# Trade Misreporting: Evidence from Pakistani Importers[*]

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*Abstract*

This paper provides direct evidence of attempted tax evasion in response to changes in tariff rates in a small open economy using transaction-level customs data for Pakistani importers. Our results show that there exists a systematic relationship between the difference in declared and assessed import values of the shipment, and the duty rate charged to the importer. We demonstrate that higher duty rates are associated with a greater misdeclaration of imports. In particular, a one-percentage point increase in duty rates, on average, is linked with 0.4 percent increase in under-invoicing of imports by Pakistani firms. The study explores several dimensions to examine the variation in estimates obtained across product types, import origins, modes of processing import transactions, and the role of firm characteristics, such as, frequency of imports, in determining the extent of misdeclaration.

*Keywords:* Misdeclaration; Tax avoidance; Small open economy

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## 1. Introduction

Misdeclaration of economic activities is a widespread phenomenon. Officially recorded economic and business activities may be misreported for several reasons but the primary motive for misdeclaration has been linked with tax evasion. Johannesen et al. (2020) highlight that the problem appears to be more acute in developing nations, although a substantial amount of false reporting also takes place in advanced economies. One such instance of misdeclaration occurs at the border where cross-border trade transactions are recorded. Bhagwati (1964) pointed out that the understatement of imports will be profitable for an importer only if the tariff rate exceeds the premium that must be paid to access illegal foreign exchange. Both exporting and importing firms face an incentive to forge data entries in official documents in order to either reduce the payment of customs duties, or to benefit from export subsidies (Yang 2008; Nitsch 2016). As a result, the quantity and/or value of a shipment is either under- or over-invoiced, and consequently, the precision of global trade statistics is compromised.

With the mounting significance of international trade as a model of economic development for developing countries, there has been a growing interest in accuracy of measurement of trade activities (Nitsch 2016).[1] According to Kar and Spanjers (2015), the sum of total trade mis-invoicing in developing countries in 2013 was approximately $1.1 trillion, and the total over 2004-13 for 55 developing countries was estimated to be roughly $7.8 trillion. The magnitude of trade mis-invoicing in Pakistan during 1972–2013 exceeded $92.7 billion, and the revenue loss borne by the national exchequer due to trade mis-invoicing was estimated at $21.2 billion (Qureshi and Mahmood 2016). Figure 1 highlights that Pakistani imports have almost doubled from about $31.6 billion in 2009 to nearly $60 billion in 2019, whereas the exports have hovered between $20-$24 billion during this period. In the fiscal year 2019-20, custom duties directly contributed more than 15% of the tax revenue to the government. In addition to the loss of state revenue, tariff evasion results in unduly favoring well-connected firms, whilst penalizing importers that report honestly.[2]

We use a newly constructed administrative customs dataset comprising of all import transactions for Pakistan in 2016 and 2017 to document the level of *attempted* tax evasion. Our study examines the micro-foundations of evasion elasticities by directly observing transaction-level import prices. Highly disaggregated data allows us to precisely estimate the discrepancy between the *assessed* and *declared* unit values of imports, and show that the estimated deviation from assessed value of imports is systematically linked with the import duty rate charged to the importer. We interpret this result as strong evidence of firms engaging in tax evasion practices. Our key findings hold at various levels of aggregation of the dataset, such as, at product and product-by-country levels. The subsequent transaction-level analysis reveals several interesting findings. We show that a

[1] Several studies investigate evasion gaps in developing countries, such as, Kenya, Mauritius, and Nigeria (Bouët and Roy 2012), Tanzania (Epaphra 2015), Pakistan, Jamaica, and Kenya (Pritchett and Sethi 1994), and Tunisia (Baghdadi and Raballand 2017), amongst others.

[2] For example, Rijkers, Baghdadi, and Raballand (2017) use Tunisian data to suggest that politically connected firms, i.e., firms owned by President Ben Ali and his family, were more prone to evade import tariffs.

percentage point increase in duty rates, on average, is linked with 0.4 percent increase in under-invoicing of import value by Pakistani firms. The study explores several dimensions to examine the variation in estimates obtained across product types, import origins, modes of processing import transactions, and the role of firm characteristics, such as, frequency of imports in determining the extent of misdeclaration. We notice that there exists a significant degree of heterogeneity in within firm responses to duty rates depending on, for example, the category of product imported, as well as the mechanism through which imports are processed at the port of entry. The methodology used to quantify misdeclaration by importers and the empirical findings highlighted in this study signifying the dispersion in estimates across firms, products, and countries of origin present novel findings which offer extremely important implications for trade and public policy.

*Figure 1 here*

Our paper makes several important contributions. First, we study the response of tariff evasions at the border in a small open economy and compare the results with bigger economies, such as, China and India.[3] Second, we use transactional trade data to study this relationship, in contrast to the earlier literature, which mostly relies on annual statistics.[4] This helps us refine the estimates obtained in the existing studies substantiating the positive association between tariff rates and the incentive to evade taxes. Our dataset does not suffer from missing trade statistics or misreporting of quantities or product classification. We advance the findings obtained by Fisman and Wei (2004) and Mishra et al. (2008) by relying on detailed transaction-level panel data.

Thirdly, our study also makes a methodological contribution to the empirical trade literature attempting to evaluate trade misreporting. We develop a simple methodology to study the degree of mis-invoicing practices amongst importing firms.[5] The most widely applied approach uses the trade gap, i.e., the discrepancy between trade statistics reported by the exporting and importing countries, as an indirect measure of tariff evasion (Javorcik and Narciso (2008); Jean and Mitaritonna (2010); Zitzewitz (2012); Stoyanov (2012)). This paper, on the other hand, exercises a direct approach to quantify misdeclaration related to the movement of goods across borders. We analyze the *declared* unit value reported by the importer, and the *assessed* unit value reported by the customs officer about the shipment at the same point in time at the port of entry into Pakistan. In the subsequent analysis, we use another proxy for measuring the magnitude of underreporting, based on the *declared* unit values by other importers of the same product from the same country within a given timeframe to quantify misdeclaration.

[3] For studies based on Chinese and Indian data, see Fisman and Wei (2004), Mishra et al. (2008), Ferrantino et al. (2012), and Rotunno and Vezina (2012).
[4] Theoretical studies hypothesizing the relationship between tax rates and tax evasion include Sequeira (2016), Allingham and Sandmo (1972), and Slemrod and Yitzhaki (2002).
[5] It should be noted that in our analysis, we focus on transactions for which the declared import value is less than or equal to the corresponding value assessed by the customs officer.

Furthermore, we account for the potential endogeneity of firm-level duty rates by using alternative measures of tariffs. Our results are not sensitive to various measures of duty rates, including, trade-weighted average tariffs and effective tariff rates, i.e., the sum of simple duty rates, regulatory duty rates, sales tax, and income tax. Our baseline estimates use the actual effective duties paid by the importer, and not just the standard duty rates reported for the respective product category. This is crucial because many importers receive tariff exemptions for different reasons which is expected to affect firm's behavior.[6]

Lastly, owing to the nature of our dataset, we can exploit additional sources of variation to isolate the effect of tariffs on evasion compared to those highlighted in the literature. This approach offers several additional advantages if misdeclaration is systematically correlated with other aspects of the firm that may potentially affect evasion, such as, the frequency of importing, political connections, or past (mis)declaration behavior of the firm. By controlling for firm fixed effects, our identification scheme allows us to capture the unobserved heterogeneity across importers, and control for such firm-specific characteristics. We exploit the richness of our dataset by examining the heterogeneity in estimates both across and within firms, and obtain several novel results. For example, we find that the incentive to underreport unit import price when there is an increase in the effective duty rate imposed on the firm is much higher when the importer engages in fewer foreign trade transactions. With higher frequency and greater reliance on foreign imports, as well as greater encounters with customs officials, the risk associated with misreporting is significantly increased which reduces the propensity to misreport. This risk is further increased by the introduction of digital records at the port of entry.

Our paper utilizes the customs database for understanding trade patterns of firms in Pakistan, and to address the crucial topic of misreporting trade statistics using the universe of import transactions. To our knowledge, this is the first study to control for variation across firms along with exploiting variation across products and time using transactional data. It is of great policy relevance because such data is generally unavailable for low-income countries and is specifically of great interest to Pakistan to formulate future policies for firms to incentivize accurate reporting of international trade transactions.

The remainder of the paper is organized as follows. Section 2 describes our dataset and presents descriptive evidence on misdeclaration behavior of Pakistani importing firms. Section 3 discusses the identification methodology used, and our baseline results using the aggregate data. The estimation results for transaction-level import data are presented and discussed in Section 4. Section 5 highlights the policy implications of our findings, and potential areas for future research. The final section concludes.

[6] More than 90% of the transactions are affected by some type of Statutory Regulatory Order.

## 2. The FBRP Data

### 2.1 Description of data

The Federal Board of Revenue Pakistan (FBRP) collects data for all export and import activities in Pakistan. In this paper, we use the data for imports collected by FBRP from January 1st, 2016, to December 31st, 2017. The dataset contains comprehensive information about the date of the transaction, product imported, country of origin, unit value of imports, and the total value and quantity imported. For each transaction, we observe an identification code for the importer. A novel feature of our dataset is that it lists two different measures of unit values of the imported product. Firstly, the data provides the unit value declared by the importing firm for each transaction, and the corresponding currency in which it is measured. Secondly, next to the unit value declared, we observe the unit value assessed by the customs officer, and the currency of measurement. All unit values are converted into Pakistani rupees. Since we directly observe the unit value, total value, and total quantity of imports, we are able to confirm that there are no major inconsistencies in quantifying one or more of these variables. Since the focus of this paper is on under-invoicing of imports in Pakistan, we exclude the observations for which the declared value of the shipment is bigger than the assessed value.[7] This leaves us with more than five million transactions over the two-year period.

Table 1 reports that there are over 27000 Pakistani firms importing from over 200 countries. Our dataset covers more than 6000 varieties of 8-digit standard industrial classification system (SITC) products imported into Pakistan during this period. More than half of the firms imported at least five different SITC-8 products in each year. The mean declared value is less than the mean assessed value for each year.[8] There is a significant variation in the misdeclaration of imports as well as the duty rates for these transactions. For nearly 20% of transactions, the declared value of imported variety is less than the value assessed by the customs officer, and the extent of under-invoicing varies substantially. In 2011, the FBRP started rolling out an electronic system, WeBOC (Web Based One Customs), to process the cross-border transactions at the point of entry into the country. During 2016 and 2017, on average, a fifth of the import transactions were still processed manually, i.e., non-WeBOC, across all ports of entry.

*Table 1 here*

[7] About 2.9% of the observations in the raw data have a declared value that is bigger than the assessed value.
[8] Although we have cut-off the measure of misdeclaration to be less than or equal to zero, the average for the raw data is also less than zero for each year, i.e., the average of the log of declared value is less than the average of the log of assessed value.

### 2.2 Misreporting by Pakistani importers

To fully understand the process of recording an import activity, let us consider a typical import transaction. Usually when the shipment arrives at the Pakistani border, the importing firm must declare the unit price of the product for calculation of duties to be paid to the customs office. The quantity (or volume) of shipment is easily verifiable at the port and the importer will report its true value. In most cases, there is no disagreement between the importer and the customs officer about the quantity of the imported shipment, as it can be validated at the time. However, there can be a disagreement about the unit value of the product which can affect the total value of the shipment. If the customs officer does not agree with the value declared by the importer, further documentary evidence that can help in gauging the value of the shipment may be requested. The customs officer can also use the data available from FBRP to assess the value of the imported product by checking the assessed value of the same (or similar) product imported recently from the given country of origin. The customs officer at the port of entry has the authority to determine the unit value for the shipment, and the value assessed is then used for the calculation of customs duties and applicable taxes. If the importer is not satisfied with the value assessed, she can appeal to the customs directorate. If the directorate decides in favor of the importer, a refund for the extra duties paid may be requested at the time of clearance of the shipment.

We observe significant variation in assessed unit values for a majority of imported products sourced from the same country of origin within specific duration. Figure 2 reports the distribution of assessed unit values for four different narrowly defined product categories imported from a specific country within the same month. Each graph indicates the product code, product description, country of origin, and the time period considered. Even though the duties charged, and tax revenue collected is based on the assessed price of imports, there is a substantial variation in price quoted by the FBRP to the customs officer. Consequently, the importer faces a strong incentive to under-invoice imports and save the tax paid. Once the assessed value of the import transaction is finalized, all types of duties and taxes, including customs duty, additional regulatory customs duty, sales tax, and income tax, are based on the assessed import value.

*Figure 2 here*

As described in the subsequent section, our principal strategy is to first compute the divergence, if any, between the value of imported shipment declared by the firm, and its value assessed by customs officials. In other words, for each import transaction, our measure of misdeclaration is given by:

$$m_{ipct} = \log\left(\frac{\text{Declared imports}_{ipct}}{\text{Assessed imports}_{ipct}}\right) \quad (1)$$

where $m_{ipct}$ represents the wedge between the declared and assessed import value for firm *i* for product *p* imported from country *c* on the date of the transaction *t*. Ideally, one would expect the

ratio, $\frac{\text{Declared imports}_{ipct}}{\text{Assessed imports}_{ipct}}$, to be equal to one, i.e., the importing firm declares the actual imported value, and no misdeclaration takes place. The corresponding value of our measure of misdeclaration would then be equal to zero. However, there exists a strong incentive for importers to under-invoice their import bills. If mis-invoicing does indeed take place, $\frac{\text{Declared imports}_{ipct}}{\text{Assessed imports}_{ipct}}$ would be equal to less than one, causing the value of $m_{ipct}$ to be negative. As indicated in Table 1, the average value of $m_{ipct}$ is -0.29 for the year 2016, and -0.22 for 2017.

*Figure 3 here*

It should be noted that given the nature of our dataset, we can only comment on the *attempted* tax evasion by the importer by declaring a lower unit price for the product; eventually, the duties charged, and taxes paid are based on the *assessed* price, and not the *declared* price of the import transaction.[9] Figure 3 plots the distribution of our measure of misdeclaration for each of the two years. We notice that for nearly 80% of the transactions, the declared value is equal to the value assessed by the customs officer.

*Figure 4 here*

It should also be acknowledged that the value assessed by customs officer might not reflect the *true* value of the import shipment because of the asymmetric nature of information between the importer and customs officer. In order to somewhat account for the information asymmetry between the importer and the customs officer, we also develop another measure to infer misdeclaration by importing firms. We proxy the *assessed* value with the average *declared* unit value by all other importers, excluding the importer themselves, that are importing the same 8-digit product from the same country within the same calendar month, and recalculate the extent of misdeclaration.[10] For this measure, we once again limit the observations as before, i.e., only focus on observations where the declared value of the shipment by the importer is less than or equal to the assessed value by the customs officer. However, this measure of misdeclaration could still be greater than zero, as for some importers, the declared unit value may be higher than the average of the declared values by other importers within the country-product-month group. The estimation results based on our misdeclaration proxy variable are explained later in the paper.

[9] We cannot comment on other corrupt practices (such as, Chalendard et al. (2020) do using Madagascar data) given the data limitation.

[10] This does not completely resolve the asymmetric information issue but is certainly an improvement over the value *assessed* by the customs officer, as it is assumed that the other importers buying the same 8-digit product from the same country within the same month are expected to have better information than the customs officer. It is still possible, nevertheless, that given the set of importers of the 8-digit product from the same country within same month may be relatively small, importers collude on determining the declared price of the product. Given the nature of the dataset, it is not possible to control for such practices in this study.

To demonstrate the variation in duty rates charged across import transactions, we plot the distribution of duty rates for each year in Figure 4. For most of the transactions, the duty rate charged is below 20 percent. Table 1 indicates that the average duty rate is approximately 13 percent for both years. It should be noted that these are the actual duty rates, i.e., the duties paid by the importer after considering the applicable Statutory Regulatory Orders (SROs). In addition, the duty rates depicted do not include the sales tax (roughly 17% on average) or the income tax (5% on average) paid on imports.[11] The importer is usually aware about any applicable SROs before customs clearance, and thus, it is more appropriate to use the actual duty paid rather than the standard duty rate for each product. Many importers under special circumstances will get SROs which results in lowering (or even exempting) the duty rates for the shipment. As noted above, sales tax as well as income tax are also based on the *assessed* value of the shipment and the import duties paid on it. This creates a strong incentive for importer to try to lower the import value as much as possible, particularly when custom duties are higher. Figure 5 plots a histogram of the coefficient of variation of effective duty rates calculated at the product-by-month level. It highlights that there exists variation in effective duty rates across import source origins within any given product-by-month pair for about a third of such groups.

*Figure 5 here*

Motivated by the descriptive evidence presented in this section, we now turn to our empirical estimation. In the following two sections, we provide empirical evidence substantiating the findings of the studies highlighted above by examining the relationship between mis-invoicing of a foreign trade transaction and the import duties charged. We first present quantitative evidence at the aggregated level, namely product-level of aggregation, followed by transaction-level estimation to offer greater granularity to our baseline findings.[12]

## 3. Misdeclaration in aggregate data

Our primary interest is to emphasize on the variation in *declared* versus *assessed* import values across Pakistani importers, and the extent to which these differences relate to duty rates charged to the importing firms. We test currently established empirical regularities based on aggregate product-level trade data and relate the systematic variation in the unit value of imports misreported across firms. This is achievable with the use of transaction-level customs database compiled by the FBRP. Our dataset records all of Pakistan's imports from January 1st, 2016, to December 31st, 2017, and corresponding to each transaction, we observe the import value declared by the firm along with the value assessed by the customs officers.

[11] For our analysis, we also later use the effective duty rates, i.e., the rates incorporating the corresponding sales tax and income tax paid for each transaction.
[12] Please refer to the Online Appendix for the results based on product-by-country level of aggregation.

In order to assess the relationship between misdeclaration and the duty rates, we start by estimating the following specification aggregated at the product-by-month level:

$$m_{pt} = \beta_0 + \beta_1(\text{duty rate}_{pt}) + \gamma_p + \gamma_t + \epsilon_{pt}, \quad (2)$$

where $m_{pt}$ is the average value of misdeclaration for 8-digit product *p* during a month *t*, as defined in Eq. (1). Note that the dependent variable would assume a negative value if there was under-invoicing. The independent variables include the mean duty rates charged to the importer for the transaction, averaged by product and month, $\text{duty rate}_{pt}$. The product and time fixed effects are denoted by $\gamma_p$ and $\varphi_t$, respectively.[13]

*Table 2 here*

Table 2 provides the estimated coefficients for Eq. (2) at the product level.[14] Columns (1)-(2) are based on customs duty rates, whereas in columns (3)-(4), we use an alternative measure of duties paid which adds up all taxes paid by the importing firm for the transaction, or an *effective* duty rate which also includes sales tax and income tax paid by the firm. Since the value of shipment varies significantly within a given 8-digit product-by-time subgroup, in columns (2) and (4) we use weighted averages for the duty rates, weighted by the share of each transaction in the total value of imports within a given product category.[15] Similarly, to adjust for the value of the shipment, the dependent variable is also measured as the weighted average of misdeclaration over product by time groups. All estimates reported in Table 2 control for the time and product fixed effects.

Column (1) of Table 2 estimates the baseline specification, capturing the statistically significant negative association between the average duty rates and misdeclaration by importing firms in Pakistan. It suggests that a one percentage point increase in average tariff rate leads to 0.375 percent higher misdeclaration, after controlling for product and time fixed effects. Column (2) reports the association between the weighted measure of misdeclaration, i.e., a weighted average of misdeclaration and duty rates. We find that the estimated coefficient associated with weighted average duty rate is also statistically significant, and higher compared to that for the simple average duty rate indicated in column (1), implying that higher duty rates result in a greater incentive for the importer to under-declare the unit price of their imports. The results in column (2) can be compared with the earlier literature where annual trade statistics are used at the product level to estimate tax evasion by importers. Our estimate lies in between the evasion elasticities estimated by Mishra et al. (2008) using Indian data, roughly equal to 0.1, and that found by Wei and Fisman (2004) based on Chinese data, i.e., approximately equal to 3.

[13] It is important to note that the duty rates for each product can vary at the transaction-level depending on the SROs being applied for each transaction.
[14] The Online Appendix also reports a similar analysis at the product-by-country level.
[15] We use the assessed values of imports to calculate the weighted average.

Columns (3) and (4) use the effective duty rates and weighted averages of effective duty rates, respectively, as explanatory variables, and their associations with two measures of misdeclaration. Although the relationship is once again negative and significant, the estimate values are lowered compared to those reported in the first two columns. The evasion elasticity reduces by about a quarter if we incorporate all the applicable taxes to be paid by the importer. We expect a rational importer to incorporate all applicable duties while responding to change in the tariff rates. These findings suggest a robust negative relationship between duty rates and level of misdeclaration by importers for the aggregated data at the product level, and the consistency of our estimates with the earlier literature.

## 4. Transaction-level estimation

Our results based on aggregated data in Section 3 confirm the findings of the existing literature on the mis-reporting behavior by importing firms. Despite the interest in detecting and correcting for misreporting of international trade transactions, due to the unavailability of transaction-level trade data for most countries, the existing literature has made modest progress in identifying the extent, magnitude, and consequences of misreporting trade transactions. To exploit the richness of our dataset, we now turn to a detailed analysis at the transaction-level and compare these results with the evasion elasticity calculated at aggregate level. Our study is the first to unlock the customs trade database for understanding mis-invoicing behavior of importing firms, focusing on the magnitude and persistence of misdeclaration over time and across trade partners.[16] We estimate the following specification:

$$m_{ipct} = \beta_0 + \beta_1(\text{duty rate}_{ipct}) + \gamma_{pc} + \gamma_{pt} + \gamma_{ct} + \gamma_i + \gamma_{et} + \epsilon_{ipct}, \quad (3)$$

where $m_{ipct}$ is the value of misdeclaration defined in Eq. (1) using two definitions for *assessed* value i.e., based on customs officer valuation, as well as using the average *declared* unit value by other importers, as explained below. The independent variables now include the actual transaction-level duty rate charged to the importer, along with additional fixed effects. Eq. (3) can indeed uncover evasion if the information asymmetry between the importer and the customs official does not correlate with the level of import tariffs. We include product fixed effects to control for this omitted variable bias if the information asymmetry is product specific. More convincingly, country of origin-by-product fixed effects are also controlled for to address this concern, as one may expect that the customs official has access to the history of imports of the same product from a given country. Product-by-quarter and country-by-quarter fixed effects are included to control for seasonality patterns. $\gamma_i$ denote firm fixed effects. Lastly, port of entry-by-quarter effects, $\gamma_{et}$, allow us to control for the mode of transportation as well as to differentiate between whether the transaction was processed manually (non-WeBOC) or electronically (WeBOC) at the port of

[16] This statement is true to the best of our knowledge.

entry.[17] All transaction-level results allow for either product-level or multi-way clustering of standard errors by firm-product-country of origin groups, to control for possible autocorrelation in the error terms along these different dimensions of variation in the data.

### 4.1 Baseline results

Table 3 reports the results for the estimation of Eq. (3) where each observation is now at the transaction level, starting with single fixed effects in column (1). Column (1) regresses our measure of *attempted* misdeclaration on customs duty rate for each transaction, controlling for product and monthly fixed effects. Interestingly, the relationship observed above between misdeclaration and duty rates averaged at the product-by-time subgroups, also holds at transaction level. Although, the coefficient is relatively smaller in magnitude, it is still negative and highly significant. The magnitude of the coefficient increases upon the inclusion of country of origin and port fixed effects. Column (3) highlights that a one percentage point increase in tariff rate leads to nearly 0.41 percent increase in misdeclaration of the value of imported shipment. The results of these three columns confirm the robustness of the relationship between tariff rates and misdeclaration at the transaction level.

*Table 3 here*

Column (4) reports estimates for specifications similar to those estimated in the first three columns but also control for the firm fixed effects. We find that the relationship is reversed when we introduce firm fixed effects in our estimation. Column (4) highlights that there is an inverse relationship between duty rates and misdeclaration if we control for firm fixed effects i.e., one percentage point increase in duty rates, on average, results in 0.19 percent reduction in the extent of misdeclaration within a given firm. The inverse relationship is robust to the inclusion of country of origin as well as port fixed effects.[18] This is somewhat surprising as it suggests that within a given firm-product-country of origin and month subgroup, an increase in tariff rate lowers attempted misdeclaration. This finding contrasts with our earlier results as well as those reported by the existing literature based on aggregated trade data. However, none of the existing empirical studies analyzing the association between tariff rates and misreporting of international trade transactions capture the within-firm variation in the estimates. This study, to our knowledge, is the first one to control for the firm fixed effects in the context of misdeclaration of imports. The reversal of sign of evasion elasticity suggests that the tax evasion behavior observed in the aggregated results might be driven by the behavior of a subset of importing firms engaged in international trade.

*Table 4 here*

[17] Effectively, there are twice as many port fixed effects as the number of ports of entry into Pakistan depending on whether the transaction was processed manually or electronically.

[18] As shown later in the paper, the relationship between misdeclaration and duty rates within the firm shows significant heterogeneity.

Table 4 uses an alternate measure for duty rates, i.e., the effective duty rates as defined above, calculated at the product-country-month level. We find similar results to those highlighted in Table 3, although in this case, the coefficient for duty rates is insignificant but positive when we control for the firm fixed effects. The coefficients for the columns in Tables 3 and 4, including the shipping port fixed effect but not the firm fixed effects, are relatively robust irrespective of the measure of duty rates used in the analysis. It reports the evasion elasticity to be about 0.4, i.e., a one-percentage point increase in the duty rate leads to 0.4 percent increase in under-reporting of value of imports. The insignificant coefficient for the effective duty rates further strengthens the idea that the increase in duty rates causes an increase in misdeclaration in aggregated results might be caused by a subset of firms amongst the Pakistani importers.

*Table 5 here*

Table 5 highlights that these results are robust to the incremental introduction of a variety of cross-fixed effects as well as levels of clustering of the standard errors. In this case, in order to control for seasonality, we switch the time variable to quarter instead of months.[19] The results shown in the last column of Table 4 are robust to the inclusion of port-by-quarter and country-by-quarter fixed effects, since the coefficient for effective duty rates remains insignificant. However, once we introduce country-by-product fixed effects, along with controlling for seasonality patterns, the coefficient for effective duty rates becomes significant. The relationship between effective duty rates and misdeclaration remains positive and significant even after clustering standard errors at the country-by-product-by-firm level. Column (4), nevertheless, highlights that the estimates reported in Table 4, without controlling for firm fixed effects, are robust to the introduction of a variety of fixed effects and levels of clustering of standard errors.

It should be noted that the value assessed by customs officer might not reflect the *true* value of the import shipment due to information asymmetry in measuring the value of the product between the firm and customs officer. The unit value assessed by customs may be far from the actual unit value, since the customs official is likely to have less information than the importer themselves on, say, the characteristics of the product. Therefore, the scale of misreporting based on the mismatch variable used in the above analysis could possibly be the result of information asymmetry between the importer and the customs official. If the customs official has little or no specific information and can only validate the importer's declaration, no mismatch is likely to occur. This interpretation of the gap measure suggests that similar to the trade gap approach used in earlier studies, a systematic and robust negative association between under-declaration and duty rates is indicative of evasion.[20]

[19] The results are robust to replacing quarters with months to control for seasonality, but quarterly fixed effects seem more intuitive if we wish to control for seasonal effects for some products, such as, air conditioners or generators, etc.
[20] We thank an anonymous referee for this suggestion.

In order to account for this information asymmetry between the importer and the customs officer, next, we develop another measure to determine underreporting by importing firms. We proxy the *assessed* value with the average *declared* unit value by all other importers, excluding the importer themselves, that are importing the same 8-digit product from the same country within the same calendar month, and recalculate the extent of misdeclaration. The outcome variable in Table 6 is this second measure of misdeclaration. In this case, a transaction is said to be under-declared if the declared price by the importer is less than the average price declared by the all other firms importing the same SITC-8 product from the same country within the same calendar month. However, the underlying set of observations to conduct this part of the analysis are still the same i.e., all transactions where the *declared* unit value by the importer is less than or equal to the *assessed* unit value by the customs officer. This measure of misdeclaration could also include positive values as the declared unit value of some of the importers, by definition, would be higher than the average of the unit values declared by other importers within the same country-by-product-by-month group.

*Table 6 here*

Table 6 illustrates that the relationship between misdeclaration proxy measure, based on the average price quoted by other importers, and the effective duty rate is negative for any combination of fixed effects as well as level of clustering of standard errors. Interestingly, the negative coefficient becomes highly significant, once we cluster standard errors at the country-product-firm level, irrespective of the inclusion of firm fixed effects. It should be noted that the coefficient of this new measure also lies within the range of evasion elasticities estimated by earlier studies, i.e., between 0.1 reported by Mishra et al. (2008) using Indian data, and 3 reported by Wei and Fisman (2004) based on Chinese data.

The next sub-section focuses on identifying various sources of this negative association between effective duty rates and the second measure of import misdeclaration by firms, where the assessed value is based on the average declared unit price by other importers within the country-product-month group.

## 4.2 Heterogeneity in misdeclaration by firms

In this section, we focus on various subsets of the transaction level data to explore other dimensions possibly related to the findings discussed in the previous section. We begin by studying the role, if any, of the frequency of imports in affecting the extent of misreporting by firms. Next, we consider the variation in estimates obtained across product types, import origins, and various modes of processing import transactions at the border.

### 4.2.1 Frequency of import transactions

It would be interesting to know if firms that trade more often are more (or less) likely to attempt

to evade taxes than firms that trade less often. One would expect that firms more regularly engaged in dealing with customs officials are less likely to misreport due to, firstly, greater likelihood of getting caught, and secondly, also due to the longer-term consequences of being flagged by the customs officers. A smaller number of import transactions, on the other hand, implies a somewhat lower risk associated with misdeclaration of a given import transaction. Based on the frequency of import transactions conducted by firms in the dataset, Eq. (3) is estimated separately for the lowest to the highest quartiles of firms categorized by their volume of import transactions. These results are depicted in Table 7.

*Table 7 here*

Table 7 reports estimates obtained for each of the four quartiles of firms, starting from the lowest frequency quartile in columns (1)-(2), to the highest frequency quartile in columns (7)-(8). All regressions include the two-way interaction fixed effects explained previously, whereas firm fixed effects are only included in the second column for each quartile. Robust standard errors clustered by firm-product-country groups are given in parentheses. Although the negative and significant coefficient of effective duty rate persists for most cases, the magnitude and statistical significance of underreporting is much higher for the lowest frequency firms. On the contrary, the negative coefficient of duty rates becomes insignificant upon the inclusion of firm fixed effects for the top two quartiles of importing firms (see columns (6) and (8)). These results confirm that the incentive to underreport unit import price when there is an increase in the effective duty rate imposed on the firm is much higher when the importer engages in fewer foreign trade transactions. With higher frequency and greater reliance on foreign imports, as well as greater encounters with customs officials, the risk associated with misreporting is significantly higher which lowers the inclination to misreport. This risk is further increased by the use of technology and introduction of digital records at the port of entry, as explained in the following section.

### 4.2.2 Use of technology

We make use of the available information contained in the FBRP customs data and the import documentation accessible by importing firms in Pakistan. FBRP introduced an electronic system of recording import transactions in 2011, referred to as the Web-Based One Customs (WeBOC), for clearance of imported goods arriving at various ports of entry. The major changes in the WeBOC clearance system involved proper checking of imported goods and classifying an imported shipment to be considered through either a "Green", "Yellow" or "Red" channel. The newly automated system could only operate effectively upon incorporation of the Valuation Module in the system. After this policy change, a new valuation module was developed to apply the valuation rulings in WeBOC for the detection of potential misdeclaration of imported consignments. We note that the implementation of proposed policy change varies across the dataset. In 2016 and 2017, about eighty percent of transactions were processed through WeBOC,

and around a fifth of the transactions were processed manually. Using the implementation information available in our data in the form of each import consignment transaction classified as either WeBOC or non-WeBOC, we estimate Eq. (3) for the sub-samples of WeBOC and non-WeBOC transactions. The results are shown in Table 8.

*Table 8 here*

Column (1) reports transaction level estimates for the complete data as reported earlier in column (3) of Table 6. Column (2) states the estimates of coefficients of effective duty rate for the transactions processed through WeBOC, whereas column (3) reports the estimation results for transactions processed manually through customs. The results in Table 8 suggest that the processing mechanism does affect the behavior of Pakistani importers. We notice that estimates for the transactions not processed electronically through WeBOC reveal results similar to those for all transactions and are significant, i.e., firms increase their misdeclaration of imports in response to an increase in effective duty rates when imports are recorded manually. On the other hand, if an import transaction is not processed manually, the relationship between misdeclaration and effective duty rate is no longer significant. Column (3) shows that a one-percentage point increase in effective duty rate is associated with a 1.81 percent increase in underreporting of the value of import shipment.

Thus, Table 8 suggests that the within firm misdeclaration behavior also depends on the import transaction processing mechanism. On average, if the transaction is processed manually, even within firm, a higher duty rate is associated with an increase in misdeclaration of imports, but not necessarily for transactions that are processed electronically. This is an important finding as the implementation of WeBOC clearance system involving classification of imported shipment and subsequently the importing firm itself to be considered through one of the three channels increases the risk of being flagged by customs officials for future transactions, thereby discouraging underreporting by firms.

### 4.2.3 Product type and sectoral differences

It would be interesting to know if certain industries or product types are more or less likely to evade tariffs. An analysis similar to our baseline estimation is conducted at the two-digit HS industry level. It is possible that the evasion results discussed earlier are being driven by certain sectors, or are stronger for specific product types. We first estimate Eq. (3) separately for each 2-digit sector. These results are depicted in Table 9. There are eighteen sectors, and the outcome variable is once again our measure of misdeclaration by the firm described above. All regressions control for the interaction fixed effects discussed earlier, and robust standard errors are clustered by firm-product-country group. A negative coefficient is obtained in eleven sectors, while the estimates are significant in only six out of these eleven industries, for example, *instruments*,

*electronic and electric equipment*, and *computer equipment and machinery*. On the other hand, the coefficient is positive and significant in four cases. In eight out of the eighteen sectors, the results obtained are inconclusive.

*Table 9 here*

In the next step, we use the indicator by Rauch (1999) to identify groups of SITC 8-digit products for which information on unit values is more difficult to obtain, i.e., differentiated products, as opposed to homogeneous goods. One would expect that under-declaration is less important in non-differentiated products due to the standardized nature, and therefore, uniformity in unit values, of these products. Following this line of argument, we would expect that the positive association between effective tariff rates and misdeclaration is higher for more differentiated products where the precise value of the customized product is unknown to the officer at the port. On the contrary, the customs official may have no choice but to follow the proposition of the importer if the true value of the differentiated product is unknown or difficult to predict.[21] The results reported in Table 10 confirm the former prediction. Columns (1)-(4) indicate that the scale of underreporting in response to an increase in duty rates is much higher for differentiated goods. Surprisingly, the estimates obtained for non-differentiated goods also appear to be highly significant, however, the magnitude of estimates is greater for differentiated goods.[22]

*Table 10 here*

Thus, the estimates reported in Tables 9 and 10 together suggest that the source of heterogeneity in findings across importing firms could possibly be related to the nature of product imported. Producers in certain sectors and importers of specific product types are more likely to misreport imports, once again possibly related to their incentive to exploit the information asymmetry in the valuation of the product.

### 4.2.4 Regional disparities

Table 11 explores regional variation in evasion elasticities for Pakistani importers. We observe that import transactions originating from the Arabian Gulf, North America, and the European Union contribute toward the positive relationship between under-reporting of import value and effective duty rates.[23] Import transactions with countries in East and South Asia, as well as ASEAN countries, are not associated with having a significant relationship between our measure of

[21] This prediction counters the findings of Javorcik and Narciso (2008) using the trade gap measure. We thank an anonymous referee for this suggestion.

[22] The Online Appendix shows estimation results obtained when Eq. (3) is run separately for differentiated and non-differentiated goods for each of the 2-digit sectors. We observe that the results are stronger for differentiated goods, while in a majority of sectors, the coefficients generated for homogeneous goods are statistically insignificant.

[23] The Arabian Gulf includes UAE, Qatar, Kuwait, Saudi Arabia, and Oman. East Asia includes China, Japan, Korea, and Hong Kong.

misdeclaration of imports and effective duty rates, on average. It should also be noted that nearly two-thirds of all import transactions originated from Asian economies. The transactions from regions outside of Asia exhibit a significant and negative coefficient of duty rates, consistent with earlier results, i.e., higher duty rates incentivize the importer to further under-report the shipment value. A supplementary online appendix reports estimates obtained by focusing on the top five import origins of Pakistan during the two years. China, being the biggest importing source for Pakistani importers, accounts for nearly a third of the transactions in 2016 and 2017. The coefficient for evasion elasticity for China is highly significant and negative. Imports from the United Arab Emirates exhibit the highest magnitude of the estimated coefficient, while the relationship appears to be statistically insignificant for Thailand and Japan. To summarize, the regional analysis carried out in this section identify the disparity in results across trade partners despite the qualitative similarity in estimates obtained, with much stronger results for imports originating from China and the UAE.

*Table 11 here*

## 5. Discussion and policy implications

An empirical examination of the effect of duty rates on misdeclaration has proved to be challenging due to the difficulties in quantifying evasion which is often not directly observed. A number of recent studies have used discrepancies between trade flows reported by trade partners to demonstrate how tariff evasion varies with duty rates (Fisman and Wei 2004), product attributes (Javorcik and Narciso 2008), the level of enforcement (Mishra et al. 2008), or importing country characteristics (Jean and Mitaritonna 2010). Kellenberg and Levinson (2018) set up a model in which firms or countries choose how much imports or exports to misreport as functions of country characteristics such as tariffs, corruption, and the strength of auditing and accounting standards using annual trade data for 126 countries from 2002 to 2012. A country-level analysis, nonetheless, is expected to suffer from aggregation bias since tariffs are measured by an average rate applied to all products for a given country.

In this study, we try to address the issue of aggregation bias by analyzing transactional trade data and provide evidence for misdeclaration of economic activities in a small open economy. Tariff evasion can take place in the form of one or more of the following three ways: mis-declaring the unit value of imported products, undercounting quantities of imports, and misclassification of high tariff commodities as a lower tariff product. The processes at the border, even in developing economies, have been significantly modernized and it is relatively difficult to misreport the quantity of the import or mis-classify the product by the importer. However, the unit price of the product varies significantly even within a short span of time, depending on the supply and demand of the product in the global economy as well as fluctuations in the currency market, as evident from Figure 1. We use the universe of import transactions for two years to investigate this relationship between the duty rates and under-reporting of unit value of imports. Our estimate for attempted tax evasion elasticity for Pakistan lies in between the one found for India by Mishra et

al. (2008), and the one for China found by Wei and Fisman (2004) when we analyze the aggregate data at the product-month level, or the transaction level data. It should be noted that this is the lower bound on the attempted tax evasion at the border as we cannot monitor the systemic misdeclaration resulting from collusion between the customs staff and the importer.

This paper offers several policy implications. While we do not explore the effects of corrupt behavior and customs reform, our results imply that absence of audits and ineffective inspections are more prone to misdeclaration of import values. Similarly, excessive discretion at the hands of custom officials also encourages the importer to under-report the shipment value. Our findings indicate that a greater use of technology, although might not eliminate the misdeclaration of imports entirely, will surely discourage the marginal importer from under-invoicing. The electronic processing of imports will not only increase efficiency but can also provide the data to the customs officer in charge. Customs authorities could use historic inclination toward misdeclaration by individual firms to implement an automated digital flagging system, like the one proposed by Wier (2020). FBRP has introduced the *Green, Yellow,* and *Red* channels in WeBOC to rate the importer behavior. Firms with a historical trend of systematically divergent misdeclaration behavior can be audited more frequently and thoroughly. FBRP need to further strengthen the WeBOC system as nearly a fifth of the transactions are still processed manually at various Pakistani ports.[24]

We also provide a relatively better measure for the duty rates to analyze the misdeclaration of imports as compared to the earlier literature. As suggested earlier, it is common to get special tax exemptions by the importers in developing economies, and hence, the transaction level analysis improves the estimation of coefficient of evasion elasticity. We have used the actual duties paid by the importer to calculate the duty rate, rather than using a standard duty rate reported for the product. We also notice that the estimate for evasion elasticity varies significantly by the type of duties used in the analysis. Sales tax as well as the income tax paid by the importer also depends on the value of the imported product. Therefore, effective duty rate, inclusive of sales tax and income tax, seems to be a better measure to assess the tax evasion elasticity of imports.

We also find a significant variation in under-reporting of imports by Pakistani firms, if any, in response to an increase in the duty rates, across origin country of imports. It would be useful to empirically relate the discussion of tariff evasion to the related issues of corruption, capital controls, and regulatory enforcement, and to measure the extent to which trade misreporting takes place across a broader set of products, and for countries belonging to different income levels or having particular institutional characteristics (Kellenberg and Levinson 2018). The availability of transaction-level trade data for many countries in recent years can be used to test the generality of our results beyond the specific case of one country analyzed in this paper.

[24] Kellenberg and Levinson (2018) find robust evidence for stronger auditing and accounting standards to decrease the underreporting of exports.

Another potential topic for future research is to further analyze the various motives for misdeclaration of trade activities by linking trade data issued by FBRP with firm-level balance sheet data. It would be worthwhile to relate firm characteristics to the observed misreporting behavior and tariff evasion to shed light on specific attributes of firms which are expected to be correlated with misdeclaration of import activities to assess the evasion propensities of different types of firms. Furthermore, as each cross-border shipment is recorded separately by two different customs administrators, i.e., at the time of leaving the country of origin as well as at the time of arriving at the destination country, mis-invoicing of international trade transactions appears to be easy to detect if comparable datasets are available for foreign countries. We aim to expand our work into exploring some of these areas building on the findings of this paper, and by complementing our dataset with additional data sources.

## 6. Conclusion

This paper offers empirical evidence quantifying the scale of under-invoicing of imports in the context of a developing country. We use a comprehensive customs database encompassing the universe of import transactions in Pakistan over 2016-2017 and find that higher tariff rates lead to increase in misdeclaration of imports. The impact of tariff rates on misreporting trade statistics has been studied extensively. Much of the earlier literature uses the aggregate data for exports and imports at year-product level from two different countries to detect these disparities. Our paper, on the other hand, focusses on misdeclaration at transaction level to understand the microeconomic underpinnings of tariff evasion. The use of large administrative datasets is common in the international trade literature for developed countries. However, such highly detailed data have mostly been unavailable for research on developing economies. To our knowledge, this is the first paper that uses transaction-level trade data to directly test for misreporting activities of firms in a developing country at disaggregated level. Our dataset allows us to perform numerous empirical exercises to hypothesize that importing firms have a strong incentive to declare lower values of imported commodities to lessen the taxes paid. We explore several dimensions to examine the variation in estimates obtained across product types, import origins, modes of processing import transactions, and the role of firm characteristics, such as, frequency of imports in determining the extent of misdeclaration.

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**Table 1: Summary statistics**

| | 2016 | | 2017 | |
|---|---|---|---|---|
| | Mean | Std. dev | Mean | Std. dev |
| Log (Declared value) | 10.86 | 3.02 | 10.96 | 2.86 |
| Log (Assessed value) | 11.15 | 2.79 | 11.19 | 2.78 |
| Customs duty rate per transaction (%) | 12.84 | 10.19 | 13.01 | 10.26 |
| Misdeclaration ($m_{ipct}$) | -0.29 | 0.87 | -0.22 | 0.71 |
| # Importing firms | 27515 | - | 28364 | - |
| # SITC-8 products | 6052 | - | 6199 | - |
| # Import origins | 249 | - | 242 | - |
| Median number of SITC-8 products imported per firm | 5 | - | 6 | - |
| Transactions processed through WeBOC (%) | 80.03 | - | 82.96 | - |
| No misdeclaration (%) | 73.14 | - | 79.36 | - |

*Notes:* Pakistan's importing firms active over 2016-2017. Based on authors' calculations using transaction-level import data obtained from the Federal Board of Revenue Pakistan (FBRP).

**Table 2: Product-level estimation results**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Average duty rate | -0.375*** | | | |
| | (0.089) | | | |
| Weighted average duty rate | | -0.501*** | | |
| | | (0.079) | | |
| Average effective duty rate | | | -0.285*** | |
| | | | (0.036) | |
| Weighted average effective duty rate | | | | -0.349*** |
| | | | | (0.032) |
| Observations | 110,273 | 110,273 | 110,273 | 110,273 |
| R-squared | 0.330 | 0.291 | 0.330 | 0.292 |
| Adjusted R-squared | 0.290 | 0.249 | 0.291 | 0.250 |
| No. of products | 6145 | 6145 | 6145 | 6145 |
| Product effects | Yes | Yes | Yes | Yes |
| Month effects | Yes | Yes | Yes | Yes |

*Notes:* The outcome variable in columns (1) and (3) is the average misdeclaration by the firm, while the dependent variable in columns (2) and (4) is the weighted average of misdeclaration. The estimates are obtained at the product level. All regressions include a constant term. Robust standard errors clustered by product are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 3: Transaction-level estimation results**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Duty rate | -0.246** | -0.348*** | -0.413*** | 0.190*** |
| | (0.101) | (0.088) | (0.096) | (0.062) |
| Observations | 5,078,011 | 5,077,995 | 5,077,994 | 5,074,669 |
| R-squared | 0.125 | 0.144 | 0.212 | 0.440 |
| Adjusted R-squared | 0.124 | 0.143 | 0.211 | 0.436 |
| Product effects | Yes | Yes | Yes | Yes |
| Month effects | Yes | Yes | Yes | Yes |
| Country effects | No | Yes | Yes | Yes |
| Shipping port effects | No | No | Yes | Yes |
| Firm effects | No | No | No | Yes |

*Notes:* The outcome variable is misdeclaration by the firm, based on the value assessed by the customs officer. The estimates are obtained at the transaction level. All regressions include a constant term. Robust standard errors clustered by product are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 4: Transaction-level estimation results – Alternative measure of duty rates**

| | (1) | (2) | (3) |
|---|---|---|---|
| Effective duty rate | -0.360*** | -0.404*** | 0.037 |
| | (0.042) | (0.047) | (0.038) |
| Observations | 5,077,995 | 5,077,994 | 5,074,669 |
| R-squared | 0.145 | 0.214 | 0.440 |
| Adjusted R-squared | 0.144 | 0.212 | 0.436 |
| Product effects | Yes | Yes | Yes |
| Month effects | Yes | Yes | Yes |
| Country effects | Yes | Yes | Yes |
| Shipping port effects | No | Yes | Yes |
| Firm effects | No | No | Yes |

*Notes:* The outcome variable is misdeclaration by the firm based on the assessed value by the customs officer. The estimates are obtained at the transaction level. All regressions include a constant term. Robust standard errors clustered by product are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 5: Transaction-level estimation results for effective duty rates – Robustness checks**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Effective duty rate | 0.053 | 0.089** | 0.089*** | -0.308*** |
| | (0.035) | (0.041) | (0.034) | (0.025) |
| Observations | 5,074,561 | 5,048,965 | 5,048,965 | 5,052,302 |
| R-squared | 0.444 | 0.483 | 0.483 | 0.305 |
| Adjusted R-squared | 0.440 | 0.471 | 0.472 | 0.295 |
| Standard error clustering | Product | Product | Country x Product x Firm | Country x Product x Firm |
| Product effects | Yes | No | No | No |
| Firm effects | Yes | Yes | Yes | No |
| Country x Quarter effects | Yes | Yes | Yes | Yes |
| Shipping port x Quarter effects | Yes | Yes | Yes | Yes |
| Product x Quarter effects | No | Yes | Yes | Yes |
| Country x Product effects | No | Yes | Yes | Yes |

*Notes:* The outcome variable is misdeclaration by the firm based on value assessed by the customs officer. The estimates are obtained at the transaction level. All regressions include a constant term. Robust standard errors are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 6: Transaction-level estimation results – Misdeclaration proxy variable**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Effective duty | -0.304 | -0.441 | -0.441*** | -2.099*** |
| | (0.287) | (0.340) | (0.154) | (0.132) |
| Observations | 4,370,166 | 4,369,862 | 4,369,862 | 4,373,247 |
| R-squared | 0.393 | 0.463 | 0.463 | 0.302 |
| Adjusted R-squared | 0.389 | 0.453 | 0.454 | 0.296 |
| Standard error clustering | Product | Product | Country x Product x Firm | Country x Product x Firm |
| Product effects | Yes | No | No | No |
| Firm effects | Yes | Yes | Yes | No |
| Country x Quarter effects | Yes | Yes | Yes | Yes |
| Shipping port x Quarter effects | Yes | Yes | Yes | Yes |
| Product x Quarter effects | No | Yes | Yes | Yes |
| Country x Product effects | No | Yes | Yes | Yes |

*Notes:* In this table, we use our second measure of misdeclaration as the outcome variable, i.e., the assessed value based on average price declared by other importers of the same product from the same country within the same calendar month, instead of the value assessed by customs officer. The estimates are obtained at the transaction level. All regressions include a constant term. Robust standard errors are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 7: Transaction-level estimation results by frequency of transactions**

| | 1st Quartile | | 2nd Quartile | | 3rd Quartile | | 4th Quartile | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Effective duty rate | -2.773*** | -1.054*** | -1.976*** | -0.420*** | -1.778*** | -0.198 | -0.763* | -0.888 |
| | (0.092) | (0.062) | (0.178) | (0.088) | (0.168) | (0.166) | (0.443) | (0.666) |
| Observations | 1,110,126 | 1,106,754 | 1,098,331 | 1,098,331 | 1,112,399 | 1,112,399 | 1,032,790 | 1,032,790 |
| R-squared | 0.398 | 0.559 | 0.397 | 0.540 | 0.371 | 0.508 | 0.441 | 0.479 |
| Adjusted R-squared | 0.381 | 0.536 | 0.382 | 0.527 | 0.358 | 0.497 | 0.433 | 0.472 |
| Product x Quarter effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country x Product effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country x Quarter effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Shipping port x Quarter effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm effects | No | Yes | No | Yes | No | Yes | No | Yes |

*Notes:* The outcome variable is misdeclaration by the firm, where assessed value is proxied by the average declared unit value by other importers in a given Country x Product x Month group. The estimates are obtained at the transaction level. All regressions include a constant term. Robust standard errors clustered by firm x product x country are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 8: Transaction-level estimation results - WeBOC vs Non-WeBOC transactions**

| | (1)<br>All transactions | (2)<br>WeBOC | (3)<br>Non-WeBOC |
|---|---|---|---|
| Effective duty rate | -0.441*** | -0.154 | -1.811*** |
| | (0.154) | (0.147) | (0.368) |
| Observations | 4,369,862 | 3,601,461 | 761,040 |
| R-squared | 0.463 | 0.485 | 0.478 |
| Adjusted R-squared | 0.454 | 0.475 | 0.464 |
| Product x Quarter effects | Yes | Yes | Yes |
| Country x Product effects | Yes | Yes | Yes |
| Country x Quarter effects | Yes | Yes | Yes |
| Shipping port x Quarter effects | Yes | Yes | Yes |
| Firm effects | Yes | Yes | Yes |

*Notes:* The outcome variable is misdeclaration by the firm, where assessed value is proxied by the average declared unit value by other importers in a given Country x Product x Month group. The estimates are obtained at the transaction level. Column (1) presents estimates for all transactions processed through customs in 2016 and 2017. Columns (2) and (3) are for transactions processed through WeBOC and manually, respectively. All regressions include a constant term. Robust standard errors clustered by firm x product x country are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 9: Transaction-level estimation results by sector**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Primary Metal | Transportation Equipment | Miscellaneous | Instruments | Electronic, Electrical Eqpt | Rubber and Plastics | Stone, Clay, Glass, Concrete | Fabricated Metal Products | Machinery, Computer Eqpt | Lumber & Furniture | Textiles & Apparel | Footwear | Chemicals | Food & Tobacco | Leather Products | Paper & Allied Products | Printing & Publishing | Fuel |
| Effective duty | 0.106 | 1.152** | 1.247* | -2.255*** | -1.609*** | 0.108 | 0.217* | -0.231 | -1.834*** | -0.323 | 0.240 | -0.134 | -0.216 | -0.081* | 0.454** | -0.785* | -9.850*** | -0.017 |
| | (0.200) | (0.567) | (0.710) | (0.370) | (0.420) | (0.147) | (0.123) | (0.495) | (0.163) | (0.953) | (0.251) | (0.280) | (0.227) | (0.046) | (0.213) | (0.411) | (1.185) | (0.065) |
| Observations | 378,688 | 294,203 | 189,885 | 183,616 | 511,996 | 377,117 | 103,999 | 78,866 | 706,738 | 29,405 | 361,571 | 42,932 | 485,926 | 305,995 | 45,712 | 84,720 | 104,860 | 57,772 |
| R-squared | 0.557 | 0.469 | 0.482 | 0.511 | 0.552 | 0.527 | 0.545 | 0.513 | 0.456 | 0.565 | 0.445 | 0.645 | 0.472 | 0.471 | 0.578 | 0.641 | 0.426 | 0.519 |
| Adj. R-sq. | 0.543 | 0.462 | 0.461 | 0.488 | 0.540 | 0.510 | 0.519 | 0.479 | 0.440 | 0.535 | 0.432 | 0.637 | 0.456 | 0.458 | 0.558 | 0.624 | 0.416 | 0.504 |
| # Products | 53488 | 17404 | 31328 | 38680 | 100371 | 52250 | 14562 | 19387 | 142610 | 3990 | 30028 | 2021 | 66579 | 23795 | 4747 | 8618 | 3441 | 2762 |

*Notes:* The outcome variable is misdeclaration by the firm, where assessed value is proxied by the average declared unit value by other importers in the Country x Product x Month group. The estimates are obtained at the transaction level. All regressions include a constant term, and the following fixed effects: Product x Quarter effects, Country x Product effects, Country x Quarter effects, Shipping port x Quarter effects, and Firm effects. Robust standard errors clustered by firm x product x country are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 10: Transaction-level results by product type – Differentiated vs. homogeneous goods**

| | Differentiated goods | | Homogeneous goods | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Effective duty rate | -2.151*** | -0.463*** | -1.419*** | -0.253*** |
| | (0.147) | (0.176) | (0.119) | (0.079) |
| Observations | 3,357,266 | 3,353,796 | 1,015,969 | 1,012,502 |
| R-squared | 0.283 | 0.461 | 0.292 | 0.439 |
| Adjusted R-squared | 0.277 | 0.452 | 0.283 | 0.423 |
| Product x Quarter effects | Yes | Yes | Yes | Yes |
| Country x Product effects | Yes | Yes | Yes | Yes |
| Country x Quarter effects | Yes | Yes | Yes | Yes |
| Shipping port x Quarter effects | Yes | Yes | Yes | Yes |
| Firm effects | No | Yes | No | Yes |

*Notes:* The outcome variable is misdeclaration by the firm, where assessed value is proxied by the average declared unit value by other importers in the Country x Product x Month group. The estimates are obtained at the transaction level. All regressions include a constant term. Robust standard errors clustered by firm x product x country are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.

**Table 11: Transaction-level estimation results - Regional analysis**

| | (1) North America | (2) European Union | (3) ASEAN | (4) Arabian Gulf | (5) South Asia | (6) East Asia | (7) Rest of the World |
|---|---|---|---|---|---|---|---|
| Effective duty rate | -0.585** | -1.259*** | 1.340 | -3.316*** | 0.067 | -0.207 | -0.832*** |
| | (0.287) | (0.344) | (0.928) | (0.725) | (0.056) | (0.134) | (0.202) |
| Observations | 289,915 | 701,207 | 364,873 | 590,888 | 239,628 | 1,907,515 | 265,154 |
| R-squared | 0.458 | 0.412 | 0.549 | 0.354 | 0.494 | 0.532 | 0.480 |
| Adjusted R-squared | 0.436 | 0.392 | 0.533 | 0.343 | 0.477 | 0.522 | 0.451 |
| Product x Quarter effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country x Product effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Country x Quarter effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Shipping port x Quarter effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes:* The outcome variable is misdeclaration by the firm, where assessed value is proxied by the average declared unit value by other importers in the Country x Product x Month group. The estimates are obtained at the transaction level. Arabian Gulf includes UAE, Qatar, Kuwait, Saudi Arabia, and Oman. East Asia includes China, Japan, Korea, and Hong Kong. All regressions include a constant term. Robust standard errors clustered by firm x product x country are given in parentheses. Asterisks denote significance levels: * significant at 10%; ** significant at 5%; *** significant at 1%.