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Price Discrimination in Bribe Payments: Evidence from Informal Cross-Border Trade in West Africa*

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Abstract

What factors explain the persistence and pervasiveness of corruption in certain parts of the world? In West Africa, many day-to-day transactions require the payment of bribes. Quantitative evidence on these bribes and their determinants is scarce. This paper sheds light on the level and the frequency of bribe payments in informal cross-border trade. It examines how bribes depend on the trade regime and on market structure. We rely on data from a survey of traders in Benin to estimate the determinants of bribe payments. We exploit variations in the trade regime across Benin's borders, as well as changes in trade restrictions over time and variations in route availability across space and time. We find that reductions in trade barriers help to lower bribes, but do not eliminate them, with bribes remaining frequent in liberalized trade regimes. These results suggest that collusive corruption - used to circumvent regulations and taxes - coexists with coercive corruption, where officials use their monopoly power to extract transfers from traders.

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1 Introduction

Why is corruption so pervasive and persistent in certain parts of the world, such as Sub-Saharan Africa, for example? Despite three campaigns against corruption organized by the World Bank in 22 years, a convention on preventing and combating corruption adopted by the African Union, and numerous reports from the World Bank and the United Nations Economic Commission for Africa (UNECA), African countries remain highly corrupt according to existing rankings (OECD/WorldBank, 2012; UNECA, 2016; World Bank, 2017).[1]

Shleifer and Vishny (1993) classify two types of corruption: "with theft" and "without". In cases with theft, bribe payers collude with officials to reduce the payment of a tax or to avoid a regulation. Rents created by the transaction are shared between the private agent and the public official. Bribery without theft requires the bribe payer to pay the official an additional amount in excess of the official price in order to access a particular public service. This type of bribe is said to be coercive. Shleifer and Vishny (1993) suggest that "corruption with theft aligns the interests of the buyers and sellers" and consequently "it will be more persistent than corruption without theft, which pits buyers against sellers."

In this paper, we use rich data from a survey on informal cross-border trade (ICBT) in West Africa to study the frequency and level of bribes paid by traders during their journey to the border. We first examine whether bribes are widespread. We then study the determinants of the bribes to understand which factors depress or increase the price of bribes. We exploit cross-sectional variations in trade regimes and products, as well as changes in trade barriers over time, to identify their impact on bribes. We also exploit precise information on transport modes, on the location of traders' starting and arrival points and of border crossing points, and on the alternative routes a trader may use.

Because of the dearth of data regarding bribery, only a handful of empirical papers have tried to break down the mechanisms at play when bribes are paid. Most existing studies have examined the trade and transport sectors, where bribery is particularly pervasive (Lavallée and Roubaud, 2018). Sequeira (2016) uses data

from an audit study of large shipments imported by formal firms into South Africa, with direct data on bribe payments at the border. She finds that bribes paid to customs agents decreased when tariffs were reduced, with some evidence of a shift from collusive to coercive bribery. Sequeira and Djankov (2014) link a dataset of bribes paid at ports in South Africa and Mozambique to data on formal importers. They find that importers adapt their transport strategy in function of corruption costs. Olken and Barron (2009) use data from a survey of truck drivers on the island of Sumatra to show that officials apply price discrimination to bribes. The authors use changes in the number of checkpoints to observe that bribe-setting depends on market structure. Their study focuses on formal operators (truck drivers employed by formal firms). Foltz and Opoku-Agyemang (2015) study cross-border trade in West Africa, also using data on formal operators (registered truck drivers in Ghana). Their focus is on the "supply side" of bribery (changes in officials' wage rates). However, there is, to our knowledge, no quantitative study of bribes paid by *informal traders* in Sub-Saharan Africa, or elsewhere.

Our paper's contribution is to provide evidence on the frequency and level of bribe payments made by informal traders and to identify some of the determinants of these bribes. Whether bribery is more or less frequent in informal trade, and whether the mechanisms sustaining corruption are similar to those found among formal (and generally larger) traders, are open questions that have implications for trade and development in the region.

ICBT is an important sector of economic activity in Africa. It has been shown to outstrip formal regional trade for the African countries where data are available (Ackello-Ogutu and Echessah, 1997; Golub and Mbaye, 2009; World Bank, 2011, 2013; Bensassi et al., 2017, 2018). ICBT in Sub-Saharan Africa also provides much-needed employment and enables deeper regional integration (Afrika and Ajumbo, 2012; IMF, 2017). At the same time, the informal nature of ICBT might make this form of trade more prone to bribery.

Our results yield three groups of findings:

First, we show that bribes are highly frequent in informal cross-border trade. Overall, about 80% of traders paid a bribe, and this rate is above 60% across all

categories of traders. Bribe payments are relatively low in comparison to the value of the goods traded.

Second, we find evidence that officials use price discrimination when setting the level of bribes, in line with Olken and Barron (2009). However, we also shed light on new discrimination mechanisms. Informal traders use a large variety of transport modes to cross borders, which creates variations in the price elasticity of demand for passage. Traders using lighter or slower modes of transport (such as motorbikes or pirogues) pay significantly lower bribes than traders using trucks.

Finally, we show that trade barriers increase the level of bribes. Using changes in trade barriers over time, we show that traders of products facing an import ban pay higher expected bribe payments. Conversely, trade of local unprocessed products, for which trade impediments have been removed in the region, pay lower bribes. These results are consistent with collusive bribery.

Overall, our paper depicts an environment of ingrained corruption in ICBT. Our results suggest that bribery may create incentives for traders to use less efficient transport modes in order to avoid paying bribes or to make lower expected payments. Deeper regional integration may reduce bribery.

This paper belongs to several strands of literature.

It contributes to the literature on the determinants of small-scale corruption. An increasing number of papers have looked at smuggling and corruption in the context of formal international trade (Yang, 2008; Sequeira and Djankov, 2014; Sequeira, 2016). We establish that price discrimination is used to set bribe levels for ICBT. Our setting is unique, in that we are able to observe the different routes and transport modes used by traders connecting the same markets. We can thus verify that the level of bribes depends on the transport mode used.

Our paper also complements a long line of development studies research examining informal traders' organizations, characteristics, and actions in Sub-Saharan Africa. These works have focused either on particular economic sectors, specific groups of traders, or geographical regions (Igue, 1976; Titeca and de Herdt, 2010; Titeca and Celestin, 2012; Walther, 2015; Grossman and Honig, 2017). Some have meticulously described the bribe payment process required to trade goods across

borders informally (Bako-Arifari, 2001) or the power relations at play between informal traders and customs officers (van den Boogaard et al., 2018), while others have focused on the most vulnerable groups of traders (Afrika and Ajumbo, 2012; Titeca and Celestin, 2012). However, none of these works have studied bribe payments at a country-wide level where the scope is not limited to particular groups of traders.

In Section 2, we present the context of ICBT in Benin and introduce our data set. We also provide descriptive statistics on traders' characteristics, the transactions involved, and bribe payments. In Section 3 we present our empirical strategy. Section 4 is dedicated to our results. Section 5 follows with some robustness checks. Section 6 concludes.

2 Context and Data

2.1 Regional trade integration in West Africa

This paper focuses on trade at the land borders of Benin. Two different trade regimes characterize these borders. Benin is a member of the the Western African Economic and Monetary Union (WAEMU), a customs union whose members also include Niger, Burkina-Faso, and Togo. The fourth of Benin's land borders is with Nigeria, which does not belong to the customs union. Nigeria and Benin share Economic Community of West African States (ECOWAS) membership, which aims to promote a West African common market. However, in the period we study (2010-2011), tariffs had not yet been removed between Nigeria and Benin. Nigeria was still applying non-preferential tariffs to imports from West African countries. Nigeria also applied import prohibitions to a list of products.

Tariffs have been removed on trade internal to the WAEMU (articles 4 and 77-81 of the WAEMU treaty), although customs controls still apply in practice. The common external tariff is applied to non-WAEMU origin goods. Many internal flows still face duties because they lack a certificate of origin, or because temporary tariffs and restrictions continue to be applied by member countries (see e.g. ITC (2017)).

Free movement of goods applies, however, to *local unprocessed products* from the agriculture, mining, and fishery sectors.[2] A certificate of origin is not required for these products (*Protocole additionnel N. III/2001, UEMOA/WAEMU*), which are often traded on secondary roads (Egg and Herrera, 1998), avoiding official customs border posts. This type of trade is well measured in the survey data we use. It provides us with a class of trade flows to which *complete trade liberalization* applies and allows us to test whether this affects traders' exposure to bribery. Trade in local unprocessed goods between ECOWAS members (and so, between Benin and Nigeria) has also been liberalized since 1993 (Article 36 of the revised treaty.) However, field reports indicate that traders of these goods are still exposed to trade restrictions, frequent harassment, and bribery at ECOWAS's internal borders (UNECA, 2010; ITC, 2017).

In 2010 and 2011, Nigeria applied most-favored-nation (MFN) tariffs, between

0% and 35% by product, to imports from all countries (including West African countries). An additional levy was collected on sugar (10%), automotive products (20%), and rice (20%) (WTO, 2011).[3] In addition, a list of import prohibitions on more than 25 groups of items was maintained by the Nigerian customs authority, with regular changes to the list. In July 2011, for example, a number of products were removed from the list.[4] In our empirical analysis, we exploit this change, which occurred between the two waves of the survey, to estimate the impact of this trade barrier on the bribes paid by traders.

2.2 Informal trade

In many parts of Sub-Saharan Africa, a large share of international trade flows does not go through official customs border posts and is not recorded in official customs data: it is generally called *informal cross-border trade*. Such flows cover many products and sectors, and their total value exceeds, in many cases, the value of official trade (Lesser and Moisé-Leeman, 2009; World Bank, 2013; Golub, 2015; Bensassi et al., 2018).

This form of trade is particularly pervasive in Benin, which led the national statistics institute (INSAE) to conduct the ECENE survey (*Enquête sur le commerce extérieur non enregistré*) in order to better estimate trade flows and measure their magnitude and composition. Several types of trade are found in this category. First, there is trade in local or regional products: imports of products from Benin's regional neighbors (mainly Nigeria and Togo) and exports from Benin to these countries. These flows are internal to the WAEMU or ECOWAS regional agreements. Among them, local unprocessed products benefit, in principle, from total free movement. Traders of transformed products need to present certificates of origin to benefit from preferential treatment.

Second, there is a large sector of *re-export* and *transit* trade in Benin. Benin and Togo have long specialized in this *entrepôt* trade activity (Igue and Soule, 1992), which involves importing products, mostly from Asia and the EU, and re-exporting them to neighboring countries (mostly Nigeria).[5]

These transactions are likely to face higher restrictions than local trade, as most

of this trade with Nigeria involves the smuggling of high-tax or banned products into Nigeria. For this reason, we carefully distinguish these trade flows using information in the data on the type of trade flow (imports, exports, re-exports, or transit) as well as on the country of origin and destination of the shipments.[6]

Finally, illicit trade in petroleum products (gasoline) is highly developed between Nigeria and Benin due to the subsidies available in Nigeria. Although this trade is illegal, it often takes place in daylight. Our data includes many examples of this type of transaction.

To summarize, our data covers extremely diverse types of informal cross-border trade, which, taken together, make up a significant share of regional trade (Bensassi et al., 2018). Some of these trades, namely *entrepôt* trade and gasoline trade, would qualify as *smuggling*: their purpose is to avoid taxes, trade restrictions, or regulations. In our data, these types of trade coexist with trade in local products, which do not face trade barriers, but may avoid customs for other reasons (such as compliance or certification costs, delays, harassment, or bribery). In our analysis, we carefully control for the different types of trade and test how exposure to bribery varies across them.

Given that Benin has one of the lowest ratios of customs officers per kilometer of land border (0.34) in the region, Benin's borders could be characterized as porous (Table 1). Nonetheless, having porous borders does not mean that this porosity is not managed. Customs agents pay individuals to serve as a supplementary force to inform them of movements of goods and to provide control outside the border posts. This supplementary force in turn accepts bribes from traders in return for failing to inform the agents (Blundo and de Sardan, 2007).

Table 1: Number of customs officers per kilometer of land border

	Benin	Burkina Faso	Niger	Nigeria	Togo
Number of customs officers	723	1795	1502	17570	748
Length of land border (km)	2123	3611	5834	4477	1880
Ratio	0.34	0.49	0.25	3.92	0.39

Source: World Customs Organization and CIA 2016

2.3 Data

Our main source of data is the ECENE survey conducted by the INSAE in order to estimate the size and composition of informal trade more precisely and to account for this component in the national accounts. The first wave was conducted in January 2010, the second in September 2011.

The institute first identified 150 illegal border crossing points that were actively used by informal traders, scattered all along Benin's land borders. According to the INSAE, this coverage of illegal crossing points was exhaustive at the time of the survey. Most crossing points were located on secondary roads. 48 points were located close to a water passage: this is important as a significant part of informal trade is transported on pirogues, due to the existence of cross-border streams. Before the second wave of the survey, a second monitoring of crossing points was conducted and the list was updated. 171 points were identified in 2011 (most of them are common with the 2010 list). Figure 1 shows the coverage of the 2011 survey points.[7] The survey was designed to cover the diverse routes that connect Benin to its neighbours and that are used by traders: all-weather highways , an extensive network of bush and rural roads (Afolayan, 2000), as well as a network of inland waterways (Azonsi et al., 2018).

In January 2010, the 150 points were surveyed over a 7-consecutive-day period by a team of 225 surveyors, 12 controllers, and 6 supervisors. In 2011, the operation was repeated, with the 171 points surveyed over 10 consecutive days (employing 350 surveyors, 30 controllers, and 12 supervisors).

A four-page questionnaire was completed by surveyors and traders. Information on the nature, quantity, and value of goods transported, the origin and destination of the shipments, and the transport mode was collected. In 2011, a total of 8,883 questionnaires were completed (5,173 in 2010) (INSAE, 2011). After data cleaning, 8,610 observations from 2011 were retained for analysis (5,045 in 2010). The unit of observation is a trader's crossing. Most traders were surveyed only once, although it is possible that traders crossing several times during the survey period could have been interviewed more than once.[8]

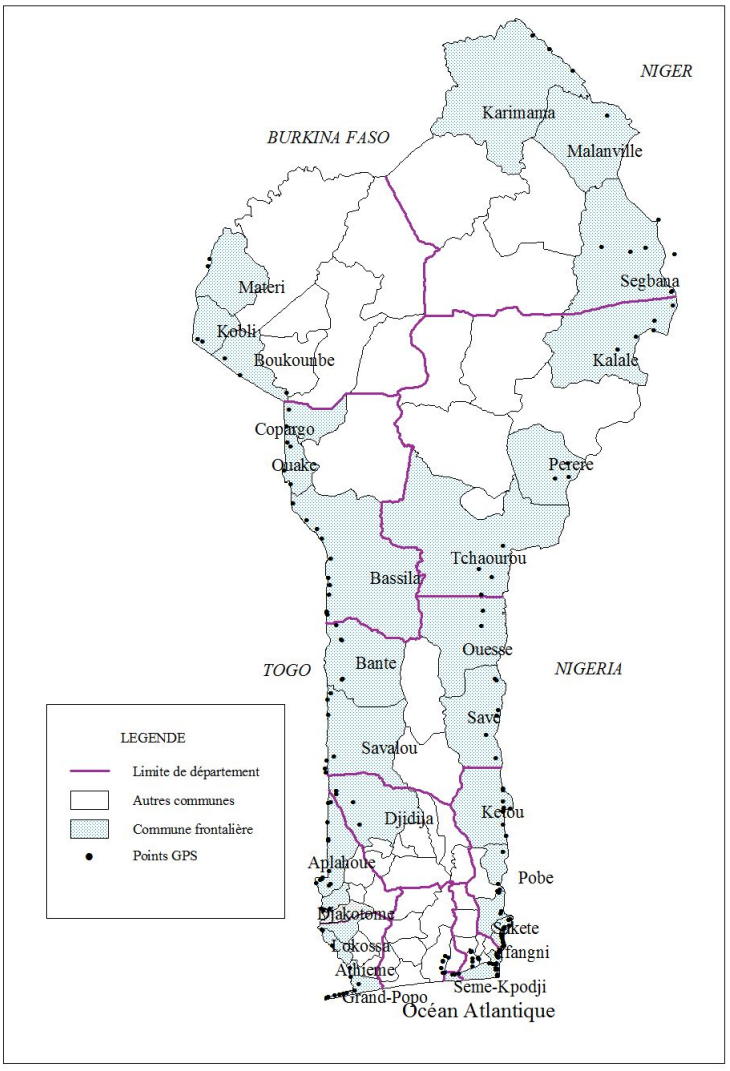

Figure 1: Map of surveyed border crossings (2011 survey). Source: INSAE.

Products were codified at a high level of detail (using the ten-digit codes of the Harmonized Commodity Description and Coding System, HS-10).[9]

Trade flows were classified as exports, imports, re-exports, and transit. The latter two categories correspond to flows of goods originating in third countries (typically in Asia or Europe) that enter Benin (possibly legally) before crossing one of Benin's land borders to reach one of the neighboring countries. We retain all these trade regimes in our analysis, but control for *entrepôt* trade, which may face higher trade barriers than domestic trade, and thus higher exposure to bribery.

Previous studies on trade in the region have underlined the quantitative importance of *entrepôt* trade (Igue and Soule, 1992; Golub, 2012). In our data, *entrepôt*

trade and gasoline smuggling are the largest types of trade in value (see Table 4). The value of *entrepôt* trade is larger than that of imports and exports (trade of domestic products with Benin's direct neighbors), which include more numerous, but lower-value transactions. Table 2 indicates the nature, the main origin, and the main destination of the five products most exchanged through *entrepôt* trade. Our data is consistent with the literature on *entrepôt* trade: products banned or heavily taxed in Nigeria compose most of it.

Table 2: Statistics: *Entrepôt* Trade

	(1)	(2)	(3)	(4)
Type of goods	Total Value Traded ('000 USD)	Share of Total Entrepôt Trade (%)	Main Country of Origin*	Main Country of Destination*
Cars	2145	32.5	France (28.2)	Nigeria (89.0)
Rice	1850	28.0	Thailand (87.7)	Nigeria (90.5)
Footwear	1112	16.8	China (99.2)	Nigeria (99.8)
Palm oil	347	5.2	Malaysia (70.8)	Nigeria (86.3)
Frozen chicken	272	4.1	France (92.1)	Nigeria (100)

Source: ECENE survey 2010 and 2011.
* Numbers in parenthesis show the share represented by the main country of origin/destination in the *entrepôt* trade for the product indicated in each row

The data are consistent with other studies on *entrepôt trade*, which is a good sign in terms of the quality of the data and the survey's ability to mitigate the risk of sample selection. Another indication is that the smuggling of gasoline from Nigeria, which is completely illegal and strongly repressed, is heavily represented in the data, with more than 4,012 observations in the original database (among these, 3,734 replied to the question on bribes). The fact that so many traders involved in illegal trade would agree to participate in a survey supervised by a public body may seem surprising. It is a consequence of the pervasiveness of informal trade in the region and of the blurred line between legal and illegal trade operations,with the latter commonly taking place in daylight. It is also a testimony to the INSAE's efforts in conducting the survey (INSAE, 2011). For example, the survey was conducted in cooperation with the customs administration to ensure that customs agents' control operations would not interfere with the conduct of the survey.

Concerns regarding sample selection are thus limited given that the trade activities facing the highest levels of risk and repression are frequently observed in the survey and do not appear to be significantly under-reported. Selection issues remain

possible, however, in particular because some of these trade operations are known to take place at night (and are therefore not covered by the survey). A related concern is that replies of traders engaged in these activities might be missing more often, or be less truthful. To address this concern, we conduct a number of tests to determine the sensitivity of our results to excluding these high-risk products, as presented in the empirical section of the article.

2.4 Bribes

Each trader was asked for the amount of *informal tax* paid during his or her travel. This question includes all payments made during the transport of a good for which the trader received no official receipts. Accordingly, this variable potentially includes payments made to the military, police, or customs officers. Unfortunately, we have no information on the recipients of these payments.[10] In this paper, we use the term *bribes* for *informal taxes*, the term used in the survey.[11]

The two waves of the ECENE survey contain 13,655 observations (crossings). Among these, the "informal tax" question is missing in 678 cases in 2011 and 229 in 2010 (overall rate of 6.6%). The stigma associated with paying bribes, if there is one, is thus relatively uncommon.

There is a risk that these non-responses may depend on some determinants of bribes. The data show that this issue is limited. For example, the non-response rate is 7% for traders of gasoline and 6.5% for other traders; the difference is not significant. To test this further, we ran probit estimates of the probability of non-response to the bribe question: the results are displayed in Table 3. Almost none of our variables of interest are significantly associated with a higher or lower rate of non-response. These results confirm that the risk of non-response does not vary significantly according to the type of trade. Paying a bribe is the norm rather than the exception among traders, as evidenced by the frequency of payment in our data. No particular stigma appears to be associated with it.

Table 3: Informal tax: determinants of non-response (probit)

	(1)	(2)
Weight	-0.00	0.02
	(0.03)	(0.03)
Unit value	0.02	0.03
	(0.03)	(0.03)
Multiproduct	-0.15	-0.13
	(0.10)	(0.09)
Entrepôt trade	-0.10	-0.18
	(0.13)	(0.14)
Petroleum products	0.15	0.10
	(0.15)	(0.14)
Local unprocessed	0.18**	0.17**
products	(0.09)	(0.08)
WAEMU	0.09	0.10
	(0.25)	(0.24)
Tariff	-0.27	-0.12
	(1.08)	(1.00)
Import ban	0.11	0.04
	(0.22)	(0.22)
Transport mode:		
Bicycle/pedestrian		0.40*
		(0.24)
Pirogues		0.15
		(0.22)
Motorcycles		0.19
		(0.20)
Cars		0.16
		(0.17)
Nb. of workers		-0.01
		(0.08)
Wholesalers		0.10
		(0.09)
Frequency		-0.04
		(0.08)
Beninese		-0.03
		(0.11)
Year 2011	0.30*	0.32*
	(0.15)	(0.17)
Observations	13387	13285
Pseudo R^2	0.018	0.025

Standard errors in parentheses clustered by crossing point.
* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

2.4.1 Bribe frequency and levels

Table 4 provides statistics on the structure of informal trade at Benin's borders and on bribery. In panel A, we split the sample by type of trade. In terms of value traded, the largest categories are *entrepôt* trade and the smuggling of gasoline. Columns 3 and 4 display the incidence of informal and formal taxes, i.e. the frequency of positive payments. Column 5 shows the average bribe payment made by traders during their journey to the border, as a percentage of total cargo value. Column 6 shows the average formal tax rate paid by traders.

It emerges, first, that bribe payments are highly frequent across all trade categories: they are the norm rather than the exception. This confirms that bribery is pervasive in the countries we consider. Note that these figures also minimize the concern that respondents might be reluctant to report paying bribes. Bribes are more frequent for *entrepôt* trade and gasoline smuggling, which face more trade barriers than trade in domestic products. However, the average value of bribes, as a share of cargo value, appears to be lower for these categories.

The ubiquity of bribes suggests that collusion - payments made to avoid the payment of formal taxes or regulations - is not the only motive for these payments. Panel C shows that trade at Benin's WAEMU borders, which should be more integrated, experiences a lower bribe incidence than that at Nigeria's border, although it remains above 60%. Similarly, trade in unprocessed products (panel B), which in principle benefits from free movement at Benin's borders, experiences scarcely less frequent bribery than other flows.

Panel D splits the sample by transportation mode. The largest share of trade (38%) is conducted using pirogues, followed by trucks (34%). The remaining share employs cars, pedestrians, and motorcycles. Bribe payments are particularly frequent for truck and car users. A stylized fact emerges: traders using lighter modes of transport tend to pay lower bribes, and lower formal taxes (relative to traded value), than trucks.[12] These features will be further examined in the econometric analysis.

Table 4: Statistics: payment frequency and value

	(1)	(2)	(3)	(4)	(5)	(6)
	Total value traded ('000 USD)	Number of obs.	Bribe incidence (%)	Formal tax incidence (%)	Bribe ratio (%)	Formal tax ratio(%)
			Panel A: trade category			
Entrepôt trade	6237	1599	85.1	25.9	1.24	1.23
Gasoline	9755	3706	89.4	37.2	2.16	0.63
Exports	3260	2480	71.0	35.7	2.25	1.04
Imports (excl. gasoline)	2579	4399	70.1	35.3	2.76	1.22
Regional trade	2395	289	79.6	38.1	2.28	0.72
			Panel B: product type			
Unprocessed pdts.	5894	3721	71.6	39.2	2.33	0.94
Other Products	8577	5046	74.8	29.8	2.31	1.31
			Panel C: border			
Nigeria	21845	7806	86	31.8	2.13	0.96
WAEMU Countries	2381	4667	65.1	39.9	2.51	1.06
			Panel D: transport mode			
Trucks	7964	1175	92.3	59.2	3.08	1.89
Bicycle/pedestrians	2154	2255	69.9	26.2	2.17	0.68
Pirogues	8922	3135	74.8	35.5	1.94	1.17
Motorcycles	645	3541	79	28.7	2.06	0.68
Cars	3661	2283	82.1	39.6	2.78	1.1

Source: ECENE survey 2010 and 2011. *Regional trade* includes re-export and transit flows with a regional (West African) country of provenance.

2.4.2 Bribe payments: comparison with trade costs and with existing estimates

To put the figures on bribe payments into perspective, we compare them to the tariffs traders would have paid using formal trade routes and to the bribes that have been reported as being paid on formal routes in other studies.

Trade between Benin and its WAEMU partners, Burkina Faso, Niger, and Togo, is, in principle, liberalized. In practice, evidence suggests that many trade flows internal to the WAEMU area nonetheless face trade restrictions, in particular because of costly origin certification. Unprocessed products are the only items that do not require a certificate to be traded inside the WAEMU.[13] If certificates of origin are not provided, customs agents should consider the products in question as not being produced in the WAEMU and should revert to the common external tariff (between 5% and 20%). In the case of trade with Nigeria, no preferential treatment applied to trade from Benin in 2011. The maximum rate on Nigeria's imports was 35%, with additional levies on some products. We compute the average most-favored nation (MFN) rate that would have been applied to shipments at the borders of Benin with WAEMU partners in cases where no certificate of origin was provided, and the rate applied to shipments at the border with Nigeria. We obtain an average MFN of 14.9%, compared to 3.57%, the sum of the informal and formal tax ratios, paid by informal traders for the WAEMU trade. In the case of Nigeria, the average MFN is 14.1%, compared to a ratio of 3.09%. These numbers provide an estimate of the difference between the *de jure* tax rates applied to shipments and the *de facto* payments made by traders. They suggest that actual payments are considerably below the duty that would apply.

How do our figures on bribe payments compare with other studies on petty corruption?

The context examined by Foltz and Opoku-Agyemang (2015) is the closest to our case: their study is based on a survey of truck drivers involved in cross-border trade between Ghana and Burkina-Faso. The incidence of bribery they report appears to be consistent with our figures: the unconditional probability of not paying a bribe

at a stop is between 4.6% and 13% (based on 2,147 trucking trips surveyed). Their survey focused on trucks plying a single route. Importantly, this route is an official one, being the main road linking Accra to Ouagadougou; and the survey selected truck drivers "with papers for the truck and cargo ... in order." Thus, the trucks in their survey qualify as being part of the formal trade sector, while our focus is on informal traders. A high frequency of bribery is clearly not a specificity of informal trade, although levels of payment may differ.[14]

Teravaninthorn and Raballand (2009) report estimates of the share of bribes in relation to variable costs for trucks operating on the main trade corridors in Africa. Looking at the bribe to fuel costs ratio, which offers the most direct comparison, their figures are between 8% and 71% for West and Central Africa. We find a mean value of 94%, and a median of 26%, for the same variable. This is consistent with their statement that bribe costs are higher for informal trade operations, the focus of our study, than for other type of trade actors.

2.4.3 Sample statistics

Table 5 displays descriptive statistics for our estimation sample. The distribution of the size of shipments is skewed, with many small-scale shipments and a few large ones. This reflects the high diversity of our data in terms of trader types and transport modes.

Distance measures the road distance between a shipment's market of origin and the border crossing point where the survey took place. We used data from the Google maps API on driving and walking itineraries between each pair of locations. The *walking* itinerary reports the shortest route on secondary/bush roads available in the application. It is therefore relevant for both pedestrians and motorcycles, and is shorter than the driving route in most cases.[15] We applied the *driving* distance to traders using cars and trucks. We thus measure the actual distance traveled by each trader as accurately as possible.[16] Note that the route is generally located in Benin, in the case of exports, re-exports, and transit; or in one of the neighboring countries, in the case of imports.

Distance is missing in cases where the market of origin could not be located on the map. We thus ran our estimations on both the subsample with the distance variable, and on the whole sample, omitting distance, in order to verify that our results hold in both cases.

Distance to official post measures the distance between the survey's border crossing and the nearest official customs post. A list of 45 customs points with their location was built using Beninese customs' codes (*code des douanes*), as well as additional sources for secondary points.

About one third of traders were operating within the WAEMU area (i.e. the goods' countries of origin and destination were both WAEMU members). Traders of local unprocessed products made up 30% of observations. Gasoline smugglers made up another 30%. About 9% of shipments contained products facing an import ban in Nigeria.

Nigeria's official tariff schedule, in 2010-2011, included five bands from 0% to 35% ad-valorem rates. In addition, the country also applied excise duties and levies

to specific products, such as rice, palm oil, and automobile parts (WTO, 2011). We included these additional taxes in the computation of our *tariff* variable (in the case of multiproduct shipments, a sum of tariffs weighted by traded value). Nigeria's trade policy also includes a list of products banned for import, which was coded using the official list from Nigeria's customs authority. In the case of import flows into Benin, the WAEMU's external tariff applies, which has four bands ranging from 0% to 20%.

It is possible that the tariff and ban variables do not capture the entirety of Nigeria's complex trade restrictions. In our empirical analysis, we rely on models with product fixed effects (at SH4 product code level) to control for unobserved trade barriers.

Beyond cargo size, we used two proxies for the size of the trader's firm: the total number of co-workers as reported by the trader (including temporary and permanent workers) and a dummy for traders who reported having wholesalers as main clients or suppliers ("Wholesalers"). The majority of traders operate alone. *Frequency* is the number of months before the survey in which the trader reported having made at least one passage (the survey asked for detailed activity month by month). Most traders operate regularly, throughout the year.

69% of traders were men, based on the 2011 survey data. This information was not available in the 2010 data.[17]

The last line of the table reports the number of distinct border crossings used by traders who connect the same markets (same origin and destination markets). This is a *de facto* measure of the number of alternative routes that traders can use. This number of alternatives varies by transport mode. We computed the number of alternative routes connecting two markets used by traders with a given transport mode. Figure 2 shows the distribution of this variable for each mode of transport. For trucks, cars, and pedestrians, the number of routes is most often between one and three. By contrast, this number is most often higher for pirogues and motorcycles, and can reach up to ten. Traders on pirogues or motorcycles have access to a greater number of alternative routes, and this could lower their willingness to pay at a given

Table 5: Statistics on estimation sample

	Mean	Median	Min	Max	Std. dev.	Nb. Obs
Cargo value (USD)	1942.34	182.91	0.2	384279.5	9589.61	12473
Weight (kg.)	2479.75	250	0.68	500000	10990.12	12473
Multiproduct	0.13	0	0	1	0.34	12473
Distance (km.)	79.32	31.9	.002	923.05	129.10	7521
Distance to official post (km.)	13.56	9.74	.02	69.50	13.37	12340
Trade regime						
WAEMU	0.34	0	0	1	0.47	12473
Entrepôt trade	0.13	0	0	1	0.34	12473
Gasoline	0.30	0	0	1	0.46	12473
Local unprocessed products	0.30	0	0	1	0.46	12473
Tariff (%)	10.4	7.8	0	45	10.6	12473
Import ban	0.09	0	0	1	0.29	12473
Trader characteristics						
Nb. of workers	2.64	1	1	143	5.07	12473
Wholesalers	0.36	0	0	1	0.48	12473
Beninese	0.72	1	0	1	0.45	12473
Frequency of passage	9.81	12	1	12	3.33	12473
Male (2011 only)	0.69	1	0	1	0.46	6023
Nb. of crossing points per market pair	3.02	2	1	23	3.94	12473

Source: INSAE, ECENE survey 2010 and 2011, authors' computations.

point. We test whether bribes are set accordingly lower for these categories of trader.

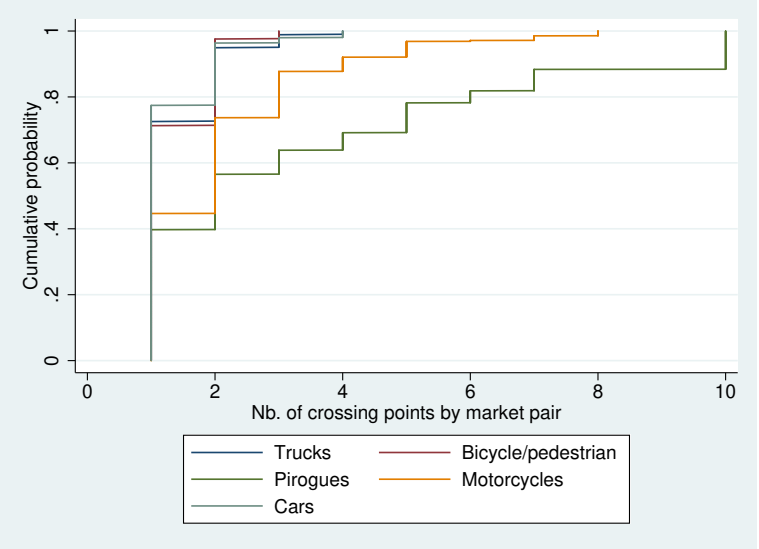

Figure 2: Number of crossing points: cumulative distribution by mode of transport

3 Empirical methodology

Our theoretical background is a model of a public official who sets the level of bribes in order to maximize revenue, similar to the approach of Olken and Barron (2009). The official may be a customs officer (or a supplementary person reporting to customs), a policeman, or another official who stands on a road and has some power to control passage. Abundant evidence exists on the numerous checkpoints that are found on roads in the region.

The official can take into account the trader's observable characteristics, such as the nature, size, and value of cargo, the mode of transport, and the type of trader, and price discriminate accordingly. A trader's willingness to pay for passage will generally not be perfectly observed by the official, who can nonetheless use third degree discrimination. In cases where a tariff or trade restriction applies to the product, the official may also demand a payment in exchange for not applying the duty, fine, or sanction (i.e. a collusive bribe).

The traders in our data may have paid one or several bribes; however, we only observe the total payment as reported by the trader. We model the expected payment in exponential form, controlling for distance traveled. The distance variable is transport-mode specific, and is measured as described in the previous section. We expect total expected payment to increase with distance (as the expected number of stops increases), and study the impact of trader and cargo characteristics on the expected bribe, conditional on distance.[18]

We estimate our model of expected payment using Poisson quasi-maximum likelihood estimation. The conditional expected bribe payment is assumed to take the form:

$$E[InfTax_{ikt}|D_i, Q_i, UV_i, X_{ikt}] = \lambda_t . D_i^{\alpha} Q_i^{\beta_1} UV_i^{\beta_2} . exp(\gamma X_{ikt}) \quad (1)$$

where $InfTax_{ikt}$ is the total bribe paid by a trader i of good k, surveyed in year t. As explained in Section 2, this variable sums all the payments without receipts made by the trader during the passage.

Q_i and UV_i are the quantity and unit value of the trader's cargo. $Q_i * UV_i$ is the

total cargo value. (In the case of multiproduct cargo, the unit value is computed as the weighted average of the prices of the goods.) D_i is the road distance between the origin market and the border crossing point where the survey took place. X_{ic} is a set of trader and cargo characteristics. They include measures of the trade regime (tariffs and bans at product level; indicator variables for within-WAEMU trade, for entrepôt trade, for trade of unprocessed local products - to which free movement applies -, and for gasoline products - which are illegal); transport mode (truck, motorcycle, pirogue, car, or pedestrian); and the trader's nationality (Benin or other), sex, and self-declared frequency of passage.

We also include measures of the number of alternative roads available to traders. We first built an interaction term *stream * non water transport*, a dummy equal to one if the respondent does not use a pirogue despite there being traders who started from the same origin market using pirogues. Second, we computed the number of crossings in the vicinity of each given crossing point.[19] These measures are intended to test the effect of traders' existing alternatives on bribes paid.

As shown in Wooldridge (2017), the Poisson QML estimator is consistent under the assumption that the conditional mean of the dependent variable is correctly specified in Equation 1. In particular, it is not necessary for the dependent variable to actually follow a Poisson distribution; there are no additional requirements regarding the variance of the dependent variable.

An alternative to the Poisson QML estimator is the negative binomial model, estimated by full maximum likelihood. This model is intended to model a variable that exhibits overdispersion - i.e. where the variance is superior to the mean.[20] Note, however, that the Poisson QML estimator is also efficient in the case of over-dispersion. In the case of over-dispersion, the actual form of the variance determines which model is more efficient - the Poisson QML or the negative binomial model.[21]

In our case, we rely primarily on the Poisson QML estimator. This model has the additional advantage of not suffering from the incidental parameters issue, which allows us to estimate models with sets of fixed effects without risk of bias in the coefficients. As a robustness check, we ran our estimations with the negative binomial model to check that our results were not dramatically different with this alternative

model.

4 Results

4.1 Expected payment

Table 6 reports the results of our estimation of model 1 by Poisson quasi-maximum likelihood. The dependent variable is a trader's expected bribe payment. Standard errors are clustered at the level of border crossing points.[22] Coefficients are to be interpreted as elasticities. In columns 4 and 5, we use fixed effects for the trader's market of origin, in order to control for unobserved, time-constant market characteristics (such as market size). In column 5, we add sector (4-digit HS code) fixed effects, which control for unobserved characteristics of the products traded that may affect bribes.

Our results show that the average bribe payment is positively correlated with cargo value (weight and unit value). The two coefficients are smaller than one, meaning that amounts paid increase less than proportionately with cargo value. Payments are also positively correlated with the road distance traveled by the trader, as are exposure to bribery and the expected number of payments. *Distance* measures road distance taking into account the trader's transport mode. In the case of pirogues, we add an interaction term with *distance* in order to control for the specificity of this transport mode.

The distance from the border crossing to the nearest official customs post is negatively associated with bribes, significantly in columns 4 and 5. This may reflect the fact that controls are more likely in the vicinity of customs posts.

Bribes vary by trade regime. Traders of local unprocessed products, which benefit from complete liberalization, pay lower bribes. Traders operating within the WAEMU area, where trade barriers are lower, also tend to pay lower bribes, although the effect is not significant. Gasoline smugglers pay higher average amounts, although the impact is, perhaps surprisingly, not so high: these traders pay an

amount about 50% higher, on average, than the amount paid by traders of other products with otherwise similar values and characteristics. These results are consistent with collusive bribery, which serves in part to avoid a restriction, regulation, or the payment of tax.

Contrary to this result, however, the coefficient for the tariff variable (applied by the importing country) and *entrepôt* trade are negative. One possibility is that traders of products facing high protection invest more resources in order to avoid the payment of bribes. We further investigate the impact of tariffs and non-tariff barriers in the next set of results, by using product fixed-effect estimates and the impact of changes in trade barriers between 2010 and 2011.

Bribes also vary in function of a trader's transport mode and characteristics. Traders operating on motorcycles pay significantly lower amounts, for otherwise similar cargo. This is also the case for pedestrians. The average bribe paid by motorcycles is about 65% (based on column 5) lower than that paid by trucks. These effects are consistent with price discrimination being used to determine bribe amounts. The demand for passage of a trader on a motorcycle is likely to be more price elastic than other transport modes, as the trader has access to greater numbers of alternative routes than traders using other transport modes. Anecdotal evidence suggests that motorcycles are used precisely for this reason: to avoid controls and payments. On the other hand, pedestrians may be less flexible in their choice of route but have a lower willingness to pay for passage. The *stream * non water transport* variable is equal to one for traders who do not use pirogues, despite operating in an area (defined by the origin market) where transport on pirogues exists. This variable is used to test whether the *possibility* of water transport influences the level of bribes paid by other transport modes, through a competition effect between alternative crossing points. Results indicate that it does. The effect is also negative, and significant, when controlling for origin market fixed effects (column 4): in that model, the coefficient measures the effect of changes in streams between the two survey periods.[23]

We also use controls for trader characteristics - nationality, frequency of passage, and two proxies for the size of the trader's firm: the reported number of co-workers

and whether the trader reported having wholesalers as main clients or suppliers. Beyond cargo size, the trader's operating size may be partially observable to a bribe-taking official, who could use this information to price discriminate. Results indicate that size is positively associated with bribes.

Impact of trade policy variables The tariffs and bans applied by the importing country vary at product (HS-6) level. Our estimates, thus far, capture both the effect of differences in trade barriers over time and across products in a given sector. The cross-sectional variation in protection could be correlated with unobserved variables: such as traders' investment and efforts to avoid controls. Non-tariff barriers, which we do not observe perfectly, could also be correlated with tariffs.

In order to focus on the impact of changes in protection over time, we turn to estimates of a model including product-origin-destination fixed effects (at the HS-6 level). This specification fully controls for all constant trade barriers. It also controls for the non-time-variable component of demand and supply for trade at the product level (such as product demand in the destination country). This model estimates the impact of changes in protection over time. In July 2011, the list of products prohibited for import in Nigeria was shortened.[24]

This model thus yields a difference-in-difference estimate of the impact of import bans on bribes. Products that remained on the prohibition list serve as the control group, to which we compare the changes in bribes for products that were removed from the list. Note that the survey took place shortly (two months) after the change in the list, so we focus on the short-term impact of the change. The informal trade sector's adjustments to the change may not have occurred at the time of the survey.

Regarding tariffs, only a few products in our data experienced a change in tariff protection between the two surveys (this concerns three product-level tariff changes in the WAEMU's external tariff, and three changes in Nigeria's MFN rate). This limits our ability to obtain a realistic estimate of the effect of tariff changes in this setting.

Table 7 displays the results of estimates of the product-origin-destination fixed effects model. In columns 1 and 2, we restrict the sample to single-product shipments.

In columns 3 and 4, we include multi-product shipments (in order to attribute a fixed effect to the shipment, the main product is taken to be the one with the highest total value in the shipment).

Our results indicate that import bans are positively correlated with bribe amounts paid. Traders of products on the prohibition list are expected to pay bribes about twice as high ($exp(1.09) - 1 = 1.97$) as traders of other products. The removal of some products from the list appears to have reduced the bribes paid by traders of these products, possibly because the threat of confiscation or penalty cannot be used by the official to extract bribes. This is consistent with collusive bribery. However, we cannot entirely exclude the possibility that other mechanisms are at work. (For instance, the removal of a ban could lower a product's price in Nigeria, reducing traders' margins and, hence, their willingness to pay for passage.) Regarding tariffs, coefficients are negative but not significant.

Number of crossing points In the next set of results, we further test the impact of alternative routes on the level of bribes by including the *number of near crossings* in the model. This variable can, however, be endogenous. It is possible, for instance, that traders facing higher bribe prices will invest more effort and resources in order to find, and use, alternative routes. To address this endogeneity, we use an instrument based on the local environment: the *terrain ruggedness index*, which measures the average local slope in an area.[25]

We expect ruggedness to be associated with higher road building costs, and to thus constrain the number of alternative routes that can be used to link two points.

For the instrument to be valid, ruggedness must not affect bribe levels through any other channel (apart from the number of routes). A threat to this assumption is that ruggedness could directly affect the transport costs incurred by traders, e.g. by lengthening the road distance connecting two points. In turn, transport costs might influence a trader's capacity to pay. We control for transport costs with the distance and transport mode variables. Our distance variable is specific to the transport mode and measures the actual road distance traveled. Conditional on transport costs, ruggedness should not influence bribes other than through its effect

on alternative routes.

Table 9 presents the results of our estimates of the influence of alternative routes. *Number of near crossings* is the number of recorded crossings within an 8 km distance of the surveyed point (which is twice the median value of distance to the nearest crossing point).

In column 1, we use Poisson QML estimates. In columns 2 and 3, we rely on a linear model and use 2SLS estimates, restricting the sample to observations with positive values for the bribe payment. In column 4, we use an IV Poisson model estimated by the control function approach. This estimate is not consistent when including fixed effects in the model.

The lower part of the table reports results from the first stage estimation (2SLS) and from the equation for *number of crossings* (IV Poisson).

These results show that ruggedness negatively predicts the number of crossings. The instrument is moderately strong. The Kleibergen-Paap statistic is about 7.

The number of near crossings is associated with lower bribes in the Poisson model. However, when instrumenting the model, we cannot confirm that this link is causal, since the coefficient is non significant.

Testing for sex discrimination There is a concern that women suffer specifically from harassment and violence from officials. For example, Brenton et al. (2011) argue that small-scale women traders face gender-specific constraints. These include household commitments and a higher risk of violence and vulnerability.[26]

To the best of our knowledge, however, there are no systematic quantitative data studies of differences in treatment between male and female traders with respect to bribe payments.

Our data allow us to test whether bribes paid by female traders differ systematically from those paid by men with otherwise similar observable characteristics - goods and quantities traded, transport modes, distance traveled. To do this, however, we have to rely on the 2011 survey data, as information on individuals' sex is only available in that dataset. Our results are shown in Table 10.

Traders' sex is not associated with any significant difference for the sample as a

whole (columns 1-3). When focusing on pedestrians only, it appears that women do pay significantly more than men (col. 4-6). This effect is not significant for the other transport modes in the data. The effect is large and significant when controlling for sector fixed-effects. However, the sample size is much reduced, and results need to be treated with caution.[27]

These results appear consistent with the hypothesis that female traders are more vulnerable than male traders, and that this translates into higher bribes. As pointed out earlier, our results seem to indicate that bribes are, at least in part, coercive. Qualitative evidence, for example as reported in Brenton et al. (2011), shows that for traders operating on foot, extraction of bribes can take the form of pure extortion. Importantly, this difference is conditional on transport modes. For example, no such effect appears among traders using pirogues, which has the highest share of female traders in our data (45%).

Table 6: Bribe payments (Poisson QML)

	(1)	(2)	(3)	(4)	(5)
Weight	0.73***	0.62***	0.56***	0.56***	0.56***
	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Unit value	0.45***	0.44***	0.42***	0.43***	0.39***
	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)
Distance	0.22***	0.24***	0.23***	0.42***	0.36***
	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)
Distance *	0.00	0.13	0.08	-0.11	-0.11
pirogue	(0.03)	(0.19)	(0.17)	(0.20)	(0.20)
Distance to	0.06	-0.03	-0.05	-0.13***	-0.16***
official point	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)
Multiproduct	-0.02	-0.05	-0.08	-0.08	-0.08
	(0.15)	(0.15)	(0.15)	(0.14)	(0.14)
Entrepôt trade	-0.47*	-0.36	-0.30	-0.01	-0.15
	(0.25)	(0.26)	(0.25)	(0.23)	(0.30)
Petroleum products	0.46*	0.56**	0.47**		
	(0.24)	(0.23)	(0.21)		
Local products	-0.49***	-0.50***	-0.50***		
	(0.15)	(0.14)	(0.14)		
WAEMU	-0.15	-0.06	-0.07	-0.42	-0.08
	(0.33)	(0.32)	(0.28)	(0.26)	(0.29)
Tariff	-0.89	-0.17	0.12	-2.34***	0.85
	(1.26)	(1.22)	(1.10)	(0.80)	(1.48)
Import ban	-0.54**	-0.66**	-0.56**	0.43**	-0.07
	(0.26)	(0.27)	(0.25)	(0.21)	(0.40)
Transport mode:					
Bicycle/pedestrian		-0.78***	-0.72***	-0.57***	-0.59***
		(0.24)	(0.25)	(0.21)	(0.21)
Pirogues		-2.00	-1.55	0.77	0.96
		(2.08)	(1.84)	(2.42)	(2.34)
Motorcycles		-1.25***	-1.18***	-0.97***	-1.07***
		(0.29)	(0.25)	(0.24)	(0.23)
Cars		-0.28	-0.26	-0.31**	-0.25
		(0.18)	(0.17)	(0.15)	(0.16)
Stream * non-water transport		-0.51***	-0.52***	-0.87**	-0.51
		(0.14)	(0.15)	(0.36)	(0.34)
Trader characteristics:					
Frequency			0.00	0.03	0.10
			(0.13)	(0.10)	(0.10)
Beninese nationality			0.02	0.09	0.00
			(0.15)	(0.15)	(0.12)
Nb. of workers			0.29***	0.23***	0.22***
			(0.07)	(0.05)	(0.05)
Wholesalers			0.41***	0.38***	0.47***
			(0.12)	(0.10)	(0.09)
Year 2011	-0.45**	-0.32*	-0.27	-0.06	-0.05
	(0.18)	(0.19)	(0.19)	(0.16)	(0.16)
Origin market f.e.				X	X
Sector (SH4) f.e.					X
Observations	7519	7519	7519	7519	7519
Pseudo R^2	0.573	0.596	0.624	0.721	0.754

Standard errors in parentheses, clustered by border crossings.

* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

Dependent variable: expected bribe payment. Local products: 1 for unprocessed products from the ECOWAS region, which benefit from free movement within the WAEMU and ECOWAS areas. Transport mode: Trucks are the omitted category. *Stream * non-water transport*: equals 1 if the transport mode is not a pirogue, despite trade by pirogue existing between the same origin and destination markets. Frequency: nb. of passages reported by the trader in the 12 months before the survey. Wholesalers: 1 if traders declare that they have wholesalers as their main clients or suppliers.

Table 7: Bribe payments (Poisson QML), product-origin-destination fixed effects

	(1)	(2)	(3)	(4)
	Single-product only			
Weight	0.76***	0.56***	0.77***	0.56***
	(0.06)	(0.05)	(0.06)	(0.05)
Unit value	0.60***	0.44***	0.58***	0.42***
	(0.10)	(0.08)	(0.09)	(0.07)
Distance	0.22***	0.19***	0.23***	0.19***
	(0.08)	(0.06)	(0.07)	(0.06)
Distance *	0.01	0.13	-0.00	0.10
pirogue	(0.03)	(0.21)	(0.03)	(0.19)
Distance to	0.06	-0.05	0.06	-0.04
official post	(0.06)	(0.05)	(0.06)	(0.05)
Multiproduct			0.08	0.04
			(0.21)	(0.18)
Tariff	-5.43	-6.70	-5.47	-6.90
	(27.85)	(23.65)	(5.31)	(4.64)
Import ban	1.99***	1.43**	1.07	1.09**
	(0.61)	(0.58)	(0.85)	(0.55)
Bicycle/pedestrian		-0.92***		-0.91***
		(0.22)		(0.21)
Pirogues		-1.89		-1.75
		(2.26)		(2.07)
Motorcycles		-1.16***		-1.24***
		(0.25)		(0.24)
Cars		-0.19		-0.24
		(0.18)		(0.17)
Stream * non-water transport		-0.40***		-0.38***
		(0.14)		(0.14)
Frequency		0.05		0.08
		(0.14)		(0.13)
Beninese		0.04		0.11
		(0.17)		(0.15)
Nb. of workers		0.35***		0.34***
		(0.07)		(0.07)
Wholesalers		0.49***		0.54***
		(0.11)		(0.11)
Year 2011	-0.42**	-0.29	-0.33	-0.20
	(0.20)	(0.20)	(0.21)	(0.20)
Observations	6373	6373	7519	7519
Pseudo R^2	0.661	0.712	0.660	0.713

Standard errors in parentheses, clustered by border crossing.

* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

Model includes fixed effects for product (HS-6 code), country of origin, and country of destination groups. In columns 1 and 2, multi-product shipments are excluded.

Table 8: Bribe payments: number of crossings

	(1)	(2)	(3)	(4)
	Poisson	2SLS		IV Poisson
Nb. near crossings	-0.08***	-0.03	-0.02	0.03
	(0.03)	(0.06)	(0.06)	(0.11)
Weight	0.63***	0.55***	0.55***	0.67***
	(0.05)	(0.03)	(0.03)	(0.04)
Unit value	0.44***	0.46***	0.45***	0.58***
	(0.05)	(0.04)	(0.04)	(0.04)
Distance	0.21***	0.08***	0.08***	0.08***
	(0.07)	(0.03)	(0.02)	(0.03)
Distance * pirogue	0.10	-0.01	-0.01	-0.01
	(0.21)	(0.08)	(0.08)	(0.09)
Distance to	-0.12*	0.10	0.09	0.10
official point	(0.07)	(0.10)	(0.09)	(0.18)
Multiproduct	-0.07	-0.13	-0.14*	-0.20*
	(0.15)	(0.08)	(0.08)	(0.11)
Entrepôt trade	-0.29	-0.23*	-0.16	-0.01
	(0.26)	(0.12)	(0.14)	(0.17)
Petroleum products	0.57**	0.29**	0.64	0.17
	(0.22)	(0.12)	(0.50)	(0.15)
Local products	-0.47***	-0.20**	0.46	-0.29***
	(0.14)	(0.08)	(0.35)	(0.07)
Bicycle/pedestrian	-0.64***	-0.66***	-0.71***	-1.01***
	(0.24)	(0.20)	(0.20)	(0.26)
Pirogues	-1.27	-0.28	-0.24	-0.79
	(2.29)	(1.01)	(0.93)	(1.23)
Motorcycles	-1.09***	-0.83***	-0.80***	-0.98***
	(0.29)	(0.15)	(0.16)	(0.20)
Cars	-0.22	-0.28**	-0.21	-0.34*
	(0.18)	(0.13)	(0.13)	(0.18)
Stream * non-water transport	-0.42***	-0.19	-0.18	-0.20
	(0.14)	(0.13)	(0.13)	(0.15)
Sector (SH4) fixed effects			X	
Observations	7503	5728	5728	7503
R^2		0.567	0.598	
Weak id. Wald F		7.20	7.31	
Underid. Chi p-value		0.02	0.01	

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

Nb. near crossings: number of border crossings at distance less than 8 km from surveyed point. Models include controls: tariffs, import bans, WAEMU dummy, year fixed effect. Weak id. Wald F statistic is the Kleibergen-Paap rank Wald F statistic. Underidentification test is based on the Kleibergen-Paap rk LM statistic. Column 4 estimates IV-Poisson model using a control function approach. See next table for first stage results.

Table 9: Table 8 continued: number of crossings equation

	(1)	(2)	(3)	(4)
	2SLS			IV Poisson
	Nb. near crossings			
Ruggedness	-0.21***	-0.22***		-0.18***
	(0.08)	(0.08)		(0.06)
Weight	-0.23***	-0.20**		-0.16**
	(0.08)	(0.08)		(0.07)
Unit value	-0.35***	-0.36***		-0.24***
	(0.10)	(0.11)		(0.09)
Distance	-0.13	-0.13		-0.08
	(0.09)	(0.09)		(0.07)
Distance * pirogue	-0.30	-0.23		-0.32
	(0.49)	(0.47)		(0.37)
Distance to	-1.26***	-1.17***		-1.41***
official point	(0.30)	(0.29)		(0.28)
Multiproduct	-0.27	-0.34		-0.28
	(0.28)	(0.25)		(0.22)
Entrepôt trade	-0.57	-0.80**		-0.36
	(0.47)	(0.38)		(0.45)
Petroleum products	0.41	1.04		0.42
	(0.59)	(1.35)		(0.55)
Local products	0.07	0.44		-0.03
	(0.23)	(1.00)		(0.20)
Bicycle/pedestrian	2.25***	2.47***		1.82***
	(0.72)	(0.73)		(0.57)
Pirogues	7.68	7.10		7.72**
	(5.22)	(4.91)		(3.93)
Motorcycles	1.08	1.15*		0.99*
	(0.67)	(0.64)		(0.54)
Cars	1.06**	1.15***		1.02***
	(0.44)	(0.41)		(0.37)
Stream * non-water transport	1.20***	1.18***		0.89***
	(0.36)	(0.35)		(0.33)
Residual				-0.09
				(0.11)
Observations	5728	5728		7503
R^2	0.567	0.598		
Weak id. Wald F	7.20	7.31		
Underid. Chi p-value	0.02	0.01		

Standard errors in parentheses, clustered at market-pair level.

* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

Nb. near crossings: number of border crossings at distance less than 8 kilometers from surveyed point. Wald F statistic is the Kleibergen-Paap rank Wald F statistic. Underidentification test is based on the Kleibergen-Paap rk LM statistic. Column 4: IV-Poisson model using control function approach. *Residual* reports coefficient on the residual variable included to control for endogeneity. Controls: WAEMU, tariff, import ban, year.

Table 10: Bribe payments, Poisson estimates: 2011 data only

	(1)	(2)	(3)	(4)	(5)	(6)
				Pedestrians only		
Weight	0.63***	0.60***	0.63***	0.27***	0.30***	0.41**
	(0.06)	(0.05)	(0.05)	(0.09)	(0.10)	(0.21)
Unit value	0.35***	0.34***	0.27***	0.80***	0.82***	1.03***
	(0.06)	(0.06)	(0.05)	(0.13)	(0.13)	(0.37)
Distance	0.12*	0.13*	0.13**	-0.12**	-0.14***	-0.20***
	(0.07)	(0.07)	(0.06)	(0.06)	(0.05)	(0.05)
Distance to	0.01	0.02	0.03	0.75***	0.77***	0.71***
official post	(0.12)	(0.11)	(0.10)	(0.12)	(0.13)	(0.13)
Multiproduct	0.28	0.20	0.27	0.31	0.35	-0.67
	(0.29)	(0.25)	(0.27)	(0.28)	(0.36)	(0.47)
Entrepot trade	0.08	0.09	0.29	-0.17	-0.20	-0.24
	(0.24)	(0.24)	(0.25)	(0.45)	(0.51)	(0.55)
Petroleum products	0.50	0.40		3.63***	3.92***	
	(0.34)	(0.32)		(0.62)	(0.76)	
Bicycle/pedestrian	-0.65*	-0.53*	-0.46*			
	(0.33)	(0.31)	(0.28)			
Pirogues	-0.97***	-1.03***	-1.21***			
	(0.36)	(0.37)	(0.35)			
Motorcycles	-1.26***	-1.12***	-1.17***			
	(0.38)	(0.35)	(0.35)			
Cars	-0.16	-0.10	-0.22			
	(0.28)	(0.26)	(0.26)			
Stream x non-water transport	-0.39**	-0.51**	-0.51***	0.80**	0.70*	0.54
	(0.19)	(0.20)	(0.19)	(0.38)	(0.40)	(0.36)
Local products	-0.61***	-0.56***		1.44***	1.45***	
	(0.15)	(0.14)		(0.45)	(0.45)	
WAEMU	-0.09	0.01	0.44	-0.45	-0.65	-0.25
	(0.42)	(0.42)	(0.41)	(0.40)	(0.41)	(0.46)
Tariff	-1.06	-0.81	1.75	8.57***	8.20***	12.54***
	(1.64)	(1.60)	(1.79)	(2.29)	(2.43)	(4.52)
Import ban	-0.88***	-0.78**	-1.58***	0.85***	0.90**	1.24
	(0.33)	(0.32)	(0.40)	(0.33)	(0.37)	(0.76)
Male trader	-0.03	0.01	-0.08	-0.50***	-0.65**	-0.94***
	(0.15)	(0.13)	(0.13)	(0.19)	(0.28)	(0.32)
Frequency		0.22**	0.22**		0.28	0.39*
		(0.09)	(0.09)		(0.20)	(0.21)
Wholesalers		0.36**	0.51***		-0.27	-0.59*
		(0.17)	(0.14)		(0.40)	(0.34)
Beninese		0.10	0.24		-0.17	-0.45*
		(0.21)	(0.18)		(0.28)	(0.24)
Nb. of workers		0.12*	0.08		-0.21	-0.34**
		(0.07)	(0.07)		(0.20)	(0.16)
Product (SH4) f.e.			X			X
Observations	4129	4129	4129	498	498	498

Standard errors in parentheses, clustered by border crossing.

* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

5 Robustness checks

5.1 Sample selection and measurement error

The objective of the ECENE survey was to obtain a representative sample of informal trade at Benin's borders. However, the nature of informal trade raises concerns in terms of both sample selection and potential measurement errors. First, the sample might suffer from selection, if traders of certain products operate at night. There is evidence that some of the smuggling activity across the Benin-Nigeria border takes place at night. Such trade would not be captured in the survey. If this type of trade is quantitatively important, it could threaten the representativeness of the survey data.

As explained in Section 2.3, a first attempt to address these issues involves verifying the consistency of the data with other sources of information on the composition of informal trade. Products known to be important in smuggling with Nigeria appear frequently in the data and show up among the top products by trade value recorded in the survey. This confirms that no major product appears to be missing from the data. Many of these products - such as rice, cars, and gasoline - are also the products that face the most stringent controls on smuggling with Nigeria. The survey thus managed to measure a significant number of these trade activities, despite their high degree of illegality and risk. However, these qualitative assessments do not rule out the possibility of sample selection. To further probe the influence that such selection may have on our results, we estimate our model excluding products with a high degree of illegality and risk.

A related concern is that of measurement error in the data. Traders' responses to the survey may not always be truthful, which is problematic if the probability of truthful responses varies with certain trader or cargo characteristics.

There is also evidence that some traders may pay a portion of the bribes in advance, through arrangements made by large smugglers, meaning that bribes paid at the time of the crossing may understate the actual bribes paid. This is a second source of potential measurement error.

To check the robustness of our results, we ran a series of estimations of our

models, excluding products with a high risk of measurement error.

We started by excluding all products classified as *entrepôt* trade. This type of trade, involving the re-exportation of products, mostly to Nigeria, may imply a higher level of measurement error risk than other products. High profitability may go hand-in-hand with larger-scale activities, as well as a specific organization of operations.

Next, we tried excluding products under an import ban in Nigeria at the time of the survey.[28]

Finally, we excluded the products most associated with smuggling: cars, rice, palm oil, poultry meat, textiles, and gasoline. Some of these products, such as rice, were not banned in 2010-2011, but were heavily smuggled into Nigeria as a result of high trade barriers in that country. Smuggling at the Benin-Nigeria border is known to be concentrated on these products (see e.g. Golub (2012)), and they appeared frequently in our data. Trade of these products is likely to be high-risk, profitable, and well organized, which could imply either undermeasurement in our data or a measurement error in the bribes reported.

Table 11 reports the results of these estimations. Most results of the baseline Poisson model are stable when excluding either of these three groups of products.

5.2 Estimates without the distance variable

The results presented so far were obtained on the subsample of data for which the *distance* variable (the distance between the goods' market of origin and the survey point) could be computed. This excludes observations for which the origin market could not be localized on the map. We relied primarily on these estimates, as the distance variable is one important determinant of the amount of the bribes paid by traders (as it measures the sum of payments made during the journey). However, there is a risk that the selection of this subsample could affect some of our results.[29]

To test whether our results were potentially affected by this selection process, we ran our estimations on the whole sample, excluding the distance variable from the model. The results are presented in Tables 12, 13, 14 and 15.

Overall, the results are similar to those obtained on the selected sub-sample

including the distance variable. Coefficients on most variables are similar in magnitude to those presented above. Coefficients on transport mode variables are the most affected: this makes sense, as the average distance traveled by traders (and thus the exposure to the risk of bribery) differs by transport mode. The coefficient for *pedestrians* is thus more negative in the no-distance estimates: this coefficient captures in part the effect of shorter distance for these traders.

For this reason, we view our estimates on the model including distance as more reliable. But it is reassuring that our effects of interest do not change dramatically when using the no distance alternative. The impact of import bans, when measured on the panel of products (Table 13), is again positive and significant. IV estimates also tend to confirm the sign of competition effects found previously: the number of crossing points available to traders is negatively associated with the level of bribes paid.

5.3 Negative binomial model

Poisson quasi-maximum likelihood estimates are consistent even if the dependent variable does not really follow a Poisson distribution, for example if the conditional variance exceeds the mean (overdispersion). However, the use of the negative binomial model is sometimes advocated as an alternative to Poisson QMLE when there is overdispersion. The negative binomial model entails a more general specification of variance, which encompasses Poisson as a special case. The Poisson QML, or the negative binomial estimation, may be more efficient, depending on the actual functional form of the variance (see Wooldridge (2010)). An additional advantage of the Poisson QML over the negative binomial is that the Poisson QML does not suffer from the incidental parameters problem, so that fixed effects can be included in the specification without introducing a risk of bias.

As a robustness check, we ran our estimations using the negative binomial model. We verify that these results are essentially similar to those obtained by Poisson QML

estimation. Results are available on request.

Table 11: Robustness check: excluding sensitive products

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All		No *entrepôt*		No banned		No smuggling	
Weight	0.56***	0.56***	0.59***	0.56***	0.57***	0.57***	0.56***	0.58***
	(0.04)	(0.04)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)
Unit value	0.42***	0.39***	0.48***	0.39***	0.45***	0.42***	0.40***	0.41***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)	(0.06)
Distance	0.23***	0.36***	0.22***	0.30***	0.21***	0.30***	0.12**	0.25***
	(0.07)	(0.08)	(0.07)	(0.08)	(0.06)	(0.08)	(0.05)	(0.07)
Distance *	0.08	-0.11	0.09	-0.08	0.07	-0.13	-0.07	0.03
pirogue	(0.17)	(0.20)	(0.18)	(0.21)	(0.18)	(0.18)	(0.12)	(0.20)
Distance to	-0.05	-0.16***	-0.04	-0.14***	-0.06	-0.16***	0.03	-0.08
official point	(0.05)	(0.04)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)
Multiproduct	-0.08	-0.08	-0.08	-0.07	-0.06	-0.07	-0.45***	-0.43***
	(0.15)	(0.14)	(0.16)	(0.16)	(0.16)	(0.15)	(0.14)	(0.11)
Entrepôt trade	-0.30	-0.15			-0.07	0.08	0.39	0.42**
	(0.25)	(0.30)			(0.24)	(0.20)	(0.25)	(0.18)
Petroleum products	0.47**		0.54**		0.41*			
	(0.21)		(0.22)		(0.22)			
Local products	-0.50***		-0.29**		-0.51***		-0.38***	
	(0.14)		(0.13)		(0.14)		(0.13)	
WAEMU	-0.07	-0.08	-0.04	-0.06	-0.18	0.32	-0.45**	-0.36
	(0.28)	(0.29)	(0.28)	(0.29)	(0.28)	(0.30)	(0.22)	(0.25)
Tariff	0.12	0.85	0.09	0.82	-0.84	2.86*	-1.56	-0.54
	(1.10)	(1.48)	(1.09)	(1.16)	(1.28)	(1.67)	(1.05)	(0.96)
Import ban	-0.56**	-0.07	-0.29	0.48			-0.83**	-0.60**
	(0.25)	(0.40)	(0.26)	(0.45)			(0.33)	(0.30)
Bicycle/pedestrian	-0.72***	-0.59***	-0.70***	-0.71***	-0.78***	-0.60***	-0.60***	-0.55**
	(0.25)	(0.21)	(0.22)	(0.21)	(0.28)	(0.22)	(0.23)	(0.23)
Pirogues	-1.55	0.96	-1.60	0.73	-1.41	1.31	0.30	-1.04
	(1.84)	(2.34)	(2.00)	(2.45)	(1.99)	(2.14)	(1.26)	(2.28)
Motorcycles	-1.18***	-1.07***	-1.08***	-1.26***	-1.21***	-1.06***	-0.86***	-0.94***
	(0.25)	(0.23)	(0.24)	(0.23)	(0.25)	(0.24)	(0.22)	(0.27)
Cars	-0.26	-0.25	-0.30*	-0.36**	-0.34**	-0.26*	-0.25	-0.21
	(0.17)	(0.16)	(0.16)	(0.15)	(0.16)	(0.15)	(0.17)	(0.18)
Stream *	-0.52***	-0.51	-0.60***	-0.49	-0.62***	-0.58*	-0.26	-0.51**
non-water transport	(0.15)	(0.34)	(0.17)	(0.33)	(0.17)	(0.31)	(0.20)	(0.24)
Frequency	0.00	0.10	-0.02	0.07	-0.04	0.16**	-0.05	-0.01
	(0.13)	(0.10)	(0.12)	(0.07)	(0.11)	(0.08)	(0.14)	(0.10)
Beninese	0.02	0.00	-0.01	0.06	0.15	0.12	0.12	0.04
	(0.15)	(0.12)	(0.16)	(0.13)	(0.17)	(0.13)	(0.16)	(0.16)
Nb. of workers	0.29***	0.22***	0.30***	0.21***	0.30***	0.20***	0.14*	0.10
	(0.07)	(0.05)	(0.07)	(0.05)	(0.07)	(0.05)	(0.07)	(0.07)
Wholesalers	0.41***	0.47***	0.48***	0.50***	0.43***	0.51***	0.23	0.32***
	(0.12)	(0.09)	(0.12)	(0.08)	(0.12)	(0.08)	(0.14)	(0.09)
Year 2011	-0.27	-0.05	-0.31	0.00	-0.20	-0.00	-0.39*	-0.47***
	(0.19)	(0.16)	(0.20)	(0.15)	(0.19)	(0.15)	(0.20)	(0.18)
Origin market f.e.		X		X		X		X
Sector (SH4) f.e.		X		X		X		X
Observations	7519	7519	6428	6428	6695	6695	4422	4422
Pseudo R^2	0.624	0.754	0.649	0.782	0.640	0.772	0.532	0.695

* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

Poisson QML estimates. entrepôt trade is excluded in col. 3-4. All products under an import ban in Nigeria are excluded in col. 5-6. The main products in large-scale smuggling into Nigeria - rice, palm oil, textiles, automobiles, and poultry meat - as well as gasoline, are excluded in col. 7-8.

Table 12: Bribe payments (Poisson QML): model without distance

	(1)	(2)	(3)	(4)	(5)
Weight	0.70***	0.62***	0.57***	0.59***	0.59***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
Unit value	0.54***	0.54***	0.53***	0.56***	0.48***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)
Distance to	0.09	0.03	0.00	-0.03	-0.11*
official post	(0.06)	(0.06)	(0.07)	(0.07)	(0.06)
Multiproduct	-0.14	-0.13	-0.13	-0.10	-0.08
	(0.14)	(0.14)	(0.14)	(0.14)	(0.12)
Entrepôt trade	-0.57*	-0.51	-0.51	-0.26	-0.54*
	(0.29)	(0.31)	(0.33)	(0.24)	(0.32)
Petroleum products	0.05	0.24	0.24		
	(0.19)	(0.19)	(0.17)		
Local products	-0.43***	-0.42***	-0.45***		
	(0.17)	(0.16)	(0.16)		
WAEMU	-0.07	0.04	0.02	-0.48	-0.16
	(0.29)	(0.28)	(0.26)	(0.32)	(0.31)
Tariff	-0.92	-0.37	-0.27	-2.55***	0.58
	(1.09)	(1.08)	(0.99)	(0.69)	(1.43)
Import ban	-0.25	-0.30	-0.33	0.64*	0.06
	(0.32)	(0.33)	(0.37)	(0.37)	(0.36)
Bicycle/pedestrian		-1.00***	-0.97***	-1.11***	-1.03***
		(0.20)	(0.19)	(0.25)	(0.20)
Pirogues		-0.66**	-0.76***	-1.79***	-1.24***
		(0.31)	(0.29)	(0.35)	(0.22)
Motorcycles		-1.36***	-1.37***	-1.37***	-1.42***
		(0.24)	(0.24)	(0.17)	(0.20)
Cars		-0.38**	-0.36**	-0.34*	-0.37***
		(0.16)	(0.16)	(0.18)	(0.14)
Stream * non-water transport		-0.16	-0.13	-1.43***	-0.87***
		(0.17)	(0.17)	(0.24)	(0.17)
Frequency			-0.20	-0.23	-0.24
			(0.16)	(0.21)	(0.23)
Beninese			-0.09	-0.11	-0.08
			(0.13)	(0.15)	(0.10)
Nb. of workers			0.26***	0.26***	0.27***
			(0.06)	(0.05)	(0.05)
Wholesalers			0.18	0.06	0.20*
			(0.15)	(0.15)	(0.12)
Year 2011	-0.31	-0.26	-0.26	-0.07	-0.07
	(0.21)	(0.19)	(0.19)	(0.18)	(0.18)
Origin market f.e.				X	X
Sector (SH4) f.e.					X
Observations	12473	12389	12389	12131	12131

Standard errors in parentheses, clustered by border crossing.

* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

Table 13: Bribe payments (Poisson QML), product-origin-destination fixed effects, no distance

	(1)	(2)	(3)	(4)
	Single-product only			
Weight	0.72***	0.59***	0.72***	0.57***
	(0.05)	(0.04)	(0.04)	(0.04)
Unit value	0.63***	0.49***	0.58***	0.46***
	(0.08)	(0.07)	(0.08)	(0.07)
Distance to	0.05	-0.06	0.06	-0.06
official post	(0.06)	(0.06)	(0.06)	(0.06)
Multiproduct			-0.10	-0.07
			(0.16)	(0.16)
Tariff	-50.60	-40.60	-13.15***	-11.91***
	(37.99)	(33.27)	(3.71)	(3.65)
Import ban	2.13***	1.65***	1.24*	1.55***
	(0.71)	(0.59)	(0.73)	(0.58)
Bicycle/pedestrian		-1.06***		-1.11***
		(0.19)		(0.18)
Pirogues		-0.73***		-0.80***
		(0.26)		(0.26)
Motorcycles		-1.28***		-1.34***
		(0.23)		(0.23)
Cars		-0.38***		-0.40***
		(0.14)		(0.13)
Stream * non-water transport		-0.18		-0.18
		(0.14)		(0.14)
Frequency		-0.29		-0.24
		(0.21)		(0.19)
Beninese		0.10		0.10
		(0.12)		(0.12)
Nb. of workers		0.30***		0.29***
		(0.06)		(0.06)
Wholesalers		0.28*		0.32**
		(0.15)		(0.14)
Year 2011	-0.53**	-0.52**	-0.28	-0.31*
	(0.22)	(0.23)	(0.22)	(0.19)
Observations	10719	10639	12340	12256

Standard errors in parentheses, clustered by border crossing.

* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

Model includes fixed effects for product (HS-6 code), country of origin, and country of destination groups. In columns 1 and 2, multi-product shipments are excluded.

Table 14: Bribes payments: number of crossings (no distance model)

	(1)	(2)	(3)	(4)
	Poisson	2SLS		IV Poisson
Nb. near crossings	-0.10***	-0.02	0.01	-0.02
	(0.03)	(0.07)	(0.07)	(0.10)
Weight	0.61***	0.60***	0.61***	0.70***
	(0.04)	(0.03)	(0.04)	(0.04)
Unit value	0.51***	0.50***	0.50***	0.60***
	(0.07)	(0.03)	(0.04)	(0.04)
Distance to	-0.12	0.13	0.13	0.02
official post	(0.08)	(0.10)	(0.10)	(0.16)
Multiproduct	-0.15	-0.12	-0.12	-0.12
	(0.14)	(0.07)	(0.07)	(0.10)
Entrepôt trade	-0.43	-0.27**	-0.23	-0.21
	(0.31)	(0.13)	(0.14)	(0.20)
Petroleum products	0.30*	0.12	0.60	0.11
	(0.18)	(0.11)	(0.40)	(0.13)
Local products	-0.42***	-0.23***	0.37	-0.23***
	(0.15)	(0.07)	(0.31)	(0.08)
Bicycle/pedestrian	-0.86***	-0.66***	-0.73***	-0.90***
	(0.20)	(0.17)	(0.17)	(0.20)
Pirogues	-0.20	-0.41	-0.55	-0.66
	(0.32)	(0.39)	(0.39)	(0.56)
Motorcycles	-1.25***	-0.66***	-0.66***	-0.86***
	(0.24)	(0.16)	(0.16)	(0.18)
Cars	-0.36**	-0.25**	-0.23**	-0.36***
	(0.16)	(0.11)	(0.11)	(0.14)
Stream * non-water transport	-0.06	-0.13	-0.16	-0.13
	(0.16)	(0.12)	(0.12)	(0.12)
WAEMU	-0.29	-0.09	0.13	-0.30
	(0.30)	(0.26)	(0.28)	(0.34)
Tariff	-0.57	-1.01*	0.15	-0.35
	(1.08)	(0.55)	(0.70)	(0.79)
Import ban	-0.39	-0.43***	-0.35**	-0.55***
	(0.34)	(0.13)	(0.15)	(0.19)
Year 2011	-0.27	-0.50***	-0.50***	-0.43***
	(0.18)	(0.12)	(0.12)	(0.13)
Observations	9538	9538	12221	
R^2	0.57	0.59		
Weak id. Wald F		6.91	7.27	
Underid. Chi p-value		0.02	0.01	

Standard errors in parentheses, clustered at border crossing level.
* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

Table 15: Table 14, continued:number of crossings equation

	(2)	(3)	(4)
	2SLS		IV Poisson
	Nb. near crossings		
Ruggedness	-0.19***	-0.19***	-0.16***
	(0.07)	(0.07)	(0.06)
Weight	-0.31***	-0.33***	-0.20**
	(0.09)	(0.10)	(0.08)
Unit value	-0.32***	-0.38***	-0.23**
	(0.12)	(0.14)	(0.10)
Distance to	-1.32***	-1.25***	-1.43***
official post	(0.27)	(0.26)	(0.24)
Multiproduct	-0.38	-0.47**	-0.41**
	(0.23)	(0.22)	(0.18)
Entrepôt trade	-0.93**	-1.22***	-0.67
	(0.44)	(0.46)	(0.41)
Petroleum products	0.58	0.06	0.51
	(0.45)	(1.13)	(0.41)
Local products	0.34	-0.10	0.17
	(0.24)	(0.85)	(0.19)
Bicycle/pedestrian	1.37**	1.43**	1.20**
	(0.61)	(0.63)	(0.49)
Pirogues	4.57***	4.54***	4.50***
	(0.77)	(0.76)	(0.70)
Motorcycles	0.92	0.90	0.95*
	(0.65)	(0.65)	(0.55)
Cars	0.52	0.53	0.59*
	(0.39)	(0.39)	(0.35)
Stream * non-water transport	0.87**	0.84**	0.77**
	(0.37)	(0.38)	(0.31)
WAEMU	-3.17***	-3.27***	-2.99***
	(0.66)	(0.81)	(0.57)
Tariff	3.76*	1.95	2.57
	(2.27)	(2.76)	(2.01)
Import ban	0.34	0.50	0.49
	(0.56)	(0.47)	(0.52)
Year 2011	0.11	0.14	0.12
	(0.43)	(0.44)	(0.35)
Residual			-0.03
			(0.11)
Observations	9538	9538	12221
Weak id. Wald F		6.91	7.27
Underid. Chi p-value		0.02	0.01

Standard errors in parentheses, clustered at border crossing level

* $p < 0.10$, ** $p < 0.05$,*** $p < 0.01$

6 Conclusion

In many developing countries, corruption is ubiquitous in the form of the small bribes that citizens are required to pay for day-to-day access to public services and for conducting business. These payments distort prices and may induce an inefficient allocation of resources. They may allow agents to circumvent taxes and regulations, thus leading to private gain for the bribe taker and payer, at the expense of the rest of society. They may also lead agents to use resources to avoid the payment of bribes. There is, therefore, a need to better understand the mechanisms of bribery and the reasons for its persistence.

In this paper, we focus on a region, West Africa, and a sector, cross-border trade, where bribes are particularly common. We rely on a unique source of information on bribe payments, an extensive survey of informal traders conducted in Benin in 2010 and 2011, which covered a wide range of cross-border transactions. We use variation in trade regimes, transport modes, and products to identify some of the determinants of the bribes paid by traders. Our results confirm that bribes are particularly pervasive in the trade sector: overall, about 80% of traders have paid a bribe. This incidence remains high across trader types and products.

Traders of local products operating within the WAEMU customs union, where most trade barriers have, in principle, been removed, face lower bribe levels. However, even these traders have to pay bribes most of the time. Our results indicate that trade barriers and restrictions are associated with higher bribes, consistent with collusive bribery. We also find evidence that bribe levels are set according to traders' elasticity of demand. Those with lighter transport modes tend to pay lower bribes. These results are consistent with a view of bribe-taking officials as profit maximizers, who exploit market power to extract bribes from traders, and use third degree price discrimination.

Overall, our results suggest that reductions in regional trade barriers may help to reduce traders' exposure to bribery, but are probably not sufficient to eliminate it. These measures could also help to formalize a large share of regional trade and make regional trade more efficient.

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Notes

[1]In 17 of the 23 years during which the Transparency International Corruption Perception Index has been published, a Sub-Saharan African country was considered the most corrupt. The number of countries ranked was quite limited until 2007. Since then, the Transparency International Corruption Perception Index has included around 180 countries. As a region, Sub-Saharan Africa has been considered the most corrupt for the last six years. Source: https://www.transparency.org/research/cpi.

[2]These include "mineral products extracted from [member countries'] soil or deposited on the shore of the maritime coasts, live animals born within the community, harvested vegetable products, fishery and hunting products, products extracted from the sea by boats registered in a member state, products from live animals that are reared in a member state" (WAEMU treaty).

[3]It is possible that other trade restrictions were applied in Nigeria without being reported to the WTO. To control for this possibility, we rely on product (SH4) fixed effects in our empirical specifications.

[4]See `https://www.customs.gov.ng/Publications/news_results.php?NewsID=132`

[5]Some transit trade is legal and takes place with landlocked countries for which Cotonou is the main sea access point. This trade is conducted within the framework of an agreement with Benin. However, most (87%) of the transit trade flows in our data go to Nigeria. The role of Benin as a trade platform is related to its geographical situation (Golub, 2015). Cotonou has a deep water port and is located only 125 km from Lagos.

[6]For example, extra-WAEMU origin imports are classified as *entrepôt*. Since they enter Benin through a land border, it is very likely that they are intended to be re-exported to Nigeria, rather than being intended for consumption in Benin.

[7]Note: some crossing points are not close to a border but are located on water streams or lakes, such as around lake Nokoue in the center of Benin's south coast. This lake communicates with Nigeria through the lagoon river Yewa and is for this reason a hotspot of trade with Nigeria.

[8]We used data on traders' characteristics to verify that at least 83% of observations related to traders observed only once in the data.

[9]The number of incorrect product codes is low; the within-product dispersion in unit values is coherent. The most frequently observed products and their direction of trade are as expected based on existing studies on informal trade in the area.

[10]Foltz and Opoku-Agyemang (2015) use data on payments made by truck drivers at each roadblock, in a context close to ours. They report that most payments were made to police and customs agents. We expect the same to be true in our case.

[11]The next question in the survey asked traders for the amount paid in formal taxes, defined as all payments made with a receipt. The distinction between the two types of payment was therefore made clear in the questionnaire.

[12]Anecdotal evidence in Igue (1976) and World Bank (2013) suggests that, because they can be driven on narrow bush paths, bicycles and motorbikes are used to avoid encounters with law enforcement officers.

[13]See, for example, the report by the International Trade Centre (ITC, 2017) based on a survey of firms in Benin: "In principle, regulations within WAEMU guarantee free movement of products of origin, with total exemption of customs taxes and duties. Yet, the survey reveals that customs taxes are applied de facto by member countries on imported products." Firms also complain about the lack of transparency surrounding these taxes, and of the delays, cost, and complexity of the procedure for obtaining certificates of origin.

[14]Foltz and Opoku-Agyemang (2015) report bribes per kilometer of "between \$0.03 and \$0.17". In our data, bribes per (straight line) kilometer have a mean of \$0.19 and a mean of \$1.1 for trucks not transporting oil.

[15]In about 10% of cases, it is longer than the driving route, which uses highways. In these cases we applied the driving distance to motorcycles.

[16]For pirogues, we used the walking itinerary, which is usually close to the waterway. In the empirical model, we interact the distance variable with an indicator for pirogues, in order to better control for the specificity of measuring distance in this case.

[17]The sex of traders was coded using traders' names, which are reported in the 2011 survey data. This variable is missing for about 20% of the cases because the name is missing or uninformative (last name only).

[18]The distance variable also serves to control for transport costs, which may influence the level of bribes.

[19]We counted the number of crossings at a distance less than a set threshold. The threshold value used was twice the median of the distance to the closest point. We then experimented with multiples of this value.

[20]Specifically, the variance of dependent variable y_i, conditional on regressors x_i, is assumed to take the form $Var(y_i|x_i) = exp(\beta x_i) + \eta^2 exp(\beta x_i)^2$, where η is the variance of an individual heterogeneity term.

[21]The Poisson QML estimator is more efficient under the assumption that $Var(y_i|x_i) = \sigma^2 exp(\beta x_i)$ for some σ. See Wooldridge (2010).

[22]We experimented with different levels of clustering and found that standard errors do not change much if the clustering is at a higher level, such as the *arrondissement* or the commune. We therefore retain the border crossing (*point de passage*) in order to keep a high number of cluster groups (following e.g. Cameron and Miller (2013)).

[23]The number of *arrondissements* in which water transport was recorded increased from 28 in the 2010 survey to 39 in 2011 (out of a total of 84 *arrondissements*) due to the fact that the first survey was conducted in January 2010 and the second in

September 2011, at the end of the rainy season.

[24]The following products were removed from the prohibition list in July 2011 (see Nigeria's customs website, `https://www.customs.gov.ng/Publications/news_results.php?NewsID=132`): raw or processed Cassava, motor vehicle seats, seats other than garden seats or camping, equipment convertible into beds, all kinds of tooth picks, lace fabrics and made-up garments like shirts, trousers, skirts, blouses, etc.

[25]We calculated the TRI using elevation data from the US geological survey (GMTED dataset). Elevation is measured at a 30' resolution. The TRI was computed as the mean square difference of altitude between each point and its eight neighbors. We then averaged the TRI by *arrondissement*.

[26]Note, however, that the majority of small-scale traders in the context studied in Brenton et al. (2011) are women, contrary to our data in which women are in the minority, including among pedestrians.

[27]The sign of the distance variable is inverted when focusing on this sub-sample. This could be due to the fact that the origin market as reported by traders does not reflect actual the actual distance traveled by the pedestrian.

[28]We excluded all shipments, including some products under ban.

[29]We measured distance for observations where the origin market could be found on geographic search engines, and thus, geolocalized. Smaller or less well-known origin markets were therefore more likely to be dropped at this point.