidence regarding which kinds of taxes (including tariffs) are the most efficient way to raise revenues for a certain public project.

Last, our estimates of the *MCF*'s are sometimes very sensitive with respect to the elasticity of the concealing cost with respect to tariff evasion, $\varepsilon_{c\alpha}$. Although the elasticities are different from commodity to commodity, depending on their nature and characteristics, I use somewhat arbitrary values of the elasticities for the calculation of the *MCF*'s, since there is no other way to estimate $\varepsilon_{c\alpha}$. For some agricultural products, due to their nature and characteristics, the elasticity of the concealing cost with respect to tariff evasion would be relatively elastic. For other goods, due to the characteristics of methods by which the importers evade tariff payments, the concealing costs would be relatively inelastic with respect to the degree of evasion. Thus, it would be interesting for further study to find ways to acquire greater certainty about the value of this parameter.

Despite some limitations mentioned above, our numerical measure of the *MCF*'s in the presence of tariff evasion can still provide valuable information in deciding the most appropriate policy tool for a certain public project. In addition, the Tobit estimates of tariff-evasion behavior and the Probit estimates of customs fraud are the first empirical studies in this area, to my knowledge. These results can also provide the basis for future research in these fields.

APPENDIX

APPENDIX

THE *MCF* AND THE OPTIMAL PROVISION OF PUBLIC GOODS

First, the Lagrangian of the individual problem is

$$£ = U(X) + V(G) + \mu[L - \boldsymbol{P}X],$$

where $\boldsymbol{P}$ equals to $P = (1 + c + t^e)P^*$ in the presence of evasion and $P^\wedge = (1 + t)P^*$ in its absence, as with the previous section. The first-order condition is as follows.

$$\partial £/\partial X = U_X - \mu \boldsymbol{P} = 0, \tag{A1}$$

where U_X $(=\partial U/\partial X)$ denotes the derivative of the individual's utility with respect to private consumption of imported goods, X. From above equations, we can implicitly derive optimal values of $X = X(t,\theta,d)$, given t, θ, and d. Substituting the optimal choice of X into the individual's budget constraint and differentiating it with respect to t, θ, and d, we get,

$$(\partial \boldsymbol{P}/\partial t)\, X + \boldsymbol{P}X_t = 0 \tag{A2}$$

$$(\partial \boldsymbol{P}/\partial \theta)\, X + \boldsymbol{P}X_\theta = 0 \tag{A3}$$

$$(\partial \boldsymbol{P}/\partial d)\, X + \boldsymbol{P}X_d = 0, \tag{A4}$$

where X_t, X_θ, and X_d denote the derivatives of the individual's consumption of imported goods with respect to the tariff rate, the penalty rate, and enforcement expenditures, respectively.

Then, the Lagrangian of the government problem is

$$\pounds = U(X(t, \theta, d)) + V(G) + \lambda[(t^e - d)P^*X - P_G G/H].$$

The first-order conditions are as follows.

$$\partial\pounds/\partial t = U_X X_t + \lambda[(\partial t^e/\partial t)P^*X + (t^e - d)\, P^*X_t] = 0 \quad \text{(A5)}$$

$$\partial\pounds/\partial\theta = U_X X_\theta + \lambda[(\partial t^e/\partial\theta)P^*X + (t^e - d)P^*X_\theta] = 0 \quad \text{(A6)}$$

$$\partial\pounds/\partial d = U_X X_d + \lambda[(\partial t^e/\partial d - 1)P^*X + (t^e - d)P^*X_d] = 0 \quad \text{(A7)}$$

$$\partial\pounds/\partial G = V_G - \lambda P_G/H = 0, \quad \text{(A8)}$$

where V_G ($=\partial V/\partial G$) denotes the derivative of the individual's utility with respect to the level of public goods, G. Using the first order condition of individual problem, equation (A1), equation (A8) can be written as,

$$HV_G / U_X = (\lambda/\mu) \times P_G/\boldsymbol{P}. \quad \text{(A8)}'$$

From (A8)′, we can derive the condition of the optimal provision of public goods,

$$\Sigma MRS = MCF_i \times MRT,$$

where $\Sigma MRS = HV_G/U_X$ is the sum of the marginal rates of substitution, $MCF_i = \lambda_i/\mu$ is the marginal cost of public funds associated with each policy variable, and $MRT = P_G/\boldsymbol{P}$ is the marginal rate of transformation.

Third, using the first-order condition of the individual problem and the derivatives of the individual budget constraint, we can derive *MCF*s of each of the government policy tools from equations (A5), (A6), (A7), and (A8)′. It should be noted that derivatives of $[(t^e - d)P^*X - P_GG/H]$ with respect to t, θ, and d, are just equal to the marginal tariff revenue from an increase in t, θ, and d, respectively. Thus, the term of $[\ \cdot\ ]$ in each equation (A5), (A6), and (A7) equals to MTR_t, MTR_θ, and MTR_d, respectively. The term, U_XX_i in each of these equation is equal to $-\mu(\partial\boldsymbol{P}/\partial i)X$, where $i = t$, θ, and d, since $U_X = \mu\boldsymbol{P}$ from equation (A1), and , $\boldsymbol{P}X_i = -(\partial\boldsymbol{P}/\partial i)X$ from equations (A2), (A3), and (A4). From equations (18) through (21), the term, $(\partial\boldsymbol{P}/\partial i)X$, is just the marginal utility loss (MUL_i) from each of the government policy tools. Thus, the $MCF_i = \lambda_i/\mu$ is shown to be equal to MUL_i/MTR_i, where $i = t$, θ, and d.

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