Does corruption sand or grease the wheels of trade? Theory and evidence from West African corridors

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December 1, 2024

Abstract.– We build a model of trade that encompasses time delays and strategic bribery during goods transportation and characterize analytically the conditions in which corruption affects trade negatively (sand the wheels) or positively (grease the wheels). We next rely on the road governance reports to construct a novel data set that measures trade-related roadblocks, time delays, and bribes on eight interstate corridors in Western Africa between 2006 and 2013 to investigate their effects on bilateral trade in the region. These interstate roads connect three land-locked countries – Burkina Faso, Niger, and Mali – to other coastal countries. We document that roadblocks, delays, and bribes are pervasive on the roads. Our empirical analyses show that the delays seriously impede bilateral trade between the connected countries. While corruption tends to match the "grease the wheels" theory it should not be seen as a good thing because people's willingness to pay bribes is motivated by their desire to relax the constraints imposed by roadblocks and delays. It is advisable that the interested countries improve the practices on the roads to move out the bad equilibrium and help trade integration and development.

Keywords: roadblocks, delays, bribes, interstate roads, bilateral trade, West Africa.

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1 Introduction

It is a well-known fact that regional trade within Africa is low compared to other regions in the world. The share of regional exports in Sub-Saharan Africa's total exports increased from 6% in 1980 to barely below 20% in 2016. That represents more than tripling over the period, and the region now has the highest share of intraregional trade integration among the world's emerging markets and developing economies. But compared with advanced economies, intraregional trade nonetheless remains relatively low (Arizala, Bellon, and MacDonald, 2018). According to the United Nations Conference on Trade and Development, intra-Africa trade represents only 12.7% in 2021 against 68.5% in Europe and 58.5% in Asia[1]. Concerned with the situation, African countries established, in 2018, the African Continental Free Trade Area (AfCFTA) with the goal of eliminating tariffs and non-tariff barriers to trade[2].

There are many reasons why intra-African trade is low. According to Longo and Sekkat (2004), besides traditional gravity variables, poor infrastructure, economic policy mismanagement and internal political tensions have a negative impact on trade among African countries. They additionally argue that, except for political tensions, the identified obstacles are specific to intra-African trade, since they have no impact on African trade with developed countries. In the same logic Njinkeu, Wilson, and Fosso (2008) examine the role of improved customs, regulatory environments, and upgrading services infrastructure on trade between African countries and find that improvement in ports and services infrastructure promise relatively more expansion in intra-African trade than other measures. Amoah (2014) also found a similar result, showing that infrastructure improvement by a trade partner of Ghana in Africa can improve significantly Ghana's trade. Kaminchia (2020) analyzes the effects of improvement of transit roads' quality in the East African Community (EAC) and finds that it lowered both domestic and cross-border trade costs and that the latter effect is larger than the former. This paper contributes to the literature by investigating the effect of some observed dubious practices – roadblocks, delays and bribery – on eight interstate roads in West Africa on bilateral trade. We document that roadblocks, delays and bribes are pervasive on West African interstate roads. During a goods transportation trucks experience up to more than 25 controls, are delayed by up to more than 5 hours and pay between 45 and 115 US dollars bribe. Our empirical analyses show that the delays seriously impede bilateral trade between West African countries while corruption tend to match the "grease the wheels" theory.

This paper is related to the literature on the effects of corruption on trade. It is

[1] https://hbs.unctad.org/trade-structure-by-partner/ (accessed on 2023-04-12).
[2] https://au-afcfta.org/about/

widely admitted that corruption negatively affects the macroeconomy – that is the so-called "sand the wheels" effect (Mauro, 1997; Gyimah-Brempong, 2002; Dincer and Gunalp, 2005; d'Agostino, Dunne, and Pieroni, 2016; Dimant and Tosato, 2018). But there are also channels through which corruption can positively affect the macroeconomy and trade. The so-called "grease the wheels" effect is also supported by a number of research works (Dreher and Gassebner, 2013; Dimant and Tosato, 2018). Musila and Sigué (2010) argue that efficiency-improving corruption can lead to an increase in international trade when bribes may enable individuals to bypass bureaucratic delays or when resource-transferring bribes replace queuing costs. Their empirical analysis shows however that corruption in African countries has adverse effects on export and import trade. On the other hand, Socrates, Moyi, and Gathiaka (2020) support that a high level of corruption increased export survival rates in Kenya. But Majeed (2014) argues that the relationship between trade and corruption is non-monotonic. For Gil-Pareja, Llorca-Vivero, and Martínez-Serrano (2019), the result depends on the measurement of corruption. When perception-based indexes of corruption are used they find a non-generalized negative effect of corruption on trade, but with a structural model-based index of corruption, they find sensible evidence for the "grease the wheels" hypothesis when low and middle-income countries (which are those with weak institutions and high regulations) are implicated. de Jong and Bogmans (2011) use measures of trade-related corruption to investigate the effects of corruption on international trade and compare the results with those of corruption in general, distinguishing between corruption in an exporting economy and that in an importing economy. Both distinctions appear to be important. Corruption in general hampers international trade, whereas bribe paid to customs enhances imports. Importantly, bribes tend to *grease the wheels* especially when the quality of the institutions is low.

We also contribute to the literature on the effects of delays on trade. Based on US import data, Hummels and Schaur (2013) famously estimate that each day in transit is equivalent to an advalorem tariff of 0.6 to 2.1 percent. According to the results of de Jong and Bogmans (2011), high waiting times at the border significantly reduce international trade. Puzzled by the collapse of world trade during the financial crisis of 2008 and 2009 and why it was much larger than the fall in world GDP and demand, Berman, de Sousa, Martin, and Mayer (2013) document that the fall in trade caused by financial crises is magnified by the time- to- ship goods between the origin and the destination country. Djankov, Freund, and Pham (2010) analyze data on the days it takes to move standard cargo from the factory gate to the ship in 98 countries and find that each additional day that a product is delayed prior to being shipped reduces trade by more than 1%, which is equivalent to a country distancing itself from its trade partners by about 70 km on average. The effect is even greater for time-sensitive

goods, such as perishable agricultural products. Sant' Anna and Kannebley Júnior (2018) estimate the impacts of turnaround time on the volume of Brazilian exports and the number of categories of exported products. According to their results, each relative additional hour of delay in the average port is equivalent to a reduction of nearly 2% in relative local exports, and a 10% reduction in relative turnaround time can increase the relative number of exported product categories by around 1%. Plane (2021) studies the domestic costs of delivering an imported container from its arrival at an African seaport to its final destination and found that abnormal processing times matter for most sub-regions, especially for Central Africa. Socrates et al. (2020) also find that time to export is a significant determinant of firms' survival in the export market in Kenya, corroborating Berman et al. (2013), who found that the probability to exit and cease exporting is amplified by time-to-ship. On the other hand, Vijil, Wagner, and Woldemichael (2019) find that uncertainty in the time to clear imported inputs impacts neither the entry nor the exit rate but translates into lower survival rates for new exporters. Other papers show that time delays and uncertainty make firms import less frequently and build inventory (Alessandria, Kaboski, and Midrigan, 2010; Alessandria, Khan, and Khederlarian, 2021; Carreras-Valle, 2021).

In this paper, we use directly measured trade-related roadblocks, bribery, and time delays on eight interstate roads in Western Africa between 2006 and 2013 to investigate their effects on bilateral trade in the region. These interstate roads connect three landlocked countries – Burkina Faso, Niger, and Mali – to other coastal countries. The novelty of the data and the countries we study constitute a significant contribution to the literature.

The rest of the paper is organized as follows. In section 2 we set up a model theory to guide intuition about the expected effect of corruption and delays on bilateral trade. As regards corruption, the model is consistent with the "sand the wheels" view. Based on the model, we discuss our empirical strategy to investigate the effects of bribery and time delays on interstate roads on bilateral trade in West Africa in section 3. Section 4 presents the data we use, and section 5 our findings. We conclude in section 6.

2 Theory

This section builds a model of trade with delays and corruption during shipment. The model is Eaton and Kortum (2002) type and draws on Hummels and Schaur (2013) and Berman et al. (2013) to account for time delays during exports shipment. We depart from these papers by embedding strategic bribery into the framework. Road officials (customs, police, gendarmes, etc.) extend the waiting time of truck drivers who do not want to pay bribe. Therefore a rational decision entails a tradeoff between the financial cost of bribery

and the time cost of delays, including consumer or client "punishment" and goods spoilage. We derive necessary and sufficient conditions for corruption to take place and show that corruption may "sand the wheels" or "grease the wheels" under some specific conditions that we characterize.

2.1 The model

We consider a world economy with N countries trading with each other. A firm can potentially export from a home country to many other countries. Let d denote any destination country. We assume that local and imported goods in the destination country d are differentiated, and exporters are subject to monopolistic competition. Home countries that export goods to destination d are indexed by the total time s it takes for the goods to arrive. We are interested in what happens during inland cross-border transportation of goods in West Africa. As the data show in section 4, truck drivers are subject to many checkpoints, bribery, and time delays on interstate highways. So we posit that s is the sum of two components as in equation (1). The first component s_n is the normal shipping time, determined by geography, i.e. by the distance between the origin and destination countries as well as by the quality of the roads. The second component s_b captures the loss of time due to often redundant inspections, customs procedures, and corruption.

$$s = s_n + s_b \tag{1}$$

A representative consumer in country d chooses from the set of varieties $\mathcal{S}$, where $s = 0 \in \mathcal{S}$ corresponds to local good. The demand $x_{s,d}$ for each variety s in country d is derived by maximizing the consumer's utility of the Dixit-Stiglitz type below.

$$\begin{aligned} \max_{x_{s,d}} & \left(\int_{s \in \mathcal{S}} \lambda(s) (x_{s,d})^{\frac{\sigma-1}{\sigma}} \, ds \right)^{\frac{\sigma}{\sigma-1}} \\ & s.t. \int_{s \in \mathcal{S}} p_{s,d} x_{s,d} \, ds \leq P_d Y_d, \end{aligned} \tag{2}$$

where σ represents the elasticity of substitutability between varieties, $p_{s,d}$ the price set by the exporter of the variety s sold in destination d, P_d the aggregate price index in country d and Y_d the aggregate production in country d such that $P_d Y_d$ represents the income of the consumer in country d. $\lambda(s)$ is a function decreasing with respect to s that captures the valuation of delivery time by the consumer. So, the consumer prefers quicker delivery as in Hummels and Schaur (2013). The demand for variety s in destination country d is as

follows.[3]

$$x_{s,d} = Y_d \left(\frac{\lambda(s) P_d}{p_{s,d}} \right)^{\sigma} \tag{3}$$

In the home country s, we assume that labor is the only production factor as is often the case in international trade models (Melitz, 2003; Berman et al., 2013). Thus, an exporter shipping goods from country s to country d faces a demand $x_{s,d}$ from that country, and chooses his price $p_{s,d}$ to maximize the present value of profit $V_{s,d}(.)$.

In addition to inspections and delays, the exporter faces bribery threat on the road by corrupt road officials (customs, police, gendarmes, etc.). He can decide to comply or not. If he complies, he must pay an average bribe of τ per unit of good transported. In return, the road officials don't bother and $s_b = 0$. If he does not comply the road officials cause annoys and set s_b to the maximum possible. Thus, the shipping time has two possible values, low s_l and high s_h. Per unit bribery has also two possible values, 0 or τ. We assume that the exporter knows s_l, s_h and τ. Therefore we abstract from uncertainties. The exporter maximizes his profit by choosing price and road behaviour (corruption or not).

$$V_{s,d}(s_l, s_h, \tau) = max\{W_{s,d}(s_l, \tau), W_{s,d}(s_h, 0)\} \tag{4}$$

where

$$\begin{aligned} W_{s,d}(s, \tau) = & \max_{p_{s,d}} p_{s,d} x_{s,d} - \phi(s)(w + \tau) x_{s,d} \\ s.t. \qquad & x_{s,d} = Y_d \left(\frac{\lambda(s) P_d}{p_{s,d}} \right)^{\sigma}, \end{aligned} \tag{5}$$

w is the labor cost per unit of production and $\phi(s)$ is an iceberg cost increasing in the shipping time s. As in literature, $\phi(s) \geq 1$ so that for one unit of good ordered the exporter ships $\phi(s)$. The fraction $\phi(s) - 1$ of the goods is lost during the shipping. In our setting, this fraction increases with the delays.

Solving the exporter's profit maximization problem stated in equation (5), we obtain the following optimal price and export quantities.[4]

$$p_{s,d}(s, \tau) = \frac{\sigma}{\sigma - 1} (w + \tau) \phi(s) \tag{6}$$

[3]See appendix A.1 for details of derivations.
[4]See appendix A.2 for details of derivation.

$$x_{s,d}(s,\tau) = Y_d P_d^{\sigma} \left[\frac{(\sigma-1)}{\sigma(w+\tau)\phi(s)} \cdot \lambda(s) \right]^{\sigma} \tag{7}$$

2.2 Predictions of the model and discussions

The simple and tractable model we set above delivers interesting predictions about competitiveness and bilateral trade between partner countries.

Time delay, bribery, and competitiveness.– Trade competitiveness is the ability to sustainably supply quality goods at a lower price. Lack of competitiveness is often pointed out when it comes to the relatively low trade between African countries (Valensisi and Lisinge, 2013; United Nations, 2022). While analyses generally refer to low productivity of firms, our model shows in a tractable way that bribery and delays during shipping can also undermine the competitiveness of exporters. This is shown in equation (6). The price charged by an exporter is a markup over the marginal cost of the product, which includes not only the wage bill of production but also bribery and delay costs incurred during shipping. Therefore pervasive roadblocks, time delays and bribery on West African interstate highways can undermine competitiveness and reduce trade ultimately.

Time delay, bribery, and trade volume.– From our model, the equilibrium quantity on the export market is negatively related to bribes and delays during shipping (equation (7)). The negative effect of bribery is indirect and seeps in through the price charged by the exporter. It is a consequence of the competitiveness effect. Therefore, normal production cost (w) and delivery delays ($\phi(s)$) can also deter quantities by deteriorating competitiveness. This price effect depends on the elasticity of export demand. On the other hand, the equilibrium quantity is further negatively affected by the distaste of the consumer at the destination country for long shipping. That is because $\lambda(s)$ is decreasing in s. From equation (3), we notice that the consumer demand for a variety is negatively related to the time before delivery and positively related to the price ratio $P_d/p_{s,d}$.

Sanding or greasing the wheels.– Our model accommodates both the "sand the wheels" and the "grease the wheels" views of corruption. We show previously that corruption can negatively affect competitiveness and trade volume. We now show that corruption may also have a positive effect on the trade volume, in presence of inefficiencies like time delays. We have the following propositions.[5].

[5]See prove in appendix A.2

Proposition 1. The exporter complies with bribery if and only if $|\lambda'(s_l)| \cdot (s_h - s_l)/\lambda(s_h)$ and/or $\phi'(s_l) \cdot (s_h - s_l)/\phi(s_l)$ is higher than a certain threshold $\Gamma(w, \tau)$ that depends on wage w and per unit bribe τ.

Proposition 2. Corruption increases trade volume over non-corruption scenario if and only if $|\lambda'(s_l)| \cdot (s_h - s_l)/\lambda(s_h)$ and/or $\phi'(s_l) \cdot (s_h - s_l)/\phi(s_l)$ is higher than a certain threshold $\Xi(w, \tau)$ that depends on wage w and per unit bribery τ.

Propositions 1 and 2 establish that corruption "greases the wheels" if the good is by nature highly time-sensitive or consumers/clients very much dislike delays, and the delay reduction effect of corruption is high. Note however that efficiency improvement of corruption is of second order. If there were no time delays there would be no role for corruption.[6] Conversely, road officials can artificially set delays high ($s_h \to \infty$) to force exporters to comply with bribery.

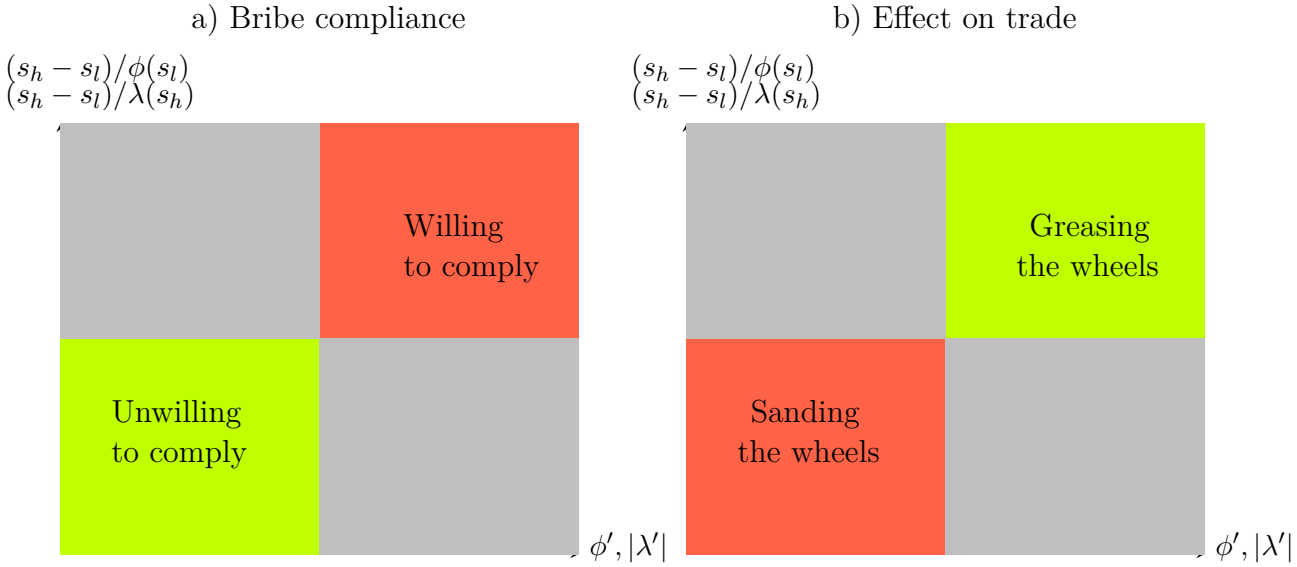

Figure 1: Exporters' willingness to comply with bribery and effect on trade

Notes.- The Figure depicts the exporter's willingness to comply with corruption in different conditions and the effect on trade. Panel a) shows that if the good is not time-sensitive and/or consumer doesn't hate late delivery and if paying bribe does not significantly speed up the process, then the exporter is not willing to pay bribe. In that case corruption would negatively affect trade. Panel b) shows on the other hand that if the good is highly time-sensitive and/or consumer hates very much late delivery and if paying bribe significantly speeds up the process, then the exporter is willing to pay bribe. In that case corruption would positively affect trade.

[6] In our theory model bribery is only a time buying game. There may be other motivations for bribery as discussed in de Jong and Bogmans (2011). For example traders may pay corrupted officials to falsely report a favorable nomenclature of products that benefits from tariffs exemption.

In sum, this theoretical framework suggests that long time delays and bribery on interstate highways can undermine competitiveness and hamper trade. Corruption could also improve trade. So the overall effect of bribery on trade is *a priori* indeterminate, depending on the competitiveness effect (which also depends on the price elasticity of exports) and the "grease the wheels" effect, if any. Next, we aim to quantify the effect, if any, of delays and bribery on West African interstate roads on bilateral trade. Our empirical strategy laid out in section 3 builds on the theoretical framework.

3 Empirical strategy

The main goal of this paper is to quantify from the data the effects, if any, of delays and bribery on West African interstate highways on bilateral trade between connected countries. In this section, we derive an empirical strategy to achieve this goal from the theoretical model we just presented. We start by taking the logarithm of equation (7):

$$\log(x_{s,d}) = \log(Y_d) + \sigma \log(P_d) + \sigma \log\left(\frac{\lambda(s)}{\phi(s)}\right) - \sigma \log(w+\tau) + \sigma \log\left(\frac{\sigma-1}{\sigma}\right) \tag{8}$$

Taking into account equation (1), we now expand equation (8) to the form of a standard gravity equation. We additionally include country and time-fixed effects. Thus, our estimation equation is as follows.

$$\begin{aligned}\log(X_{ijtk}) = &\mu_{jn} + \eta_t + \alpha_1 \log(Y_{jt}) + \alpha_2 \log(\frac{P_{it}}{P_{jt}}) + \gamma_1 \log(Dist_{ij}) + \gamma_2 \log(s_{b,ijt}) + \\ &\theta \log(NbCtrl_{ijt}) + \lambda \log(\tau_{ijt}) + \beta_1 Z_{1,it} + \beta_2 Z_{2,jt} + \epsilon_{ijtk},\end{aligned} \tag{9}$$

where subscripts i, j,t, and k stand respectively for origin country, destination country, year, and product. X is aggregate export, Y is GDP, and P is the price index. μ and η are country- and year-fixed effects. $Dist$ is the distance between origin and destination countries, used to approximate the *normal* shipping time s_n between the two places, $NbCtrl$ the number of control points on the road between places i and j, and ϵ an error term. Finally, Z is a vector of possible additional control variables.

We consider two levels of trade data aggregation: – when k represents a specific product, the equation corresponds to product-level estimation. – When you aggregate across all products, k is omitted, and $W_{ijt} = \sum_k W_{ijtk}$.

Endogeneity and identification.– Our coefficients of interest are γ_2, θ and λ. They capture respectively the effect of delays, the number of controls, and bribes on the roads. Those are arguably exogenous since they result mostly from administration organization, governance and culture, and from lack of infrastructure and adequate technology (Ocean Shipping Consultants, Ltd., 2008; Djankov et al., 2010; Barka, 2012; Montagnat-Rentier and Parent, 2012; The World Economic Forum and The Global Alliance for Trade Facilitation, 2016). One can still worry about the risk of reversal causality: more bilateral trade implies more traffic on the roads, which in turn can lead to more controls, delays and bribes. However, that is unlikely because traffic is not that busy on those interstate roads. de Jong and Bogmans (2011) systematically tested the endogeneity of bribes in relationship with trade and found that bribery is exogenous. In addition they tried a number of candidate instrumental variables – the percentage of the population belonging to a certain religion , the origin of law , the population density, the country's area in square kilometres, and ethnic fractionalization – and refuted them all based on statistical tests.

To avoid another risk of endogeneity from omitted variables bias we consider in Z control variables that the existing literature considers as important for trade: common language, contiguity, tariffs, and being a member of an economic union. All the countries in our data except Ghana are French-speaking and members of the West African Economic and Monetary Union (WAEMU), and all the pairs share a common border. WAEMU countries don't apply tariffs among themselves but had common tariffs toward other countries since 2001. Thus, these control variables are all perfectly correlated in our sample. Then we just use one: a common language. Besides, we include a fixed effect of time and country or corridor. These capture the effect of any omitted variable specific to countries and corridors. Finally, the estimation errors in our regressions are robust to heteroskedasticity, and clustered either by corridor or reporter country.

4 Data

Our empirical analysis uses data from various sources, including i) the road governance reports that emcompass the Improved Road-Transport Governance (IRTG), the Agribusiness and Trade Promotion (ATP) and the Expanded Agribusiness and Trade Promotion (EATP)reports; ii) Trade Map from the International Trade Centre (ITC); iii) the World Development Indicators (WDI) from the World Bank; and iv) GeoDist from The CEPII.

4.1 Data sources

IRTG data.– We rely on the Improved Road-Transport Governance (IRTG) reports to construct a novel data set that measures trade-related roadblocks, delays, and bribes on interstate highways in Western Africa. IRTG is an initiative jointly set up by the Economic Community of West African States (ECOWAS) and the West African Economic and Monetary Union (WAEMU), on interstate roads, with the financial support of the U.S. Agency for International Development (USAID) through its West Africa Trade Hub/Accra (WATH/A), and of the Sub-Saharan African Transport Program financed principally by the World Bank. Its goal is to quantify the number of roadblocks on a given corridor, corridors with the highest number of barriers, total bribes paid, and length of delays at those roadblocks, and to know who is responsible. To this end, survey data were collected on a quarterly basis from October 2006 until June 2013.[7] Trained IRTG agents distribute data-collection sheets to drivers in ports (or inland ports). They choose only drivers with trucks in good condition (according to legal standards) and with paperwork in order. Their counterparts at the other end of the corridor collect the completed data-collection sheets from drivers completing their journeys. If the agents judge the data reliable, they computerize it and send it to the Information Technology Department of the WAEMU Commission for analysis. Thus, the survey approach is robust and tried to avoid gross measurement errors. We collect the data from the annexes of individual IRTG reports from the first to the 24th accessed on the Borderless Alliance site web [8]. The data covers eight corridors linking eight countries. Table 1 and Figure **??** present the roads. Overall, the data is an unbalanced panel at corridor and country levels.

ATP/EATP data.– The Agribusiness and Trade Promotion (ATP) and the Expanded Agribusiness and Trade Promotion (EATP) projects are supported by USAID and aim to increase the value and volume of intra-regional agricultural trade. They target six value chains (maize, onions/shallots, livestock/meat, millet/sorghum, rice, and poultry) along the transport corridors linking production zones to consumer markets in West Africa. The ATP/EATP project collects the same data as the IRTG (roadblocks, delays, and bribes). However, there are some specificities related to the trucks and cargo that are useful for the purpose of this paper. On the one hand, trucks monitored by IRTG transport all sorts of cargo and are all roadworthy. On the other hand, trucks monitored by ATP/EATP carry specific products, perishable goods most of the time and corresponding to specific

[7] Maybe the IRTG project expands beyond June 2013. But the last report we are able to get is the 24th on that date.

[8] https://borderlesswa.com/publications/, under "Road Governance Reports". Accessed on April 15, 2023.

Table 1: IRTG corridors

# corridor	**Corridor name**	**Partner 1**	**Partner 2**	**Length of corridors in Km**
1	Abidjan-Bamako	Côte d'Ivoire	Mali	1174
2	Ougadougou-Abidjan	Burkina-Faso	Côte d'Ivoire	1263
3	Bamako-Dakar	Mali	Senegal	1365
4	Ougadougou-Bamako via Heremakono	Burkina-Faso	Mali	934
5	Ougadougou-Bamako via Koury	Burkina-Faso	Mali	1035
6	Cotonou-Niamey	Benin	Niger	1041
7	Ougadougou-Lomé	Burkina-Faso	Togo	1020
8	Ougadougou-Tema	Burkina-Faso	Ghana	992

Figure 2: IRTG road map. Source: 22^{nd} Road governance report.

value chains followed by the project. In addition, the ATP/EATP trucks may not be all roadworthy and cargo may not have been covered by proper documentation.

The IRTG and the ATP/EATP data improves on every previous data in our knowledge used to assess the impact of corruption and delays on trade. Indeed most studies rely on general perception of corruption (e.g. Méon and Weill (2010); Aidt, Dutta, and Sena

Table 2: ATP/EATP corridors

Product	Corridor name	Partner 1	Partner 2	Corridor length (Km)
Onion/shallots	Kantchari - Accra	Burkina-Faso	Ghana	1316
Livestock/Meat	Fada N'Gourma - Parakou	Burkina-Faso	Benin	469
Maize	Techiman - Kantchari	Ghana	Burkina-Faso	976
Rice	Bobo-Dioulasso - Koutiala	Burkina-Faso	Mali	273
Millet/Sorghum	Koutiala - Dakar	Mali	Senegal	1865

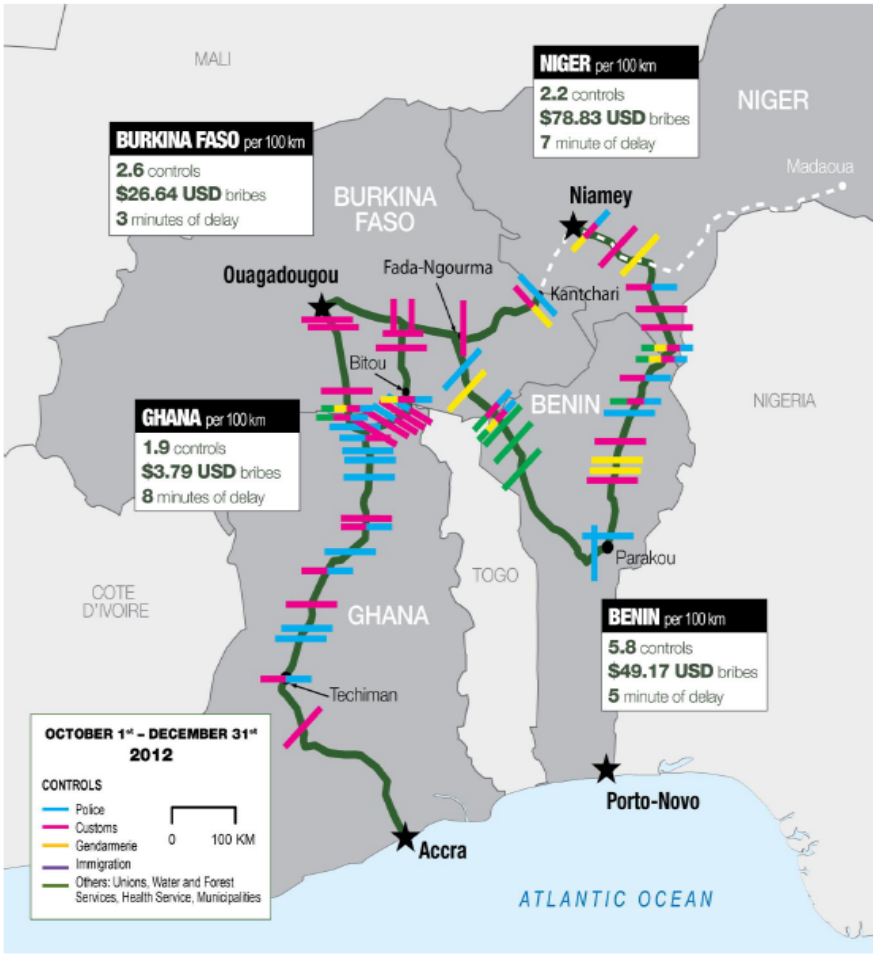

Figure 3: ATP/EATP road map. Source: 22^{nd} Road governance report.

(2008); Méon and Sekkat (2005)). A limitation of perception indexes is that they measure people's general feeling as opposed to experience and facts. de Jong and Bogmans (2011) and Kaufmann and Wei (2000) used surveys data that captures firms' experience. However the WBES is based on self-declaration of past experience. Known weaknesses of this type of data include inaccuracies due to memory failure and false declarations motivated by self

image. ATP/EATP data on the contrary reports in writing and in real time a direct measure of the drivers during the road transportation. Therefore it is trade-related and arguably as accurate as possible.

Trade Map and WDI data.– The Trade Map and the WDI data sets are well-known and widely used. We draw bilateral and total trade data (imports and exports) from the Trade Map, while aggregate variables like GDP, inflation rate, and population are provided by the WDI. These are at an annual frequency.

GeoDist.– Finally, we get data on the distance between countries from the GoeDist database of the CEPII. [9]

4.2 Summary statistics

Roadblocks, delays, and bribes on the roads.– According to the IRTG data, roadblocks, delays and bribes are pervasive on West African interstate roads or corridors. The average number of controls a goods truck undergoes between 2006 and 2013 ranges from 12.5 on the Cotonou-Niamey corridor to 26.25 on the Ouagadougou-Bamako via Hermakono corridor. This amounts to two to three controls every hundred kilometers on most of the roads (Figure 4).

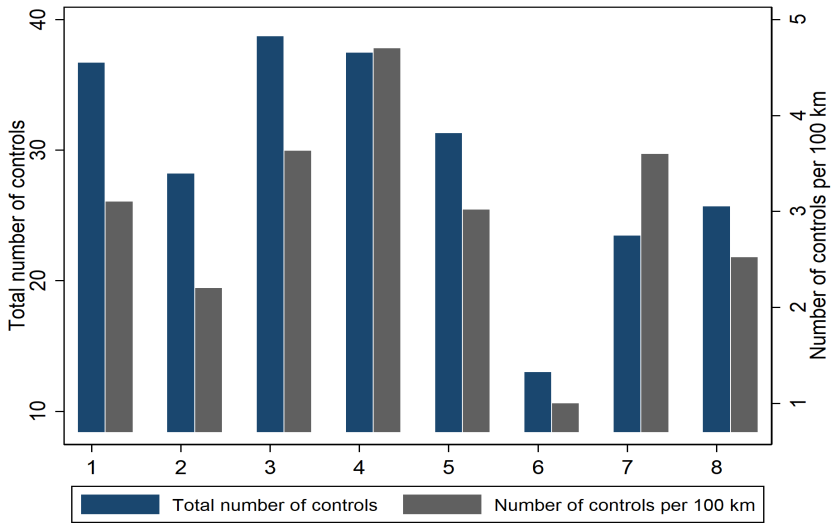

Figure 4: Average total control on West African interstate roads between 2006 and 2013
Note: On the horizontal axis are the corridors' number as assigned in Table 1.

[9] http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=6

Of course, these multiple and often redundant controls generate delays during the transportation of goods. The average total related delay in the same period varies from 114 minutes on the Cotonou-Niamey corridor to 321 minutes on the Bamako-Dakar corridor. Put differently, trucks get delayed 11 to 32 minutes every hundred kilometers (Figure 5). If the average speed of trucks on the roads is 70 km/h, the delays are equivalent to the connected countries being distanced from each other by some 133 to 374 more kilometers.

Controls and delays are also opportunities for corrupt uniformed officers to collect bribes. We showed in the theoretical model that there is a rationale for exporters to comply with bribery under some conditions that we discussed in section 2. IRTG data provide a measurement of unlawful payments on the roads. To rule out legal penalties, the surveys selected only truck drivers who had their papers in order and whose trucks were in good condition. The data show, as in Figure 5, that bribes on the road can reach significant amounts. The average bribe per trip between 2006 and 2013 is about 20 thousand Francs CFA ($US 45) on the Cotonou-Niamey, Ouagadougou-Lomé, and Ouagadougou-Tema corridors. That is about 5% of the average yearly GDP per capita in the eight countries in the same period, or 70% of the monthly minimum wage in Togo in 2018. On the five remaining corridors, the average bribe per trip over the period ranges between 40 thousand Francs CFA ($US 90) and 52 thousand Francs CFA ($US 115). Put differently, these bribe figures represent 10 to 13 percent of the average yearly GDP per capita in the eight countries in the same period, or 1.4 to 1.8 times the monthly minimum wage in Togo in 2018.

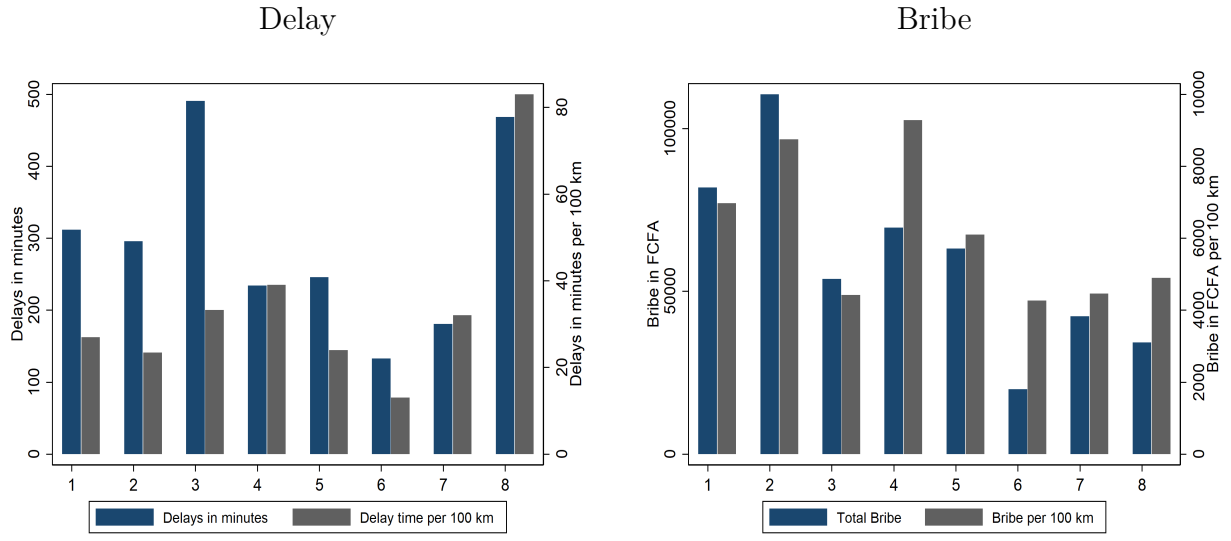

Figure 5: Average total delay and bribe on West African interstate roads in 2006-2013

Notes.- Bribe is presented in Franc CFA, the local currency of the countries, except Ghana whose currency is the Cedi. Based on the IRGT reports, we use the exchange rates $US 1 = 450 FCFA, and $US 1 = 1.24 Cedi. Source: IRTG reports and the authors' calculations.

Figures 6 and 7 decompose the controls, delays, and bribes by country. They show that controls are most pervasive in Côte d'Ivoire, Ghana, Mali, Senegal, and Togo. Delays are the longest in these countries, except Togo. The amount of bribes is by far the most important in Côte d'Ivoire, followed by Mali and Senegal.

In Figure 8, we show the proportions of controls and bribes by uniformed service. It appears that customs are responsible for 34% ? of controls and 33% of bribes. They are followed by the police service for 31% of controls and 26% of bribes. The remaining is accounted for by the gendarmerie (21% of controls and 19% bribes) and other undefined services.

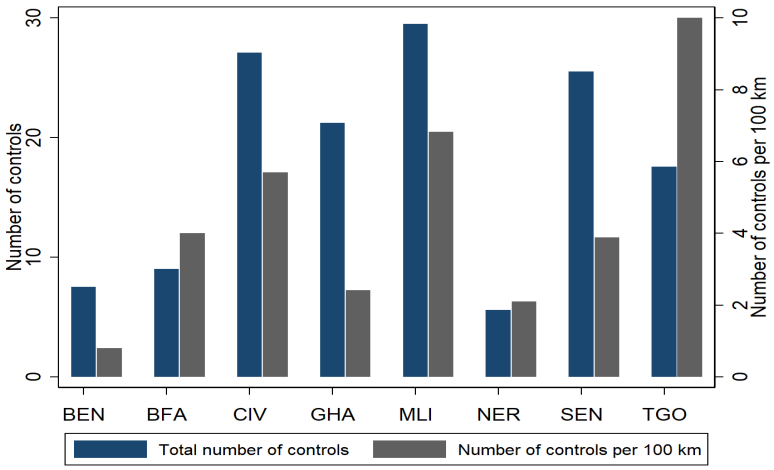

Figure 6: Average total control on West African interstate roads between 2006 and 2013

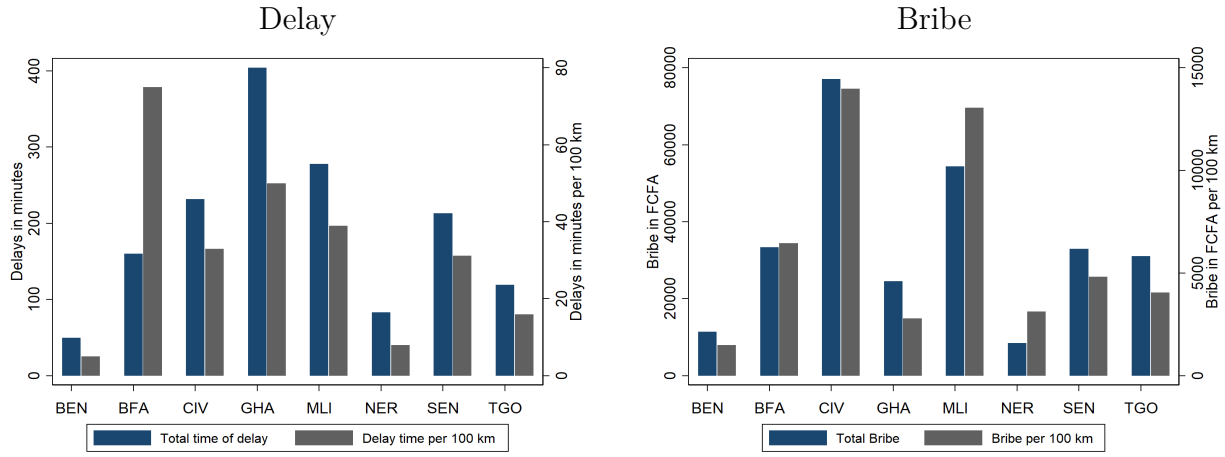

Figure 7: Average total delay and bribe on West African interstate roads between 2006 and 2013 by country

The evolution of trends over time did not show significant improvements either. In Figure

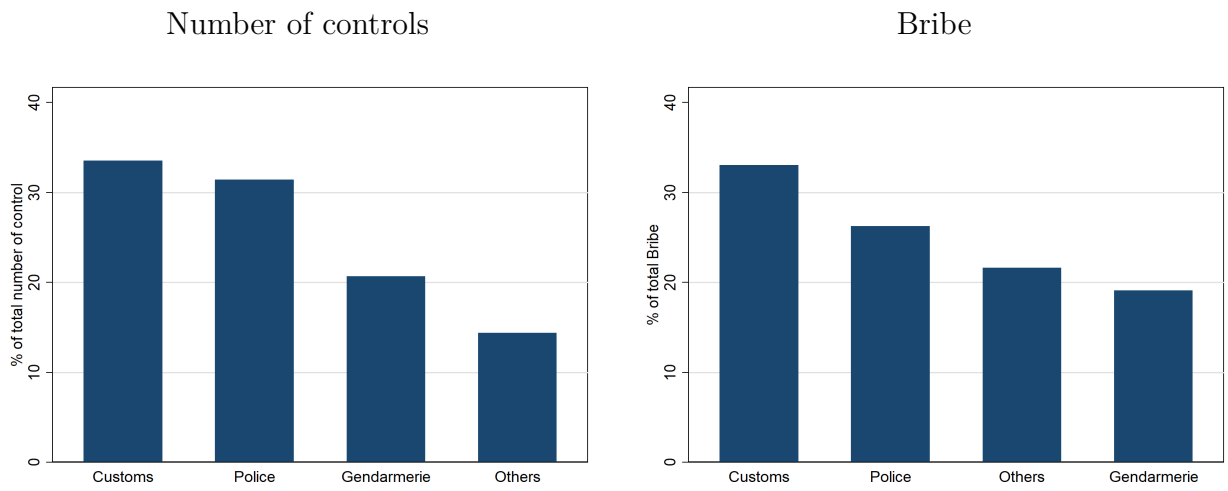

Figure 8: Average total delay and bribe on West African interstate roads between 2006 and 2013 by uniformed service

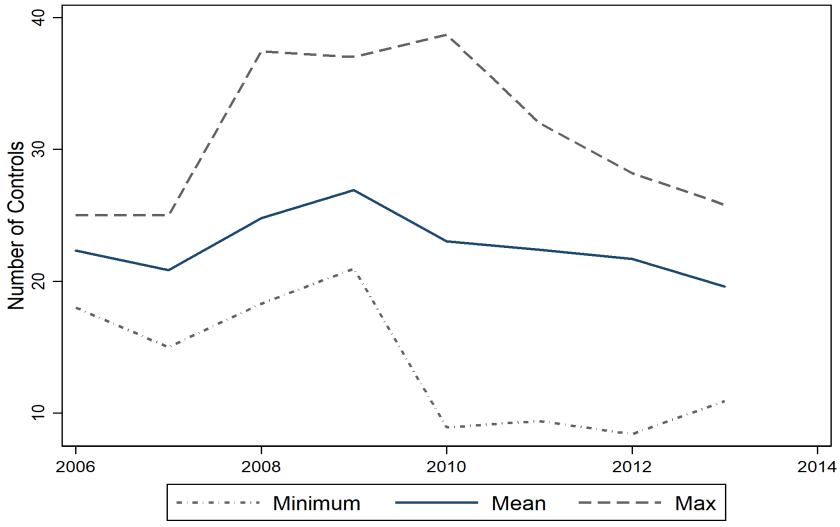

Figure 9: Evolution of the number of controls on West African interstate roads in 2006-2013

9, the number of controls has increased on the roads from 24 to 27 between 2006 and 2009. From 2010 we observe a decrease, but the average number of controls is only a little lower in 2013 than it was in 2006. On the other hand, delays and bribes increased between 2008 and 2011 before they decreased to the levels they were in 2006 (Figure 10).

Road experience in IRTG versus ATP/EATP.– The data collection designs of IRTG and ATP/EATP provide a quasi-experiment setup to test our theory. As previously described, products followed under ATP/EATP are likely more time-sensitive compared to those followed under IRTG. If Propositions 1 and 2 are correct, one can expect drivers in ATP/EATP panel

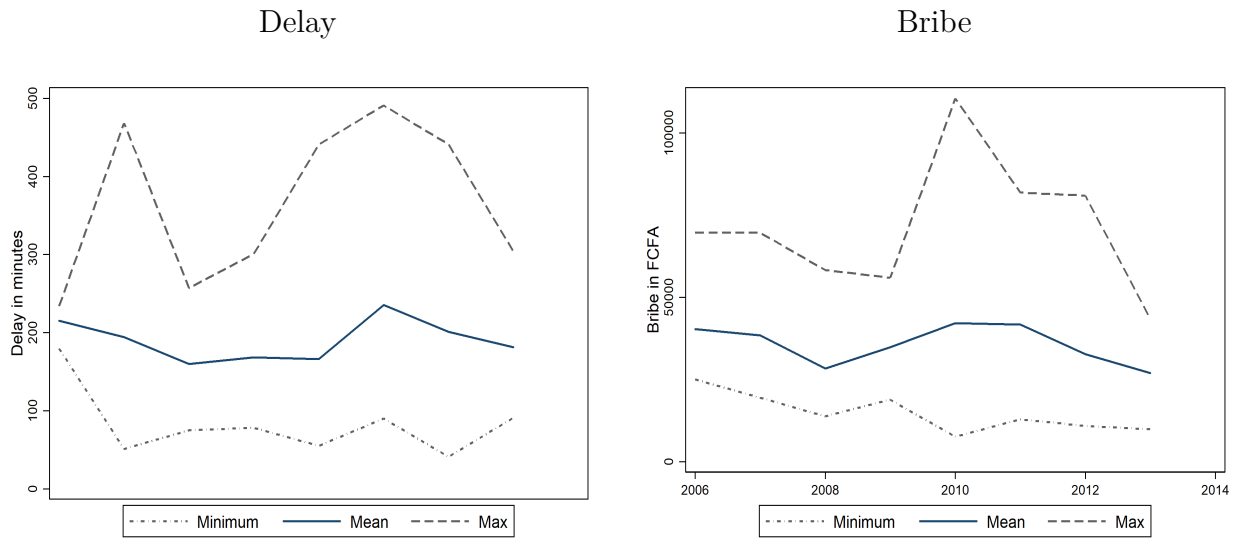

Figure 10: Evolution of delay and bribe on West African interstate roads in 2006-2013

to pay higher bribes compared to drivers in IRTG panel. Which is confirmed in the data (Figure 11). ATP/EATP drivers undergo 15 controls and pay CFA 72,333 bribe per 100 Km against 11 and CFA 14,583 respectively for IRTG drivers. In addition, the delays of ATP/EATP drivers are shorter on average compared to those of IRTG drivers. This suggests that bribes indeed help reduce time delays and that exporters tend to submit more to corruption when the goods are time-sensitive, as predicted by our theory.

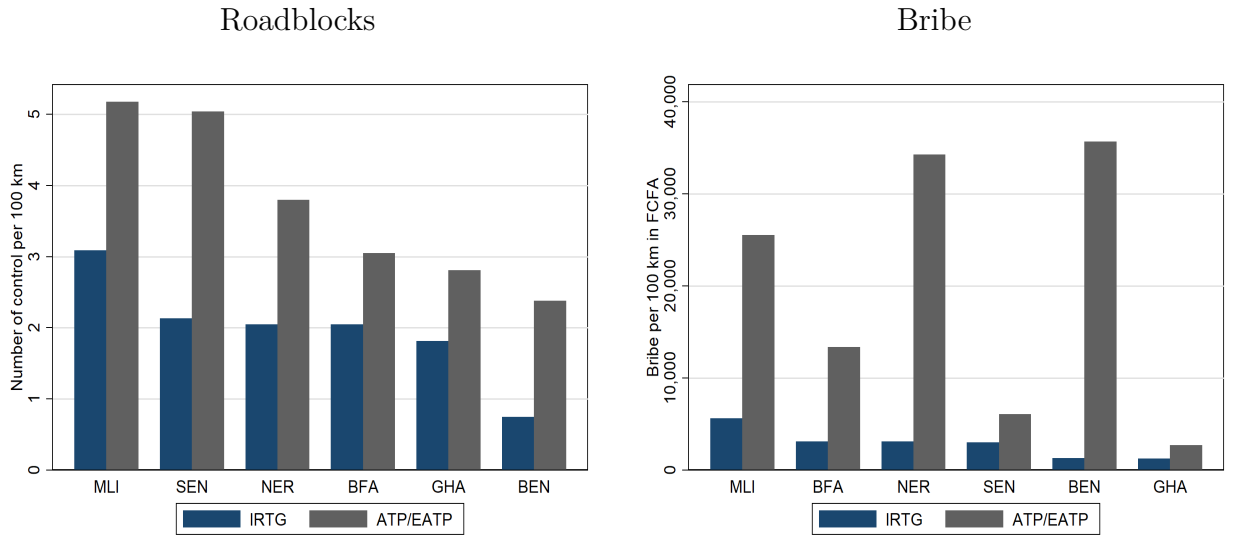

Figure 11: Roadblocks and bribes in IRTG and ATP/EATP panels

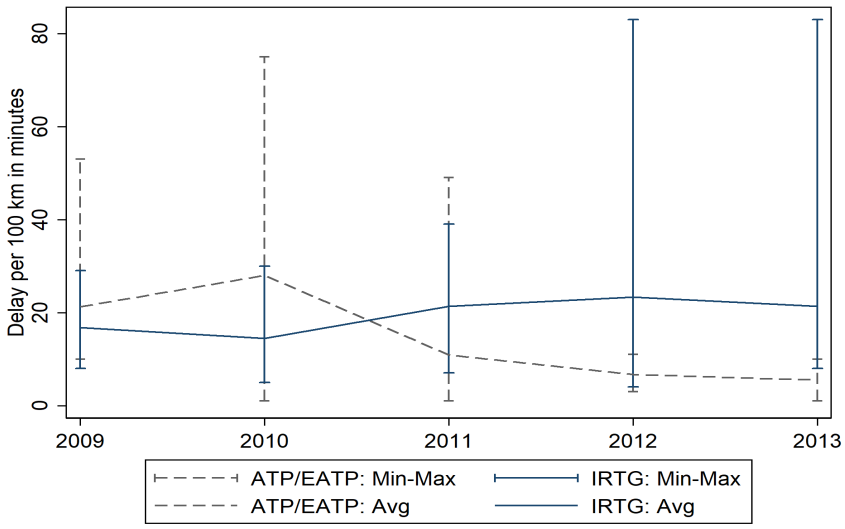

Figure 12: Delays in IRTG and ATP/EATP panels

Trade.– In our empirical analysis, we estimate the effect of controls, delays, and bribes on the West African interstate roads on bilateral trade between the connected countries. We provide here some summary statistics about bilateral trade. We measure the volume of trade for each country as the half sum of imports and exports with the rest of the world; and we define bilateral trade as the half sum of imports and exports between pairs of countries connected by the corridors (see Table 1). While the overall trade and the the average share of bilateral trade flow in the countries' total trade with the rest of the world have been on an increasing trend during the period 2006-2013, bilateral trade between the countries remains relatively low as shown in Table 3. The pairs of countries that trade most are Mali and Senegal (8.5%), Burkina Faso and Côte d'Ivoire (6.2%), and Côte d'Ivoire and Mali (4.08%). The share of bilateral trade between Benin and Niger is less than 1%.

Table 3: Bilateral trade share between 2006 and 2013

Partner 1	**Partner 2**	**Bilateral trade share in %**	
		Mean	**SD**
Côte d'Ivoire	Mali	4.08	2.72
Burkina-Faso	Côte d'Ivoire	6.20	4.90
Mali	Senegal	8.50	3.75
Burkina-Faso	Mali	1.28	0.65
Benin	Niger	0.95	0.81
Burkina-Faso	Togo	3.22	0.57
Burkina-Faso	Ghana	2.36	1.49

Trade composition and time-sensitivity.– In terms of composition, cross-border trade between the countries is dominated by minerals, which account for an average of 47% in 2007-13, followed by vegetables and animals (13%). Chemicals, prepared food and other manufactured goods make up respectively 12%, 9% and 9%. The right panel of Figure 13 shows the time-sensitivity of non-mineral products. We classified the goods into three categories: highly time-sensitive, time-sensitive and non time-sensitive. Highly time-sensitive products include for example raw vegetables and animals that can quickly perish or are difficult to maintain in good conditions during transportation. On the other hand, non time-sensitive product include for example metal or wood articles that don't perish in a short period of time. Time-sensitive products are in-between the two extremes (e.g. prepared foods and chemicals). Thus, highly time-sensitive products account for about 22% of non-mineral trade while time-sensitive and non time-sensitive goods account for about 39% each.

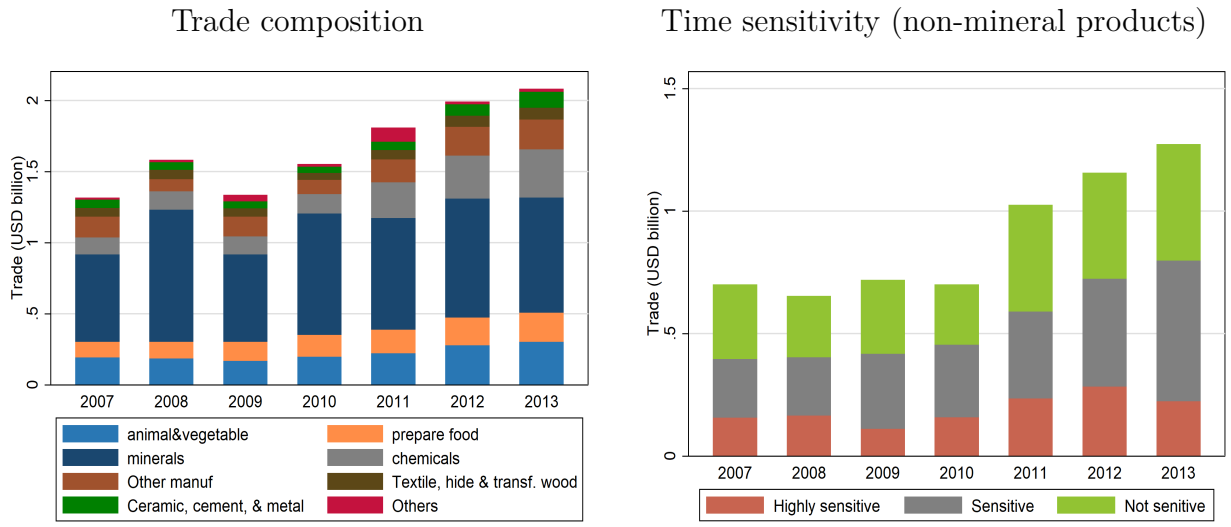

Figure 13: Trade composition and time sensitivity

We next estimate econometric equations to assess whether controls, delays, and bribes observed on the roads contribute to lower bilateral trade between the countries.

5 Estimations

The aim of this section is to quantify the effects of time delays and bribes on bilateral trade in West Africa. For this purpose, we run different sets of estimations. We find that, along the corridors, the delays on the interstate highways negatively and significantly affect the trade and the bribes appear to increase the trade while the number of controls have a positive but not significant impact on the trade. The finding is robust to different specifications and

regressions.

5.1 Impact of bribe and delay on West Africa Intra Trade

To assess the effects of roadblocks, delays, and bribes on trade across the eight West African countries in our data, we rely on the estimation of two sets of panel equations. The first assesses the effects of roadblocks, bribes, and delays along the corridors, and the second, those effects on each end of the corridors.

Effects of roadblocks, delays and bribes on bilateral trade along corridors.– The panel equation estimated to assess the impact of inefficient and unlawful practices along the corridors is the following:

$$\begin{aligned}\log(X_{ijtk}) = &\mu_{ijk} + \eta_t + \alpha_1 \log(Y_{jt}) + \alpha_2 \log(Y_{it}) + \varphi \log(\frac{P_{it}}{P_{jt}}) + \gamma_1 \log(Dist_{ij}) \\ &+ \gamma_2 \log(s_{b,ijt}) + \theta \log(NbCtrl_{ijt}) + \lambda \log(\tau_{ijt}) + \beta_1 Z_{1,it} + \beta_2 Z_{2,jt} + \epsilon_{ijtk},\end{aligned} \tag{10}$$

where X_{ijtk} is the average of imports and exports of product k across the pairs of countries that connect each corridor. Our variables of interest $\log(s_{b,ijt})$, $\log(NbCtrl_{ijt})$, and $log(\tau_{ijt})$ are the log of time delays, number of controls, and bribes along the interstate highways corridors in eight West African countries. We consider the first difference of all variables with a trend, including the dependent variable.

Table 4 displays the estimated parameters of interest of the equation 10. In the regression reported in Column (1), the dependent variable is (the log variation of) the average total trade along the corridors whereas in column (2) we consider the average product-level trade along the corridors and include additionally the interaction terms between the road practices and time-sensitivity of the products.

The results in column (1) show that the effect of delays on trade is negative and statistically significant whereas that of bribes is positive and statistically significant as well. More specifically, a 1% increase in delays implies 1.2 percentage points drop in trade while 1% increase of bribes implies a 0.8 percentage points increase in trade. Quite consistent with our theory, column (2) results show that these results are mostly driven by highly time-sensitive products. Indeed, the interaction terms of time-sensitivity and delays and bribes have the signs and statistical significance previously described for highly time-sensitive products but not for moderately time-sensitive ones compared to non time-sensitive products. The effect of the number controls is not statistically significant in these regressions. These results suggest that the evidence corroborates the *"grease the wheels"* hypothesis. Exporters

tend to pay bribes to reduce the road harassment thereby reducing the negative effects of delays.

Table 4: Regression on Trade flows along corridors

	(1)	(2)
Log Delay per 100km Corr	-1.226^{***}	-0.298
HS X Delay		-1.159^{**}
MS X Delay		0.153
Log Bribe per 100 km Corr	0.804^{**}	0.051
HS X Bribe		0.910^{*}
MS X Bribe		0.010
Log Nb control per 100 km Corr	0.023	-0.012
HS X Control		-0.445
MS X Control		-0.171
D.Log GDP O	6.223^{***}	2.775^{*}
D.Log GDP D	4.315^{**}	-1.333
Inflation Diff	0.003	0.076
Observations	34	3267
Number of Groups	8	769
Number of Cluster	8	8
R-sq	0.600	0.040

Note: *** p<0.01, ** p<0.05, * p<0.10. Dependant variable: Log Trade flows along corridors. The full estimates of these equations are reported in Table **??** in the appendix. In parenthesis are the robust and clustered standard deviations.

Effects of roadblocks, delays and bribes on exports and imports.– Our data provides a breakdown of the road practices by country along the corridors. Leveraging this detail information, we now analyze the effects of roadblocks, delays and bribes on exports and imports separately. To this end, we estimate the following equation.

$$\begin{aligned}\log(X_{ijtk}) = {} & \mu_{ik} + \eta_t + \alpha_1 \log(Y_{jt}) + \varphi \log(\frac{P_{it}}{P_{jt}}) + \gamma_1 \log(Dist_{ij}) + \gamma_2 \log(s_{b,ijt}) \\ & + \gamma_3 \log(s_{b,jit}) + \theta_1 \log(NbCtrl_{it}) + \theta_2 \log(NbCtrl_{jt}) + \lambda_1 \log(\tau_{ijt}) \\ & + \lambda_2 \log(\tau_{jit}) + \beta_1 Z_{1,it} + \beta_2 Z_{2,jt} + \epsilon_{ijtk},\end{aligned} \tag{11}$$

Where the $\log(X_{ijtk})$ is the log of the exports (or the imports) of product k of origin country i of each corridor

The results of the estimates of our variables of interest when the dependent variable is the exports are reported in Table 5. As previously, the dependent variable in the regression in Column (1) is (the log variation of) the average total exports while the dependent variable in the regression of Column (2) is (the log variation of) the product-level exports. In column (2) we include additionally the interaction terms between the road practices and the time sensitivity of the products.

In the regression reported in column (1), only the coefficient of delays in the origin country is statistically significant. More specifically, delay in the origin country negatively affects export growth. In the regression in column (2), this coefficient is no longer statistically significant but its interaction with time-sensitivity is for highly time-sensitive products. In addition, the effect of bribes on exports in this regression is negative. But the interaction effect between bribes and high time-sensitivity is positive and statistically significant. The overall effect of bribes on export of highly time-sensitive products is positive. Finally, this regression suggest that the effect of delays in the destination country on exports is also negative and statistically significant.

We repeat the same analysis for imports and the result is reported in Table 6. The results suggest that bribes in origin and destination countries negatively affect import growth, especially for time-sensitive products.

5.2 Robustness analysis

In the previous analysis, we normalized our variables of interest - roadblocks, delays, and bribes - per 100 kilometers. While the normalization allows comparison across corridors with different lengths, it may not reflect appropriately the impacts on trade. Indeed, what matters most for trade: is how often exporters/importers are stopped and how much time and money they pay on a regular frequency or the cumulative experience, i.e the total number of controls and the total amount of time and money it costs to transit on the entire corridor road?

As a robustness analysis, we consider alternative regressions where our variables of interest are the total values instead of those normalized per 100 km. More precisely, we estimate the equations 10 and 11 with $NbCtrl$, s_b, and τ being respectively the total number of controls, the total time delays, and the total amount of bribes either along the corridor or in each countryside of the corridors.

Along the corridors, the estimated parameters of our variables of interest are roughly consistent with those obtained in the main regressions, with some differences in the magnitude of the effects (see Table 7). Time delays negatively and statistically significantly affect

Table 5: Exports regressions

	(1)	(2)
Log Delay per 100km O	−1.188***	0.220
HS X Delay O		−0.054
HS X Delay O MS X Delay O		0.293
Log Delay per 100km D	0.280	0.078
HS X Delay D		−0.610*
MS X Delay D		−0.401
Log Bribe per 100 km O	0.260	−0.304
HS X Bribe O		0.090
MS X Bribe O		−0.282*
Log Bribe per 100 km D	0.095	−0.338**
HS X Bribe D		0.563**
MS X Bribe D		0.282
Log Nb control per 100 km O	−0.000	0.007
HS X Control O		−0.457
MS X Control O		−0.050
Log Nb control per 100 km D	1.122	0.357
HS X Control D		0.313
MS X Control D		−0.057
D.Log GDP D	−1.735	−2.575
Inflation Diff	−0.052	−0.026
Observations	66	6342
Number of Groups	14	1346
Number of Cluster	6	6
R-sq	0.388	0.031

Note: *** p<0.01, ** p<0.05, * p<0.10. Dependant variable: Log Trade flows from the country to abroad. In parenthesis are the robust and clustered standard deviations.

trade while bribes positively impact trade, even more so for highly time-sensitive products. However, the negative effect of delays is smaller while the positive effect of bribes for highly time-sensitive products is bigger.

The results of our estimations are also broadly consistent with the main regressions when we separate the effects of roadblocks, delays, and bribes in each countryside of corridors. The results of export regressions in Table 8 show that time delays in the origin country affect negatively and statistically significantly export growth as also does delay in the destination

Table 6: Imports regressions

	(1)	(2)
Log Delay per 100km O	0.280	0.078
HS X Delay O		−0.610
MS X Delay O		−0.401
Log Delay per 100km D	−1.188	0.220
HS X Delay D		−0.054
MS X Delay D		0.293
Log Bribe per 100 km O	0.095	−0.338*
HS X Bribe O		0.563
MS X Bribe O		0.282
Log Bribe per 100 km D	0.260	−0.304
HS X Bribe D		0.090
MS X Bribe D		−0.282**
Log Nb control per 100 km O	1.122	0.357
HS X Control O		0.313
MS X Control O		−0.057
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D.Log GDP O	−1.735	−2.575
Inflation Diff	0.052	0.026
Observations	66	6342
Number of Groups	14	1346
Number of Cluster	6	6
R-sq	0.388	0.031

Note: *** p<0.01, ** p<0.05, * p<0.10. Dependant variable: Log Trade flows from the country to abroad. In parenthesis are the robust and clustered standard deviations.

country for highly time-sensitive products. The results also align with the previous results in showing that the effect of bribes in the destination country on export growth is negative and statistically significant, but is mitigated for highly time-sensitive products by a positive and statistically significant effect of the interaction between bribes and time-sensitivity. Finally, the results of import regressions reported in Table 9 are slightly different from the baseline regressions. In the regression without the interaction effects, only the negative effect of delay in the destination country is statistically significant. When we consider the interaction

Table 7: Regression on Trade flows along corridors for alternative specification

	(1)	(2)
Log Delay Corr	−0.872*	−0.013
HS X Delay		−1.141**
MS X Delay		0.269
Log Bribe Corr	0.461	−0.119
HS X Bribe		1.067**
MS X Bribe		0.427
Log Nb control Corr	0.149	0.926*
HS X Control		−0.515
MS X Control		−1.027
D.Log GDP O	5.679***	2.553
D.Log GDP D	4.544	−1.614
Inflation Diff	−0.013	0.056
Observations	34	3267
Number of Groups	8	769
Number of Cluster	8	8
R-sq	0.551	0.042

Note: *** p<0.01, ** p<0.05, * p<0.10. Dependant variable: Log Trade flows along corridors. In parenthesis are the robust and clustered standard deviations.

effects, the estimates suggest that the effect of delays in the origin country is also statistically significantly lower for highly time-sensitive products compared to non-time-sensitive ones. This regression suggests also that bribes in the origin country negatively and statistically significantly affect import growth.

6 Conclusion

In this paper we rely on the Improved Road-Transport Governance reports, the Agribusiness and Trade Promotion (ATP) and the Expanded Agribusiness and Trade Promotion (EATP) reports to construct a novel panel data set that measures roadblocks, time delays, and bribes on eight interstate roads in Western Africa between 2006 and 2013 to investigate their effects on bilateral trade in the region. These interstate roads connect three landlocked countries – Burkina Faso, Niger, and Mali – to other coastal countries. We document that roadblocks, delays, and bribes are pervasive on the roads. Our empirical findings show that the delays seriously impede bilateral trade between the connected countries while the

Table 8: Exports regressions for alternative specification

	(1)	(2)
Log Delay O	−1.118***	0.268
HS X Delay O		−0.079
MS X Delay O		0.325
Log Delay D	0.264	0.121
HS X Delay D		−0.559**
MS X Delay D		−0.458
Log Bribe O	0.318	−0.360
HS X Bribe O		0.324
MS X Bribe O		−0.121
Log Bribe D	−0.160	−0.688***
HS X Bribe D		0.511**
MS X Bribe D		0.170
Log Nb control O	0.004	0.478**
HS X Control O		−0.969*
MS X Control O		−0.602
Log Nb control D	2.557*	1.522***
HS X Control D		0.531
MS X Control D		0.268
D.Log GDP D	−2.602	−3.310
Inflation Diff	−0.052	−0.034**
Observations	66	6342
Number of Groups	14	1346
Number of Cluster	6	6
R-sq	0.448	0.048

Note: *** p<0.01, ** p<0.05, * p<0.10. Dependant variable: Log Trade flows from the country to abroad. In parenthesis are the robust and clustered standard deviations.

effect of corruption is mostly positive. That is in line with the *"grease the wheels"* theory of corruption and should not be seen as a good thing because people's willingness to pay bribes is motivated by their desire to relax the constraints imposed by roadblocks and delays. We developed a theory consistent with the empirical evidence and derived analytically the conditions where bribery takes place and when it *"greases"* or *"sands"* the wheels of trade. It is advisable that the interested countries improve the practices on the roads to move out the bad equilibrium and help trade integration and development.

Table 9: Imports regressions for alternative specification

	(1)	(2)
Log Delay O	0.264	0.121*
HS X Delay O		−0.559*
MS X Delay O		−0.458
Log Delay D	−1.118*	0.268
HS X Delay D		−0.079
MS X Delay D		0.325
Log Bribe O	−0.160	−0.688**
HS X Bribe O		0.511
MS X Bribe O		0.170
Log Bribe D	0.318	−0.360
HS X Bribe D		0.324
MS X Bribe D		−0.121
Log Nb control O	2.557	1.522**
HS X Control O		0.531
MS X Control O		0.268
Log Nb control D	0.004	0.478**
HS X Control D		−0.969
MS X Control D		−0.602
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Note: *** p<0.01, ** p<0.05, * p<0.10. Dependant variable: Log Trade flows from the country to abroad. In parenthesis are the robust and clustered standard deviations.

References

Aidt, T., J. Dutta, and V. Sena (2008): "Governance regimes, corruption and growth: Theory and evidence," *Journal of Comparative Economics*, 36, 195–220.

Alessandria, G., J. P. Kaboski, and V. Midrigan (2010): "Inventories, Lumpy Trade, and Large Devaluations," *American Economic Review*, 100, 2304–2339.

Alessandria, G., S. Y. Khan, and A. Khederlarian (2021): "Taking Stock of Trade

Policy Uncertainty: Evidence from China's Pre-WTO Accession," Working Paper, World Bank, Washington, DC.

Amoah, G. (2014): "Intra-African Trade: Issues Involved in Improving Ghana's Trade with the Rest of Africa," *Developing Country Studies*, 4.

Arizala, F., M. Bellon, and M. MacDonald (2018): "Sub-Saharan Africa is becoming more integrated - which will aid growth but is not without risk," Finance & Development, International Monetary Fund.

Barka, H. B. (2012): "Border Posts, Checkpoints, and Intra-African Trade: Challenges and Solutions," Tech. rep., The African Development Bank.

Berman, N., J. de Sousa, P. Martin, and T. Mayer (2013): "Time to Ship during Financial Crises," *NBER International Seminar on Macroeconomics*, 9, 225–260, publisher: The University of Chicago Press.

Carreras-Valle, M.-J. (2021): "Increasing Inventories: Role of Delivery Times," Ph.D. thesis, University of Minnesota.

de Jong, E. and C. Bogmans (2011): "Does corruption discourage international trade?" *European Journal of Political Economy*, 27, 385–398.

Dimant, E. and G. Tosato (2018): "Causes and Effects of Corruption: What Has Past Decade's Empirical Research Taught Us? A Survey," *Journal of Economic Surveys*, 32, 335–356.

Dincer, O. C. and B. Gunalp (2005): "Corruption, Income Inequality, and Growth: Evidence from U.S. States," *SSRN Electronic Journal*.

Djankov, S., C. Freund, and C. S. Pham (2010): "Trading on Time," *The Review of Economics and Statistics*, 92, 166–173.

Dreher, A. and M. Gassebner (2013): "Greasing the wheels? The impact of regulations and corruption on firm entry," *Public Choice*, 155, 413–432, publisher: Springer.

d'Agostino, G., J. P. Dunne, and L. Pieroni (2016): "Government Spending, Corruption and Economic Growth," *World Development*, 84, 190–205.

Eaton, J. and S. Kortum (2002): "Technology, Geography, and Trade," *Econometrica*, 70, 1741–1779, publisher: [Wiley, Econometric Society].

Gil-Pareja, S., R. Llorca-Vivero, and J. A. Martínez-Serrano (2019): "Corruption and international trade: a comprehensive analysis with gravity," *Applied Economic Analysis*, 27, 3–20.

Gyimah-Brempong, K. (2002): "Corruption, economic growth, and income inequality in Africa," *Economics of Governance*, 3, 183–209.

Hummels, D. L. and G. Schaur (2013): "Time as a Trade Barrier," *American Economic Review*, 103, 2935–2959.

Kaminchia, S. (2020): "Effect of transit road quality on trade costs in East Africa," *African Development Review*, 32, 316–326.

Kaufmann, D. and S.-J. Wei (2000): *Does 'Grease Money' Speed Up the Wheels of Commerce?*, no. Working Paper No. 00/64 in IMF Working Papers, Washington, D.C: International Monetary Fund.

Longo, R. and K. Sekkat (2004): "Economic Obstacles to Expanding Intra-African Trade," *World Development*, 32, 1309–1321.

Majeed, M. T. (2014): "Corruption and Trade," *Journal of Economic Integration*, 29, 759–782.

Mauro, P. (1997): *Why worry about corruption ?*, no. 6 in Economic issues, Washington, D.C: International monetary fund.

Melitz, M. J. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71, 1695–1725.

Montagnat-Rentier, G. and G. Parent (2012): "Customs administration reform and modernization in Francophone sub-Saharan Africa, 1995-2010," *Revue d'économie du développement*, 20, 105–146.

Musila, J. W. and S. P. Sigué (2010): "Corruption and International Trade: An Empirical Investigation of African Countries," *World Economy*, 33, 129–146.

Méon, P.-G. and K. Sekkat (2005): "Does corruption grease or sand the wheels of growth?" *Public Choice*, 122, 69–97.

Méon, P.-G. and L. Weill (2010): "Is Corruption an Efficient Grease?" *World Development*, 38, 244–259.

Njinkeu, D., J. S. Wilson, and B. P. Fosso (2008): *Expanding Trade Within Africa: The Impact Of Trade Facilitation*, Policy Research Working Papers, The World Bank.

Ocean Shipping Consultants, Ltd. (2008): "DIAGNOSTICS DES INFRASTRUCTURES NATIONALES EN AFRIQUE," Tech. rep., Ocean Shipping Consultants, Ltd.

Plane, P. (2021): "What Factors Drive Transport and Logistics Costs in Africa?" *Journal of African Economies*, 30, 370–388.

Sant' Anna, V. P. and S. Kannebley Júnior (2018): "Port efficiency and Brazilian exports: A quantitative assessment of the impact of turnaround time," *The World Economy*, 41, 2528–2551.

Socrates, M. K., E. Moyi, and K. Gathiaka (2020): "Explaining Export Duration in Kenya," *South African Journal of Economics*, 88, 204–224.

The World Economic Forum and The Global Alliance for Trade Facilitation (2016): *The Global Enabling Trade Report*, World Economic Forum, and Global Alliance for Trade Facilitation.

United Nations (2022): *Rethinking the Foundations of Export Diversification in Africa: The Catalytic Role of Business and Financial Services : Economic Development in Africa Report 2022*, Geneva: United Nations, oCLC: 1342986610.

Valensisi, G. and R. T. Lisinge (2013): *Trade facilitation from an African perspective*, United Nations, Economic Commission for Africa.

Vijil, M., L. Wagner, and M. T. Woldemichael (2019): *Import Uncertainty and Export Dynamics*, World Bank, Washington, DC.

Appendix

A Theory

A.1 Derivation of consumer's demand for variety s in country d

The Program solved by the consumer is as follows:

$$\max_{x_{s,d}} \left(\int_0^1 \lambda(s)(x_{s,d})^{\frac{\sigma-1}{\sigma}} ds \right)^{\frac{\sigma}{\sigma-1}} \tag{12}$$

$$\text{s.t. } \int_0^1 p_{s,d} x_{s,d} ds \leq P_d Y_d$$

Let γ be the Lagrange multiplier so that the first-order condition of the problem implies that:

$$x_{s,d} = \left(\frac{\sigma}{\sigma - 1} \frac{\gamma p_{s,d}}{\lambda(s)} \right)^{-\sigma} \tag{13}$$

To get rid of γ, we express the ratio of demand for two varieties s and s' as follow:

$$\frac{x_{s,d}}{y_{s',d}} = \left(\frac{p_{s,d}}{p_{s',d}} \frac{\lambda(s')}{\lambda(s)} \right)^{-\sigma} \tag{14}$$

Integrating (14) over all the variety gives:

$$\int_0^1 (p_{s,d} x_{s,d}) ds = \int_0^1 \left[p_{s,d} y_{s',d} \left(\frac{p_{s,d}}{p_{s',d}} \frac{\lambda(s')}{\lambda(s)} \right)^{-\sigma} \right] ds \tag{15}$$

Using the budget constraint of consumers we get

$$Y_d P_d = y_{s',d} \left(\frac{\lambda(s')}{p_{s',d}} \right) \int_0^1 \left(\lambda^{\sigma}(s)(p_{s,d})^{1-\sigma} \right) ds \tag{16}$$

Let's define the index price P_d as follows:

$$P_d = \int_0^1 \left(\lambda^{\sigma}(s)(p_{s,d})^{1-\sigma} \right) ds \tag{17}$$

So the demand of consumers for variety s in country d is:

$$x_{s,d} = Y_d \left(\frac{p_{s,d}}{\lambda(s) P_d} \right)^{-\sigma} \tag{18}$$

A.2 Derivation of the price set by the exporter of variety s to country d

The program solved by the exporter is :

$$V_{s,d}(s_l, s_h, \tau) = max\{W_{s,d}(s_l, \tau), W_{s,d}(s_h, 0)\} \tag{19}$$

where

$$\begin{aligned} W_{s,d}(s,\tau) = \quad & \max_{p_{s,d}} \; p_{s,d}x_{s,d} - \phi(s)(w+\tau)x_{s,d} \\ s.t. \qquad & x_{s,d} = Y_d \left(\frac{\lambda(s)P_d}{p_{s,d}}\right)^{\sigma}, \end{aligned} \tag{20}$$

The first order condition of the program (20) is:

$$x_{s,d} + p_{s,d}\frac{\partial x_{s,d}}{\partial p_{s,d}} - \phi(s)(w+\tau)\frac{\partial x_{s,d}}{\partial p_{s,d}} = 0$$

The exporter of variety s to country d takes as given the index price P_d such that $\frac{\partial x_{s,d}}{\partial p_{s,d}} = -\sigma\frac{x_{s,d}}{p_{s,d}}$. Substituting this expression into the first order condition gives the equilibrium price $p_{s,d}$

$$p_{s,d} = \frac{\sigma}{\sigma-1}(w+\tau)\phi(s) \tag{21}$$

Finally, when we substitute the price into the demand equation we get

$$x_{s,d} = Y_d P_d^{\sigma}\left[\frac{\sigma}{\sigma-1}(w+\tau)\phi(s)\frac{1}{\lambda(s)}\right]^{-\sigma} \tag{22}$$

A.3 Bribery compliance and effect of corruption on trade

Substituting (21) and (22) in the value defined in (20), we get

$$W_{s,d}(s_h, 0) = \frac{\phi(s_h)\cdot w}{\sigma-1}Y_d P_d^{\sigma}\left[\frac{(\sigma-1)\lambda(s_h)}{\sigma w\phi(s_h)}\right]^{\sigma} \tag{23}$$

and

$$W_{s,d}(s_l, \tau) = \frac{\phi(s_l)\cdot(w+\tau)}{\sigma-1}Y_d P_d^{\sigma}\left[\frac{(\sigma-1)\lambda(s_l)}{\sigma(w+\tau)\phi(s_l)}\right]^{\sigma} \tag{24}$$

Bribery compliance (Proposition 1).– An exporter complies and pays the bribery if and only if $W_{s,d}(s_l, \tau) > W_{s,d}(s_h, 0)$.

$$W_{s,d}(s_l, \tau) > W_{s,d}(s_h, 0) \iff \left(\frac{w}{w+\tau}\right)^{\sigma-1} \left[\frac{\phi(s_h)}{\phi(s_l)}\right]^{\sigma-1} \left[\frac{\lambda(s_l)}{\lambda(s_h)}\right]^{\sigma} > 1 \tag{25}$$

Notice that $\frac{w}{w+\tau} < 1$, $\frac{\phi(s_h)}{\phi(s_l)} > 1$, and $\frac{\lambda(s_l)}{\lambda(s_h)} > 1$. Therefore, condition (25) is satisfied only and only if $\frac{\phi(s_h)}{\phi(s_l)}$, and/or $\frac{\lambda(s_l)}{\lambda(s_h)}$ is superior to a certain threshold $\widetilde{\Gamma}(w, \tau)$. Then consider the derivative, for small variations of s: $\frac{\phi(s_h) - \phi(s_l)}{s_h - s_l} = \phi'(s_l)$. By approximation, $\frac{\phi(s_h)}{\phi(s_l)} \approx \phi'(s_l) \cdot \frac{s_h - s_l}{\phi(s_l)} + 1$. Hence,

$$(25) \iff \phi'(s_l) \cdot \frac{s_h - s_l}{\phi(s_l)} > \widetilde{\Gamma}(w, \tau) - 1 \text{ or } |\lambda'(s_l)| \cdot \frac{s_h - s_l}{\lambda(s_h)} > \widetilde{\Gamma}(w, \tau) - 1 \qquad QED.$$

Effect of bribery on trade volume (Proposition 2).– Apply (22) at points $(s, \tau) \in \{(s_h, 0); (s_l, \tau)\}$ and get

$$\frac{x_{s,d}(s_l, \tau)}{x_{s,d}(s_h, 0)} > 1 \iff \left(\frac{w}{w+\tau}\right)^{\sigma} \left[\frac{\phi(s_h)}{\phi(s_l)}\right]^{\sigma} \left[\frac{\lambda(s_l)}{\lambda(s_h)}\right]^{\sigma} > 1 \tag{26}$$

Given the similarity between equations (25) and (26), the demonstration of **Proposition 2** follows by analogy.

B Data

Table B.1: summary statistics by corridor

Nb	Quarters	Nb of Trips		Police Control		Customs Control		Gendamerie Control		Others Control		Total of Control		Control per 100 km	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	14	96.36	33.87	7.31	2.20	2.61	1.99	4.85	1.89	8.96	7.94	22.71	7.47	1.93	0.64
2	14	80.79	53.64	4.37	2.11	5.39	2.05	3.92	2.47	7.21	5.60	21.08	5.51	1.66	0.44
3	15	139.47	33.79	9.94	1.92	2.99	1.03	11.22	5.16	1.24	1.15	25.41	7.50	1.84	0.67
4	25	69.10	30.60	6.81	1.44	8.86	2.03	5.97	1.53	4.33	2.83	26.25	5.36	2.94	0.68
5	14	59.29	22.60	6.22	0.81	9.76	2.07	5.77	1.13	3.43	2.63	25.69	4.48	2.47	0.43
6	2	110.00	35.36	4.00	0.00	3.00	0.00	5.50	0.71	0.00	0.00	12.50	0.71	1.00	0.00
7	25	178.50	49.46	24.93	100.86	7.94	2.08	2.85	1.33	1.21	1.03	17.00	3.61	1.75	0.51
8	25	96.90	46.13	8.87	2.12	10.41	2.53	1.72	1.56	1.39	1.36	21.75	3.67	2.08	0.36

Nb	Police Bribe		Customs Bribe		Gendamerie Bribe		Others Bribe		Total Bribe		Bribe per 100 km		Delay time		Delay per 100 km	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	10297	3101	5514	2887	5921	1560	30697	25559	51875	23888	4419	2035	173	76	15	6
2	7264	2834	8881	5231	6453	2957	31027	21933	53624	22915	4246	1814	157	84	12	6
3	15430	3765	9990	4140	12589	6036	3282	1557	39723	10662	2847	828	321	112	23	7
4	11416	2357	123121	531671	9266	2650	11179	6589	49054	12567	5436	1603	172	49	19	7
5	11159	3304	17537	5759	7957	1540	6861	3622	43529	11560	4206	1117	199	64	19	6
6	4429	112	2735	0	11131	1632	298	182	18592	1926	3092	1661	114	28	11	3
7	5026	2068	7126	2525	3831	1543	2532	2680	18516	6843	1894	839	120	45	12	6
8	5074	1577	8264	3157	2319	913	3280	3995	18938	7030	2548	1317	246	85	32	20

Notes.- The Table shows summary statistics of the number of controls, delays, and bribes on interstate roads (corridors) 1 to 8 between 2006 and 2013. Corridor 1 is Abidjan-Bamako, 2 Ougadougou-Abidjan, 3 Bamako-Dakar, 4 Ouagadougou-Bamako via Heremakono, 5 Ougadougou-Bamako via Koury, 6 Cotonou-Niamey, 7 Ouagadogou-Lomé, and 8 Ouagadogou-Tema. Source: IRTG reports and the authors' calculations.

Table B.2: Summary statistics by country

Country	Quarters	Nb of Trips		Police Control		Customs Control		Gendamerie Control		Others Control		Total of Control		Control per 100 km	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
BEN	2	81.00	5.66	3.20	0.14	0.70	0.14	3.00	0.71	0.00	0.00	7.00	0.71	0.75	0.07
BFA	103	100.58	60.61	2.89	17.33	3.65	1.35	0.99	0.35	0.55	0.54	6.39	1.37	2.05	0.90
CIV	28	88.57	44.73	3.21	1.79	1.51	1.45	2.58	1.79	7.45	6.27	14.82	5.43	2.09	1.03
GHA	25	96.90	46.13	7.65	2.21	7.46	2.00	0.66	1.35	0.93	0.94	15.93	3.27	1.82	0.37
MLI	68	89.73	42.98	4.92	1.15	3.68	1.83	4.15	1.55	2.38	2.34	14.90	5.66	3.09	1.49
NER	2	71.50	19.09	0.85	0.07	2.00	0.14	2.45	0.07	0.15	0.21	5.55	0.07	2.05	0.07
SEN	15	139.47	33.79	5.87	1.71	0.63	0.32	7.71	4.34	0.30	0.40	14.52	6.00	2.13	0.90
TGO	25	178.50	49.46	16.59	65.73	4.59	1.21	1.85	1.30	0.78	0.61	10.73	3.15	1.81	1.76

Country	Police Bribe		Customs Bribe		Gendamerie Bribe		Others Bribe		Total Bribe		Bribe per 100 km		Delay time		Delay per 100 km	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
BEN	3363	113	937	1	5604	1632	208	182	10112	1927	1313	250	31	27	4	2
BFA	2081	854	4896	2947	1922	738	1579	1984	10477	4514	3136	1233	60	29	21	18
CIV	3994	2679	3080	2521	3083	2210	27649	23302	37065	20514	5575	3152	110	66	15	9
GHA	3452	1615	4529	2940	496	1024	2261	3405	10718	6451	1235	746	162	81	19	10
MLI	8325	2584	8280	4902	5543	2547	5653	5048	27648	11639	5604	2948	128	64	24	10
NER	910	219	1650	209	5611	119	297	293	8469	18	3125	6	42	59	4	6
SEN	8507	3185	2354	1329	8897	5065	1464	984	20358	7961	2996	1180	129	49	19	7
TGO	3123	1672	3864	1908	1926	1413	1384	1745	10233	5480	1354	713	66	26	9	4

Notes.- The Table shows summary statistics of the number of controls, delays, and bribes observed in countries on the interstate roads (corridors) of Table B.1 between 2006 and 2013. BEN stands for Benin, BFA for Burkina Faso, CIV for Côte d'Ivoire, GHA for Ghana, MLI for Mali, NER for Niger, SEN for Senegal, and TGO for Togo. Source: IRTG reports and the authors' calculations.