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Bargain to Extort: Spatial Allocation of Checkpoints and Highway Corruption in West Africa

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Abstract

Petty corruption in the developing world impedes citizens to receive public services and operate business. In this paper, we show the importance of market structure in determining corruption equilibrium in the setting of highway merchandise transportation in West Africa, where checkpoint officials on the road stop truck drivers for petty bribes. Exploiting a road system with two alternative corridors, our model predicts that checkpoints on the two competing corridors follow a Bertrand game as they set price equal to the marginal cost. Moreover, when there is extra cost to pass through one corridor, checkpoints on the other corridor raise prices as more drivers choose them. We implement a difference-in-differences model to confirm that a road construction does increase both bribes and enforced delays for stops on the unaffected corridor. Our paper points out the importance of competition among corrupted officials to facilitate citizens to get public services. Moreover, it shows that the effectiveness of an anti-corruption policy can be offset by officials beyond the scope of the policy.

1 Introduction

In the developing world, corruption is pervasive among public officials, politicians, and state-owned companies (Svensson, 2005). Despite its potential "grease the wheel" effect under the distortion caused by ill-functioning institutions (Leff, 1964; Méon & Sekkat, 2005), the prevalence of corruption can cause large dead weight loss as profit is spent bidding a license to do business rather than raising productivity (Tullock, 2001; Shleifer & Vishny, 1993). Apart from corruption taking place in large public projects, developing countries also see widespread petty corruption that affects citizens and the private sector on a daily basis. Such corruption usually involves small bribery payments to low level officials to expedite services or continue operating a business (Carr & Jago, 2014). Though vital to people's daily life and economic efficiency, petty corruption is relatively less explored in the current literature.

In West Africa, policy makers have been paying special attention on the rampant petty corruption that takes place in the transport sector. Along inter-state highway corridors, long-haul drivers frequently encounter checkpoint stations where they are forced to pay bribes to proceed without enforced delay. Such extra transportation costs negatively affect regional trades (Nayo & Egoumé-Bossogo, 2011), international exports (Freund & Rocha, 2011), and even local investment in agricultural assets (Foltz & Bromley, 2013). Traditional interventions, including monitoring and rewarding good behavior, turn out to be unsuccessful to mitigate or even eliminate the highway bribery (Foltz & Opoku-Agyemang, 2015; Cooper, 2018). Such a resilient pattern of corruption behavior leads to a necessity to better understand how the market structure of bribes may determine the way corrupt officers compete with each other.

In this paper, we study how a petty corruption equilibrium on the West Africa's corridors arises from the strategic interactions among checkpoints. We argue that the spatial allocation of checkpoints determines the way checkpoint officials compete for driver-customers. By exploiting an episode of road construction on the dual road corridors between Bamako (the capital of Mali) and Ouagadougou (the capital of Burkina Faso), we are able to test this model of strategic interactions. Specifically, starting from Ouagadougou, the two corridors proceed by sharing a single route. They then separate into two parallel roads after departing from the city Bobo-Dioulaso (Bobo), and eventually re-merge in the destination city of Bamako. Such a road structure makes checkpoints on the two parallel segments between Bamako and Bobo competitors with each other for long-haul driver-customers. Economic theory expects that such a competition will lead to lower payment on the two non-shared segments.

We further study how the strategic interactions among checkpoints change with the market structure by exploiting an exogenous shock to one non-shared segment. From November 2009 to March 2012, the Malian government launched a road construction project on one non-shared segment, which exacerbates the road condition on that route. We hypothesize that the extra cost to pass through one route will push drivers to choose the alternative road. As a result, checkpoints on the other road gain extra bargaining power against drivers and therefore extort more from them.

We demonstrate the ideas above through a model featured by Cournot-style competition and a time-consuming bargaining process between officials and drivers. In the model, each checkpoint posts a package of price and time to "attract" drivers who have idiosyncratic reference points to pay for a stop. A driver can immediately pass the checkpoint if agreeing to pay the posted price. Otherwise, he has to wait for the posted time. The bargaining process ends after the enforced delay with a payment of the driver's reference point to the official. The aggregate quantity (flow) of drivers on the road is negatively dependent on the aggregated price and delay.

The model predicts a unique Nash equilibrium where checkpoints on the two non-shared segments both set price and time to be 0. On the other hand, the checkpoint on the shared segment behaves as a monopolist. When there is an extra cost going through one segment, both the posted bribe and time on the competing segment increase, indicating an increasing in the bargaining power of that segment. Moreover, the total cost (cash plus time) on the shared segment decreases. In summary, the model predicts a a redistribution of corruption benefits from those deterred by the road construction to those who are not affected after checkpoints adapt to the market's changed structure.

We then implement a difference-in-differences framework to test the model's predictions. Specifically, we evaluate how illegal payments & delays changes in other segments relative to the segment under the road construction. We use data collected by the USAID's West Africa Trade Hub, which survey drivers on six main corridors sprawling in West Africa. For each stop they encountered along the journey, the surveyed drivers recorded both the money paid and the time waiting. Consistent with the model predictions, we find that both the bribes and the minutes delayed on the unaffected non-shared segment increase during the period of the road construction, relative to those on the affected non-shared segment. Meanwhile, we find that the total cost on the shared segment decreases during the period of the road construction, relative to those on the non-shared segment of the same corridor.

We further validates the model predictions by evaluating the heterogeneous effects of the road construction by rainfall level. During periods of heavy rainfall, drivers experience more inconvenience when choosing the segment undergoing the road construction because the road becomes more muddy and rivers become harder to cross. Therefore, checkpoints on the other segment gain more bargaining power against drivers in the rainy season compared to that in a dry season. Conducting a triple-difference model, we do find that drivers pay more and stay longer on the other non-shared segment on rainy days, relative to dry days. Moreover, they pay less and experience fewer delays on the shared segment on rainy days, relative to dry days.

Our paper relates to three streams of literature. First of all, it contributes to the literature exploring the economics logic of highway corruption in developing countries. In their pioneering work, Olken & Barron (2009) show that highway corruption is subject to industrial organization theory as checkpoints extort more when there are fewer competitors along the same road using data from Indonesia. Oki (2016) finds evidence that the bribe level is associated with road traffic and rainfall through the same set of our data. Our paper differs from existing literature by emphasizing the importance of checkpoints' locations to shape spatial equilibrium and by showing how the way checkpoints compete with each other is determined by such spatial allocations. To our knowledge, it is the first attempt to link spatial competition to corruption outcomes in related studies.

Secondly, the paper relates to works on the effectiveness of anti-corruption policies in general. Current literature finds evidence that traditional interventions like monitoring, awarding, and punishment can effectively reduce corruption by changing the expected utility of corrupted officials (Olken, 2007; Duflo et al., 2012; Fisman & Miguel, 2007; Tella & Weinschelbaum, 2008). However, those traditional interventions turn out to be mostly unsuccessful in the West Africa: Cooper (2018) finds null effects of being "monitored" by a foreigner on checkpoint officials' extortion behavior using a field experiment along West African highways. Meanwhile, Foltz & Opoku-Agyemang (2015) evaluate if extra rewards can reduce petty corruption leveraging a policy by the Ghana government to double its police officers' salaries in 2010. Surprisingly, they find out that Ghanaian police collect more bribes after the policy, relative to customs officers and police in control countries. Our paper contributes to the literature by providing an explanation to the resilient pattern of highway corruption. We argue that an important factor to the robust positive corruption outcome is the strategic interactions between checkpoints. We show this by exploiting an intervention which leads to a reduction in competition level and find that competitors that are unaffected by the intervention increase their extortion from drivers.

Moreover, the paper argues that a local intervention against corruption can bring about unintended consequences, as there will be a redistribution of benefit from checkpoint officials that are affected toward those that are not (Maheshri & Mastrobuoni, 2019). We show that drivers facing extra cost passing through the road under construction are more inclined to choose the alternative route. As a result, officials on the alternative route gain extra bargaining power against drivers and thus extort more. We argue that policy makers should take the spillover effect into account as the redistribution of corruption benefit will certainly offset the effect of any local interventions.

Finally, the paper contributes to the theoretical literature on bargaining. Canonical bargaining models predict instantaneous deals in equilibrium (Rubinstein, 1982), which is not realistic to a settings, such as bargaining over bribes, where enforced delays are common. In the more recent literature, Yildiz (2003, 2004) builds a bargaining model that allows time delay in a bargaining process when both parties are excessively optimistic. However, it does not allow each party to endogenize the waiting time. Our work contributes to the literature by building a model which incorporates time as an endogenous choice made by checkpoint officials.

The remainder of the paper is organized as follows. Section 2 provides more background on the highway corruption in the West Africa. Section 3 presents a math model and deduces predictions to guide the empirical strategies. Section 4 describes the data. Section 5 presents empirical strategies and regression results. Section 6 concludes.

2 Background

2.1 Petty Bribes on Inter-state corridors in West Africa

In West Africa, long-haul merchandise transportation is realized through inter-state highway corridors, which are vital trade routes for landlocked countries such as Mali. A typical truck driver travels two or three days along a corridor to carry goods (oil, shipping containers, and general merchandise), from a port city to land-lock areas, and then takes goods back to the port for export.[1] En route, the driver frequently encounters checkpoints run by the military police (gendarmerie), police or customs officials, and is asked for some petty bribes in order to proceed. In most cases, an official on duty would stop the truck to check the driver's licence and registration papers. Once the official has these in hand, he threatens the driver to pay on the order of 2-3 US $ to get those

[1] Many trucks, for example oil trucks, area mostly or entirely empty on the return trip to the port. We account for the direction of travel in our estimates

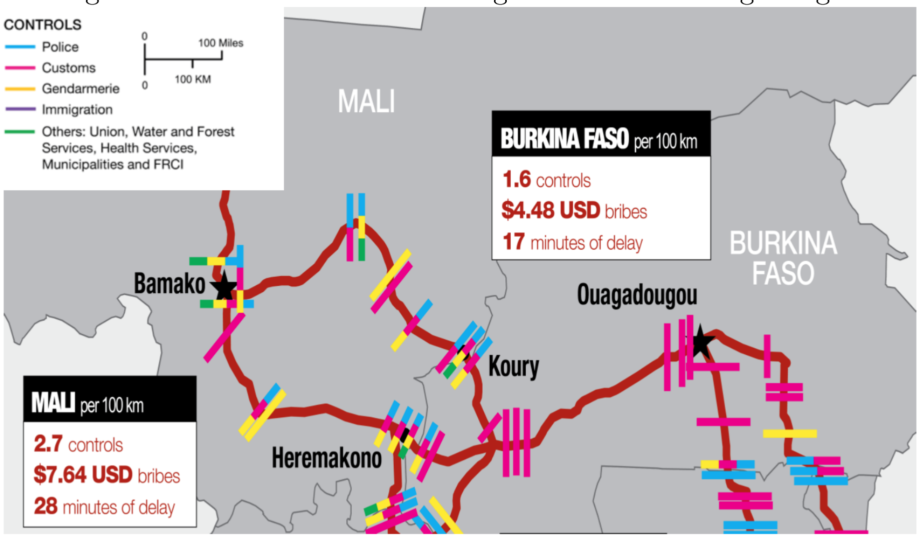
documents back. If the driver refuses to pay, he is forced to stay under excuses such as the papers are not in order or the truck is overweight, even though there is not mechanism to weigh the truck. Throughout the trip, the driver will be stopped 20 to 50 times, which causes 40 - 100 US $ in bribe payments and 2-3 hours enforced delay in total.

Experienced drivers have some knowledge about the “going rate” for each stop through long-term interactions with checkpoint officials. When stopped, they will simply include a payment when handing over the requested documents. As an equilibrium out of negotiation dynamics, the “going rate” at a checkpoint is determined by the bargaining power of two sides. Officials conduct price discrimination against drivers based on their observable features, including the country where the truck is registered (foreigners pay more), the type and weight of goods, and the trip’s direction (from or to the port). The guess usually works as a majority of drivers agree to pay the offered amount to proceed. On the other hand, when a driver has a lower willingness to pay and is patient enough, he can negotiate the price by taking up his time until his truck causes traffic. In some cases, the official gives up by extorting less or simply lets the driver go.

Checkpoints located at vital places tend to have higher bargaining power against drivers than others. Along a corridor, checkpoints are usually no more than a patrol car or a makeshift road-block. It is in contrast to those locating near the country borders and big cities’ entrances, where checkpoints are usually regular stations with parking lots. Officials running the latter type of check-points often charge higher “going rates” than those at the wildcat points because of their ability to stop trucks at parking lots to avoid traffic and because of a high demand for passing through those vital checkpoints.

In the paper, we analyze another spatial source that varies officials’ bargaining power against drivers: the competition between two parallel routes. Figure 1 illustrates the dual road system between Bamako and Ouagadougou. There are two corridors serving the needs of long-haul trans-portation between the two cities. Starting from Ouagadougou, the two corridors share a single segment of road until they reach Bobo, the second largest city in Burkina Faso. The two corridors then proceed as two separate routes and cross the state border through Koury and Hérémakono (Héré) respectively. They eventually re-merge in the destination city Bamako. The road system features two parallel segments to travel along (hereafter we will refer them as the non-shared *Koury* and the non-shared *Héré*), which makes checkpoints along the two non-shared segments competi-

Figure 1: Two corridors connecting Bamako and Ouagadougou



Sources: Borderless Aliance Road Governant Report

tors to each other for driver-customers. On the other hand, checkpoints on the shared segment conduct monopoly power against drivers because all of them have to pass through it.

In the following section, we deduce the Nash equilibrium of bribes and enforced delays for each segment. To evaluate how the change of bargaining power leads to the change of bribes and delays, we will exploit a road construction project occurring along the non-shared *Héré* segment, which is supposed to incur extra cost to proceed along this segment. The road construction was initiated by the Malian government in September 2009 to improve the road condition between Bougouni and Sikasso. The project involved rebuilding and paving the road and constructing multiple bridges, which are finally done in March 2012. During the construction period, in many of the portions from Bougouni to Sikasso, traffic was diverted off the road being repaired onto a plowed dirt track through the bush. Similarly, where bridges were being repaired, the dirt track would go down into the gully to cross small seasonal streams without a bridge. Thus, during construction the non-shared Héré road is of poorer condition for drivers to proceed because of the mud, dust, and potential to get a truck stuck in a stream crossing. We argue that the extra inconvenience cost pushes drivers to choose the other segment and thus increases the bargaining power of officials along the non-shared *Koury*.

3 Model

In this section, we develop a model to depict the bargaining process between drivers and checkpoint officials. We deduce both bribes and enforced delays as equilibrium outcomes out of competition between checkpoints. In the model, each checkpoint posts a package of price and waiting time for a driver to pass through it. A driver can select which routes to go when possible based on his valuation on cash and time cost. He can also choose to opt-out. One important feature of the model is that even though the waiting time is posted ex ante, a deal can still not be reached instantaneously. This feature relies on the fact that the checkpoint official cannot perfectly infer the willingness to pay of a random driver solely based his observable features. With asymmetric information, the official can raise the chance that a random driver agrees to pay immediately when receiving the initial offer using a threat to make the driver wait if he rejects. On the other hand, the official has to actually keep those who still refuse to pay waiting to make it a credible threat. The time-costly bargaining process produced from this model is in contrast to the instantaneous deal in classic bargaining models (Rubinstein (1982)), but is closer to the reality of this particular situation.

We first deduce the Nash equilibrium of bribes and enforced delays for the two non-shared segments and the shared segment respectively. To make the model tractable, we assume a single, monopolistic checkpoint at each segment.[2] We find that both the non-shared *Héré* and the non-shared *Koury* follows a Bertrand game as both charge no bribe and no enforced delay.[3] On the other hand, the checkpoint along the shared segment solves a monopoly optimization problem as it is the only player on the road setting positive going rate.

In the next step, we introduce an extra cost to pass through the non-shared *Héré* which reflects the effects of the road construction. The new Nash equilibrium features an increase in bribes and delays charged on the non-shared *Koury*, due to an increase in the bargaining power of the non-shared *Koury* relative to the non-shared *Héré*. The modeling reveals how the market adapts to a local action to deter corruption by displacing customers to another choice. Moreover, the model shows a decrease in total cost (cash plus time) to pass through the non-shared *Héré*. This result is

[2] Multiple checkpoints along each segment yield the same equilibrium.

[3] Notice here zero bribes and waiting time is only a metaphor that bribes and enforced delays will not be set higher than the marginal cost.

driven by the extra competition from the non-shared segments.

Formally, let's first consider a truck driver with an idiosyncratic willingness to pay b_0 to pass through a checkpoint immediately. The driver's reference point is a function of the driver's observable characteristics (the type of goods, the driver's nationality and education level), the trip's direction, the driver's willingness to pay, his budget constraint, and so on. Not all those characteristics are observable to a checkpoint official upon his arrival. As a result, the checkpoint official will infer the driver's willing to pay by a random variable ϵ which is distributed as $F(.)$. Without loss of generality, we will abstract away from all characteristics observable to the checkpoint official and only focus on ϵ.

Without asymmetric information, the checkpoint official requests all drivers to pay a price b in exchange for an immediate pass. If a driver rejects the offer, the official keeps him waiting at the checkpoint for time t. When the time expires, there will be an automatic deal where the driver ends up paying his reference point $b_0(\epsilon)$ and leave. The automatic deal reflects the fact that the official can perfectly figure out a driver's reference point during the waiting period, and that an official is reluctant to stop a driver for too long fearing the risk of blocking traffic and being caught.[4] Both the official and the driver suffers from a delay cost $c(t)$ and $v(t)$ respectively.[5]

To summarize, each checkpoint posts a package (b, t) to "attract" driver-customers. The official ends up extorting b immediately from drivers whose willing to pay satisfying $b < b_0(\epsilon) + v(t)$. He has to wait for time t and ends up obtaining payoff $b_0(\epsilon) - c(t)$ from drivers whose willing to pay satisfying $b > b_0(\epsilon) + v(t)$. As a result, the official has the following expected payoff from a random driver:

$$R(b,t) = \int_{b<b_0(\epsilon)+v(t)} b\, dF(\epsilon) + \int_{b>b_0(\epsilon)+v(t)} (b_0(\epsilon) - c(t)) dF(\epsilon)$$

We now consider the flow of drivers along the road. Denote q as the demand of drivers to travel a corridor within a very short period of time. It is negatively dependent on the sum of posted bribes $B = \sum b$ and delayed minutes $T = \sum t$ for all checkpoints they encounter along the corridor. In the simple case where there is one corridor and a single checkpoint on it, drivers have no other option

[4]While enforcement levels are low, an official increases the probability of being caught by creating visible sign of his behavior such as a traffic jam.

[5]Since the delay time at each stop is less than an hour we do not use discount rates, but rather utility reductions to capture the opportunity cost of delay.

for long-haul travel. The monopolist checkpoint sets both posted bribes and time to maximize the revenue as follows.

$$\max_{b,t} q(b,t)[\int_{b<b_0(\epsilon)+v(t)} bdF(\epsilon) + \int_{b>b_0(\epsilon)+v(t)} (b_0(\epsilon) - c(t))dF(\epsilon)\,] \tag{1}$$

In the setting of two competing corridors with part of the segments overlapping (as illustrated by figure 2), drivers gain bargaining power against checkpoint officials who face the competition from counterparts along the alternative segment. The driver selects one road segment based on the packages offered by two roads. Denote the package offered by the non-shared *Koury*, the non-shared *Héré* and the shared segment as (b_k, t_k), (b_h, t_h), and (b_s, t_s) respectively. We can infer that drivers whose reference point satisfies $b_0(\epsilon) > \max\{b_k - v(t_k), b_h - v(t_h)\}$ will choose to enter the segment offering $\min\{b_k, b_h\}$. A thorough enumeration of the driver's choice problem can be found in the appendix B.1.

Proposition 1. *Under the market illustrated by the figure 2, there is a unique Nash Equilibrium as follows:* $(b_k, t_k) = (b_h, t_h) = (0, 0)$*, and the shared checkpoint sets* (b_s, t_s) *to maximize the objective function (1).*

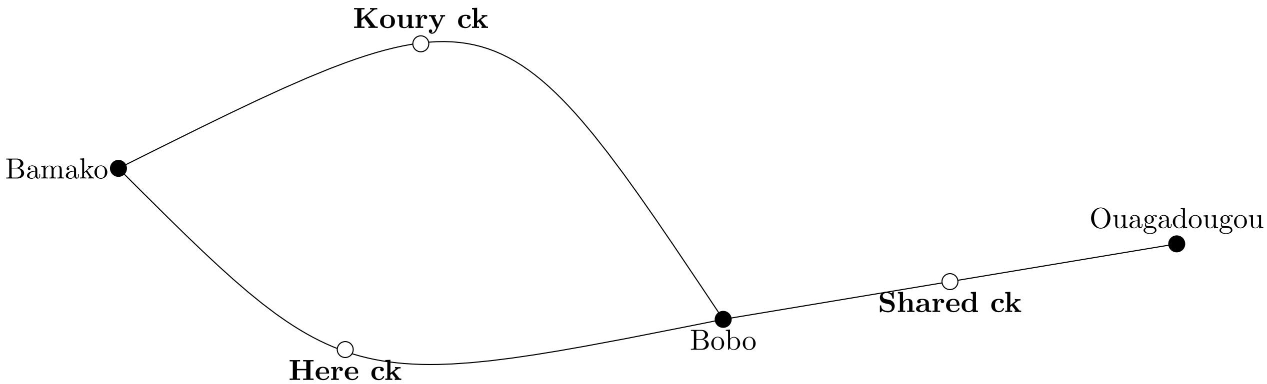
Proof. See Appendix B.1 ■

In essence, proposition 1 reveals that the competition between the non-shared *Koury* and the non-shared *Héré* checkpoints follows a Bertrand game: The two players keep lowering their prices to attract customers until they can no longer make any profit. In this case, both *Koury* and *Héré* checkpoints have no bargaining power against drivers at all. Meanwhile the shared checkpoint acts as a *de facto* monopolist. It sets posted prices and waiting time by solving the optimizing equation 1.

Now we introduce an extra inconvenience cost w if the driver uses the non-shared *Héré* to transport merchandise. The change of the equilibrium on each segment is depicted by proposition 2.

Proposition 2. *With road construction occurring on the non-shared Héré, the Nash Equilibrium on the non-shared Héré is still (0,0). For the non-shared Koury, both the posted bribe* b_k *and time*

Figure 2: Roads between Bamako and Ouagadougou



t_k increase. For the shared segment, the total cost (cash plus time value) decreases. However, it's ambiguous which one (bribe or time) decreases without further assumption on the functional forms.

Proof. see Appendix B.2 ■

It is not surprising that both bribes and enforced delays increase on the non-shared *Koury* segment. With a package such that $\min\{b_0(\epsilon) + v(t_k), b_k\} < \min\{b_0(\epsilon) + v(t_h), b_h\} + w$, the *Koury* official can keep attracting all drivers away from the *Héré* segment. On the other hand, the total cost passing through the shared segment decreases because of extra competition from the *Koury* segment as it starts to charge positive bribes. The model cannot explicitly tell us whether it's bribe or time or both that drop, without further assumptions on the functional forms. For example, both posted bribe b_s (or t_s) on the shared segment will decrease when the flow of drivers $q(B, T)$ is linear with B and T, and that the elasticity of $R(b, t)$ with respect to b (or t) is a decreasing function of b (or t).

To summarize, the model reveals that competition along two parallel roads can facilitate long-haul transportation as they will reduce bribes to attract drivers. On the other hand, a reduction in competition caused by the road construction on the *Héré* pushes drivers to the *Koury* corridor, which leads to a redistribution of bribes towards checkpoints unaffected by the road construction. In the section 5, we will test the model predictions through a difference-in-differences framework. We compare the change of bribes on the non-shared *Koury* following the road construction, to that on the non-shared *Héré*.

4 Data Context

4.1 Bribes and Enforced Delays along the road

Our data on bribes and enforced delays comes from the Improved Road Transport Governance (IRTG) project sponsored by USIAID's West Africa Trade Hub. From 2006 to September 2012, the study team surveyed over 10,000 truck drivers along six main inter-state corridors sprawling across West Africa. The drivers recorded bribes paid and enforced delays at more than 250,000 stops. Local enumerators surveyed drivers in the following way: At the beginning of to a trip, they would approach the truck driver in ports or inland depots and asked if the driver was willing to take the survey. If so, the driver would be given a survey and he would record money paid and minutes delayed each time he were stopped along the journey. In the end of the trip, another team of enumerators would collect these surveys.

The enumerator team only surveyed long-haul drivers that traveled across a whole trade route. Moreover, it only surveyed those drivers with all their papers for the truck and cargo in order. Focusing on legitimate drivers excludes the cases where drivers with illegal papers, trucks, or cargo seek to pay more in order to proceed. The data thus provides a lower bound estimate of bribes actually paid by all trucks. According to Bromley & Foltz (2011), who discussed procedures with the enumerators, the drivers being surveyed represented about one third of the long–haul trucks on these routes.

Since the data accuracy relies on honest self reports from drivers, there could be concerns whether drivers systematically concealed or exaggerated bribery activities along the journey. According to Oki (2016) and Salisbury et al. (2018), under-reporting is very rare since road bribery is so common that it is not a taboo topic of discussion. Another concern is that drivers might over-report the bribery to voice their complaints. This is unlikely to be a major issue in our setting though, since we focus on relative, rather than absolute, level of bribery. It is not likely that the extent to which drivers exaggerate bribery vary across segments and/or over time.

In the setting of our paper, we make use of the data on two corridors connecting Bamako and Ouagadougou. We further narrow down the sample starting from one year prior to the end of the road construction project, since we have a short post-period (March 2012 - September 2012). Table 1 shows the summary statistics both at the stop level (Panel A) and the trip level (Panel B).

The pattern of bribery activities share very common features between these two corridors: A stop at a checkpoint typically involves a payment of more than 1700 CFA franc (3 US dollars) and an enforced delay of more than 7 minutes. A whole trip on average takes 41,000 - 45,000 CFA franc (67 - 74 US dollars) as well as three hours of enforced delay, through 23 - 25 stops. Meanwhile, drivers traveling along one of two corridors share very similar characteristics. For example, almost all drivers encountered a stop in their home country (0.98 for both corridors).

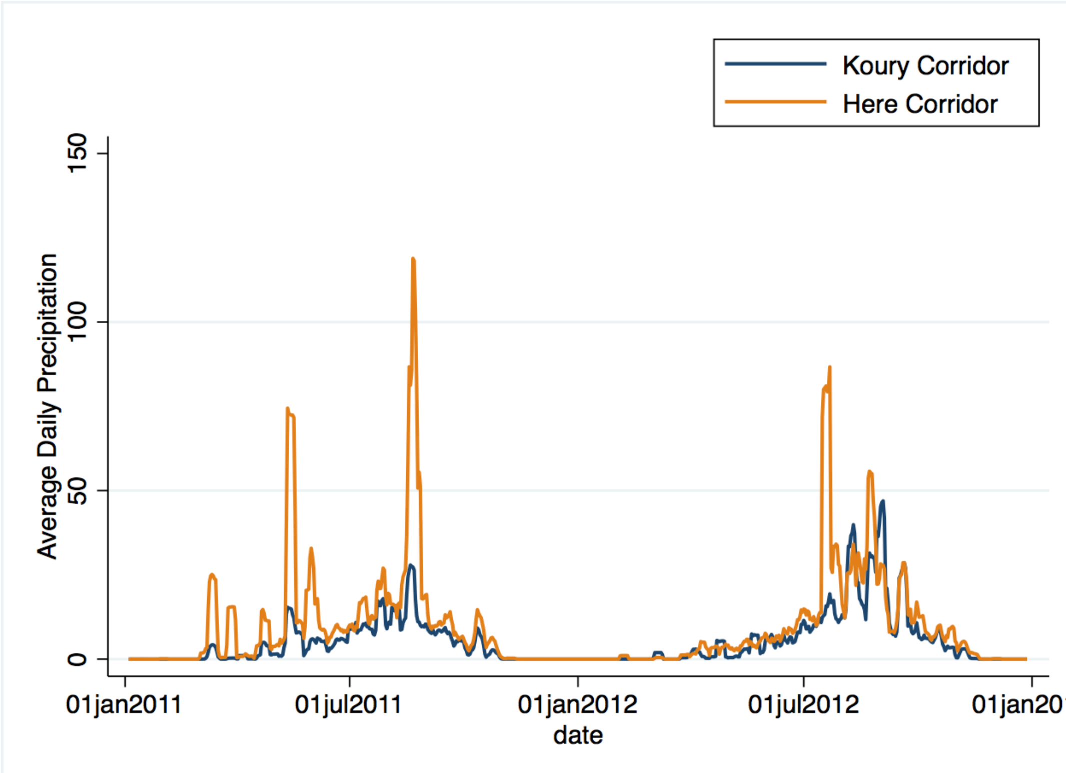
Table 1: Summary Statistics

	Koury Corridor			Here Corridor		
	Mean	S.D.	N	Mean	S.D.	N
Panel A: Stop-level						
Bribes, CFA franc	1754.62	1832.70	10305	1741.07	1916.73	12061
Enforced Delay, min	7.74	8.40	10305	7.39	9.79	12061
Driver in own country	0.98	0.15	10305	0.98	0.13	12061
Vehicle in country of registration	0.36	0.48	10305	0.40	0.49	12061
Any holiday time	0.14	0.35	10305	0.15	0.35	12061
Panel B: Trip-level						
Total bribes, CFA franc	45545.09	23689.76	397	41336.61	23749.72	508
Total enforced delays, min	200.93	90.22	397	175.54	105.82	508
Number of stops in a trip	25.96	6.81	397	23.74	7.79	508
Weight vehicle	17.75	3.73	396	17.84	3.79	507
Mechandise weight	39.11	11.53	394	38.66	11.73	503
type_veh==Container	0.02	0.15	397	0.02	0.14	508
type_veh==Tanker	0.01	0.07	397	0.01	0.10	508
edu==Primary	0.75	0.43	397	0.77	0.42	508
edu==JSS	0.19	0.39	397	0.19	0.39	508
edu==SSS or higher	0.01	0.07	397	0.00	0.04	508
Whether from port city?	0.55	0.50	397	0.44	0.50	508

4.2 Daily Precipitation in Mali

While the construction on the Héré corridor produced additional costs, these costs, especially the chance of getting stuck in the mud for extended periods, will be highest during the rainy season and most acute during actual rainy days. Without knowing the exact extra costs of passing through the Héré corridor in a rainstorm, we use rainfall level as a proxy. It is because the rainfall will disproportionately exacerbate the condition of the road segment that are under construction. We expect checkpoints on the non-shared *Koury* gain more bargaining power against drivers on rainy days, compared to dry days.

Figure 3: Average daily precipitation of Mali communes that the two corridors pass through



We collect rainfall data from the Modern-Era Retrospective analysis for Research and Applications (MERRA-2) at NASA website. The data provides daily precipitation (unit mm) for each commune of Mali. We merge the bribe data with the rainfall data through the commune where a checkpoint is located. We measure only daily precipitation in Mali, because most of the two shared segments are within Mali. Moreover, the road construction is only targets routes within Mali.

Figure 3 presents the daily precipitation for all communes along the two corridors respectively. There is noticeable variation in term of precipitation seasonally. The dry season (October - May) sees almost no rainfall, while the rainy season (June - September) can have a commune-level precipitation as high as 100 mm per day. In the regression analysis, the rainfall level will be a proxy of road condition on the *Héré* corridor as segments that are not well paved become much more muddy, stream crossings become treacherous, and trucks run the risk of getting stuck in the mud for extended periods of time.

5 Empirical Strategy & Results

In this section, we estimate difference-in-difference models to evaluate the two predictions by the model: (1) there is an increase in both bribes and time delayed on the non-shared *Koury* during the road construction, relative to those on the non-shared *Héré*; and (2) there is a decrease in the total cost (bribe plus time) on the shared segment during the road construction, relative to those on the non-shared *Héré*. We discuss about the empirical specifications and present results for these two predictions in the following two subsections. In subsection 5.3, We show results by a triple-difference model which uncovers the heterogeneous effects of the road construction by rainfall levels. In line with the model's predictions, higher levels of inconvenience on non-shared the Héré section induced by rainfall should heighten predictions (1) and (2). In the last subsection, we test the parallel trend assumption by conducting an event study.

5.1 Non-shared Koury vs. non-shared Héré

We compare the two non-shared segments by estimating the following difference-in-differences model:

$$Y_{ict} = \beta \mathbb{1}\{Construction\} \times \mathbb{1}\{Koury\} + X_t'\gamma + \theta_c \times \delta_d + \eta_m + \sigma_r \times m + \epsilon_{ict} \tag{2}$$

The regression uses stop observations that take place along the two non-shared segments only. The dependent variable Y_{ict} refers to the bribes paid or minutes delayed during a stop i at checkpoint c along a trip t. We are interested in the coefficient β of the interaction term $\mathbb{1}\{Construction\} \times \mathbb{1}\{Koury\}$, where $\mathbb{1}\{Construction\}$ equals to 1 if the trip is before March, 2012, and $\mathbb{1}\{Construction\}$ equals to 1 if the trip takes place the *Koury* Corridor. The coefficient β identifies the change of stop-level bribes (minutes) on the *Koury* following the road construction, relative to the that on the *Héré*. We add in the model a vector of trip-level characteristics X_t, which includes weights and types of vehicles and merchandise, a driver's nationality and education level, and holiday indicators. We further control for checkpoint-level heterogeneity by checkpoint-direction fixed effects $\theta_c \times \delta_d$, and control for time trends through month fixed effects η_m as well as route-specific linear monthly trends $\sigma_r \times m$. The standard errors are clustered at checkpoint-authority level.

Table 2 presents results of the equation (2). The first two columns use bribe level as the dependent variable, and the last two enforced delay. The odd numbered columns show results without controls, while the even numbered ones show those with. To summarize, we find that the road construction increases both the bribes and minutes delayed on the *Koury* segment, relative to the *Héré* segment. As shown by column (2), the road construction increases the payment at a stop along the *Koury* segment by 560 CFA franc (about 1 US dollar), relative to the change of bribes in the *Héré* segment. The increase is of great magnitude as it consists of more than 30% of the outcome mean. Meanwhile, column (4) shows that a driver spends 2.1 minutes more during a stop along the *Koury*, relative to the change of enforced delay along the *Here*. The number means an extra 26% time waiting compared to the mean delay time.

Table 2: The effect of the road construction on bribes & enforced delays on the *Koury* corridor, using stop level data

	Bribes (CFA)		Enforced Delay (min)	
	(1)	(2)	(3)	(4)
Road Construction × Koury	540.800***	560.727***	1.917***	2.092***
	(166.014)	(170.143)	(0.449)	(0.469)
Truck & merchandise types		×		×
Driver Characteristics		×		×
Holiday		×		×
Checkpoint-Direction FE	×	×	×	×
Month FE	×	×	×	×
Corridor-specific Time Trends	×	×	×	×
N	18973	18805	18973	18805
R^2	0.556	0.565	0.634	0.639
Outcome Mean	1856.839	1857.474	7.859	7.886

*** 0.1 ** 0.05 *** 0.01**

Notes: The unit of observation is a driver's stop at a checkpoint during a certain trip. Truck & merchandise types include weight of vehicle, weight of merchandise, whether the vehicle is at the registration country, whether the vehicle is a container, and whether the vehicle is a tanker. Driver characteristics include whether the driver is at home country, and her education level. Holiday is a dummy indicating whether the stop date is a holiday. Standard errors are clustered at checkpoint-authority level and shown in parentheses.

We also evaluate the change of bribes on the *Koury* segment using an alternative specification (3) which is at the trip level. The specification involves first aggregating bribes and enforced delays up to the trip level, and then regressing them on the same set of variables shown in the equation

(2). For controls that are not constant along a trip, we generate their trip-level counterparts by picking its maximum value.[6]

$$Y_t^{aggr} = \beta \mathbb{1}\{Construction\} \times \mathbb{1}\{Koury\} + X_t' \gamma + \sigma_r \times \delta_d + \eta_m + \sigma_r \times m + \epsilon_t \tag{3}$$

In equation (3), β identifies the change of total bribes (minutes) on the *Koury* following the road construction, relative to the change of that on the *Héré*. We now control for corridor-level heterogeneity through corridor-direction fixed effects $\sigma_r \times \delta_d$, and control for time trends through month fixed effects η_m and corridor-specific linear monthly trends $\sigma_r \times m$. Here we estimate Heteroskedastic standard errors instead since trips are fairly independent to each other.

The trip level specification serves as a robustness check to the stop level one. Moreover, it avoids a potential concern about checkpoint selection. In some cases, checkpoints are no more than a patrol car or a makeshift roadblock. Those flexible checkpoints can easily exit and enter the market from time to time. When analyzing a stop-level regression with checkpoint fixed effects, only checkpoints that appear both during and after the road construction contribute variation to the estimation of β, which might cause some bias if checkpoints' exit decisions are associated with the road construction. The trip-level specification avoids the problem by adding up all those exit decisions as zeros.

Table 5 presents results for the equation (3). In general we find a similar pattern to that in Table 4. Specifically, column (2) shows that the road construction increases the total payment along the *Koury* segment by 7316 CFA franc (12 US dollar), relative to the change of total bribes in the *Héré* segment. The increase consists of 18% of the outcome mean. Meanwhile, column (4) shows that a driver spends 24 minutes more in total along the *Koury*, relative to the change of total enforced delay along the *Héré*. It means extra 15% time waiting compared to the outcome mean. All estimates are statistically significant at least at a 10 percent level.

[6]There are three such variables: Whether the truck is in the country of registration, whether the driver is in the home country, and whether the stop date is a holiday. Take the first variable as an example, we define its counterpart at trip level as a dummy if the truck is ever in the country of registration during the trip.

Table 3: The effect of road construction on bribes & enforced delays on the *Koury* corridor, using trip level data

	Bribes (CFA)		Enforced Delay (min)	
	(1)	(2)	(3)	(4)
Road Construction × Koury	8639.388**	7316.769*	26.121*	24.296*
	(4182.448)	(3942.306)	(13.396)	(13.153)
Truck & merchandise types		×		×
Driver Characteristics		×		×
Holiday		×		×
Corriodor-Direction FE	×	×	×	×
Month FE	×	×	×	×
Corridor-specific Time Trends	×	×	×	×
N	905	895	905	895
R^2	0.831	0.854	0.896	0.900
Outcome Mean	38937.901	39038.883	164.796	165.724

*** 0.1 ** 0.05 *** 0.01**

Notes: The unit of observation is a unique trip. Truck & merchandise types include weight of vehicle, weight of merchandise, whether the vehicle is ever at the registration country during the trip, whether the vehicle is a container, and whether the vehicle is a tanker. Driver characteristics include whether the driver is ever at home country during the trip, and her education level. Holiday is a dummy indicating whether there is any holiday during the trip. Standard errors are heteroskedastic and shown in parentheses.

5.2 Shared Héré vs. Non-shared Héré

We implement specification (4) to evaluate how the bribe level and enforced delay on the shared segment change with the road construction.

$$Y_{ict} = \beta \mathbb{1}\{Construction\} \times \mathbb{1}\{Share\} + X_t' \gamma + \theta_c \times \delta_d + \eta_m + \epsilon_{ict} \tag{4}$$

The regression uses stop observations from trips that go through the *Héré* corridor. The dummy $\mathbb{1}\{Share\}$ equals to 1 if a stop takes place on the shared segment. The dummy $\mathbb{1}\{Construction\}$ equals to 1 if the trip is before March 2012. The coefficient of the interaction term β identifies the change of stop-level bribes (minutes) on the shared segment following the road construction, relative to the change of that on the non-shared *Héré*. Again we include trip-level characteristics X_t, checkpoint-direction fixed effects $\theta_c \times \delta_d$, and month fixed effects η_m. There is no corridor-specific time trends since now we only use one corridor for analysis.

Table 4 presents results of the equation (4). The first two columns use bribes as the dependent variable (without and with controls), while the last two columns use enforced delay. We find expected signs from the first two columns' coefficients, however, they are not statistically significant. In contrast, we find statistically significant effects of the road construction on enforced delays on the shared segment, and it decreases the time waiting by a bit less than 1.5 minutes (shown by both column (3) and (4)), relative to the change of enforced delay in the non-shared segment. The time reduction consists of 19% of the outcome mean. Consistent with the second model's prediction, the total cost (bribe plus time delay) is reduced on the shared segment relative to the non-shared segment when the road construction takes place.

Table 4: The Effect of the road construction on bribes & enforced delays on the shared segment, using stop level data

	Bribes (CFA)		Enforced Delay (min)	
	(1)	(2)	(3)	(4)
Road Construction × Share	-62.253 (103.500)	-53.644 (104.297)	-1.492*** (0.406)	-1.462*** (0.401)
Truck & merchandise types		×		×
Driver Characteristics		×		×
Holiday		×		×
Checkpoint-Direction FE	×	×	×	×
Month FE	×	×	×	×
N	12057	11938	12057	11938
R^2	0.187	0.204	0.321	0.326
Outcome Mean	1741.312	1741.498	7.395	7.427

*** 0.1 ** 0.05 *** 0.01**

Notes: The unit of observation is a driver's stop at a checkpoint during a certain trip. Truck & merchandise types include weight of vehicle, weight of merchandise, whether the vehicle is at the registration country, whether the vehicle is a container, and whether the vehicle is a tanker. Driver characteristics include whether the driver is at home country, and her education level. Holiday is a dummy indicating whether the stop date is a holiday. Standard errors are clustered at checkpoint-authority level and shown in parentheses.

Similarly, we also implement a trip-level counterpart of equation (4) as a robustness check. The dependent variable now is bribes or enforced delays aggregated up to the segment level (the shared segment and the non-shared segment).

$$Y_{st}^{aggr} = \beta \mathbb{1}\{Construction\} \times \mathbb{1}\{Share\} + X_t'\gamma + D_s \times \delta_d + \theta_m + \epsilon_t \quad (5)$$

In the equation (5), we also include trip characteristics X_t. Moreover, we control for heterogeneity varying along the trip direction and the segment by including the shared-checkpoint fixed effects $D_s \times \delta_d$. We also control for common time trends through month fixed effects θ_m.

Table 5 presents results for the equation (5). In contrast to Table 4, we now find that both bribes and minutes delayed decrease on the shared segment when the road construction takes place. Specifically, the road construction leads to a reduction in bribes by 4205 CFA franc (7 US dollars), and enforced delays by 21 minutes on the shared segment, which represent 20% and 23% of the outcome mean respectively. These results suggest that there exists a checkpoint selection effect in this setting.

Table 5: The Effect of road construction on bribes & enforced delays on the shared segment, using trip level data

	Bribes (CFA)		Enforced Delay (min)	
	(1)	(2)	(3)	(4)
Road Construction × Share	-4341.775***	-4205.658***	-21.585***	-21.364***
	(1643.492)	(1608.062)	(6.345)	(6.313)
Truck & merchandise types		×		×
Driver Characteristics		×		×
Holiday		×		×
Share-Direction FE	×	×	×	×
Month FE	×	×	×	×
N	1001	989	1001	989
R^2	0.656	0.675	0.737	0.742
Outcome Mean	20978.022	21025.278	89.085	89.664

*** 0.1 ** 0.05 *** 0.01**

Notes: The unit of observation is a unique trip. Truck & merchandise types include weight of vehicle, weight of merchandise, whether the vehicle is ever at the registration country during the trip, whether the vehicle is a container, and whether the vehicle is a tanker. Driver characteristics include whether the driver is ever at home country during the trip, and her education level. Holiday is a dummy indicating whether there is any holiday during the trip. Standard errors are heteroskedastic and shown in parentheses.

5.3 Heterogeneous Effects during the Rainfall season

In this subsection, we implement a triple difference model to evaluate heterogeneous effects of the road construction on other road segments by rainfall level. Rainfall level serves as a proxy to the actual road conditions on the *Héré* corridor. It is because that the construction bypass roads that are poorly paved become much more muddy than those that are well-paved. Therefore, a journey taking place during a rainy season generates a higher inconvenience cost to the driver if he chooses the *Héré* corridor. By doing the triple-difference model, we expect a positive coefficient of the triple interaction term for regressions that compare the *Koury* corridor with the *Héré* corridor, and a negative one for regressions that compare the shared segment with the non-shared segment of the *Héré* corridor.

Table 6 presents the results for the comparison between the non-shared *Koury* and the non-shared *Héré* using stop level data. The *Precipitation* variable refers to the precipitation (measure by mm) of the commune where a driver is stopped on that date. It assumes that checkpoint officials and drivers on the *Koury* corridor infer the rainfall level on the *Héré* corridor based on the rain they are experiencing on their own road. Anecdotal stories shows that this is mostly the case in reality. When drivers and *Koury* officials observe a heavy rain, they would both agree that more drivers would choose *Koury* on that day, which increases the bargaining power of the *Koury* officials and therefore raise the going rate. According to column (2), an extra 10 mm increases in the daily precipitation (a small rainstorm) at the commune of a stop would further increase the bribes on the non-shared *Koury* corridor by 47 CFA. Since the precipitation in Mali ranges from almost 0 in a dry season to 50-100 mm in a rainy season, the extra bribe per stop during a trip in July could be 200-400 CFA more than that taking place during a trip in January. The extra cost accounts for 10-20 percent of the average bribe per stop. On the other hand, we don't find differentiated effects of rainfall on the enforced delay. It might be due to the fact that both drivers and officials are unwilling to stay too long negotiating in the rain.

Table 6: Heterogeneous effects on bribes & enforced delays on the *Koury* corridor by rainfall level, using stop level data

	Bribes (CFA)		Enforced Delay (min)	
	(1)	(2)	(3)	(4)
Road Construction × Koury	560.727***	648.364***	2.092***	1.652***
	(170.143)	(180.402)	(0.469)	(0.495)
Road Construction × Koury × Precipitation		4.721*		-0.007
		(2.803)		(0.010)
Koury × Precipitation		2.787		-0.011
		(2.434)		(0.011)
Precipitation		-0.481		0.003
		(0.383)		(0.003)
Truck & merchandise types	×	×	×	×
Driver Characteristics	×	×	×	×
Holiday	×	×	×	×
Checkpoint-Direction FE	×	×	×	×
Month FE	×	×	×	×
Corridor-specific Time Trends	×	×	×	×
N	18805	15361	18805	15361
R^2	0.565	0.556	0.639	0.598
Outcome Mean	1857.474	1808.977	7.886	7.115

*** 0.1 ** 0.05 *** 0.01**

Notes: The unit of observation is a driver's stop at a checkpoint during a certain trip. Truck & merchandise types include weight of vehicle, weight of merchandise, whether the vehicle is at the registration country, whether the vehicle is a container, and whether the vehicle is a tanker. Driver characteristics include whether the driver is at home country, and her education level. Holiday is a dummy indicating whether the stop date is a holiday. Standard errors are clustered at checkpoint-authority level and shown in parentheses.

Table 7 presents results for the comparison between the shared segment and the non-shared segment of the *Héré* corridor. Since we are only using Mali precipitation data, it's inappropriate to use daily stop level precipitation for checkpoints out of Mali. Therefore, we do it at trip level as in Table 5. The new *Precipitation* variable is now the average precipitation of all stops a driver ever encounters in the Mali part. According to column (2) and (4), an extra 1 mm increase in the average precipitation on the Malian *non-shared* segment leads to a decrease in the segment-total bribes by 113 CFA (column 2) and in the enforced delays by more than a half minutes (column 4). If the trip-average precipitation increases by 30 mm, then the extra reduction of bribes and enforced delays is almost equivalent the base reduction in a dry season (see the first coefficient of the column 2 and column 4). The results are consistent with the model prediction that checkpoints on the shared segment reduce extortion in general due to extra competition from the non-shared segment when there is the road construction.

Table 7: Heterogeneous effects on bribes & enforced delays on the shared segment by rainfall level, using trip level data

	Bribes (CFA)		Enforced Delay (min)	
	(1)	(2)	(3)	(4)
Road Construction × Share	-4205.658***	-3434.248**	-21.364***	-21.186***
	(1608.062)	(1682.114)	(6.313)	(6.565)
Road Construction × Share × Average Prcp		-113.956*		-0.547*
		(60.209)		(0.297)
Share × Average Prcp		21.488*		-0.123
		(11.971)		(0.082)
Average Prcp		-19.577		0.113
		(12.424)		(0.078)
Truck & merchandise types	×	×	×	×
Driver Characteristics	×	×	×	×
Holiday	×	×	×	×
Share-Direction FE	×	×	×	×
Month FE	×	×	×	×
N	989	978	989	978
R^2	0.675	0.682	0.742	0.746
Outcome Mean	21025.278	21243.354	89.664	90.564

*** 0.1 ** 0.05 *** 0.01**

Notes: The unit of observation is a unique trip. Truck & merchandise types include weight of vehicle, weight of merchandise, whether the vehicle is ever at the registration country during the trip, whether the vehicle is a container, and whether the vehicle is a tanker. Driver characteristics include whether the driver is ever at home country during the trip, and her education level. Holiday is a dummy indicating whether there is any holiday during the trip. Standard errors are heteroskedastic and shown in parentheses.

5.4 Event Studies to test Parallel Trends

The validation of the difference-in-differences estimation relies on the assumption of stability in the outcomes in the absence of the treatment. In our setting, this would imply that the two corridors should not differ in trends of bribes and enforced delays when there was no road construction. Unfortunately we do not have data from before the road construction, so we implement an ex-post test. We implement the test for this assumption in this subsection using the available data.

Below is the event study specification (6) that tests the parallel trend assumption for the non-shared *Koury* and the non-shared *Héré*. In this specification, we interact the *Koury* indicator with a set of quarter dummies starting from the first quarter in 2011 to the third quarter of 2012. Unlike usual event studies which conduct placebo test by looking at the statistical significance of coefficients before a treatment takes place, here the periods used to test parallel trends are those after the road construction finishes (the second and third quarter in 2012). This is because the data collection on these two corridors only started after the road construction began.

$$Y_{ict} = \sum_{q=-4}^{2} \beta_q \mathbb{1}\{quarter\ q\} \times \mathbb{1}\{Koury\} + X_t'\gamma + \theta_c \times \delta_d + \eta_m + \sigma_r \times m + \epsilon_{ict} \tag{6}$$

In equation (6), the dummy $\mathbb{1}\{quarter\ q\}$ equals to 1 if a trip takes places in quarter q. $q = -4$ refers to the first quarter in 2011, while $q = 2$ refers to the third quarter in 2012. We normalize the coefficient for the second quarter in 2012 to be 0 (i.e., quarter 1). If the ex-post parallel trend assumption holds, the coefficient for the third quarter in 2012 (quarter 2) should be statistically insignificant.

Figure 4 presents coefficients of different quarters when the dependent variable is the bribe level. The x-axis label "11m1-3" refers to the first quarter in 2011, and so on. We find that the coefficient of the third quarter in 2012 is indeed statistically insignificant. Moreover, it is smaller in magnitude compared with others. Both findings validate as best we can with the available data the parallel trend assumption. The coefficients of quarters before the end of the road construction are mostly positive and statistically significant. More interestingly, there is a decline in magnitude for those coefficients as the inauguration date of the new road approaches. It indicates that the effect of road construction on corruption diminishes gradually as the conditions on the non-shared *Here* segment of road improves. For example, the bridge repairs likely finished months before the final paving of the whole route were complete. As a result, officials along the *Koury* corridor lose bargaining power against drivers as the costs of driving on the non-shared *Here* segment diminish.

Figure 5 provides counterpart results to figure 4 using minutes delayed as the dependent variable. Similarly, we find a small and statistical insignificant coefficient for the third quarter in 2012. Moreover, there is a even more clear pattern of diminishing effect of the road construction as we approach the final completion of the road repairs.

In the appendix A, we further show event study figures that test the parallel trend assumption between the shared segment and the non-shared segment of *Here* corridor as well. Figure 6 shows coefficients and confidence intervals using bribe level as the dependent variable. Again, we find a small and statistically insignificant coefficient for the third quarter 2012. We also find a statistically significant coefficient for the second quarter in 2011, after which the remaining coefficients are all statistically insignificant, again showing a declining trend of the effect. This is also the case in the figure 7, which uses the minutes delay as the dependent variable. In the figure 7, the coefficients from the second quarter in 2011 to the first quarter in 2012 become closer to 0 as time goes by, indicating a diminishing effect of the road construction on the shared segment in terms of enforced delay.

Figure 4: Event Study of the non-shared *Koury* vs. the non-shared *Here*, bribes

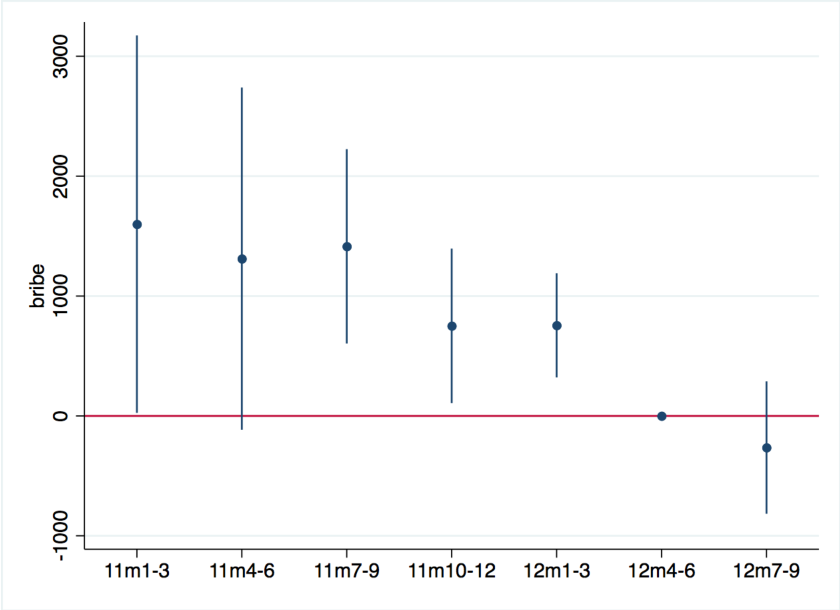
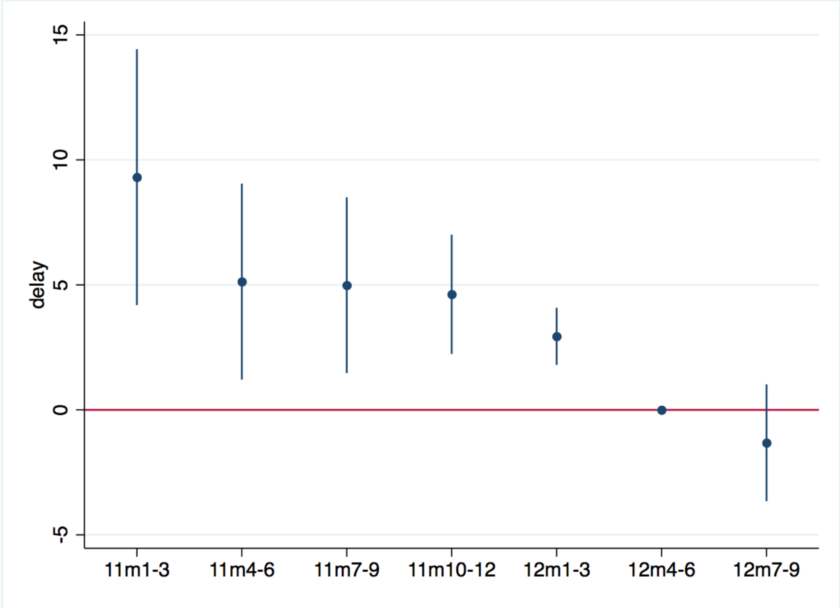


Figure 5: Event Study of the non-shared *Koury* vs. the non-shared *Here*, delays



6 Conclusion

In this paper, we argue that an important part of an effective anti-corruption intervention needs to be a better understanding to the market structure that shapes corruption behavior. We demonstrate this idea in the setting of highway corruption in West Africa, where long-haul drivers encounter frequent stops by checkpoint officials and are asked to pay petty bribes. We build a math model to depict the competition between checkpoints along a dual road system. The model endogenizes time of a bargaining process between checkpoint officials and truck drivers. It presents a more realistic version of bargaining where short-term delay is the primary of strategy of both sides, which tend to be very common in developing countries. Theoretically, it contributes to the literature as being the first model with endogenous negotiation time of bargaining.

Specifically, our model predicts a Bertrand-style equilibrium on the two competing corridors, where checkpoint officials on both roads set price and waiting time to be zero. We further exploit an exogenous shock of the road construction on the non-shared *Héré* to explore how the corruption equilibrium changes with a different market structure. The model predicts that the extra inconvenience cost caused by the construction project pushes drivers to choose the non-shared *Koury*. It thus increases the bargaining power of checkpoints officials along that route, who end up extort more from drivers. Moreover, checkpoints officials along the shared segment will reduce bribes and enforced delays as they start to face more competition from the non-shared *Koury* segment.

Empirically, we confirm model predictions by implementing a difference-in-differences framework. We find that the bribes and minutes delayed on the non-shared *Koury* segment increases following the road construction, relative to those on the non-shared *Héré* segment. Furthermore, we find evidence that the total cost passing through the shared segment decreases following the road construction, relative to that on the non-shared segment of the *Héré* corridor. Both results are consistent with the the prediction. We further explore the heterogeneous effects of the road construction by interacting it with a precipitation measure. The idea is that the *Héré* corridor is of poorer condition under heavy rain so the checkpoints along the *Koury* corridor gain more bargaining power on rainy days relative to dry days. We do find the effects of the road construction are heightened on rainy days.

Our paper reveals that competition among corrupted agents facilities customers to get public services. In the paper's setting, the spatial competition stemmed from two parallel corridors forces officials to keep going rate low to attract driver-customers. As a result, the total cost for long-haul transportation declines. Our paper suggests that increasing competition can be a way to fight against corruption, especially when other methods are not feasible. In our setting, it's to pave more inter-state corridors for merchandise transportation. That being said, we'd like to put a caveat that increasing competition, even if it reduces corruption, is not always desirable to the society. In Burgess et al. (2012)'s work, they find that competition among forestry officials in Indonesia increases deforestation by facilitating illegal logging. Whether competition is conducive to citizens really depends on the nature of the service under study.

Our paper also shows that a reduction in competition caused by a local construction project leads to a redistribution of corruption benefits towards checkpoints unaffected by the road construction. Such a spillover effect should be taken into account by policy-makers who launches an anti-corruption intervention, since its effectiveness can be offset by corrupted officials who are beyond the scope of the intervention. In fact, the spillover effect of a local intervention can also be found in others settings. (Maheshri & Mastrobuoni, 2019) finds that banks' hiring security guards causes more robberies against unguarded banks. (Dell, 2015) shows that the Mexican drug war leads to an increase in drug-related violence along alternative drug routes. In general, a global anti-corruption policy can avoid such a spillover effect. When such a policy is not available, it's important to carefully evaluate possible spillovers for any local interventions at hand.

References

Bromley, D. & Foltz, J. (2011). Sustainability under siege: Transport costs and corruption on West Africa's trade corridors. In *Natural Resources Forum*, volume 35 (pp. 32–48).: Wiley Online Library.

Burgess, R., Hansen, M., Olken, B. A., Potapov, P., & Sieber, S. (2012). The political economy of deforestation in the tropics. *The Quarterly Journal of Economics*, 127(4), 1707–1754.

Carr, I. & Jago, R. (2014). Petty corruption, development and information technology as an antidote. *The Round Table*, 103(5), 465–482.

Cooper, J. (2018). How robust is institutionalized corruption? A field experiment on extortion along West African highways. *Unpublished Working Paper.*

Dell, M. (2015). Trafficking networks and the mexican drug war. *American Economic Review*, 105(6), 1738–79.

Duflo, E., Hanna, R., & Ryan, S. P. (2012). Incentives work: Getting teachers to come to school. *American Economic Review*, 102(4), 1241–78.

Fisman, R. & Miguel, E. (2007). Corruption, norms, and legal enforcement: Evidence from diplomatic parking tickets. *Journal of Political Economy*, 115(6), 1020–1048.

Foltz, J. D. & Bromley, D. W. (2013). Highway robbery: the economics of petty corruption in West African trucking. *WP, University of Wisconsin.*

Foltz, J. D. & Opoku-Agyemang, K. A. (2015). Do higher salaries lower petty corruption. *A Policy Experiment on West Africa's Highways*, (pp. 1–47).

Freund, C. & Rocha, N. (2011). What constrains africa's exports? *The World Bank Economic Review*, 25(3), 361–386.

Leff, N. H. (1964). Economic development through bureaucratic corruption. *American behavioral scientist*, 8(3), 8–14.

Maheshri, V. & Mastrobuoni, G. (2019). The race between deterrence and displacement: Theory and evidence from bank robberies. *Review of Economics and Statistics*, (pp. 1–45).

Méon, P.-G. & Sekkat, K. (2005). Does corruption grease or sand the wheels of growth? *Public choice*, 122(1-2), 69–97.

Nayo, A. & Egoumé-Bossogo, P. (2011). Feeling the elephant's weight: The impact of côte d'ivoire's crisis on waemu trade. *IMF working papers*, (pp. 1–32).

Oki, T. (2016). Bandits on patrol: An analysis of petty corruption on West African roads. *Unpublished Working Paper.*

Olken, B. A. (2007). Monitoring corruption: Eevidence from a field experiment in Indonesia. *Journal of Political Economy*, 115(2), 200–249.

Olken, B. A. & Barron, P. (2009). The simple economics of extortion: Evidence from trucking in Aceh. *Journal of Political Economy*, 117(3), 417–452.

Rubinstein, A. (1982). Perfect equilibrium in a bargaining model. *Econometrica: Journal of the Econometric Society*, (pp. 97–109).

Salisbury, A. et al. (2018). *Cutting the Head off the Snake: An Empirical Investigation of Hierarchical Corruption in Burkina Faso.* Technical report, Centre for the Study of African Economies, University of Oxford.

Shleifer, A. & Vishny, R. W. (1993). Corruption. *The quarterly journal of economics*, 108(3), 599–617.

Svensson, J. (2005). Eight questions about corruption. *Journal of economic perspectives*, 19(3), 19–42.

Tella, R. D. & Weinschelbaum, F. (2008). Choosing agents and monitoring consumption: A note on wealth as a corruption-controlling device. *The Economic Journal*, 118(532), 1552–1571.

Tullock, G. (2001). Efficient rent seeking. In *Efficient Rent-Seeking* (pp. 3–16). Springer.

Yildiz, M. (2003). Bargaining without a common prior—an immediate agreement theorem. *Econometrica*, 71(3), 793–811.

Yildiz, M. (2004). Waiting to persuade. *The Quarterly Journal of Economics*, 119(1), 223–248.

Appendix

A Figures and Tables

A.1 Event studies on Share ***Héré*** vs. Non-shared ***Héré***

Figure 6: Event Study of the shared *Héré* vs. the non-shared *Héré*, bribes

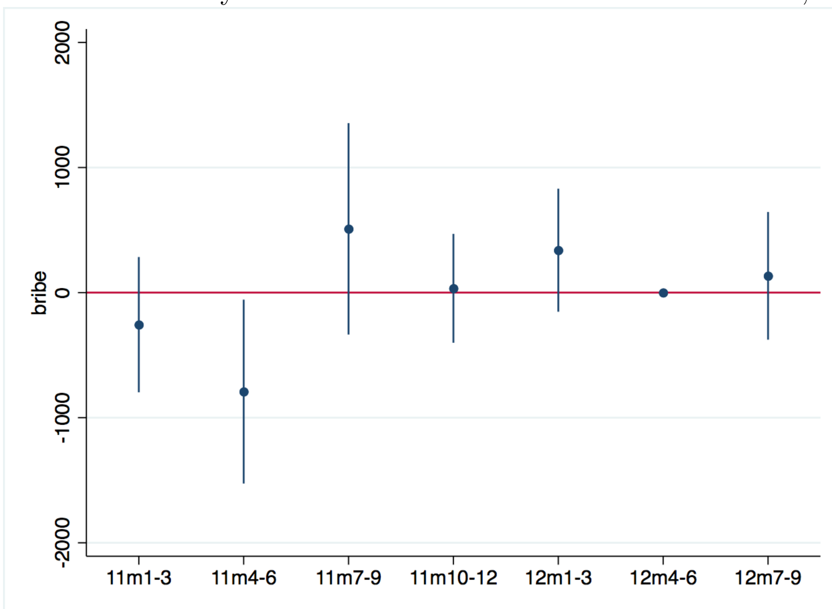
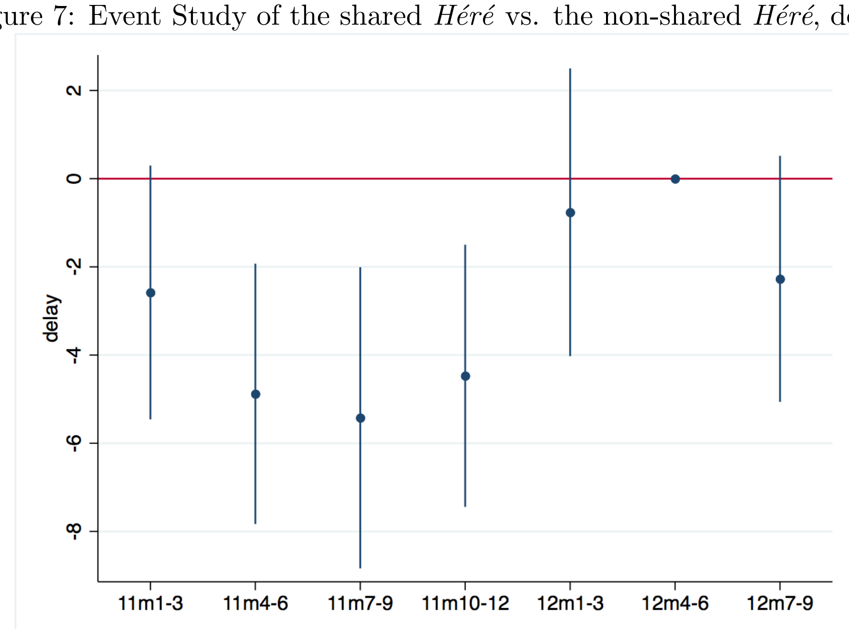


Figure 7: Event Study of the shared *Héré* vs. the non-shared *Héré*, delays

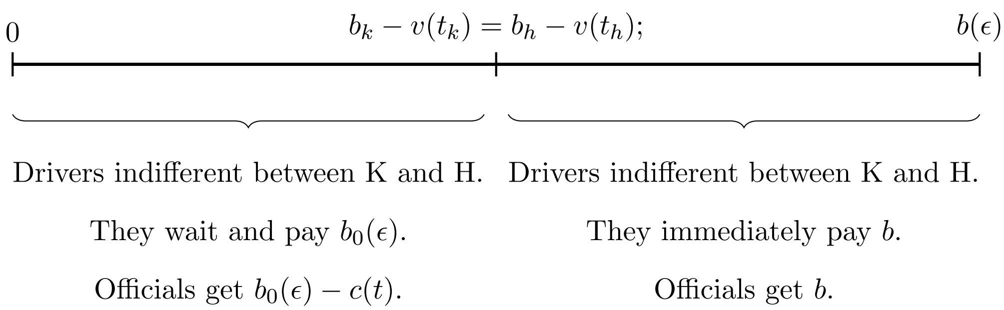


B Model Proof

B.1 The Proof of proposition 1

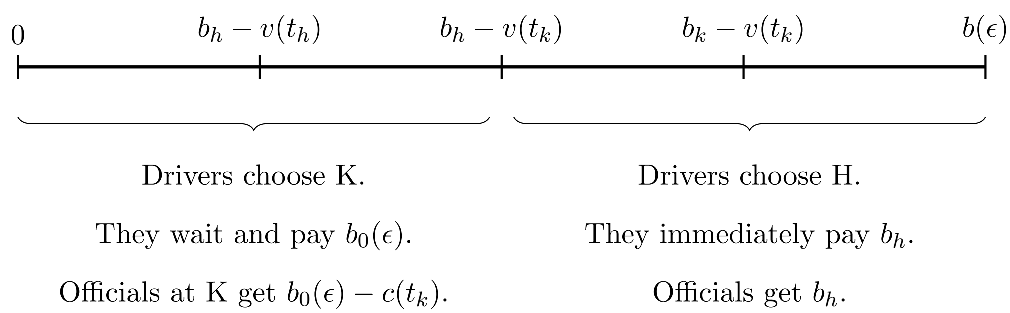
Proof. First of all, notice that $(b_k, t_k) = (b_h, t_h) = (0, 0)$ is indeed a Nash equilibrium since no one is willing to deviate. In the next step, we want to show that it is the only equilibrium by exclude all other cases. We do so by providing a dominant strategy for each case.

Case 1: $b_k = b_h > 0$ **and** $v(t_k) = v(t_h) > 0$. In this case, the separation of drivers between two segment can be shown below. The Official in K is better off if he sets bribe and time a bit lower but still with $b_k - v(t_k) = b_h - v(t_h) > 0$ holds. Basically, he increases the revenue by attracting all drivers on the road.



Case 2: $b_k > b_h > 0$ **and** $v(t_k) > v(t_h) > 0$. In this case, all drivers choose H because $\min\{b_0(\epsilon) + v(t_k), b_k\} > \min\{b_0(\epsilon) + v(t_h), b_h\}$. Knowing this, the K official can set both bribe and time slightly lower than those in H and grab all drivers.

Case 3: $b_k > b_h > 0$ **and** $v(t_h) > v(t_k) > 0$. In this case, the separation of drivers between two segments can be shown below. As we can see, drivers with $b_0(\epsilon) > b_h - v(t_k)$ choose H and all of them pay b_h immediately; drivers with $b_0(\epsilon) < b_h - v(t_k)$ choose K and all of them wait for time t and pay $b_0(\epsilon)$. It is not a Nash because the H official can set $v(t_h) = v(t_k)$. By doing so, he keeps all drivers with $b_0(\epsilon) > b_h - v(t_k)$ while attracts a proportion of drivers with $b_0(\epsilon) < b_h - v(t_k)$ from K.



Case 4: $b_h = t_h = 0$ and $b_k > 0, t_k > 0$. In this case, H official is better off by raising bribes and time a little bit but still with $\min\{b_0(\epsilon) + v(t_k), b_k\} > \min\{b_0(\epsilon) + v(t_h), b_h\}$ holding.

Case 5: $b_h = t_k = 0$, and $b_k > 0, t_h > 0$. In this case, H official is better off by raising b_h a little bit but still with $b_h < \min\{b_k, b_0(\epsilon)\}$ holding. ■

B.2 The Proof of Proposition 2

Proof. We prove the proposition for the *Koury* segment and the shared one separately.

For the *Koury* checkpoint, it is obvious that any package with $0 < \min\{b_0(\epsilon) + v(t_k), b_k\} < \min\{b_0(\epsilon) + v(t_h), b_h\} + w$ dominates the (0,0) package. In this case, the official sets a positive bribe price without losing any drivers to the *Héré* route. For both a positive t_k and a positive b to be a dominant strategy, there needs to be an assumption that $c(t)$ is much smaller than $v(t)$, which basically says a driver values time a lot more than a checkpoint official. In reality, the assumption is very close to what's going on, since the driver has a trip to complete, while the official is sitting at his office.

For the shared segment, we prove it by transfering the question to a single-road-two-checkpoint case. The road construction allows the *Koury* checkpoint to charge positive bribes equal to the value of the inconvenience costs. The case can be translated to a single-road situation where the checkpoint on the shared segment competes against the other checkpoint which charges some positive $(\bar{b}, \bar{t})$. Similarly, the case without road construction is equivalent to a single-road-single-checkpoint situation, in which $(\bar{b}, \bar{t}) = (0, 0)$. Now denote the revenue from a single driver

$$R(b,t) = \int_{b < b_0(\epsilon)+v(t)} b \, dF(\epsilon) + \int_{b > b_0(\epsilon)+v(t)} (b_0(\epsilon) - c(t)) dF(\epsilon)$$

Also denote its elasticity with respect to bribes $\delta_b^R = R_b(b,t)\frac{b}{R(b,t)}$, and the elasticity of driver flow with respect to bribes $\delta_b^q = q_b(B,T)\frac{b}{q(B,T)}$. For the checkpoint on the shared segment, its first order condition satisfies:

$$\delta_b^q + \delta_b^R = 0, \quad \text{with} \quad \delta_b^q < 0$$

When q is linear with B and T, we have $\delta_b^q|_{\bar{b}=0} < \delta_b^q|_{\bar{b}>0} < 0$. This result is because q is a decreasing function of B and that $q_b(B,T)$ is a constant. For the first order conditions to hold, δ_b^R increases when $\bar{b}$ becomes positive, which can be achieved by reducing the b if δ_b^R is a decreasing function of b. We can learn without assumption that in the optimal point $R(b,t)$ should always be an increasing function of b because $R_b(b,t)$ is positive (otherwise δ_b^R will be negative). To make δ_b^R a decreasing function of b, the only assumption needed is that $R_b(b,t)b$ is a decreasing function of b. In fact, the assumption holds when ϵ, $v(t)$, and $c(t)$ are relatively small compared to b. To make the point more clearly, let's parameterize the problem as follows: ϵ is uniformly distributed within interval $[0,\bar{\epsilon}]$, $b_0(\epsilon) = \epsilon$, and $q(b,t) = 1 - (b + v(t))$. As a result,

$$\begin{aligned}
R(b,t) =& \frac{1}{\bar{\epsilon}}[\int_{b-v(t)}^{\bar{\epsilon}} b d\epsilon + \int_0^{b-v(t)} (\epsilon - c(t)) d\epsilon] \\
=& \frac{1}{\bar{\epsilon}}[b\epsilon|_{b-v(t)}^{\bar{\epsilon}} + (\frac{1}{2}\epsilon^2 - c(t)\epsilon)|_0^{b-v(t)}] \\
=& \frac{1}{\bar{\epsilon}}[-\frac{1}{2}b^2 + \frac{1}{2}v(t)^2 - bc(t) + c(t)v(t) + b\bar{\epsilon}]
\end{aligned}$$

Therefore, the partial derivative with respect to b is:

$$[R(b,t) * b]_b = -\frac{3}{2}b^2 + 2b[\bar{\epsilon} - c(t)] + [\frac{1}{2}v(t)^2 + c(t)v(t)] \approx -\frac{3}{2}b^2$$

The proof for decreased t of the shared checkpoint after the road construction is similar to that of b. ■