Roadblocks, Time Delays and Bribery on Interstate Roads: the Effects on Regional Trade Integration in West Africa

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Abstract.– It is a well-known fact that regional trade within Africa is low compared to other regions in the world. In this paper, we rely on the Improved Road-Transport Governance reports to construct a novel data set that measures trade-related 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. During 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 the connected countries while corruption tends to match the "grease the wheels" theory.

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) analyze the effects of improvement of transit roads' quality in the East African Community (EAC) and find 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 – bribery and delays – 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 widely admitted that corruption negatively affects the macroeconomy – that is the so-

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

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.

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

In this section, we propose a theoretical model whose mechanisms guide intuition about the expected effects of corruption and delays on bilateral trade. We base on the existing literature and adopt the "sand the wheels" view of corruption as a hypothesis. Our model builds on Hummels and Schaur (2013) and Berman et al. (2013).

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, 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. 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_d^s for each variety s in country d is derived by maximizing the consumer's utility of the Dixit-Stiglitz type below.

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

where σ represents the elasticity of substituability between varieties, p_d^s 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 decreasing function of 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]

$$x_d^s = Y_d \left(\frac{\lambda(s) P_d}{p_d^s} \right)^{\sigma} \tag{3}$$

In the home country s, we assume that labor is the only production factor as is often the

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

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_d^s from that country, and chooses his price p_d^s to maximize the present value of profit V_d^s. The exporter problem is defined as follows.

$$\begin{aligned} V_d^s = & \max_{p_d^s} p_d^s x_d^s - \phi(s)(w+\tau)x_d^s \\ s.t. \quad & x_d^s = Y_d \left(\frac{\lambda(s) P_d}{p_d^s} \right)^{\sigma}, \end{aligned} \tag{4}$$

where w is the labor cost per unit of production, and τ represents the average bribery per unit of goods shipped. In fact, the data in section 4 show that significant amounts of bribes are extorted from drivers conveying goods on interstate highways in West Africa. $\phi(s)$ in 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 duration of delivery.

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

$$p_d^s = \frac{\sigma}{\sigma - 1}(w+\tau)\phi(s) \tag{5}$$

$$x_d^s = Y_d P_d^{\sigma} \left[\frac{(\sigma - 1)}{\sigma(w+\tau)\phi(s)} \cdot \lambda(s) \right]^{\sigma} \tag{6}$$

2.2 Predictions of the model

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). But analyses of this type generally refer to low productivity of firms. But 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 (5). Indeed, The price charged by an exporter is a markup over the marginal cost of the

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

product, which includes not only the wage bill of production but also bribery and delay costs incurred during shipping. To the extent that corruption and time delays are pervasive on West African interstate highways, competitiveness is undermined and trade is reduced ultimately.

Time delay, bribery, and trade volume.– From our model, the equilibrium quantity on the export market is negatively related to bribery and delays during shipping (equation (6)). 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 ($\phi(s)$) 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_d^s.

In sum, this theoretical framework suggests that heavy time delays and bribery on interstate highways can undermine competitiveness and hamper trade. 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 (6):

$$\log(x_d^s) = \log(Y_d) + \sigma \log(P_d) + \sigma \log\left(\frac{\lambda(s)}{\phi(s)}\right) - \sigma \log(w+\tau) + \sigma \log\left(\frac{\sigma-1}{\sigma}\right) \tag{7}$$

Taking into account equation (1), we now expand equation (7) to the form of a standard gravity equation. We additionally include country and time-fixed effects. Thus, our estimation equation is as follows.

$$\log(X_{ijt}) = \mu_j + \eta_t + \alpha_1 \log(Y_{jt}) + \alpha_2 \log(\frac{P_{it}}{P_{jt}}) + \gamma_1 \log(Dist_{ij}) + \gamma_2 \log(s_{b,ijt}) + \quad (8)$$
$$\theta \log(NbCtrl_{ijt}) + \lambda \log(\tau_{ijt}) + \beta_1 Z_{1,it} + \beta_2 Z_{2,jt} + \epsilon_{ijt},$$

where subscripts i, j, and t stand respectively for origin country, destination country, and year. X is aggregate export, Y is GDP, and P is the price index. μ and η are respectively country and year fixed effects. $Dist$ is the distance between origin and destination countries, used to instrument for 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.

Endogeneity and identification.– Our coefficients of interest are γ_2, θ and τ. They capture respectively the effect of delays, 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. Yet, in a robustness exercise, we instrument controls, delays, and bribes with their respective lags.

To avoid the bias of omitted variables that can lead to endogeneity 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 Improved Road-Transport Governance (IRTG), Trade Map from the International Trade Centre (ITC), the World Development Indicators (WDI) from the World Bank, and 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.[5] 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 [6]. The data covers eight corridors linking eight countries. Table 1 and Figure 1 present the roads. Overall, the data is an unbalanced panel both at corridor and country levels.

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.

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

[6] 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 1: IRTG road map

Source: IRTG 22^{nd} report.

GeoDist.– Finally, we get data on the distance between countries from the GoeDist database of the CEPII. [7]

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

4.2 Summary statistics

Controls, delays, and bribes on the roads.– According to the IRTG data, controls, 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 2).

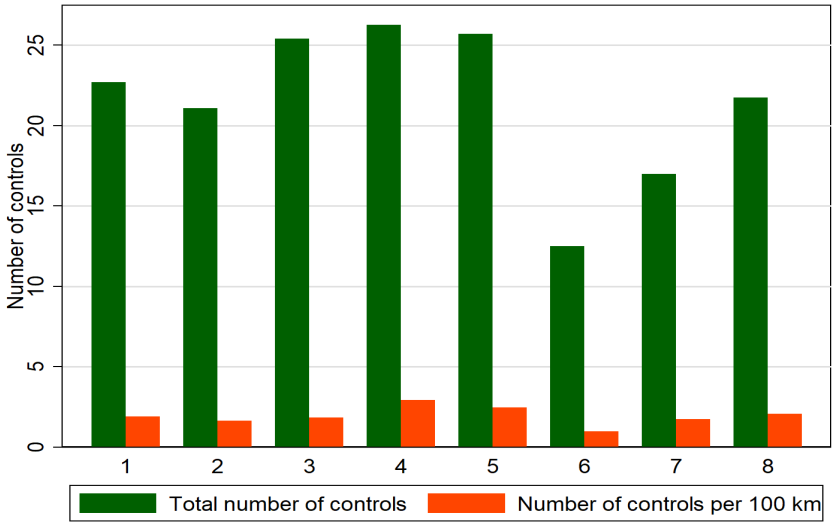

Figure 2: Average total control on West African interstate roads between 2006 and 2013

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 3). 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. IRTG data provide a measurement of unlawful payments on the roads. To rule out legal penalties, the surveys selected only truck drivers that had their papers in order and whose truck is in good condition. The data show, as in Figure 3, 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 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.

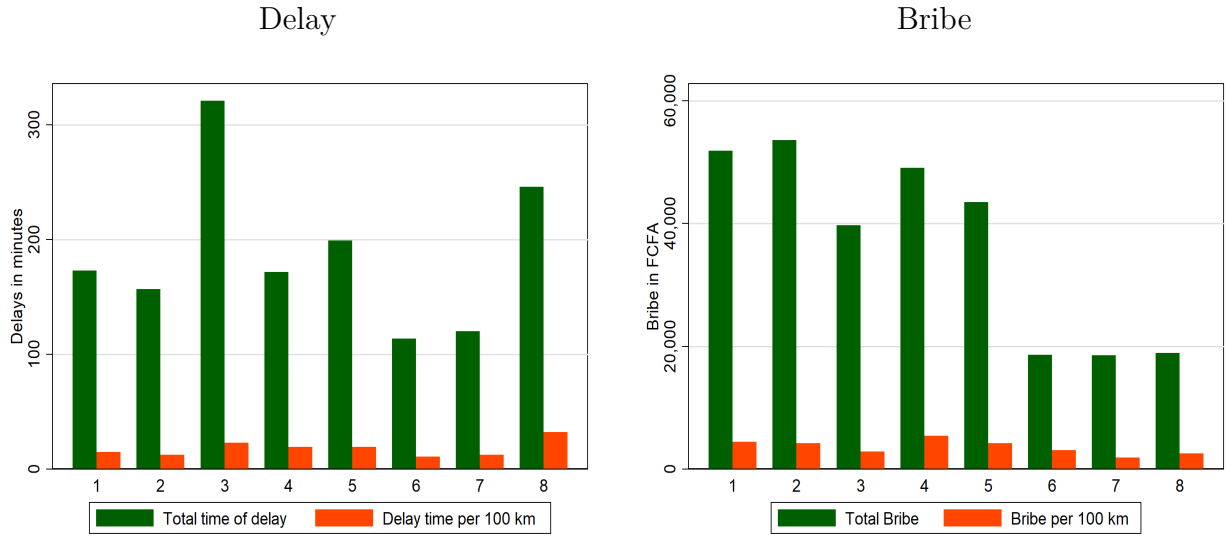

Figure 3: Average total delay and bribe on West African interstate roads in 2006-2013

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 4 and 5 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 6, 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.

The evolution of trends over time did not show significant improvements either. In Figure 7, 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 8).

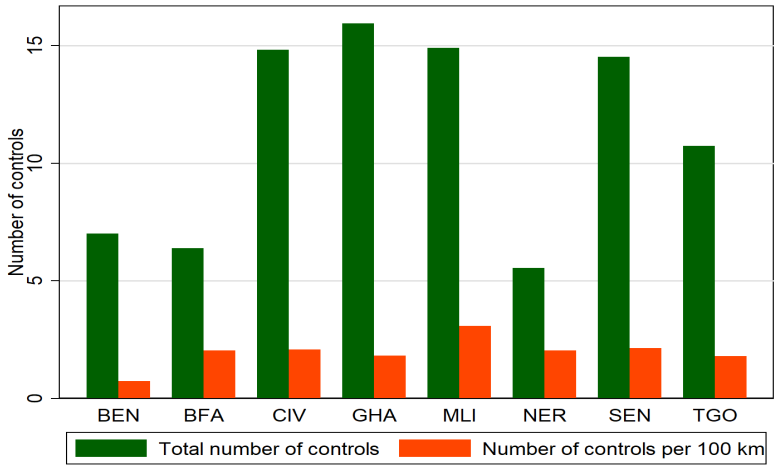

Figure 4: Average total control on West African interstate roads between 2006 and 2013

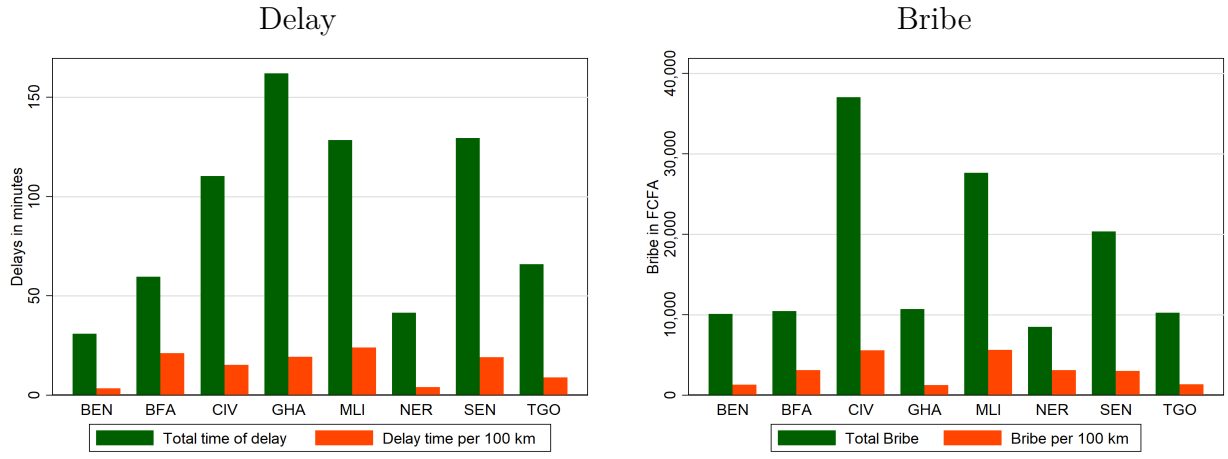

Figure 5: Average total delay and bribe on West African interstate roads between 2006 and 2013 by country

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. Figure 9 shows the average volume of trade with the rest of the world for the eight countries, and the average proportion of 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). The dashed line in the figure shows that there is an increasing trend of trade during the period 2006-2013. Similarly, the solid line shows that the average share of bilateral trade flow in the countries' total trade with the rest of the world has slightly increased during the

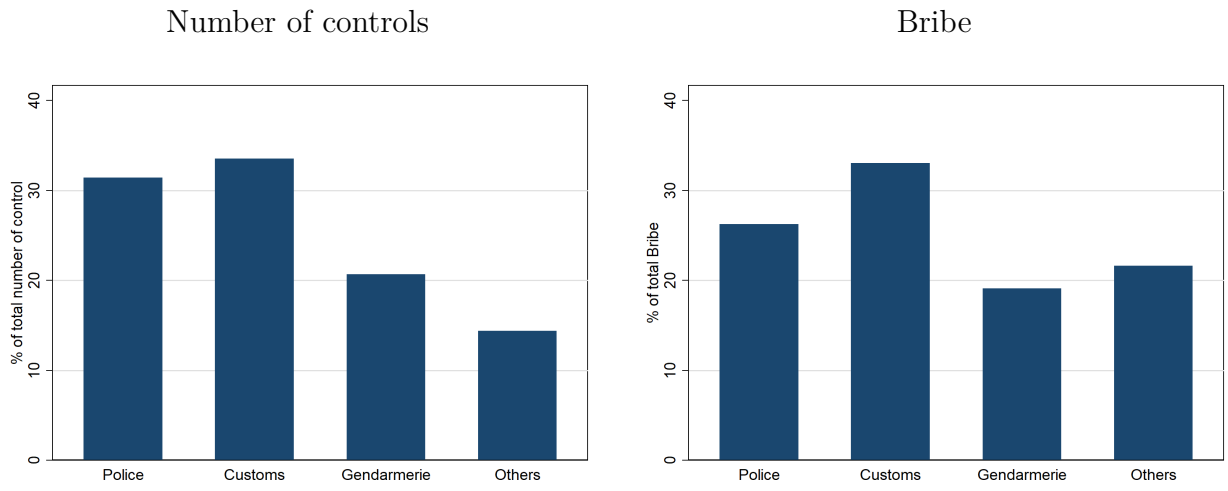

Figure 6: Average total delay and bribe on West African interstate roads between 2006 and 2013 by uniformed service

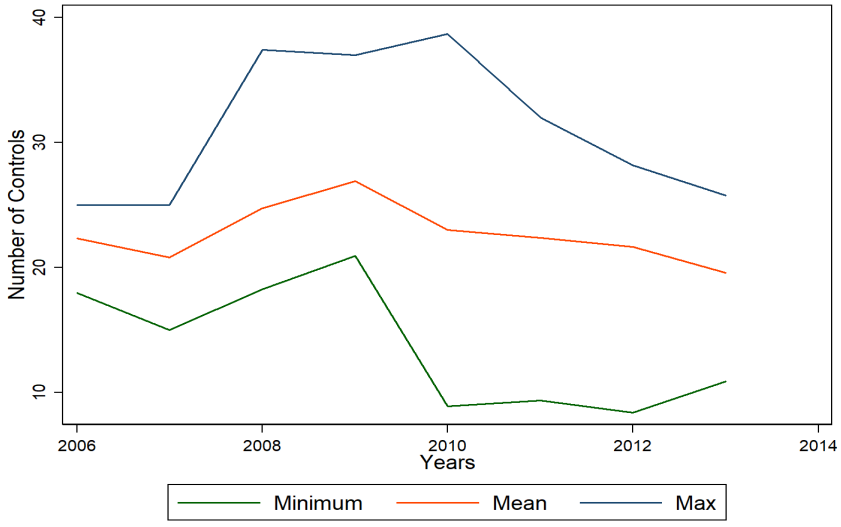

Figure 7: Evolution of the number of control on West African interstate roads in 2006-2013

same period. However, bilateral trade between the countries remains relatively low as shown in Table 2. 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%.

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

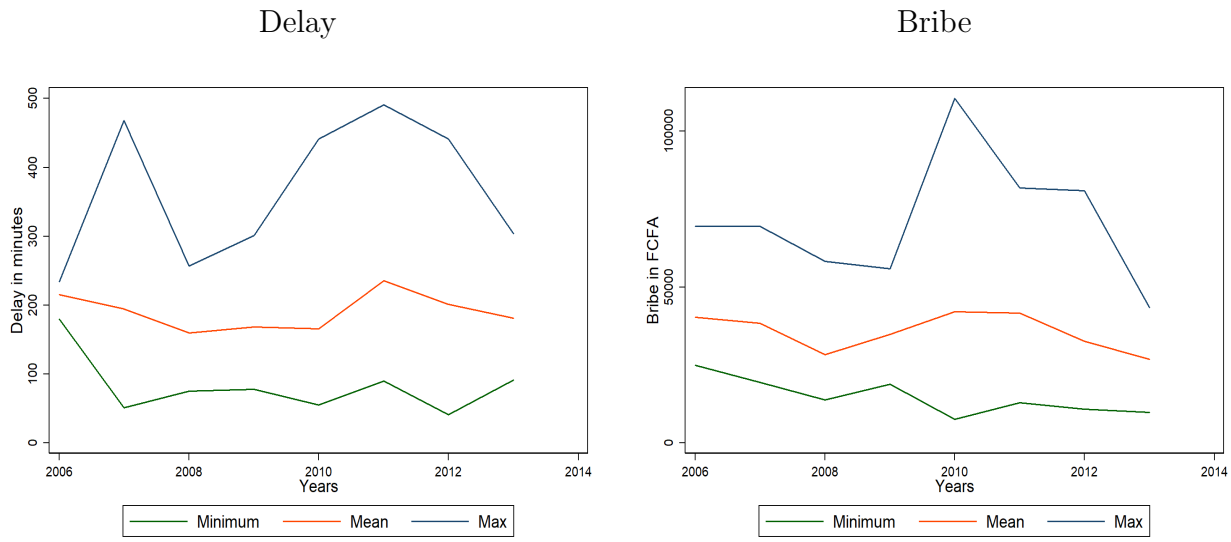

Figure 8: Evolution of delay and bribe on West African interstate roads in 2006-2013

Table 2: 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

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 consider two 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. When we consider the unlawful practices in each section of the corridors, the delays in the origin countries negatively and significantly decrease the trade.

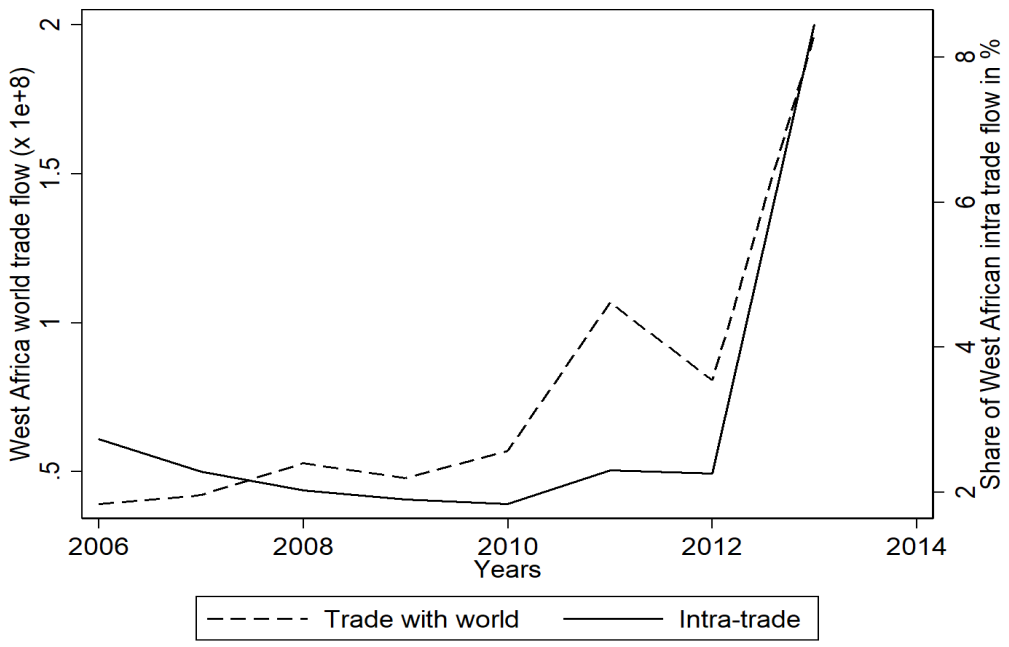

Figure 9: Evolution of Trade in West Africa

Note.- The Figure shows on the left y-axis the average volume of trade with the rest of the world for the eight countries our data covers. The volume of trade with the rest of the world is computed as half the sum of imports and exports with the rest of the world. On the right y-axis, the Figure shows the average proportion of bilateral trade in the total trade. Source: Trade Map data and the authors' calculations.

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 kinds of panel equations. The first assesses the effects of roadblocks, bribes and delays along the corridors and the second those effects on each side of the corridors.

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

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

where (X_{ijt}) is the average of imports and exports 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 that have a trend including the dependent variable.

Table 3 displays the estimated parameters of interest of the equation 9. We made four estimations of this equation varying among the corridor fixed effect and the time fixed effect. It comes out that including the fixed effects increases the percentage of the variation of trade accounted for by the explanatory variables as indicated by the within coefficient of determination $(R - sq)$. The final estimate of our coefficients of interest is displayed in the last column of the table. The time delays on interstate highways negatively and significantly affect trade in West Africa. More specifically, everything else equal, a 1% increase in the time delays per 100 km will decrease bilateral trade growth by 1.24 percentage points. However, the bribes along the corridors positively impact bilateral trade supporting the "grease the wheels" theory of corruption. Indeed, everything else equal, an increase of 1% of bribes on the highways will raise the bilateral trade by 0.822 percentage points. On the other hand, the impact of the number of control is positively low but non-significant on bilateral trade in West Africa.

Table 3: Regression on Trade flows along corridors

	(1)	(2)	(3)	(4)
Log Bribe per 100 km Corr	0.969	0.110	1.027	0.822**
	(0.762)	(0.327)	(0.881)	(0.266)
Log Delay per 100km Corr	−0.444	0.168	−0.608	−1.240***
	(0.538)	(0.314)	(1.031)	(0.287)
Log Nb control per 100 km Corr	−1.181	0.653*	−1.114	0.019
	(1.100)	(0.338)	(1.602)	(0.183)
Observations	34	34	34	34
R-sq	0.023	0.123	0.350	0.600
Time fixed effects	No	No	Yes	Yes
Corridor fixed effects	No	Yes	No	Yes

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 C.1 in the appendix. In parenthesis are the robust and clustered standard deviations.

Bilateral trade and delay and bribe in each country.– After our investigations on how roadblocks, delays, and bribes along the corridors affect the trade, we aim to disentangle those effects across each country connected by the corridors. The panel equation we estimate for that purpose is the following:

$$\begin{aligned}\log(X_{ijt}) = &\mu_i + \eta_t + \alpha_1 \log(Y_{jt}) + \varphi \log(\frac{P_{it}}{P_{jt}}) + \gamma_1 \log(Dist_{ij}) + \gamma_2 \log(s_{b,ijt}) \\ &+ \gamma_3 \log(s_{b,jit}) + \theta_1 \log(NbCtrl_{it}) + \theta_2 \log(NbCtrl_{jt}) + \lambda_1 \log(\tau_{ijt}) \\ &+ \lambda_2 \log(\tau_{jit}) + \beta_1 Z_{1,it} + \beta_2 Z_{2,jt} + \epsilon_{ijt},\end{aligned} \tag{10}$$

Where the $\log(X_{ijt})$ is the log of either the exports or the imports of country i to or from country j. Our variables of interest s_b, τ, and $NbCtrl$ are split to account for the poor and unlawful practices occurring in each countryside of the corridors. We also take the difference of the variables that have a trend including the dependent variable.

The results of the estimate of our variables of interest when the dependent variable is the exports are reported in Table 4. As indicated by the within coefficient of determination ($R-sq$) the country-fixed effects and the time-fixed effects improve the percentage of variation of trade explained by the regressors. After controlling for the fixed effects, it turns out that only the delays that occurred in the origin country of exportation impacts significantly the bilateral trade. More specifically an increase of delay time by 1% per 100 km, everything else equal, will lower the export growth of origin countries along corridors by 1.19 percentage points. The number of controls in the origin countries also has a negative, though non-significant, effect on exports. The bribes in the destination countryside have a positive but non-significant effect on exports.

To assess the impacts of roadblocks, delays and bribes on imports we estimate the equation 10 with imports as the dependent variable. The estimates for our variables of interest reported in Table 5 show that the effects of time delays and roadblocks in the destination country on imports are negative but not significant. More generally, none of the variables of interest is significant in this regression.

Table 4: Exports regressions

	(1)	(2)	(3)	(4)
Log Bribe per 100 km O	0.230	0.314*	0.151	0.264
	(0.329)	(0.143)	(0.234)	(0.470)
Log Delay per 100km O	−0.551	−0.653	−0.779***	−1.187***
	(0.405)	(0.526)	(0.232)	(0.240)
Log Bribe per 100 km D	−0.116	0.210	−0.215**	0.104
	(0.130)	(0.727)	(0.100)	(0.174)
Log Delay per 100km D	0.347**	0.848*	0.107	0.286
	(0.139)	(0.369)	(0.084)	(0.388)
Log Nb control per 100 km O	0.514	−0.083	0.645	−0.011
	(0.350)	(0.273)	(0.465)	(0.405)
Log Nb control per 100 km D	0.245	1.094	0.369	1.121
	(0.562)	(0.545)	(0.506)	(0.723)
Observations	66	66	66	66
R-sq	0.133	0.230	0.296	0.388
Time fixed effects	No	No	Yes	Yes
Country fixed effects	No	Yes	No	Yes

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.

Table 5: Imports regressions

	(1)	(2)	(3)	(4)
Log Bribe per 100 km O	−0.116	0.210	−0.215	0.104
	(0.166)	(0.528)	(0.131)	(0.517)
Log Delay per 100km O	0.347	0.848	0.107	0.286
	(0.400)	(0.575)	(0.348)	(0.585)
Log Bribe per 100 km D	0.230	0.314	0.151	0.264
	(0.460)	(0.341)	(0.419)	(0.293)
Log Delay per 100km D	−0.551	−0.653	−0.779	−1.187
	(0.513)	(0.692)	(0.576)	(0.707)
Log Nb control per 100 km O	0.245	1.094	0.369	1.121
	(0.561)	(1.021)	(0.621)	(1.154)
Log Nb control per 100 km D	0.514	−0.083	0.645	−0.011
	(0.335)	(0.293)	(0.438)	(0.521)
Observations	66	66	66	66
R-sq	0.133	0.230	0.296	0.388
Time fixed effects	No	No	Yes	Yes
Country fixed effects	No	Yes	No	Yes

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.

5.2 Alternative specifications: robustness

For our main specification, we assess the effects of roadblocks on trade in West Africa by considering the number of controls, delays, and bribes per 100 km. This specification allows us, everything else equal, to infer the impacts of roadblocks on the trade occurring on other corridors knowing the unlawful practices per 100 km.

As a robustness check, we consider an alternative specification where our variables of interest are the total values instead of those values per 100 km. More precisely, we estimate the equations 9 and 10 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 with the main specification (see Table 6). The time delay still has a negative and statistically significant effect on trade. This effect is however lower. Besides, even if the bribes still positively impact the trade, their effects appear no longer significant.

Table 6: Regression on Trade flows along corridors for alternative specification

	(1)	(2)	(3)	(4)
Log Bribe Corr	0.435	0.309	0.456	0.458
	(0.743)	(0.311)	(1.044)	(0.466)
Log Delay Corr	−0.167	0.485	−0.636	−0.874*
	(0.640)	(0.479)	(0.870)	(0.419)
Log Nb control Corr	−1.532	0.310	−1.099	0.176
	(1.777)	(0.254)	(2.061)	(0.233)
Observations	34	34	34	34
R-sq	0.000	0.141	0.292	0.551
Time fixed effects	No	No	Yes	Yes
Corridor fixed effects	No	Yes	No	Yes

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.

The results of our estimated parameters are also broadly consistent with the main specification when we separate the effects of roadblocks, delays, and bribes in each countryside of corridors. The results of regressions on exports in Table 7 show that the time delays and

the number of controls in the origin country still negatively affect the trade. In addition, we now found that the bribes in the destination country, everything else equal, harm the trade in the region.

Table 7: Exports regressions for alternative specification

	(1)	(2)	(3)	(4)
Log Bribe O	0.040	0.361	−0.072	0.324
	(0.220)	(0.229)	(0.153)	(0.374)
Log Delay O	−0.548	−0.565	−0.880***	−1.119***
	(0.427)	(0.462)	(0.138)	(0.156)
Log Bribe D	−0.202	−0.096	−0.347	−0.156
	(0.182)	(0.702)	(0.218)	(0.238)
Log Delay D	0.300*	0.895	−0.053	0.274
	(0.154)	(0.476)	(0.112)	(0.562)
Log Nb control O	0.814	−0.392	1.216***	−0.013
	(0.614)	(0.525)	(0.431)	(0.707)
Log Nb control D	0.453	2.253*	0.885	2.554*
	(0.888)	(1.044)	(0.730)	(1.087)
Observations	66	66	66	66
R-sq	0.127	0.282	0.314	0.447
Time fixed effects	No	No	Yes	Yes
Country fixed effects	No	Yes	No	Yes

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.

The estimates of the regressions on imports reported in Table 8 show that the delays and the number of controls in the destination countries negatively affect trade. A 1% increase in time delays in the destination country, everything else equals, will lower the growth rate of imports by 1.11 percentage points. On the other hand, while the bribes in the origin countries negatively impact the imports, the bribes in the destination countries appear to have a positive effect. The effects of bribes are however low and statistically not significant.

Table 8: Imports regressions for alternative specification

	(1)	(2)	(3)	(4)
Log Bribe O	−0.202	−0.096	−0.347	−0.156
	(0.140)	(0.453)	(0.233)	(0.502)
Log Delay O	0.300	0.895	−0.053	0.274
	(0.525)	(0.660)	(0.500)	(0.707)
Log Bribe D	0.040	0.361	−0.072	0.324
	(0.330)	(0.347)	(0.321)	(0.280)
Log Delay D	−0.548	−0.565	−0.880	−1.119*
	(0.624)	(0.719)	(0.649)	(0.487)
Log Nb control O	0.453	2.253	0.885	2.554
	(0.872)	(1.651)	(1.077)	(1.775)
Log Nb control D	0.814	−0.392	1.216	−0.013
	(0.780)	(0.561)	(0.982)	(1.113)
Observations	66	66	66	66
R-sq	0.127	0.282	0.314	0.447
Time fixed effects	No	No	Yes	Yes
Country fixed effects	No	Yes	No	Yes

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.

6 Conclusion

In this paper we rely on the Improved Road-Transport Governance reports to construct a novel data set that measures trade-related 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 analyses show that the delays seriously impede bilateral trade between the connected countries while the effect of corruption is 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. It is advisable that the interested countries improve the practices on the roads to help trade integration and development.

References

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.

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.

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.

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 INFRASTRUC-

TURES 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 followed:

$$\max_{x_d^s} \left(\int_0^1 \lambda(s)(x_d^s)^{\frac{\sigma-1}{\sigma}} ds \right)^{\frac{\sigma}{\sigma-1}} \tag{11}$$

$$\text{s.t. } \int_0^1 p_d^s x_d^s ds \leq P_d Y_d$$

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

$$x_d^s = \left(\frac{\sigma}{\sigma - 1} \frac{\gamma p_d^s}{\lambda(s)} \right)^{-\sigma} \tag{12}$$

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

$$\frac{x_d^s}{y_d^{s'}} = \left(\frac{p_d^s}{p_d^{s'}} \frac{\lambda(s')}{\lambda(s)} \right)^{-\sigma} \tag{13}$$

Integrating 13 over all the variety gives:

$$\int_0^1 (p_d^s x_d^s) ds = \int_0^1 \left[p_d^s y_d^{s'} \left(\frac{p_d^s}{p_d^{s'}} \frac{\lambda(s')}{\lambda(s)} \right)^{-\sigma} \right] ds \tag{14}$$

Using the budget constraint of consumers we get

$$Y_d P_d = y_d^{s'} \left(\frac{\lambda(s')}{p_d^{s'}} \right) \int_0^1 \left(\lambda^{\sigma}(s)(p_d^s)^{1-\sigma} \right) ds \tag{15}$$

Let's define the index price P_d as follow:

$$P_d = \int_0^1 \left(\lambda^{\sigma}(s)(p_d^s)^{1-\sigma} \right) ds \tag{16}$$

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

$$x_d^s = Y_d \left(\frac{p_d^s}{\lambda(s) P_d} \right)^{-\sigma} \tag{17}$$

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

The program solved by the exporter is :

$$\max_{p_d^s} V_d^s \equiv p_d^s x_d^s - \phi(s)(w+\tau)x_d^s \tag{18}$$

$$\text{s.t. } y_d = f(P_d, p_d^s, Y_d)$$

The first order condition of the program is:

$$x_d^s + p_d^s \frac{\partial x_d^s}{\partial p_d^s} - \phi(s)(w+\tau)\frac{\partial x_d^s}{\partial p_d^s} = 0$$

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

$$p_d^s = \frac{\sigma}{\sigma - 1}(w+\tau)\phi(s) \tag{19}$$

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

$$x_d^s = Y_d P_d^\sigma \left[\frac{\sigma}{\sigma - 1}(w+\tau)\phi(s)\frac{1}{\lambda(s)}\right]^{-\sigma} \tag{20}$$

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.

C Results of regressions

Table C.1: Regression on Trade flows along corridors

	(1)	(2)	(3)	(4)
Log Bribe per 100 km Corr	0.969	0.110	1.027	0.822**
	(0.762)	(0.327)	(0.881)	(0.266)
Log Delay per 100km Corr	−0.444	0.168	−0.608	−1.240***
	(0.538)	(0.314)	(1.031)	(0.287)
Log Nb control per 100 km Corr	−1.181	0.653*	−1.114	0.019
	(1.100)	(0.338)	(1.602)	(0.183)
Inflation Diff	−0.002	−0.028	−0.003	0.003
	(0.029)	(0.040)	(0.046)	(0.036)
Log Distance	0.471	0.000	1.272	0.000
	(0.537)	(.)	(1.436)	(.)
Common language	−0.016	0.000	−0.108	0.000
	(0.569)	(.)	(0.890)	(.)
D.Diff Log Real GDP per capita O	5.475*	2.680*	10.023*	6.240***
	(3.034)	(1.399)	(5.122)	(0.665)
D.Diff Log Real GDP per capita D	6.199	4.019	6.864*	4.394**
	(3.900)	(4.010)	(3.988)	(1.719)
Observations	34	34	34	34
R-sq	0.023	0.123	0.350	0.600
Time fixed effects	No	No	Yes	Yes
Corridor fixed effects	No	Yes	No	Yes

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.

Table C.2: Regression on Trade flows along corridors for alternative specification

	(1)	(2)	(3)	(4)
Log Bribe Corr	0.435	0.309	0.456	0.458
	(0.743)	(0.311)	(1.044)	(0.466)
Log Delay Corr	−0.167	0.485	−0.636	−0.874*
	(0.640)	(0.479)	(0.870)	(0.419)
Log Nb control Corr	−1.532	0.310	−1.099	0.176
	(1.777)	(0.254)	(2.061)	(0.233)
Inflation Diff	−0.005	−0.027	−0.005	−0.014
	(0.048)	(0.046)	(0.060)	(0.041)
Log Distance	0.241	0.000	1.450	0.000
	(1.218)	(.)	(1.784)	(.)
Common language	0.149	0.000	−0.117	0.000
	(1.124)	(.)	(1.395)	(.)
D.Diff Log Real GDP per capita O	3.149	3.839**	6.856	5.572***
	(2.524)	(1.577)	(5.352)	(1.371)
D.Diff Log Real GDP per capita D	3.730	5.392	3.131	4.585
	(5.374)	(4.352)	(4.201)	(2.654)
Observations	34	34	34	34
R-sq	0.000	0.141	0.292	0.551
Time fixed effects	No	No	Yes	Yes
Corridor fixed effects	No	Yes	No	Yes

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.

Table C.3: Exports regressions

	(1)	(2)	(3)	(4)
Log Bribe per 100 km O	0.230	0.314*	0.151	0.264
	(0.329)	(0.143)	(0.234)	(0.470)
Log Delay per 100km O	−0.551	−0.653	−0.779***	−1.187***
	(0.405)	(0.526)	(0.232)	(0.240)
Log Bribe per 100 km D	−0.116	0.210	−0.215**	0.104
	(0.130)	(0.727)	(0.100)	(0.174)
Log Delay per 100km D	0.347**	0.848*	0.107	0.286
	(0.139)	(0.369)	(0.084)	(0.388)
Log Nb control per 100 km O	0.514	−0.083	0.645	−0.011
	(0.350)	(0.273)	(0.465)	(0.405)
Log Nb control per 100 km D	0.245	1.094	0.369	1.121
	(0.562)	(0.545)	(0.506)	(0.723)
Inflation Diff	−0.028***	−0.059	−0.027***	−0.053
	(0.010)	(0.042)	(0.008)	(0.034)
Log Distance	0.113	0.000	0.092	0.000
	(1.272)	(.)	(0.646)	(.)
Common language	−0.215	0.000	−0.493***	0.000
	(0.154)	(.)	(0.089)	(.)
D.Diff Log Real GDP per capita D	−2.855	0.571	−4.042***	−1.435
	(3.518)	(7.440)	(1.498)	(4.793)
Observations	66	66	66	66
R-sq	0.133	0.230	0.296	0.388
Time fixed effects	No	No	Yes	Yes
Country fixed effects	No	Yes	No	Yes

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.

Table C.4: Exports regressions for alternative specification

	(1)	(2)	(3)	(4)
Log Bribe O	0.040	0.361	−0.072	0.324
	(0.220)	(0.229)	(0.153)	(0.374)
Log Delay O	−0.548	−0.565	−0.880***	−1.119***
	(0.427)	(0.462)	(0.138)	(0.156)
Log Bribe D	−0.202	−0.096	−0.347	−0.156
	(0.182)	(0.702)	(0.218)	(0.238)
Log Delay D	0.300*	0.895	−0.053	0.274
	(0.154)	(0.476)	(0.112)	(0.562)
Log Nb control O	0.814	−0.392	1.216***	−0.013
	(0.614)	(0.525)	(0.431)	(0.707)
Log Nb control D	0.453	2.253*	0.885	2.554*
	(0.888)	(1.044)	(0.730)	(1.087)
Inflation Diff	−0.016	−0.059	−0.016	−0.052
	(0.029)	(0.036)	(0.023)	(0.033)
Log Distance	−0.552	0.000	0.064	0.000
	(0.632)	(.)	(0.459)	(.)
Common language	−0.302	0.000	−0.529***	0.000
	(0.295)	(.)	(0.140)	(.)
D.Diff Log Real GDP per capita D	−3.280	0.033	−4.268**	−2.330
	(2.292)	(7.287)	(2.034)	(5.455)
Observations	66	66	66	66
R-sq	0.127	0.282	0.314	0.447
Time fixed effects	No	No	Yes	Yes
Country fixed effects	No	Yes	No	Yes

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

Table C.5: Imports regressions

	(1)	(2)	(3)	(4)
Log Bribe per 100 km O	−0.116	0.210	−0.215	0.104
	(0.166)	(0.528)	(0.131)	(0.517)
Log Delay per 100km O	0.347	0.848	0.107	0.286
	(0.400)	(0.575)	(0.348)	(0.585)
Log Bribe per 100 km D	0.230	0.314	0.151	0.264
	(0.460)	(0.341)	(0.419)	(0.293)
Log Delay per 100km D	−0.551	−0.653	−0.779	−1.187
	(0.513)	(0.692)	(0.576)	(0.707)
Log Nb control per 100 km O	0.245	1.094	0.369	1.121
	(0.561)	(1.021)	(0.621)	(1.154)
Log Nb control per 100 km D	0.514	−0.083	0.645	−0.011
	(0.335)	(0.293)	(0.438)	(0.521)
Inflation Diff	0.028**	0.059	0.027**	0.053
	(0.014)	(0.048)	(0.012)	(0.033)
Log Distance	0.113	0.000	0.092	0.000
	(1.465)	(.)	(1.427)	(.)
Common language	−0.215	0.000	−0.493*	0.000
	(0.385)	(.)	(0.281)	(.)
D.Diff Log Real GDP per capita O	−2.855	0.571	−4.042	−1.435
	(5.092)	(7.091)	(4.100)	(7.875)
Observations	66	66	66	66
R-sq	0.133	0.230	0.296	0.388
Time fixed effects	No	No	Yes	Yes
Country fixed effects	No	Yes	No	Yes

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.

Table C.6: Imports regressions for alternative specification

	(1)	(2)	(3)	(4)
Log Bribe O	−0.202	−0.096	−0.347	−0.156
	(0.140)	(0.453)	(0.233)	(0.502)
Log Delay O	0.300	0.895	−0.053	0.274
	(0.525)	(0.660)	(0.500)	(0.707)
Log Bribe D	0.040	0.361	−0.072	0.324
	(0.330)	(0.347)	(0.321)	(0.280)
Log Delay D	−0.548	−0.565	−0.880	−1.119*
	(0.624)	(0.719)	(0.649)	(0.487)
Log Nb control O	0.453	2.253	0.885	2.554
	(0.872)	(1.651)	(1.077)	(1.775)
Log Nb control D	0.814	−0.392	1.216	−0.013
	(0.780)	(0.561)	(0.982)	(1.113)
Inflation Diff	0.016	0.059	0.016	0.052
	(0.037)	(0.045)	(0.029)	(0.031)
Log Distance	−0.552	0.000	0.064	0.000
	(1.024)	(.)	(1.206)	(.)
Common language	−0.302	0.000	−0.529	0.000
	(0.399)	(.)	(0.327)	(.)
D.Diff Log Real GDP per capita O	−3.280	0.033	−4.268	−2.330
	(4.320)	(6.107)	(3.155)	(6.631)
Observations	66	66	66	66
R-sq	0.127	0.282	0.314	0.447
Time fixed effects	No	No	Yes	Yes
Country fixed effects	No	Yes	No	Yes

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