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Import Tax Evasion in Cross-Border E-commerce

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Abstract

Cross-border e-commerce is increasingly important today. Unfortunately, this sector involves widespread under-declaration of goods' valuation (selling price) to avoid import taxes. Customs brokers play a crucial role in this value chain by ensuring proper declarations at customs, and pay stiff penalties if the retailer is caught under-reporting value in an audit. We illuminate the incentives of import tax evasion by developing a theoretical model of an optimal contract between a customs broker (principal) and an overseas retailer (agent) who may expend resources to under-value his goods, but risks getting caught in an audit. We show that fraud is inevitable at all valuations. We further show that increasing audit accuracy lowers fraud but fails to eliminate it. Our model leads to the following policy prescriptions: (a) higher import duties lead to more fraud, and (b) penalties imposed on the broker are more effective in reducing under-reporting than those imposed on the retailer. Our results can help explain observed trends in cross-border e-commerce.

Keywords: Cross-border e-commerce; fraud; contract theory; optimal control

JEL Classification: D82, D86, F13, K2, L81

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1 Introduction

Cross-border Business-to-Customer (B2C) and Customer-to-Customer (C2C) e-commerce constitute important chunks of organized retail today. DHL estimates that about 77% of all US e-commerce shoppers are open to buying from outside the US, with 44% already having done so. It estimates about $80.2 billion worth of goods being imported to the US (primarily from the UK, China, Canada, Hong Kong and Australia) as a result of cross-border e-commerce (DHL, 2018). A PayPal (2018) survey estimates that about 64% Canadian, 38% British, 40% French, 34% Indian, 61% Australian, 48% Brazilian, 43% Chinese and 34% US online shoppers indulge in cross-border shopping.

Chinese e-commerce major Alibaba has a dedicated cross-border B2C marketplace subsidiary called AliExpress, that sells goods from China to over 120 million shoppers worldwide (Russell and Liao, 2019). Club Factory, another Chinese cross-border fashion retailer, gets about 60% of its business from Indian consumers and is the country's second-largest online fashion retailer after the home-grown Myntra (Bhattacharya, 2018). C2C e-commerce too has a significant cross-border component—it accounted for 20% of eBay's 2014 business (eBay, 2015). The company estimates that over 90% of its US sellers sell to consumers abroad (eBay, 2012). Another online marketplace Mercadolibre (offering both B2C and C2C retail), facilitates daily sales of over a million items in the Latin American region (Mercadolibre, 2020).

A key component in the cross-border e-commerce value chain is the customs broker.[1] This is the person who is licensed by an importing country's customs authority to facilitate smooth passage of imported goods by ensuring that appropriate import duties commensurate with the valuation (selling price) of each good, are paid. Customs brokerage is a restricted profession in most countries—candidates often need to pass a stringent exam and undergo thorough background checks to obtain a customs brokerage license. Her job is to ensure that imports are compliant with the law of her land, and she often bears the legal responsibility to do so, with the possibility of strict penalties in case of irregularities, especially under-valuation of goods by retailers to avoid customs duties. In return for her services, the customs broker usually charges the cross-border retailer a brokerage fee commensurate with the value of goods handled.

It is in this setting that we motivate our study. Under-reporting the value of imported goods is pervasive in cross-border, especially small-time B2C and C2C e-commerce (see section 2.2 for a detailed discussion). In many countries, the customs broker pays fines and risks significant reputational damage if a small-time seller is caught under-reporting the value (selling price) of goods sold. In C2C settings, ensuring cross-border legal action

[1] The nomenclature for this term varies by country: it is called "clearance agent" in India and Pakistan, "declaring agent" in Singapore, "déclarant en douane" in France, etc., but the role is roughly similar.

is even more complicated. In this setting, we develop an optimal contract between a risk-neutral customs broker (principal), and a risk-neutral overseas retailer (agent). The retailer must pay the customs broker a fee for her services, as well as an import duty on the value of goods she has sold in the broker's country. The retailer has the possibility of misreporting the valuation of goods sold, but incurs a cost to do so. There is a non-strategic customs audit which can find if there is under-reporting with a positive probability. In case of fraud being reported, the broker and the retailer both incur damages. The cost of faking for the retailer in this case is escalated by an exogenous multiplier.

Under these settings, we show that the retailer under-reports the valuation of his goods at all prices. However, the degree of under-reporting decreases as the true valuation increases. We also show that under-reporting increases as the rate of the import duty increases. On the other hand, exogenous increases in the accuracy of the non-strategic audit and penalties incurred by both the retailer and the customs broker decrease under-reporting. Our model leads to the following policy prescriptions: (a) higher import duties lead to more fraud, and (b) penalties imposed on the broker are more effective in reducing under-reporting as compared to those imposed on the retailer.

The rest of the paper is structured as follows. Section 2 contextualizes our study with a brief literature survey on cross-border e-commerce and tax evasion. We then outline our analytical model, characterize the optimal contract, and provide key results and numerical illustrations in section 3. We provide a brief discussion of managerial implications and scope for future work in section 4.

2 Literature review

2.1 Cross-border e-commerce and customs brokers

Cross-border e-commerce provides several advantages to both retailers and consumers. One major factor is cost—when imports happen from countries with low taxes, labor and manufacturing costs, these savings are passed on to the customer. However, cost may not be the only reason for this form of retail to flourish. Hu and Wang (2010) find that US-based sellers on eBay enjoy a significant country-of-origin advantage, leading to an ability to charge price premiums for it. Consumers, especially in developing countries, also enjoy greater product variety as well as options of multiple retailers selling the same goods. Small-time retailers also enjoy enhanced reach and lower entry barriers in this format (Bai et al., 2018). In C2C settings too, the role of geographical distance as a deterrent decreases significantly (Hortaçsu et al., 2009).

Despite their crucial role in enabling cross-border trade (including e-commerce), the world of customs brokers is rarely covered outside the community's trade journals. Martincus et al. (2015) estimate the negative impact of customs clearance times on exports, and find a more pronounced effect for newer buyers over older buyers. Carballo et al. (2016) study customs delays in a Peruvian port, to identify sources of delay in transit. Related to our theoretical study is the empirical study by Chalendard (2017), who identifies factors that can reduce tax evasion in cross-border trade. She suggests the use of pre-shipment checks to increase tax compliance.

To the best of our knowledge, there exists no research specifically studying the interplay of individual incentives and tax regulations involved in the transaction between an offshore B2C retailer and a customs broker based in the consumer's country, and the possible under-reporting of value it entails. Given that import tax evasion is endemic in international e-commerce, we address this important issue from a contract-theoretic framework.

2.2 Under-reporting of value by retailers

Tax evasion is a general concern for tax authorities worldwide, and naturally the focus of much research in economics and its adjacent fields. Whether it is income tax evasion (eg. Allingham and Sandmo, 1972), corporate tax evasion (eg. Crocker and Slemrod, 2005; Chen and Chu, 2005) or our own context of import duty evasion (eg. Fisman and Wei, 2004), this phenomenon has attracted a lot of interest from both theoretical and empirical researchers. Slemrod (2007)'s well-known essay on the economics of tax evasion begins with the cynical line, "No government can announce a tax system and then rely on taxpayers' sense of duty to remit what is owed." This problem is then obviously more complicated when the payer of the said tax is in a different country, and must pay customs duty to a tax authority in another, where his customer resides. In the case of cross-border B2C e-commerce, the problem is compounded even more, as the consumer may not even be aware of participating in a potential tax dodge.

Import duty evasion is omnipresent in cross-border B2C e-commerce, and the evolving nature of these transactions has challenged legal and tax scholars (Sweet, 1998). In 2019, acting on complaints from domestic retailers, India withdrew tax exemption on imports valued at INR 5,000 (approx. $70) or less. While these were meant for gifts and samples, Indian customs authorities realized that a large number of offshore retailers, operating on online marketplaces like Club Factory, AliExpress and and Shein, were declaring their sales to Indian customers as "gifts" (WARC, 2019). Countries like Mexico, Nigeria, Thailand and Vietnam have proposed laws enlisting banks and digital payment gateways as tax collectors in cross-border e-commerce transactions (Bloomberg, 2019).

A recent report finds that the European Union may be inadequately collecting value-added tax in cross-border online transactions (European Union, 2019). US authorities too are cognizant of under-reporting of values of cross-border imports, making several adjustments in their enforcement policies, to avoid tax evasion by foreign B2C retailers (Mongelluzzo, 2018).

Under-valuing goods to evade import duty is costly. Overseas retailers have been known to cover up the true valuations of their goods in many ways. Multiple studies have reported cases of overseas retailers issuing fake invoices, package labels and other documentation (eg. Deloitte, 2015; WCO, 2017). Retailers and customers are occasionally known to solicit collusion from each other to undervalue goods, a risky act given that it leaves a written trail of intent to defraud the exchequer. Such experiences are sometimes shared on public forums as illustrated in Figure 1. Another method is for the retailer to establish an overseas subsidiary with its own warehouse, and dispatch multiple purchases bundled together as a single import unit (Anand, 2019).

Insert Figure 1 about here

The customs broker's role in the B2C and C2C e-commerce process is crucial because she ensures that the importing country's import duties are correctly paid. In the absence of any method to catch a small-time tax evader in a foreign country, and lack of expertise on the consumer's part, the customs broker thus ends up shouldering a large part of the responsibility, risking her professional reputation in the process. Understanding the role of this crucial link in the increasingly popular cross-border e-commerce value chain is thus crucial to the overall B2C and C2C retail sector, as well as the national exchequer of every importing country.

3 Model

We now outline our model in detail. Table 1 summarizes algebraic notation used in this paper.

Insert Table 1 about here

Consider a risk-neutral principal (customs broker) and a risk-neutral agent (overseas retailer).[2] The retailer has sold goods for a price of x dollars to his customer in the broker's country. The goods are now at the customs office where the retailer must declare

[2]This may seem somewhat odd given that the words "broker" and "agent" are almost synonymous in the English language. The reader is advised to exercise special caution given that the customs broker in our model is the principal, and not the agent.

a value at customs. He may or may not under-report this to avoid import duty, but never over-reports it. Let this reported value be the function $u(x) \leq x$ that is endogenously determined based on the incentive structure of the contract between the broker and retailer. Let the customs office impose an exogenous import duty rate α.[3]

The true value (i.e. selling price) x is private information to the retailer, and he may or may not report it truthfully. The case $u(x) = x$ represents no falsification, and $u(x) < x$ represents falsification by the retailer. Such falsification is costly (see section 2.2 for a discussion on falsification methods) to the retailer, as he has to obfuscate information in many ways, to avoid getting caught in audits. Let this cost be denoted as the function $c(x - u(x))$ with the following assumptions: (a) $c(0) = 0$ i.e. no falsification is costless, (b) $c'(0) = 0$ i.e. the no-falsification case is the minimum, (c) $c'(z) > 0\ \forall z > 0$ i.e. falsification cost increases with the level of falsification, and (d) $c''(z) > 0\ \forall z \geq 0$, i.e. a convex falsification cost that progressively increases as the falsification increases.

We assume that there is a probability with which a non-strategic audit by the customs office can establish that the retailer has engaged in under-reporting the value of his goods. The audit is not perfect, and is successful with an exogenous probability γ. If fraud is successfully detected, it leads to an exogenous penalty $\rho c(x - u(x))$ to the customs broker. It incorporates any fines paid and reputational damages incurred by the customs broker. The retailer also suffers an escalation of his own falsification cost, such that instead of the $c(x - u(x))$ cost incurred earlier, he now incurs an escalated cost $\delta c(x - u(x))$, where $\delta > 1$ is an exogenous constant. In contrast, the broker's escalation factor $\rho > 0$ because she does not indulge in the falsification, but merely suffers a damage commensurate with the amount of fraud done by the retailer. The retailer, on the other hand, incurs not just his falsification cost which he has already spent but an additional escalation in reputational damages, blacklisting etc. Note that both broker and retailer suffer no damages if $u(x) = x$, i.e. no falsification.

Further, we assume that neither the customs agent, nor the non-strategic customs office can do anything to make the retailer pay any restitution to the affected customs broker. This is an assumption that is mostly valid for small-time overseas retailers operating in online marketplaces, and not big Business-to-Business (B2B) exporters whose reputations are thoroughly vetted by both buyers and customs brokers themselves, apart from being bound by international treaties. A large chunk of cross-border e-commerce

[3] Many countries charge tax beyond a certain threshold value, known as a *De Minimis*. For example, India used to exempt imports below INR 5,000 (approx. \$70) but has discontinued this due to massive under-declarations in cross-border B2C e-commerce (WARC, 2019). On the other hand, the US recently raised their tax-exempt threshold from \$200 to \$800 (Mongelluzzo, 2018). This threshold is a function of many things, including bilateral trade agreements and the prevailing economic conditions. For the sake of parsimony, we set this *De Minimis* threshold to zero in this paper. WCO (2017) presents a list of most countries' *De Minimis* thresholds.

happens via small fly-by-night B2C retailers and C2C hobbyists, who can change their online identity and resume business if caught for fraud; making them pay restitutive penalties to customs brokers in a foreign land is often infeasible and of questionable face validity. We illustrate the entire flow of our model in Figure 2 below.

Insert Figure 2 about here

The true valuation x is private information to the retailer. The customs broker however knows that the x is distributed according to the continuous probability density function $f(x)$ and cumulative distribution function $F(x)$ in the support $[x_L, x_H]$. As per industry convention, she charges the retailer a fee v based on the declared value of goods. Due to laws regarding conflicts of interest, we assume that there is no revenue sharing between the retailer and customs broker. While in practice any contract must be conditioned on the reported value $u(x)$, we invoke the revelation principal (Myerson, 1979) to look at direct mechanisms only, i.e. $v(x)$ rather than $v(u(x))$. Thus, we define the broker's (principal) payoff function as,

$$\begin{aligned} \Pi(u(x), v(x)) &= v(x) - (1-\gamma) \cdot 0 - \gamma\rho c(x - u(x)) \\ &= v(x) - \gamma\rho c(x - u(x)) \end{aligned} \tag{1}$$

with the principal's objective being to maximize expected profit, expressed as,

$$\max_{u(x),v(x)} \int_{x_L}^{x_H} \Pi(u(x), v(x)) f(x) dx \tag{2}$$

The retailer's (agent) payoff function is expressed as,

$$\begin{aligned} Y(u(x), v(x)) &= x - \alpha u(x) - v(x) - (1-\gamma)c(x - u(x)) - \gamma\delta c(x - u(x) \\ &= x - \alpha u(x) - v(x) - \{(1-\gamma) + \gamma\delta\}c(x - u(x)) \end{aligned} \tag{3}$$

The above payoff structure is similar to the corporate tax evasion model of Crocker and Slemrod (2005), which relaxes the assumption in Crocker and Morgan (1998) that a fraud is never detectable. However, Crocker and Slemrod bundle all expected costs of being detected into a single term depicting audit severity—our model decomposes audit accuracy γ and severity ρ for the customs broker (principal); and δ for the retailer (agent). Decomposing audit accuracy and severity helps us perform separate comparative statics on each parameter, giving more granular policy implications of our model. As equation (1) indicates, the principal here does *not* share revenue or profits with the agent. This is a fundamental difference from Crocker and Slemrod, and leads to substantially different policy implications.

Incentive compatibility for the retailer (agent) dictates that,

$$Y(v(x), u(x), x) \geq Y(v(\hat{x}), u(\hat{x}), x) \qquad \forall \hat{x} \neq x \in [x_L, x_H] \tag{4}$$

Equation (4) implies that the retailer agent always prefers the contract $\{u(x), v(x)\}$ as compared to the alternative $\{u(\hat{x}), v(\hat{x})\}$ for every $x \neq \hat{x}$. Considering the total differentiation of $Y(u(x), v(x), x)$ with respect to x, we obtain

$$\frac{dY}{dx} = Y_u u' + Y_v v' + Y_x \tag{5}$$

From the first-order conditions, we obtain that $Y_u u' + Y_v v' = 0$ at x and hence equation (5) can be re-written as

$$\frac{dY}{dx} = \frac{\partial Y}{\partial x} \tag{6}$$

Furthermore, an optimal contract must satisfy the individual rationality constraint, such that the retailer's payoff must exceed his outside option. We normalize this outside option to zero, and thus have,

$$Y(u(x), v(x), x) \geq 0 \tag{7}$$

The principal's optimization program is thus objective function (2) subject to the incentive compatibility and individual rationality constraints of equation (4) and (7) respectively. Note that the valuation x is exogenous and *not* a decision variable that can be chosen during optimization.[4] The optimization problem is rather to choose the functions $u(x)$ and $v(x)$, turning this into an optimal control problem where Y is the state variable, with its equation of motion represented by equation (6).

3.1 Optimal contract

We can now express the customs broker's (principal) optimization problem with the following Hamiltonian,

$$\mathbb{H} = \Pi(v, u) f(x) + \lambda(x) Y_x + \mu Y(v, u, x) \tag{8}$$

where $\lambda(x)$ is the co-state variable, $u(x)$ is the control variable and μ is a Lagrange multiplier.

[4]This assumption can be relaxed in large-scale B2B imports, where price may be endogenous given the large quantities involved. We suggest this as a promising avenue for further research.

Proposition 1. *The optimal contract must satisfy the following necessary conditions :*

$$f \cdot (\Pi_u - \Pi_v Y_u / Y_v) + \lambda (Y_{ux} - Y_{vx} Y_u / Y_v) = 0 \tag{9}$$

$$\frac{d\lambda}{dx} = -f \cdot \frac{\Pi_v}{Y_v} - \lambda \frac{Y_{vx}}{Y_v} - \mu \tag{10}$$

Proof. See appendix A. □

Proposition 1 above characterizes the general necessary conditions for the optimal contract (Crocker and Morgan, 1998). We now investigate its outcomes for this specific optimal contract given the specifications of equation (1) for Π and equation (3) in this scenario.

Proposition 2. *The optimal contract between the customs broker (principal) and retailer (agent) is characterized by:*

$$\frac{c'}{c''} = \frac{(\alpha f / c'') + (1 - F)\{(1 - \gamma) + \gamma\delta\}}{\{(1 - \gamma) + \gamma(\rho + \delta)\} f} \tag{11}$$

$$u(x) < x \ \forall x \in [x_L, x_H] \tag{12}$$

$$v(x) = x - \alpha u(x) - \{(1 - \gamma) + \gamma\delta\} c(x - u(x)) - \int_{x_L}^{x} [1 - \{(1 - \gamma) + \gamma\delta\} c'(t - u(t))] \, dt \tag{13}$$

Proof. See appendix B. □

We thus observe that the optimal contract mandates some faking at all revenue levels x for the retailer (agent). The customs broker (principal) tolerates this because of the information asymmetry between the two, and accordingly adjusts her compensation $v(x)$ to absorb the risk of getting caught in a customs audit. Proposition 2 characterizes the necessary conditions for the optimal contract. We need to state two other requirements so that the sufficiency conditions are satisfied for the optimal contract. The optimization exercise considers μ equal to zero and this is valid as long as we have $Y_x > 0$. This is satisfied when we assume the following holds:

$$c'(x - u(x)) < \frac{1}{\{(1 - \gamma) + \gamma\delta\}} \tag{14}$$

Thus the individual rationality binds only at $x = x_L$ and for all values greater than x, the retailer would obtain a positive payoff. Next, we need to ensure that the contract is implementable. From the Spence-Mirrlees single crossing condition, when $Y_v < 0$ as we have, the contract is implementable only if:

$$\frac{\partial}{\partial x} \left(\frac{Y_u}{Y_v} \right) \frac{du}{dx} \leq 0$$

Referring to equation (3) and substituting appropriate partial derivatives we have the sufficient condition for implementability as:

$$\begin{aligned} \frac{\partial}{\partial x}\left[\alpha - \{(1-\gamma)+\gamma\delta\}c'(x-u(x))\right]\frac{du}{dx} &\leq 0 \\ \text{i.e.}\quad u'(x) &> 0 \end{aligned} \tag{15}$$

3.2 Effects of regulations on retailer's tax compliance

We now present key comparative statics on $u(x)$, given that the exchequer's revenue is directly linked to it as $\alpha u(x)$.

Proposition 3. *The reported valuation $u(x)$ changes according to exogenous factors $\alpha, \gamma, \delta, \rho$ as:*

$$\frac{du}{d\alpha} = \frac{-f}{\{(1-\gamma)+\gamma(\rho+\delta)\}c''f - (1-F)c'''\{(1-\gamma)+\gamma\delta\}} \tag{16}$$

$$\frac{du}{d\gamma} = \frac{(\delta+\rho-1)c'f - (\delta-1)(1-F)c''}{\{(1-\gamma)+\gamma(\rho+\delta)\}c''f - (1-F)c'''\{(1-\gamma)+\gamma\delta\}} \tag{17}$$

$$\frac{du}{d\delta} = \frac{\gamma\{c'f - (1-F)c''\}}{\{(1-\gamma)+\gamma(\rho+\delta)\}c''f - (1-F)c'''\{(1-\gamma)+\gamma\delta\}} \tag{18}$$

$$\frac{du}{d\rho} = \frac{\gamma c'f}{\{(1-\gamma)+\gamma(\rho+\delta)\}c''f - (1-F)c'''\{(1-\gamma)+\gamma\delta\}} \tag{19}$$

Proof. See appendix C. □

While proposition 3 presents generalized results, we present the signs of the derivatives under the commonly used assumption of a quadratic cost function i.e. $c''' = 0$, allowing easier interpretation.

Corollary 3.1. *When $c''' = 0$ and $\frac{c'}{c''} > \frac{(1-F)}{f}$ the following hold:*

$$du/d\alpha < 0 \tag{20}$$

$$du/d\gamma > 0 \tag{21}$$

$$du/d\delta > 0 \tag{22}$$

$$du/d\rho > 0 \tag{23}$$

Proof. See appendix C.1. □

Corollary 3.1 establishes sufficient conditions where under-reporting increases when the tax rate is increased, reported value is higher when the audit is more accurate, and when the punitive penalties on either the retailer or the customs broker are increased. A closer look at proposition 3—equation (16) and equation (19)—reveals that when

$c''' = 0$, an exogenous increase in the tax rate α always leads to a lower reporting function $u(x)$, and an exogenous increase in the customs broker's penalty ρ always increases this reporting function. Thus, when $c''' = 0$, it is unambiguous (and unsurprising) that increasing the tax rate incentivizes more fraud by the retailer. It is also unambiguous that when $c''' = 0$, exogenous increases in the broker's penalty factor ρ are effective in increasing the reported valuation $u(x)$, i.e. deterring fraud.

However, the results are not so unambiguous for the effects of the audit accuracy γ, and the retailer's penalty factor δ. From equations (17) and (18), under the additional condition $c'/c'' > (1-F)/f$, audit deters fraud via exogenous increases in either accuracy γ or retailer penalty factor δ. However, if $c'/c'' < (1-F)/f$ then increasing the retailer penalty factor δ can lead to more under-reporting.

It is of course of interest to us to see which of the two penalties (ρ to the customs broker and δ to the retailer) has a greater marginal effect on inducing the retailer to declare a valuation closer to the true x. Corollary 3.2 below establishes that the customs broker's penalty is more effective in reducing under-reporting than the overseas retailer's penalty. Hence the impact of increasing the penalty on the reporting function $u(x)$ is not symmetric.

Corollary 3.2. *Under the sufficient conditions of corollary 3.1 it follows that:*

$$\frac{du}{d\rho} > \frac{du}{d\delta} > 0 \tag{24}$$

Proof. See appendix C.2. □

Corollary 3.2 is both counter-intuitive and illustrative. It establishes that pressuring the broker actually induces her to adjust her own brokerage in such a way as to incentivize the overseas retailer to declare valuations closer to the real value x. This result is also illustrative of why customs brokers are often subject to stiff penalties and reputation costs by the regulators if under-reporting is detected (see section 4 for a detailed discussion).

3.3 Illustration

We illustrate our model with some numerical examples now. Let $x_L = 100$ and $x_H = 200$. Let $x \sim \text{TruncExp}(\beta, x_L, x_H)$, a truncated exponential, with truncation points at x_L and x_H. Thus,

$$\begin{aligned} f(x) &= \frac{\beta e^{-\beta x}}{e^{-\beta x_L} - e^{-\beta x_H}} \\ F(x) &= \frac{e^{-\beta x_L} - e^{-\beta x_L}}{e^{-\beta x_L} - e^{-\beta x_H}} \end{aligned}$$

We assume $\beta = 0.1$ in this illustration. Figure 4 (a) illustrates the cumulative distribution of this truncated exponential distribution. Let the cost function be the quadratic denoted by $c(z) = az^2$. Note that our model applies only to cost functions satisfying the constraint of equation (14) and corollary 3.2 — Figure 3 illustrates regions where our results apply. We set $a = 0.0005$ in this illustration. Figure 4 (b) illustrates this cost function.

Insert Figure 3 about here

Insert Figure 4 about here

Figure 5 illustrates how declared valuation increases and under-reporting is lowered as audit accuracy γ increases *ceteris paribus*. Though not illustrated here, we note that in (γ, δ) combinations which are consistent with the assumption of equation (14), $\gamma = 1$ can yield some faking—as the penalty structures are insufficient to deter fraud completely.

Insert Figure 5 about here

Figure 6 illustrates how declared valuation increases and under-reporting is lowered as audit penalties δ (on retailer) and ρ (on customs broker) increase *ceteris paribus*. While there is an initial large effect in reducing fraud, this progressively decreases as either δ or ρ are increased. *Prima facie*, the deterrence effects seem similar.

Insert Figure 6 about here

4 Discussion

Our model illuminates the incentives behind customs brokerage in cross-border e-commerce. It establishes that there exists some under-valuation at all true valuations x, and the level of fraud $x - u(x)$ is highest at the lower end of the support $[x_L, x_H]$, and decreases as x approaches the upper end. We demonstrate that audits serve to reduce fraud, but do not eliminate it completely. Our model leads to the following policy prescriptions: (a) higher import duties lead to more fraud, and (b) penalties imposed on the broker are more effective in reducing under-reporting than those imposed on the retailer.

Our model is consistent with the observed steep penalties in the form of fines, license termination and even revocation that customs brokers are subjected to, if malpractice is detected by regulatory authorities (WCO, 2016). For example, US regulations dictate that customs brokers who enter wrong tariffs may be subjected to strict scrutiny, with penalties of up to \$1,000 for erroneous entries (CBP, 2004). Indian regulators levy penalties of up to INR 50,000 (approx. \$674) (CBIC, 2018), while the Canadian Border Services Agency fines customs brokers up to Canadian \$900 (approx. \$684) (CBSA, 2019).

It is of course easier to implement penalties on domestic customs brokers than offshore retailers. However, as our model indicates, this practice is also surprisingly more effective in deterring under-valuation by offshore retailers, than penalizing the retailers themselves.

Our model can be extended in a few ways. Notably, the true valuation, i.e. selling price x itself can be endogenized, leading to an endogenous quantity being exported by the retailer given the change in consumer demand. In this case, the customs broker must optimize her profit based on a price times quantity. However, this is more appropriate in B2B settings rather than B2C or C2C settings, where customers buy a single, or very small quantities of goods. Finally, a richer model incorporating a strategic customs office is also possible.

Customs brokerage is an important component, and a crucial bottleneck in the ever-expanding world of cross-border trade, including B2C and C2C e-commerce. Given that tax evasion and customs brokerage in this context have not been studied much, our work illuminates a phenomenon that is of utmost importance to regulators worldwide.

Appendices

A Proof of proposition 1

The first order Pontryagin conditions are:

1. Optimality condition:

$$\max_u \mathbb{H} \qquad \forall x \in [x_L, x_H] \equiv \frac{d\mathbb{H}}{du} = 0$$

2. Equation of motion for state:

$$\frac{dY}{dx} = \frac{\partial \mathbb{H}}{\partial \lambda} = Y_x$$

3. Equation of motion for costate:

$$\frac{d\lambda}{dx} = -\frac{\partial \mathbb{H}}{\partial Y}$$

4. Transversality condition for state:

$$\lambda(x_H) = 0$$

A.1 Optimality condition

Since the control function is $u(\cdot)$ the derivative of $\mathbb{H}$ with respect to $u(\cdot)$ must be 0, yielding:

$$\frac{d\Pi}{du} \cdot f + \lambda \cdot \frac{dY_x}{du} + \mu \cdot \frac{dY}{du} = 0 \tag{25}$$

We also note that:

$$\frac{d\Pi}{du} = \Pi_v \frac{\partial v}{\partial u} + \Pi_u \tag{26}$$

$$\frac{dY_x}{du} = \frac{\partial Y_x}{\partial v} \cdot \frac{\partial v}{\partial u} + \frac{\partial Y_x}{\partial u} \cdot 1 \tag{27}$$

$$\frac{dY}{du} = \frac{\partial Y}{\partial v} \cdot \frac{\partial v}{\partial u} + \frac{\partial Y}{\partial u} \cdot 1 \tag{28}$$

Reinserting the above in (25):

$$f \cdot \left(\Pi_v \cdot \frac{\partial v}{\partial u} + \Pi_u \right) + \lambda \cdot \left(Y_{v,x} \cdot \frac{\partial v}{\partial u} + Y_{u,x} \right) + \mu \cdot \left(Y_v \cdot \frac{\partial v}{\partial u} + Y_u \right) = 0 \tag{29}$$

Additionally, at the optimal, since $\frac{dY}{dx} = \frac{\partial Y}{\partial x}$

$$\frac{\partial Y}{\partial v} \cdot \frac{dv}{dx} + \frac{\partial Y}{\partial u} \cdot \frac{du}{dx} = 0 \tag{30}$$

leading to:

$$\frac{\partial v}{\partial u} = -\frac{Y_u}{Y_v} \tag{31}$$

We now express the optimality condition for the optimal control problem as:

$$f \cdot \left(\Pi_u - \Pi_v \frac{Y_u}{Y_v} \right) + \lambda \cdot \left(Y_{u,x} - Y_{v,x} \frac{Y_u}{Y_v} \right) = 0 \tag{32}$$

A.2 Equation of motion for costate

$$\frac{d\lambda}{dx} = -\frac{\partial \mathbb{H}}{\partial Y} \tag{33}$$

Consider the right hand side:

$$\frac{\partial \mathbb{H}}{\partial Y} = \frac{\partial \mathbb{H}}{\partial v} \cdot \frac{\partial v}{\partial Y} + \frac{\partial \mathbb{H}}{\partial u} \cdot \frac{\partial u}{\partial Y}$$

From the optimal condition the last term is 0. Thus

$$\frac{\partial \mathbb{H}}{\partial Y} = \frac{\partial \mathbb{H}}{\partial v} \frac{\partial v}{\partial Y} \tag{34}$$

Expanding $\frac{\partial \mathbb{H}}{\partial v}$ and substituting it back in the equation of motion for costate, we get:[5]

$$\dot{\lambda} = \frac{d\lambda}{dx} = -f \cdot \frac{\Pi_v}{Y_v} - \lambda \cdot \frac{Y_{v,x}}{Y_v} - \mu \tag{35}$$

B Proof of proposition 2

The participation constraint in equation (7) is slack ($Y > 0$) and hence μ in (10) is zero. Thus:

$$\frac{d\lambda}{dx} = f(x) \tag{36}$$

which along with the transversality condition $\lambda(x_H) = 0$ yields:

[5] Assuming $\frac{\partial Y}{\partial v} \neq 0$.

$$\lambda(x) = -(1 - F(x)) \tag{37}$$

Substituting λ in equation (9), and substituting the appropriate partial derivatives from equations (1) and (3), we get:

$$\frac{c'}{c''} = \frac{(\alpha f/c'') + (1-F)\{(1-\gamma)+\gamma\delta\}}{\{(1-\gamma)+\gamma(\rho+\delta)\}\, f}$$

which is equation (11). In this expression, it is easy to see that the right hand side is strictly positive for all $x \in [x_L, x_H]$. Thus, the left hand side must also be positive, which implies that $c' > 0$, which directly leads to:

$$u(x) < x \;\forall x \in [x_L, x_H]$$

which is equation (12). Now, to derive $v(x)$ we recognize that the total surplus $\Pi + Y$ is given by adding the right hand sides of equations (1) and (3). At every, x this must equal $\Pi + \int_{x_L}^{x} Y_t dt$. Thus, $v(x)$ is the solution of

$$\begin{aligned} v(x) - \gamma\rho c(x-u(x)) + \int_{x_L}^{x} [1 - \{(1-\gamma)+\gamma\delta\}c'(t-u(t))]\, dt \\ = x - \alpha u(x) - \{(1-\gamma)+\gamma\delta\}c(x-u(x)) \end{aligned}$$

Rearranging the above to solve for $v(x)$ yields,

$$\begin{aligned} v(x) &= x - \alpha u(x) - \{(1-\gamma)+\gamma\delta\}c(x-u(x)) \\ &\quad - \int_{x_L}^{x} [1 - \{(1-\gamma)+\gamma\delta\}c'(t-u(t))]\, dt \end{aligned}$$

which is equation (13).

C Proof of proposition 3

We rewrite equation (11) as follows

$$[(1-\gamma+\gamma(\delta+\rho))c' - \alpha]f - (1-F)(1-\gamma+\gamma\delta)c'' = 0 \tag{38}$$

Taking total differentiation of equation (38), we obtain

$$[(1-\gamma+\gamma(\delta+\rho))c''f+(1-\gamma+\gamma(\delta+\rho))c'f'-\alpha f'+f(1-\gamma+\gamma\delta)c''-(1-F)(1-\gamma+\gamma\delta)c''']dx$$
$$+[(\delta+\rho-1)c'f-(\delta-1)(1-F)c'']d\gamma+[\gamma c'f-(1-F)\gamma c'']d\delta+\gamma c'f d\rho-f d\alpha$$
$$-[(1-\gamma+\gamma(\delta+\rho))c''f-(1-F)(1-\gamma+\gamma\delta)c''']du=0 \quad (39)$$

Setting $dx = d\gamma = d\delta = d\rho = 0$ in equation (39), we obtain

$$\frac{du}{d\alpha} = -\frac{f}{(1-\gamma+\gamma(\delta+\rho))c''f-(1-F)(1-\gamma+\gamma\delta)c'''} \quad (40)$$

Now setting $dx = d\delta = d\rho = d\alpha = 0$ in equation (39), we obtain

$$\frac{du}{d\gamma} = \frac{(\delta+\rho-1)c'f-(\delta-1)(1-F)c''}{(1-\gamma+\gamma(\delta+\rho))c''f-(1-F)(1-\gamma+\gamma\delta)c'''} \quad (41)$$

Now setting $dx = d\gamma = d\rho = d\alpha = 0$ in equation (39), we obtain

$$\frac{du}{d\delta} = \frac{\gamma c'f-(1-F)\gamma c''}{(1-\gamma+\gamma(\delta+\rho))c''f-(1-F)(1-\gamma+\gamma\delta)c'''} \quad (42)$$

Finally setting $dx = d\gamma = d\delta = d\alpha = 0$ in equation (39), we obtain

$$\frac{du}{d\rho} = \frac{\gamma c'f}{(1-\gamma+\gamma(\delta+\rho))c''f-(1-F)(1-\gamma+\gamma\delta)c'''} \quad (43)$$

C.1 Proof of corollary 3.1

We rewrite equation (39) as follows

$$(A+B)dx+[(\delta+\rho-1)c'f-(\delta-1)(1-F)c'']d\gamma+[\gamma c'f-(1-F)\gamma c'']d\delta+\gamma c'f d\rho-f d\alpha-A du=0 \quad (44)$$

where $A = (1-\gamma+\gamma(\delta+\rho))c''f-(1-F)(1-\gamma+\gamma\delta)c'''$
and $B = f'[(1-\gamma+\gamma(\delta+\rho))c'-\alpha]+f[1-\gamma+\gamma\delta]c''$

Under the assumption of quadratic cost function, $c''' = 0$ we obtain $A > 0$. Hence following equation (40) we obtain

$$\frac{du}{d\alpha} < 0$$

Under the assumption $\frac{c'}{c''} > \frac{1-F}{f}$, the following also holds $\frac{c'}{c''} > \frac{\delta-1}{\delta+\rho-1}\frac{1-F}{f}$ since $\frac{\delta-1}{\delta+\rho-1} < 1$

and hence from equation (41), we obtain

$$\frac{du}{d\gamma} > 0$$

Under the assumption $\frac{c'}{c''} > \frac{1-F}{f}$, we obtain from equation (42)

$$\frac{du}{d\delta} > 0$$

From equation (43), given that $A > 0$ we obtain that

$$\frac{du}{d\rho} > 0$$

C.2 Proof of corollary 3.2

Under the assumption that $\frac{c'}{c''} > \frac{1-F}{f}$, $c''' = 0$ and from equation (42) and (43), it follows that

$$\frac{du}{d\rho} > \frac{du}{d\delta} > 0$$

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Term	*Description*
x	True selling price
$f(x), F(x)$	Probability density and cumulative distribution function of x
$[x_L, x_H]$	Support of the probability density function f
α	Exogenous import duty rate
$u(x)$	Retailer's reported selling price
$v(x)$	Payment to the customs broker
$c(x - u(x))$	Cost of falsification
$\Pi(\cdot)$	Customs broker's payoff
$Y(\cdot)$	Retailer's payoff
$\mathbb{H}$	Hamiltonian
$\lambda(x)$	Co-state variable
μ	Lagrange multiplier
γ	Probability of successful detection of retailer's (agent) fraud
$\delta > 1$	Penalty factor incurred by retailer (agent)
$\rho > 0$	Penalty factor incurred by customs broker (principal)

Table 1: Model notation

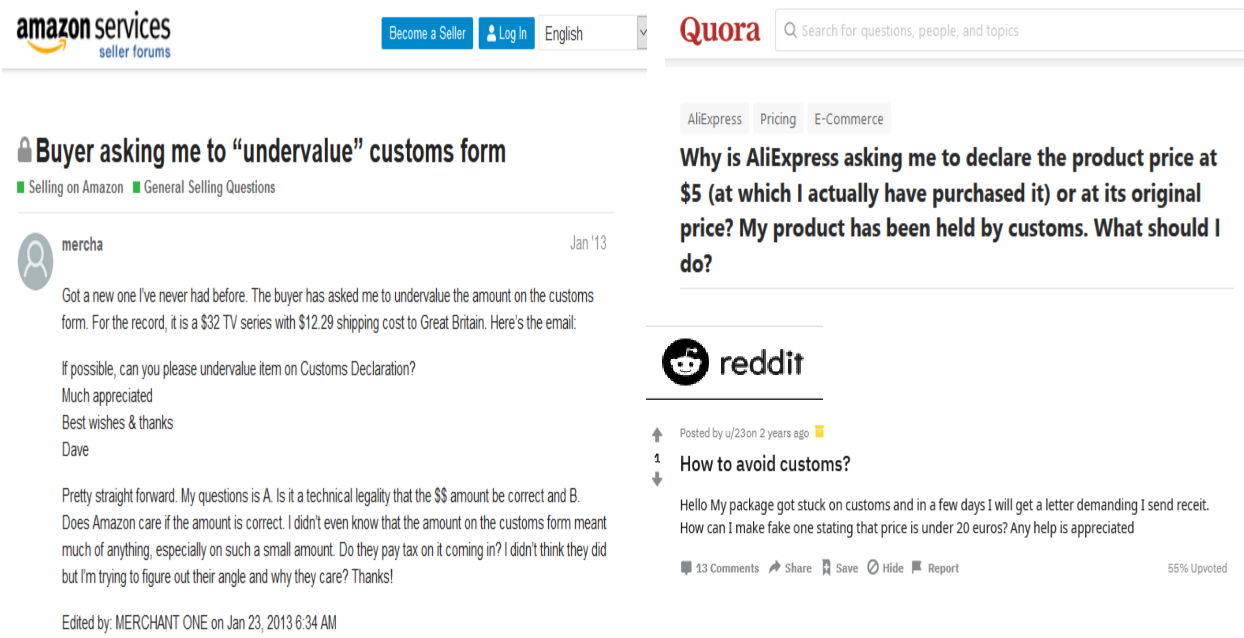


Figure 1: Example posts on social media illustrating various experiences with under-valuation of goods on Amazon seller forums (https://amzn.to/2AWTxCu), Quora (https://bit.ly/32f8UkT) and Reddit (https://bit.ly/3j1MgCF). All URLs were last accessed on 07/14/2020.

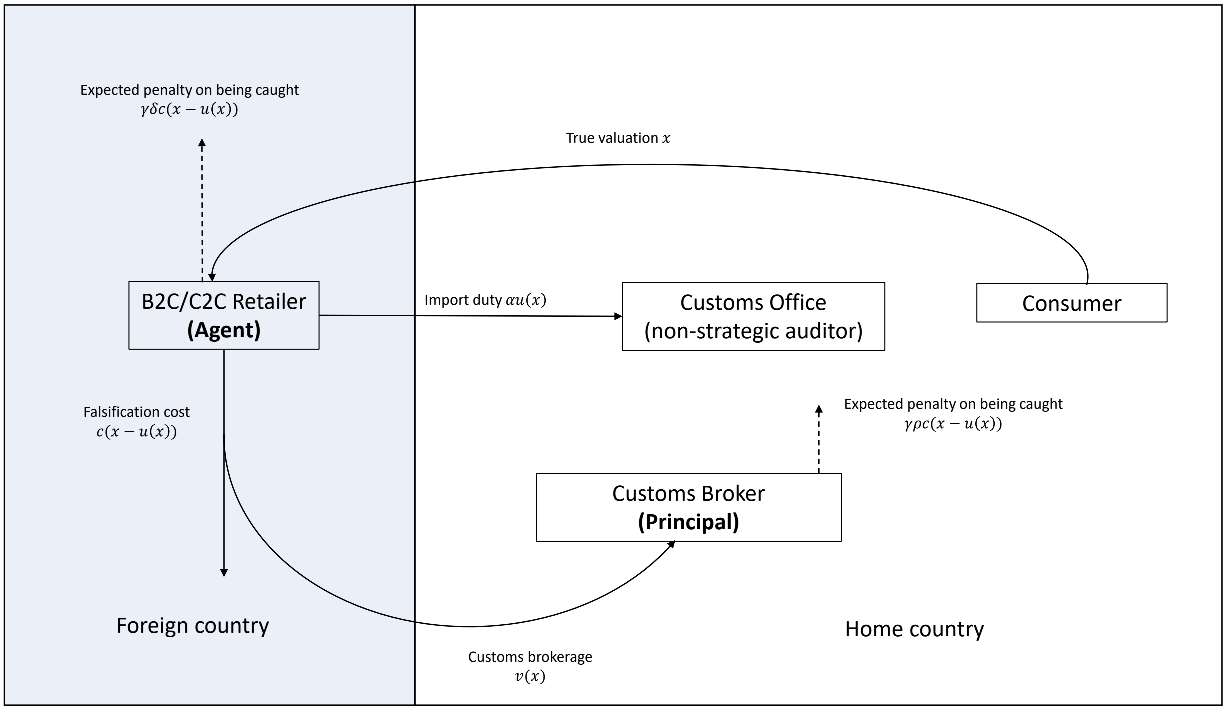


Figure 2: Flow of money amongst various actors in our model. Solid lines indicate sure inflows or outflows, while dotted lines indicate probabilistic penalties when caught by a non-strategic customs audit.

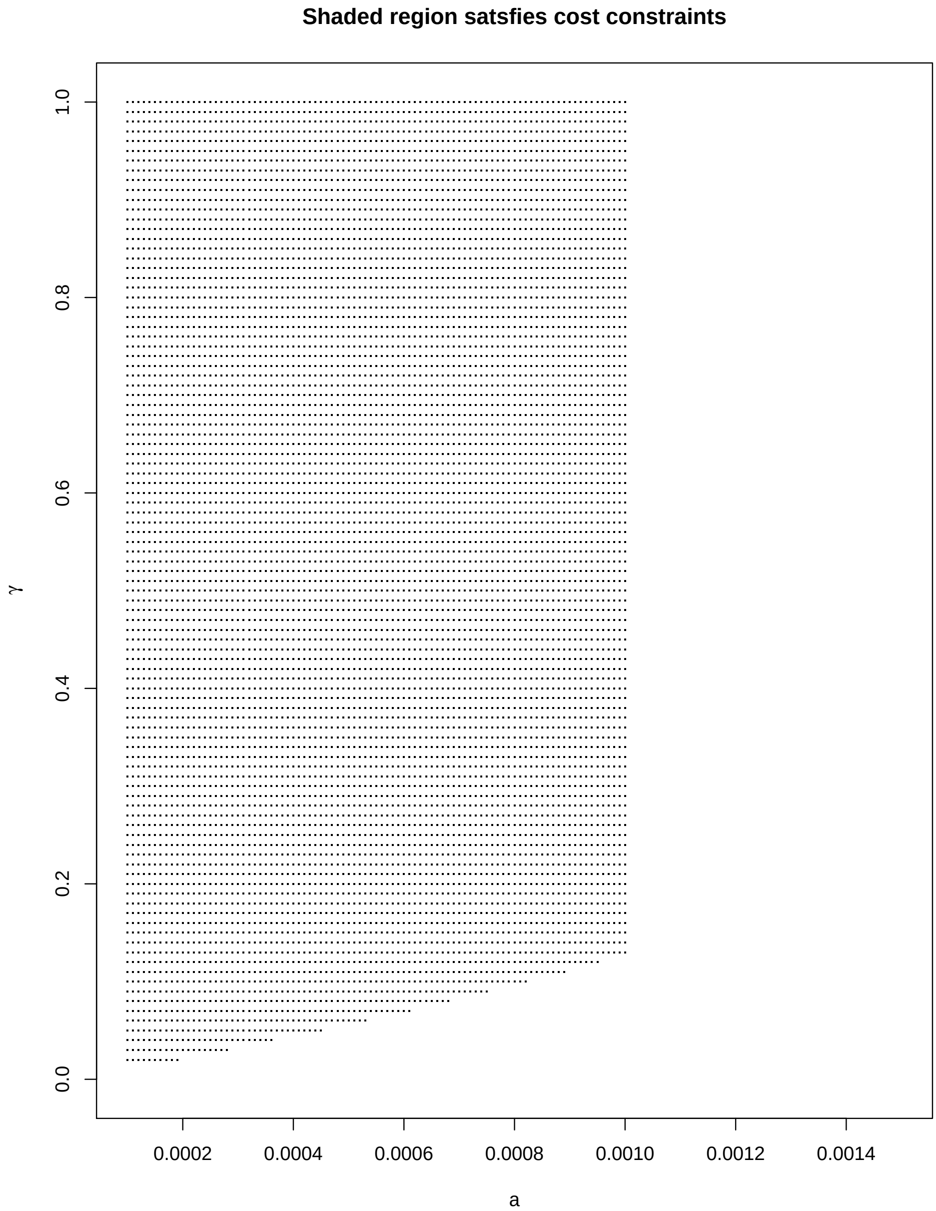


Figure 3: A example plot of a versus γ for which results are applicable in the illustration of section 3.3 keeping constant other parameters $x_L = 100, x_H = 200, \beta = 0.1, \alpha = 0.1, \gamma = 0.5, \rho = 2, \delta = 2$. These regions vary as parameters vary, and we take care to ensure that all our illustrations are compliant with equation (14), by explicitly computing the constraint numerically using an R script.

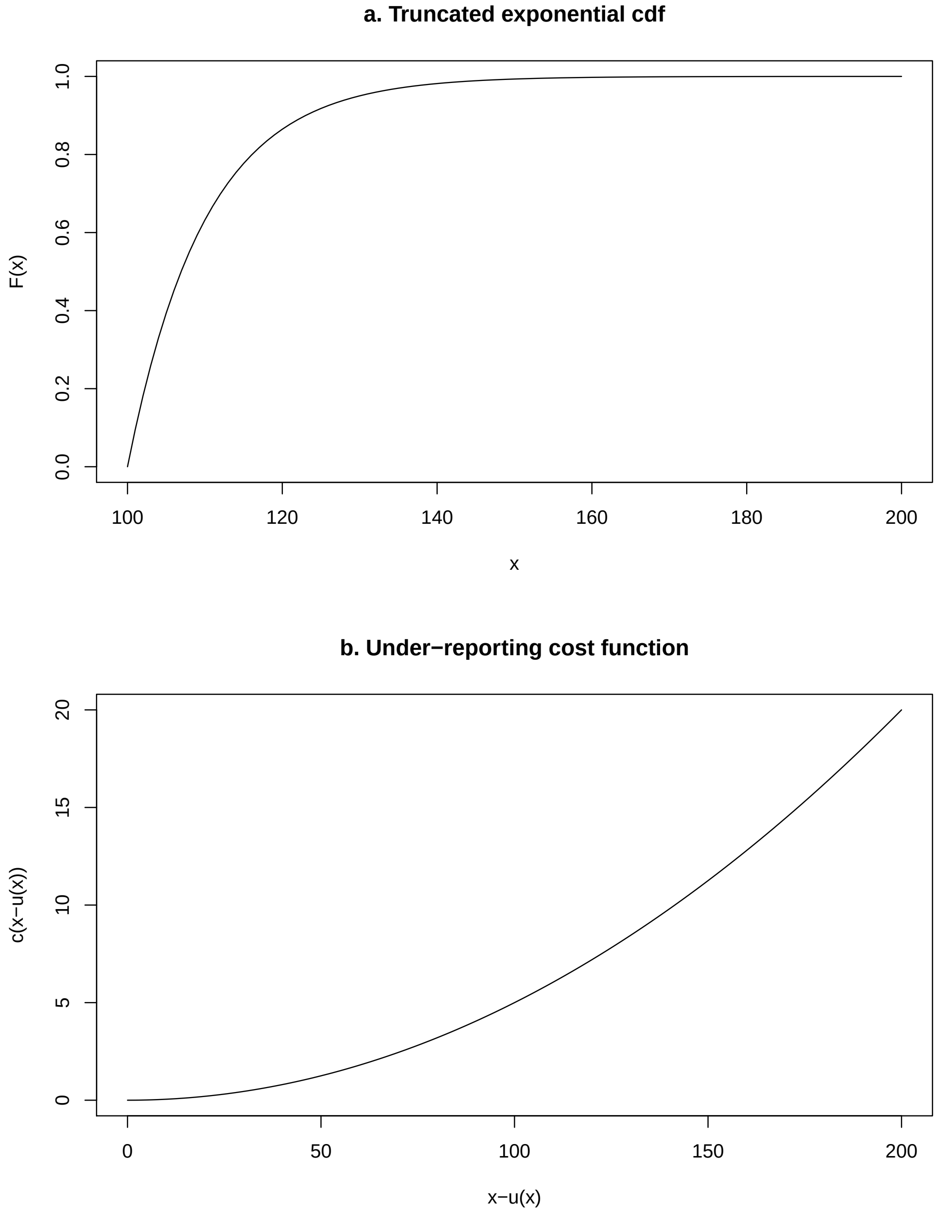
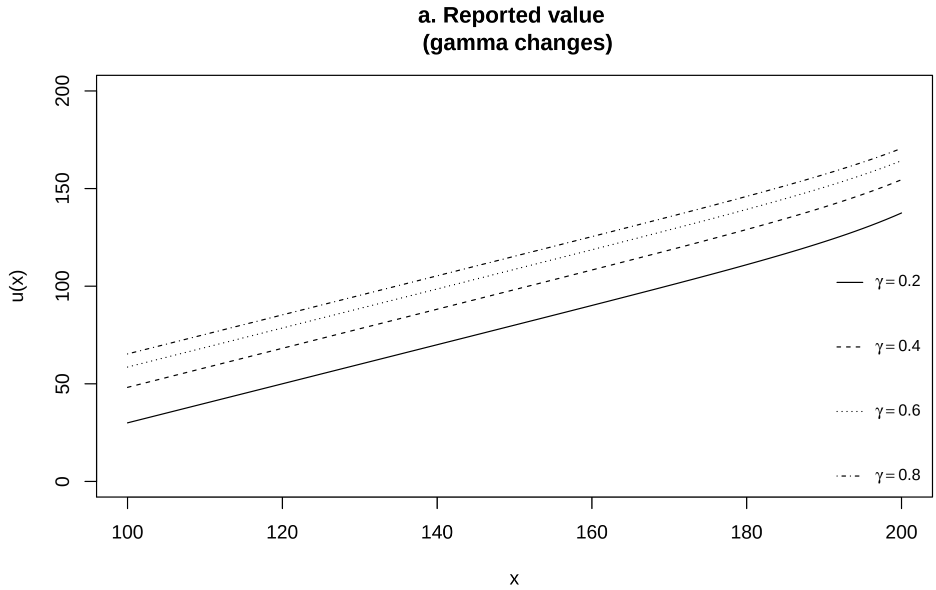


Figure 4: (a) The truncated cumulative distribution function TrExp(β); $x \in [x_L, x_H]$. Here $\beta = 0.1, x_L = 100, x_H = 200$. (b) the quadratic cost function $c(x - u(x)) = a(x - u(x))^2$. Here $a = 0.0005$.



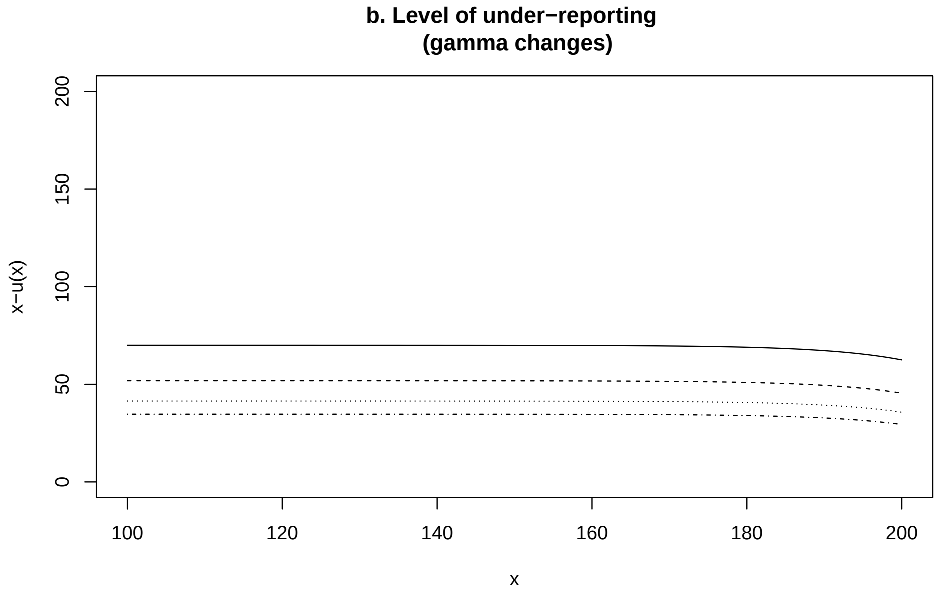


Figure 5: (a) Reported value $u(x)$ and (b) the level of under-reporting $x - u(x)$ as a function of the true value x. Here $a = 0.0005, x_L = 100, x_H = 200, \beta = 0.1, \alpha = 0.1, \delta = 2, \rho = 2$.

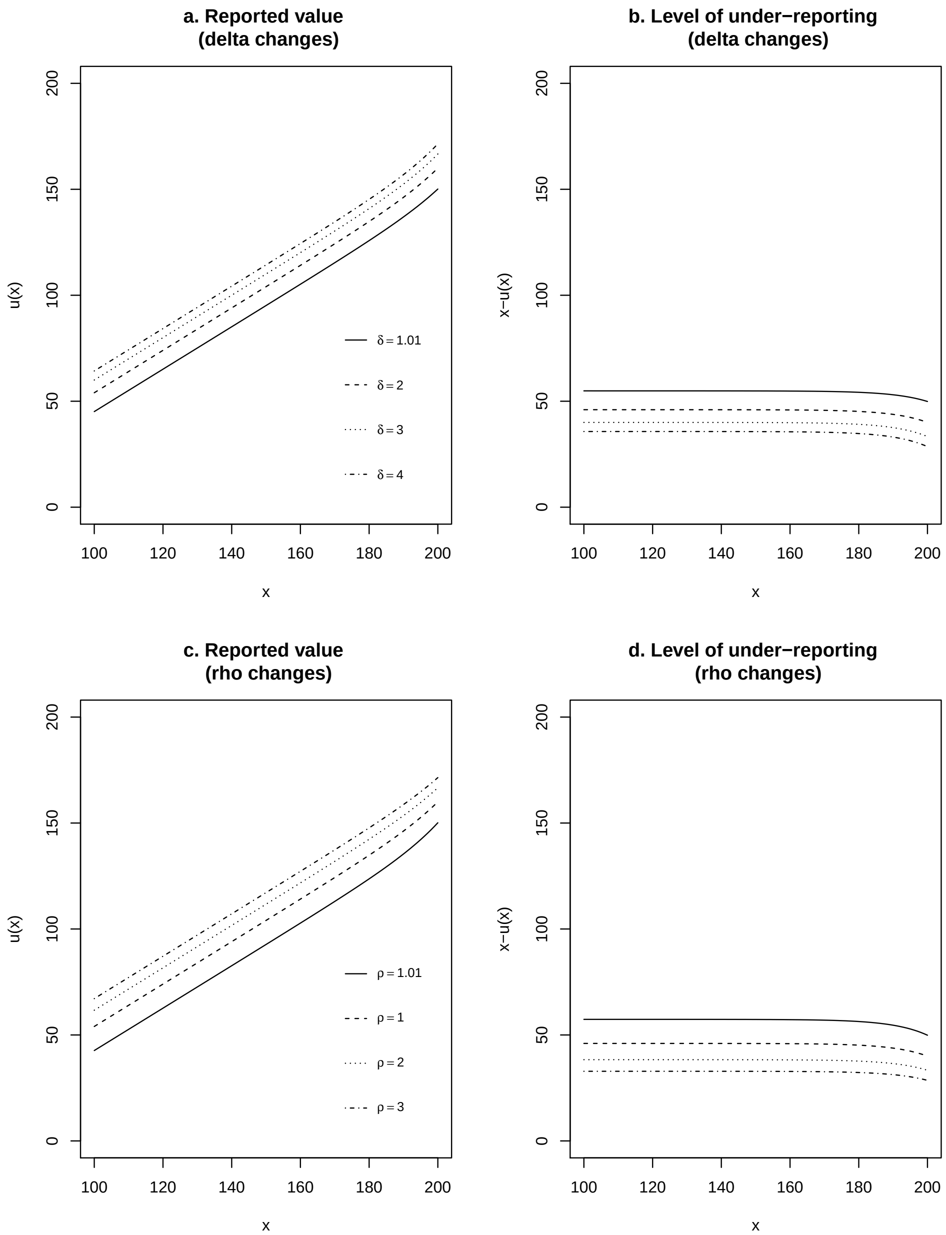


Figure 6: (a) Reported value $u(x)$ and (b) the level of under-reporting $x - u(x)$ as a function of the true value x as δ changes. (c) Reported value $u(x)$ and (d) the level of under-reporting $x - u(x)$ as a function of the true value x as ρ changes. Here $a = 0.0005, x_L = 100, x_H = 200, \beta = 0.1, \alpha = 0.1, \gamma = 0.5$. In (a) and (b), $\rho = 2$. In (c) and (d), $\delta = 2$.