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# THE SIMPLE ECONOMICS OF EXTORTION: EVIDENCE FROM TRUCKING IN ACEH

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## ABSTRACT

This paper tests whether the behavior of corrupt officials is consistent with standard industrial organization theory. We designed a study in which surveyors accompanied truck drivers on 304 trips along their regular routes in two Indonesian provinces, during which we directly observed over 6,000 illegal payments to traffic police, military officers, and attendants at weigh stations. Using plausibly exogenous changes in the number of police and military checkpoints, we show that market structure affects the level of illegal payments, finding evidence consistent with double-marginalization and hold-up along a chain of vertical monopolies. Furthermore, we document that the illegal nature of these payments does not prevent corrupt officials from extracting additional revenue using complex pricing schemes, including third-degree price discrimination and a menu of two-part tariffs. Our findings illustrate the importance of considering the market structure for bribes when designing anti-corruption policy.

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## 1. Introduction

Corruption is widely thought to be a major factor retarding growth in the developing world. As a result, there is substantial interest from both developing country governments and international institutions in understanding the forces that drive corrupt behavior.

Most theoretical and empirical work on corruption focuses on the individual corrupt transaction – potentially corrupt officials weigh the benefits from corruption against the expected punishments if they are caught, and choose accordingly. However, the level of corruption may also be influenced by market forces. In this view, first articulated by Shleifer and Vishny (1993), corrupt officials behave like profit maximizing firms, and the level of corruption is determined by the structure of the "market" for bribes, the elasticity of demand for the officials' services, and the degree to which corrupt officials can coordinate with one another in setting prices.

This paper takes the market forces view of corruption seriously, and examines the degree to which standard pricing theories from industrial organization are consistent with actual patterns of bribes and extortion payments. We study these questions in the context of bribes paid by truck drivers on their trips to and from the Indonesian province of Aceh. Truck drivers in Aceh make a variety of illegal payments, including payments to police and military officers to avoid harassment at checkpoints along the roads, payments at weigh stations to avoid fines for driving overweight, and protection payments to criminal organizations and the police.

To investigate these payments, we designed a study in which enumerators accompanied truck drivers along their regular routes to and from Aceh. From November 2005 to July 2006, enumerators accompanied drivers on a total of 304 trips to and from Aceh, and directly observed more than 6,000 illegal payments along the routes. To the best of our knowledge, this represents the first large-scale survey that has ever directly observed actual bribes in the field.[1] On average, drivers spent about US $40 per trip, or about 13 percent of the total cost of a trip, on bribes, extortion, and protection payments.

Using this data, we first examine how the bribes charged at checkpoints respond to changes in market structure. During the period we study, the Indonesian government withdrew over 30,000 police and military from Aceh province in accordance with a peace agreement signed earlier in the year to end a thirty-year civil war between separatists and the Indonesian government. Since the troops and police that were withdrawn previously manned many of the checkpoints that extracted payments from truck drivers, this withdrawal represents a plausibly exogenous change in the market structure for illegal payments in this area. Moreover, the roads to and from Aceh pass through two provinces, Aceh and North Sumatra, while the military withdrawal affected only troops and police stationed in Aceh province. We can therefore use the change in average bribes charged in North Sumatra in response to the reduction in checkpoints in Aceh to measure the extent of double-marginalization in this market.

We find that the average bribe paid in North Sumatra increased significantly in response to the reduction in the number of checkpoints in Aceh, and that the magnitude of these changes suggests that checkpoints are behaving as decentralized, rather than centralized, price-setters. Specifically, the elasticity of the average bribe paid at a checkpoint in North Sumatra province with respect to the expected total number of checkpoints encountered along a trip is between $-0.54$ and $-0.81$. By contrast, had price setting been exogenous with respect to market structure, this elasticity would have been 0; had price setting been fully coordinated among the

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[1] The only other dataset consisting of observed bribe payments, as opposed to reported bribe payments, is McMillan and Zoido (2004), which consists of videotapes the bribe-giver (Montesinos, the head of the Peruvian intelligence under Fujimori) took to help him maintain leverage over bribe recipients later on. Much of the other recent work with objective measures of corruption focuses on graft and tax evasion, not bribes (e.g., Di Tella and Schargrodsky 2003, Fisman and Wei 2004, Reinnika and Svensson 2004, Hsieh and Moretti 2006, Olken 2007, Yang forthcoming).

checkpoints, this elasticity would have been equal to -1. The results therefore provide evidence for the Shleifer-Vishny view that the market structure has an impact on the total amount of bribes charged, and more specifically, that price setting in this particular context is decentralized rather than centralized.

Second, since a driver needs to successfully pass all checkpoints on a route in order for the journey to be completed, the amount of surplus to be extracted by officials at checkpoints at the beginning of the trip may differ from the amount of surplus to be extracted at the end of the trip. If prices are not fully set in advance, this will translate into systematic differences in bribes paid at different points in the route. Using information on how each transaction physically took place, we show that different officials have different amounts of bargaining power and, indeed, that prices are in part set through ex-post bargaining rather than being fully determined ex-ante. Then, taking advantage of the fact that our data includes trips in both directions, we examine how the pattern of payments changes as the truck gets closer to its destination. We find that, consistent with the hold-up theory, 'downstream' checkpoints – i.e., those that are closest to the final destination – receive higher bribes than 'upstream' checkpoints – i.e., those that are closer to the origin of the trip.

The analysis so far has focused on the level of bribes, and shown that the level of bribes responds to market forces. A natural next question is whether there is heterogeneity in bribes paid, and whether that heterogeneity is also the result of profit-maximizing behavior. While firms are often able to use price discrimination mechanisms to increase revenue by charging different prices to different buyers (e.g., Varian 1989, Shepard 1991, Borenstein and Rose 1994), the illegal nature of corruption might make implementing these types of price discrimination difficult in this context.

We show, however, that corrupt officials do in fact practice several types of price discrimination. Officials at checkpoints, for example, appear to practice third-degree price discrimination, charging higher prices to those drivers with observable characteristics that indicate a higher willingness to pay, such as those driving newer trucks or carrying valuable cargo. Moreover, we document that officials at one weigh station have implemented a complex system of second-degree price discrimination, involving a coupon system whereby drivers self-select, before the trip starts, into one of multiple two-part tariffs. The fact that such types of price discrimination exist suggests that the illegal nature of the market does not prevent the emergence of quite sophisticated contracts.

While the pricing behavior described here may be privately optimal for decentralized corrupt officials, much of this type of pricing behavior serves to increase the efficiency costs of corruption. For example, decentralized pricing at checkpoints implies higher bribes charged, and thus a higher distortion on truck behavior, than if bribes were centralized. Moreover, this type of double-marginalization also reduces the total profits received by all firms put together, so both the private welfare of bribe-collectors, as well as social welfare, would be higher under a centralized regime. By contrast, the emergence of second-degree price discrimination at weigh stations increases the profits made by corrupt officials, but decreases social welfare by allowing more overweight trucks.

The remainder of the paper is organized as follows. Section 2 describes the setting in more detail. Section 3 describes the data collection and presents descriptive statistics. Section 4 examines the degree to which market structure affects the level of bribe payments. Section 5 examines price-discrimination. Section 6 concludes by discussing some implications for anti-corruption policy.

## 2. Setting

### *2.1. Trucking in Aceh*

The data in this study come from the two Indonesian provinces located at the northern tip of the island of Sumatra, the province of Nanggroe Aceh Darussalam (hereafter referred to as Aceh) and the province of North Sumatra. Aceh is perhaps best known throughout the world as the site of the December 2004 tsunami, which killed an estimated 167,000 people along the province’s western and northern coasts. It was also the site of a thirty-year civil war between the separatist Free Aceh Movement (GAM) and the Indonesian government, which ended in August 2005 with the signing of a peace agreement between the two parties.

This study focuses on the two major long-distance transportation routes in Aceh, shown in Figure 1. The first route runs along the west coast from the Achenese city of Meulaboh to Medan, the capital of North Sumatra province and the largest city on the island of Sumatra. A typical truck takes about 35 hours to complete this 637 km journey. The second route runs along the northeast coast from the capital of Aceh province, Banda Aceh, to Medan. A typical truck takes about 24 hours to complete this 560 km journey. As is visible in the figure, both the Meulaboh route and the Banda Aceh route have portions in Aceh province and portions in North Sumatra province.

These two routes represent the primary means of transporting goods to and from Aceh. Since the tsunami washed out the west coast road north of Meulaboh, the two routes are essentially not connected. For the Banda Aceh route, there are therefore no alternative land routes; for the Meulaboh route, an alternative road through the center of the province exists, but it is of very low quality, containing unpaved sections that can only be traversed in the dry season (approximately March – September).

Trucking along these routes is dominated by a relatively small number of firms, each of which has offices in Medan as well as in Meulaboh or Banda Aceh. Trips from Medan to both Meulaboh and Banda Aceh predominantly carry manufactured goods and construction materials. Trips from Meulaboh to Medan predominantly carry agricultural produce, particularly rubber. Trips from Banda Aceh to Medan predominantly carry scrap metal from the wreckage of the tsunami which is of questionable legal status; there are reports that other smuggled goods are sometimes hidden in the trucks underneath the scrap metal.

Illegal payments along these routes take three main forms—payments at checkpoints, payments at weigh stations, and protection payments. First, checkpoints are set up by police and military officers stationed in the area. These checkpoints can serve a security function, particularly in conflict areas, but they also exist purely as a rent-extraction tool in areas where there is no security threat. Second, as shown in Figure 1, there are four weigh stations located on the routes included in this study, two on each road. These weigh stations are operated by the provincial transportation departments (*Dinas Perhubungan*). Officially, a truck entering a weigh station weighing more than 5 percent above the maximum per-axle limit is supposed to be ticketed, immediately unload its excess cargo, and the driver is meant to appear in court to have a fine determined.[2] In practice, almost all drivers pay a bribe to avoid this fine.

The third type of payments are protection payments. Most trucks make a regular monthly payment to a criminal organization for protection purposes; those firms that do not run the risk of their trucks being hijacked and the cargo stolen. Trucks also pay police and/or the military in

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[2] One of the four weigh stations, at Seumedam in Aceh province on the Banda Aceh – Medan road, was part of a pilot program launched by the national government to reduce corruption at weigh stations. As part of this pilot program, the official tolerance was increased substantially (to between 50-70 percent over the legal limit), but attendants were given incentives to issue tickets (*tilang*) for trucks exceeding the threshold, rather than accepting bribes. See Foster (2005) for more details.

order to travel as part of a protected convoy.[3] As will be discussed in Section 5.2 below, trucks leaving from Medan to Banda Aceh also have the option of purchasing a time-stamped coupon from a second criminal organization which reduces the bribe they have to pay at one of the weigh stations. Other, less popular, criminal organizations provide a variety of other services, such as reducing bribes at the Aceh – North Sumatra border and providing protection in case of accidents.[4]

### *2.2. Military presence in Aceh*

As discussed above, starting in the mid-1970s, Aceh was home to a separatist movement known as the Free Aceh Movement (or GAM in Indonesian). Intermittent military conflicts between the Indonesian Army and GAM occurred from the mid-1970s until the signing of the peace agreement in August 2005. At the time the peace agreement was signed, 55,480 police and military were in Aceh. These were divided among three primary groups: the army (TNI), militarized police (*Brimob*), and the regular police force (*Polri)*.

As a result of the peace agreement, 31,690 military and police personnel were withdrawn from Aceh in four waves, from September 2005 to January 2006.[5] Which troops were to be withdrawn in which wave was determined by the Indonesian government, with the aim of maintaining some troops in all areas for as long as possible to ensure stability. Since these officers and troops were responsible for manning many of the checkpoints that extracted payments from truck drivers, and since there was no longer personnel to staff many of the

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[3] Convoys were run by the army, the militarized police (Brimob), and the military police (PM) for a fee of between Rp. 300,000 – Rp. 600,000 (US $32-$64). Convoys supposedly provided protection from GAM rebels, although the rebels were no longer active by the time our survey began. Convoys were used by trucks traveling from Banda Aceh to Medan (many of whom were carrying scrap metal of questionable legal status) and by trucks traveling in both directions on the Medan – Meulaboh route (until March 2006). The results in the paper are similar if we restrict the data to the period when all trucks on the Meulaboh route used convoys.

[4] We provide more details about the role of these different organizations in Tajima, Barron, Muhamad, and Olken (2007).

[5] All remaining police and military are ‘organic,’ which means that they are permanently based in Aceh (and almost always of Achenese ethnic origin).

checkpoints after the troops withdrew, the military withdrawal provides a source of plausibly exogenous variation in the number of checkpoints, and hence in the market structure for bribes. As will be described in more detail below, the data used in this paper was collected beginning in November 2005, and so encompasses the third and fourth waves of the military withdrawal. These withdrawals affected only checkpoints in Aceh province; there was no change in the allocation of troops in North Sumatra province during this time. We obtained data on army withdrawals from each district from the EU-led Aceh Monitoring Mission (AMM), and data on police and militarized police withdrawals from the provincial police command in Banda Aceh.[6]

## 3. Data

### *3.1. Data Collection*

We collected data on bribes by having locally-recruited Achenese surveyors accompany drivers on their regular routes. Data were collected between November 2005 and July 2006. Surveyors recorded the time, location, and amount paid at every checkpoint, weigh station, or other post where the truck stopped. At each of the checkpoints, they noted the organization of the officer manning the checkpoint (e.g., police, army, etc), the number of officers visible at the checkpoint, and whether any of the officers were visibly carrying a gun. They also recorded detailed information about other expenditures incurred during the trip, the weight of the truck reported at the weigh stations, and well as background characteristics about the truck and the truck driver. To protect the identity of the driver, no identifying information about the driver, truck, or firm was recorded. Drivers were aware that their behavior was being recorded by the

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[6] AMM was a joint EU-ASEAN mission of around 230 persons who oversaw the peace process from the signing of the peace agreement in August 2005 until the end of 2006. Monitors were spread across twelve district offices and Banda Aceh headquarters. While the police data contains information on the date of withdrawal from each district, the AMM data is broken down by AMM sub-region, which on average encompasses two districts. When we use the AMM data at the district level, we allocate troops in each AMM sub-region to districts in the same proportions that police are allocated to those districts. Conducting all the analysis at the AMM sub-region level, rather than the district level, does not substantively change the results.

survey, but since virtually all truck drivers have at least one assistant anyway, the surveyors blended in and those manning the checkpoints were, to the best of our knowledge, unaware of their presence.

Due to the clandestine nature of the survey, and the military occupation underway when the survey began, we could not obtain a strictly random sample of trucks operating on the routes. Instead, we sought out several cooperative firms on each route who agreed to let our surveyors accompany their drivers. Within firms, enumerators accompanied whichever driver was next departing, provided that the driver gave permission, that the surveyor had not ridden with that driver in the previous month, that the truck was transporting cargo rather than traveling empty, and that no other surveyor was departing with the same firm on the same day. The survey is therefore approximately representative of the trips undertaken by these particular firms, but is not necessarily representative of all trucks traveling on the route.[7] We coupled this survey with qualitative investigative work that focused on the various criminal organizations described above; the qualitative findings are discussed in more depth in Tajima, Barron, Muhamad, and Olken (2007).

There are advantages and disadvantages of obtaining this data by direct observation. In pilot interviews we conducted with drivers who had recently completed trips, they reported remembering the approximate total amount paid, but not the specific locations or even the number of times they stopped at checkpoints. Direct observation allowed us to record data on each payment made, checkpoint-by-checkpoint. A second advantage of direct observation is that drivers may exaggerate bribe payments; by exaggerating bribe payments, drivers may be able to extract more money from their bosses to pay bribes than they actually need, and pocket the

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[7] For example, certain types of goods, such as timber, are carried by special trucks and hence are not included in our survey. Our survey also did not include humanitarian aid to tsunami victims from international organizations, which was often sent in special convoys and was typically exempt from bribe payments.

difference. In fact, we compared the amount of bribes we observed on 40 trips between January 25th, 2006 and February 20th, 2006 with twelve interviews we conducted around the same time with drivers who had just completed their trips, and found that on average the bribes drivers reported in interviews were more than double the amount of the bribes we recorded by direct observation.

The potential concern with direct observation is that there may be Hawthorne effects – i.e., drivers may change their decisions about how much they should pay in bribes because they are observed. Although it is not possible to rule out Hawthorne effects entirely, there are a number of reasons to think that these effects have at most a minimal impact on the study. First, the truck driver is the residual claimant for all bribe payments – the driver receives a flat payment from the firm to cover all expenses on the road, including bribes, and keeps whatever remains at the end of the journey. Under all circumstances, he therefore had a strong personal incentive to minimize bribe payments. Second, there is no stigma associated with making these types of illegal payments – they are completely common and well known, and drivers face essentially no risk of going to jail or even paying an additional fine for making such payments. Third, as already mentioned, the surveyors were locally recruited and instructed to dress like a normal truck driver's assistant and to help out with tasks in the way that a driver's assistant would normally do; since it is common to have multiple people riding in the cab of the truck, there would have been nothing unusual about this truck to outside observers, and therefore no reason for officials to treat the truck differently. Finally, and most importantly for the analysis in this paper, any Hawthorne effects are expected to be similar across our entire sample; they might therefore affect the *levels* of our reported bribe payments, but they should not affect any of our analysis of the differences in bribe payments across checkpoints, trips, or routes.

The survey was kept entirely secret from the start of the study in November 2005 until April 4th, 2006, when the preliminary time-series results from the survey for the Banda Aceh-Medan route were announced in Banda Aceh at a joint Aceh Reconstruction and Rehabilitation Agency (BRR) - World Bank press conference. This press conference, and subsequent coverage in Acehenese provincial newspapers, resulted in additional declines in the number of checkpoints in Aceh province until the end of the study in July 2006. These declines were concentrated almost entirely on the Meulaboh route since there were almost no checkpoints remaining in Aceh province on the Banda Aceh – Medan route at the time of the press conference.[8] Despite the publicity, surveyors were able to continue collecting data unobserved.

### *3.2. Descriptive statistics*

Summary statistics from the data are presented in Table 1. Table 1 indicates that, on average, the marginal cost of a one-way trip from Aceh to Medan was approximately Rp. 3 million (US $325).[9] Of these costs, fuel represents the largest component (about 53%). The remainder of the cost is attributable to loading and unloading of cargo (14%), various types of illegal payments (13%), salaries for the driver and his assistant (10%), and food and lodging during the trip (5%).

The magnitude and composition of illegal payments varies substantially across the two routes, as can be seen by comparing columns (2) and (3) of Table 1. In particular, throughout the entire period checkpoints were much more important on the Meulaboh road than on the Banda Aceh road; on average across the sample, a typical trip on the Meulaboh road stopped at more than double the number of checkpoints (27 as compared to 11), and paid nearly four times as

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[8] All of the results in the paper are robust to limiting the sample to the pre-press conference period (i.e., before April 4th, 2006).

[9] All prices in the paper have been normalized to October 2006 Indonesian prices using monthly CPI data, though doing so does not meaningfully change any of the results since inflation over the period under study averaged only 6% on an annual basis.

much at checkpoints (US $23 as compared to US $5), as a typical trip on the Banda Aceh road. Conversely, payments at weigh stations appear to be much more substantial on the Banda Aceh route than on the Meulaboh route.

A first look at the data provides some insights into the way these illegal transactions work in practice. Transactions at checkpoints work as follows. The police or military officers manning the checkpoint flag down trucks (or, anticipating that they will be flagged down, in 30% of cases the truck drivers simply stop on their own accord). The truck driver offers the officer manning the checkpoint a payment of between Rp. 5,000 – Rp. 10,000 (US $0.55 - $1.10). On the Banda Aceh route, these payments are in cash; on the Meulaboh route, they often take the form of 1-2 packets of cigarettes. The officer manning the checkpoint usually accepts the offered payment; in only 13 percent of cases does he reject the initial payment and try to bargain for more. If no payment is made, the police or military may chase the truck down and harass the driver, either physically (drivers have reported being beaten for failing to pay bribes or for offering too little), by delaying the truck, or by finding a violation and issuing a ticket, which requires the driver to come to court and therefore lose several days of work.

In practice, these payments appear much closer to outright extortion (or, perhaps less pejoratively, to a toll) than to bribes paid to avoid an official fine. In fact, out of the 5,387 transactions at checkpoints we observed where money changed hands, on only 21 occasions – i.e., less than 0.5% of all transactions – did the officer at the checkpoint even state a specific violation that the truck driver was accused of committing. Instead, in most cases, the driver simply hands over the payment without discussion and continues on his way.[10]

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[10] Of course, the fact that a violation is not stated does not mean that, in the off-equilibrium path where the driver refused to pay, the officer would not at that point state a violation; nevertheless, the fact that the transactions are so routine as to not require mentioning a violation is still remarkable.

The second common type of payment is made at weigh stations. The data indicate that, in equilibrium, almost all trucks operate overweight – in our data, for example, 84 percent of trucks operated at more than 5 percent above their legal weight limit, and 42 percent operated at more than 50 percent above their legal weight limit. Despite this, only 3 percent of trucks actually received an official ticket for being overweight; instead, the remaining truck drivers paid a bribe at the weigh station to avoid penalties.

To examine the overall relationship between the weight of the truck and the bribe paid at the weigh stations, Figure 2 plots locally-weighted Fan (1992) regressions for each of the four weigh stations, where the dependent variable is the total bribe paid at the weigh station and the independent variable is the number of tons the truck is overweight. Figure 2 shows that at all four weigh stations the amount of the bribe is clearly increasing in the amount the truck is overweight. Separate linear regressions for each weigh station of the total bribe on the number of tons the truck is overweight confirm that the slope is positive and statistically significant ($p < 0.01$) for all four weigh stations. On average across all four stations, drivers pay Rp. 3,345 (US $0.36) for each additional ton they are overweight. From an efficiency perspective, the positive relationship between the amount overweight and the bribe paid means that, although official fines are almost never levied, weigh stations are at least creating *some* marginal disincentive for trucks to travel overweight, although the slope is likely not nearly as steep or convex as would be socially optimal.[11] Moreover, there exists evidence of outright extortion: even trucks that were not overweight all paid bribes at weigh stations in two-thirds of cases (results not reported).

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[11] The standard engineering estimate is that the damage a truck does to a road is proportional to the 4th power of the truck's weight (AASHO 1961). As can be seen in Figure 2, the rate of increase in the bribes is clearly increasing at a rate less than the 4th power that would be needed for the bribes to be sufficient to make the truck drivers fully internalize the cost of driving overweight.

## 4. Does market structure matter? Evidence from checkpoints

### *4.1. Theoretical framework*

We first present a very simple theoretical framework to demonstrate how the number and location of checkpoints may affect the bribes charged at each checkpoint. The idea is to model checkpoints as a chain of vertical monopolies. To illustrate the potential for double-marginalization in such a situation (as in Spengler 1950, Bresnahan and Reiss 1985, Shleifer and Vishny 1993), we first discuss the case in which checkpoints can commit to a fixed, posted price. We then relax the assumption of full commitment to illustrate the potential for increasing hold-up by "downstream" checkpoints (following Grossman and Hart 1986, Hart and Moore 1990, Blanchard and Kremer 1997).

#### *4.1.1. Model with fixed prices*

To begin, suppose that there are $n$ identical checkpoints arrayed throughout the road. Each checkpoint announces, in advance, a price $p$ for the truck to pass; if the truck driver does not pay the price $p$, the goods are confiscated by the checkpoint, and are worth 0 to both the truck driver and the officer at the checkpoint. Theoretically, the structure of the problem is similar to a chain of production with Leontief production technologies in each of the intermediate goods (Blanchard and Kremer 1997); since you must pass *all* checkpoints to deliver the goods, failing to reach agreement with any checkpoint can render the entire trip worthless, with the goods stuck in some intermediate location.

Suppose that all goods have value 1 if they complete the trip and value $v$ if they do not complete the trip and stay in the place of origin. Knowing the full vector of prices they will face, owners of the goods will make the trip if $\sum_j p_j < (1-v)$. The distribution of reservation values $v$ determines a demand function $q\left(\sum_j p_j\right)$, which is the quantity of trucks that travel the route.

Naturally, $q$ is a decreasing function of the total amount of payments that must be made to complete the trip.

Given this demand function, each checkpoint $i$ maximizes

$$p_i q\left( p_i + \sum_{j \neq i} p_j \right) \tag{1}$$

The first-order condition is

$$p_i q'\left( p_i + \sum_{j \neq i} p_j \right) = -q\left( p_i + \sum_{j \neq i} p_j \right) \tag{2}$$

In equilibrium, symmetry implies that $p_i = p_j = p$. Define the total price $P = np$. Then, in equilibrium, equation (2) implies that

$$\frac{q'(P)P}{q(P)} = -n \tag{3}$$

i.e., the total price is set so that the elasticity of demand $\varepsilon(P)$ is equal to $-n$.

Under the usual assumption that the elasticity of demand is increasing in absolute value in the price (as it is, for example, with a linear demand curve), the above analysis shows that the total price paid to pass through the road is increasing in the number of checkpoints $n$, i.e. $\frac{\partial P}{\partial n} > 0$.[12] Under additional assumptions that guarantee that $q(P)$ is not too convex – for example, it is sufficient that $\frac{q''(P)P}{q'(P)} > -1$, which is clearly satisfied by any demand function where $q''(P) \leq 0$, including linear demand – one can also show that while the total amount paid is increasing in the number of checkpoints, the price charged *per checkpoint* is decreasing in the

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[12] The assumption that the elasticity of demand is increasing in absolute value in the price is required to generate a finite equilibrium price in any monopoly pricing model with zero marginal cost, such as the model considered here.

number of checkpoints, i.e., $\frac{\partial p_i}{\partial n} < 0$. Thus, the elasticity of the total price paid along the route (*P)* with respect to the number of checkpoints (*n*) is between 0 and 1, and the elasticity of the average price paid per checkpoint ( $p_i$ ) with respect to *n* is between -1 and 0.

By contrast, if the prices were set by a central authority, rather than by decentralized officers at the checkpoints, then equation (3) becomes the standard monopoly result

$$\frac{q'(P)P}{q(P)} = -1 \tag{4}$$

In this case, the total cost of passing through the road does not depend on the number of checkpoints. Since the total price $P$ is constant, the elasticity of the price charged per checkpoint, $p_i = \frac{P}{n}$, with respect to the number of checkpoints is exactly equal to -1.

The intuition for these results is straightforward. When prices are decentralized, the person setting the price at each checkpoint does not internalize the effect of his price on the revenues at the other checkpoints; this leads him to charge a higher per-unit price than he would charge if he internalized the negative effects on other checkpoints, which is the familiar double-marginalization result. Given this, the total price of traveling the road $P$ is lowest when there is only one checkpoint. When prices are set centrally, the centralized price-setter sets the total price $P$ equal to the monopoly price no matter how many checkpoints there are. In the centralized case, the per-checkpoint price is therefore just equal to the optimal price $P$ divided by the number of checkpoints. These implications will be examined in the empirical work below.

This model, taken literally, implies that the elasticity of demand will be quite high in equilibrium. In a more general model, however, similar comparative statics could obtain but the equilibrium elasticity of demand could be much smaller. Suppose, for example, that as corruption levels increase, there is an increased possibility of political backlash in which all military officers are fired. These effects could be incorporated into the model above by assuming that price setters maximize a weighted sum of consumer surplus and their own profits, rather than purely maximizing their own profits. In that case, the equilibrium elasticity could be much less than 1, bribes much smaller, but the comparative statics above would still obtain, since a centralized officer would internalize the full effect of corruption on political backlash (or consumer surplus) whereas decentralized officers would not fully internalize these effects.

#### *4.1.2. Relaxing full commitment*

The previous model assumed that prices could be fully committed to in advance. To allow for the possibility of bargaining and hold-up, we now relax this assumption by allowing prices to have two components – a fixed component, set in advance, and a component that is determined at each checkpoint through a process of bilateral bargaining. As in the chain of Leontief production technologies, if there is bilateral bargaining at each step, rather than prices that are fully fixed in advance, the ‘downstream’ producers – in our case, the checkpoints at the end of the journey – will be able to extract more of the surplus than the ‘upstream’ producers, the checkpoints at the beginning of the journey.[13]

Specifically, suppose that now, at each checkpoint, there are two actors – the boss of the checkpoint, who sets a fixed price $p_i$, and the officer manning the checkpoint. The officer manning the checkpoint is required to pay $p_i$ to the boss for each truck that passes the

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[13] Note that sequencing also matters in the double-marginalization model of Bresnahan and Reiss (1985), who model the relationship between car manufacturers and dealers. In that model, the sequencing matters because the manufacturer sets the price first, the dealer chooses a price taking the manufacturers price as given, and then a purchaser decides whether to buy after observing the total price. In the setting studied here, the truck driver has to decide whether to travel or not without observing the full set of prices along the route, so the logic of this model is slightly different.

checkpoint.[14] Although the price $p_i$ is fixed in advance, the officer manning the checkpoint has leeway as to whether or not to detain the truck, and can use this leeway to extract additional rents from the truck driver. We assume the officer engages in Nash bargaining with the truck driver, with the officer having relative bargaining power $\alpha$ (we assume $\alpha$ is identical across checkpoints). Appendix A shows that if the bargaining power of the officer $\alpha$ is not too large, the same double-marginalization results shown in the simple model above still apply in this more complex setting.

Once we introduce this bargaining element into the model, the pattern of prices changes – in particular, rather than the prices being identical at all checkpoints, now the ordering of the checkpoints matters, and the bribes paid at the end of the journey are higher than the bribes at the beginning. To see the intuition, suppose for simplicity that there are only two checkpoints, and that the amount that has to be paid to the bosses ( $p_i$ ) is 0. At the second checkpoint, the surplus from agreement is 1. Nash bargaining with weight $\alpha$ for the officer at the checkpoint implies that the amount paid at the second checkpoint, $b_2$, is equal to $\alpha$. At the first checkpoint, however, anticipating the bribe to be paid at the second checkpoint, the surplus from agreement is no longer 1; the surplus at the first checkpoint is now $1-\alpha$, since if agreement is reached at checkpoint 1 then the driver will still have to pay $\alpha$ at the second checkpoint . Given that the surplus from agreement is $1-\alpha$, and that the officer at the checkpoint has bargaining weight $\alpha$, the bribe at the first checkpoint $b_1 = \alpha\left(1-\alpha\right)$. Note that $b_1 < b_2$; more generally, no matter how many checkpoints there are, the key prediction of this model is that the bribes are *increasing* as the driver gets closer to the end, so that $b_j < b_k$ if $j < k$. Appendix A shows that the same results

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[14] Note that having this two-part pricing scheme (i.e., the boss setting one part of the price and the officer bargaining over the other part) is not crucial for generating the result derived below that prices are increasing at later posts. However, it is important to have some portion of the price fixed in advance in order to continue to generate the double-marginalization results derived above.

obtain in the more general setup with an arbitrary number of checkpoints and with endogenously set fixed prices $p_i$.

Overall, the theory has two sets of predictions that will be explored in the empirical work below. First, Section 4.2 will explore the degree to which the overall price level responds endogenously to changes in market structure. Then, Section 4.3 will explore the degree to which prices are set through ex-post bargaining, and to the extent that there is some ex-post bargaining over prices, whether this results in higher prices at checkpoints later in the route.

### *4.2. Empirical evidence on the impact of changes in market structure*

To examine how prices respond to changes in market structure, we use the fact that the staggered withdrawal of military and police from Aceh province generates plausibly exogenous variation in the number of checkpoints. In Subsection 4.2.1 we present the main results, which examine how prices on the portion of the roads in North Sumatra province responded to the reduction in checkpoints on the portion of the roads in Aceh province. In Subsection 4.2.2 we present results from an alternative empirical approach that exploits the differential timing of the withdrawal in different districts in Aceh, which allows us to look at changes within Aceh as well.

#### *4.2.1. Changes in bribes paid in North Sumatra in response to reductions in checkpoints in Aceh*

We begin by examining how officials in North Sumatra province responded to the reduction in checkpoints in Aceh province. Since the military withdrawal was restricted to Aceh, the advantage of this approach is that there was no direct change in the military or police environment in North Sumatra. Any change in prices paid at checkpoints in North Sumatra can therefore be attributed to the military withdrawal from the portion of the route running through Aceh province.

The theory predicts that if price-setting is decentralized, then as the number of checkpoints declines the amount charged at each remaining checkpoint should increase, though not enough to fully offset the lost revenues from the checkpoints that were eliminated, i.e., the elasticity of average bribes charged at checkpoints with respect to the total number of checkpoints should be between -1 and 0. By contrast, if pricing were centralized, the amount charged at each remaining checkpoint would increase enough to fully offset the lost revenues from the checkpoints that were eliminated, i.e., the elasticity would be equal to -1. If pricing was exogenous with respect to market structure, then the prices charged at the remaining checkpoints would not change at all, and the elasticity would be equal to 0.

During the period covered by our data collection, the number of checkpoints encountered in Aceh province on the Meulaboh – Medan route fell from an average of above 40 at the beginning of the sample to an average of 15 after the military withdrawal. This represents a more than 60 percent reduction in the total number of checkpoints encountered along the entire route.[15] By contrast, on the route from Banda Aceh to Medan, most of the checkpoints on the portion of the route in Aceh had already disappeared before our data began being collected. We therefore focus the analysis of the effect of checkpoint reduction on the Meulaboh route where most of the changes occurred, and report additional specifications that use data from the Banda Aceh route to confirm that the results are not being driven by unobserved time trends.

Figure 3 plots these changes over time for both the Meulaboh route and the Banda Aceh route. The graphs in the leftmost column of Figure 3 show the total number of checkpoints encountered on each trip, the graphs in the center column of Figure 3 show the log average price paid at checkpoints in North Sumatra on the trip, and the graphs in the rightmost column of

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[15] Since payments at checkpoints represented about 15 percent of the total cost of a trip at the beginning of the period, if prices did not adjust the reduction in checkpoints would have resulted in a reduction in the total cost of a trip of at least 9 percent.

Figure 3 show the log of total payments in North Sumatra (at checkpoints and weigh stations). The solid line indicates the number of troops remaining in the districts in Aceh through which the trip passed at the time the trip began. The graphs in the left column show that the number of checkpoints encountered by trucks on the Meulaboh route declines substantially as troops are withdrawn, and further declines following the press conference in April, whereas the number of checkpoints declines much less on the Banda Aceh route.[16] The center panel shows that there was an increase in average prices at the Meulaboh route, coincident with the dramatic reduction of checkpoints on that route, while if anything there appears to have been declines in average prices on the Banda Aceh route. Similarly, the right panel shows that total payments in North Sumatra rise on the Meulaboh route, while if anything total payments are falling slightly on the Banda Aceh route over the same period. These results suggest that prices on North Sumatra portion of the Meulaboh route increase in response to the reduction in checkpoints on the Aceh portion of the route, as the model of endogenous price responses would predict.

To econometrically estimate the relationship between the reduction of checkpoints in Aceh and the increase in average prices in North Sumatra, we estimate the following regression:

$$LOGPRICE_{ci} = \alpha_c + X_i^{'}\gamma + \beta LOGEXPECTEDPOSTS_i + \varepsilon_{ci} \qquad (5)$$

Each observation in (5) is a bribe paid at a particular checkpoint, and only checkpoints in North Sumatra province are included. The key coefficient of interest is $\beta$, which is the elasticity of average prices at checkpoints with respect to the number of checkpoints. $LOGPRICE_{ci}$ is the log of the bribe paid at checkpoint *c* on trip *i*, and $LOGEXPECTEDPOSTS_i$ is the log of the expected number of checkpoints encountered on trip *i*. The expected number of checkpoints uses

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[16] Note that although the graphs in the left column show the total number of checkpoints, we have verified that the changes shown are all due to changes that occurred in Aceh province, and that the number of checkpoints in North Sumatra remains roughly constant over the period. In the econometric estimation below, we will explicitly isolate the variation in the number of checkpoints that comes from changes in Aceh province.

only variation in checkpoints in Aceh province, and is calculated as follows. For each two-week period, we calculate the average number of checkpoints encountered on the route in Aceh province. In calculating this two-week average, we use all trips in the two-week window except the current trip in order to avoid potential endogeneity concerns. We then add the average number of checkpoints encountered on the route in North Sumatra province, computed over the entire nine-month period under study. This yields the expected total number of checkpoints encountered in both provinces on a given trip, using only variation in checkpoints from Aceh province.[17]

The control variables $X$ in equation (5) include six dummies for the type of cargo, the log of the driver's monthly salary, truck age and age squared, and number of tons the truck is overweight; the impact of all of these characteristics on average payments will be explored in more detail in Section 5.1 below. We include checkpoint × direction of travel fixed effects ($\alpha_c$) to control flexibly for heterogeneity in checkpoints and to capture the fact that not all checkpoints operate every day.[18] Following Cameron, Gelbach, and Miller (2006), we cluster standard errors simultaneously on two dimensions, checkpoint and trip. We estimates versions of equation (5) where we include only trips on the Meulaboh route, where the main reductions in checkpoints took place, as well as versions of equation (5) where we include Banda Aceh trips, as well as a cubic polynomial in time, to control for overall unobserved time trends.

One potential concern with equation (5) is that, because it is estimated at the checkpoint level, it might not pick up changes due to the entry or exit of checkpoints, as well as changes in

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[17] This expectation therefore a) only uses variation in checkpoints coming from the changes in Aceh province, and b) excludes any idiosyncratic factors from the particular trip in question. Alternatively, using the actual number of checkpoints encountered in Aceh, instead of the expected number of checkpoints, produces very similar results.

[18] Specifically, we have information on the sub-district, or *kecamatan*, in which each checkpoint was located, and the organization (military, police, militarized police, etc) manning the checkpoint. We therefore approximate a checkpoint fixed effect by including a fixed effect at the sub-district * the organization manning the checkpoint level. This uniquely identifies the particular checkpoint in 63 percent of cases; in only ten percent of cases are there more than two checkpoints from the same organization in the same sub-district.

the amounts paid at weigh stations. We therefore estimate an alternative specification which focuses on the *total* amount paid at checkpoints and weigh stations in North Sumatra. Specifically, we estimate the following regression:

$$LOGPAYMENTS_i = \alpha + X_i^{'}\gamma + \beta LOGEXPECTEDPOSTS_i + \varepsilon \qquad (6)$$

In this specification, each observation is a single trip. $LOGPAYMENTS_i$ is the log of total illegal payments (checkpoints and weigh stations) in North Sumatra province on trip *i*, and Newey-West robust standard errors are computed, allowing for serial correlation with up to 10 lags.[19] As with equation (5), we estimates versions of equation (6) where we include only trips on the Meulaboh route, where the main reductions in checkpoints took place, as well as versions of (6) where we include Banda Aceh trips, as well as a cubic in time, to control for overall unobserved time trends. The mapping between estimated coefficients $\beta$ and the three alternative pricing structures discussed above is the same as with equation (5) above: $\beta$ = -1 for the fully centralized case, $-1 < \beta < 0$ for the decentralized case, and $\beta$ = 0 for the exogenous pricing case.[20]

Panel A of Table 2 presents the checkpoint-level results from estimating equation (5), and Panel B of Table 2 presents the aggregate time-series results from estimating equation (6). Column (1) presents OLS estimates for the Meulaboh route without controls *X*. Panel A shows that the elasticity of the average bribe in North Sumatra with respect to the expected number of checkpoints on the route is -0.545, and Panel B shows that the elasticity of the total payments in

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[19] Alternatively, clustering standard errors by two-week interval produces similar results.

[20] To see this, note that the total payments in North Sumatra, $P_S$, is equal to $\frac{P}{n}n_S$, where $P$ is the total amount paid on the entire route, $n$ is the total number of checkpoints, and $n_S$ is the number of checkpoints in North Sumatra. Since $n_S$ is not changing in response to the military withdrawal, $\log(P_S) = \log\left(\frac{P}{n}n_S\right) = \log\left(\frac{P}{n}\right) + c$. Thus, the predicted coefficients for the regression in (5) of $LOGPRICE_{ci}$ on $LOGEXPECTEDPOSTS_i$ are the same as the predicted coefficients for the regression in (6) of $LOGPAYMENT_i$ .on $LOGEXPECTEDPOSTS_i$ .

North Sumatra with respect to the expected number of checkpoints on the route is -0.736. The reason that the latter elasticity is slightly larger is likely due to the fact that Panel A includes only checkpoints, whereas Panel B includes weigh stations as well as checkpoints. Column (2) adds controls for the trip, which do not noticeably affect the results. In column (3), we restrict attention to the period before the press-conference, yielding estimates of -0.684 and -0.643. In column (4), to verify that the results are in fact related to the military withdrawals, we instrument for the log number of checkpoints with the log number of troops remaining in Aceh, yielding estimates of $-0.788$ and $-0.782$.

These estimates are all highly statistically significant from 0, and confirm that prices charged at the same checkpoints in North Sumatra increase as the number of checkpoints on the route in Aceh declines. Moreover, the elasticities are all smaller than 1 in absolute value (statistically significantly so in columns (1) and (2), not quite statistically significantly so in columns (3) and (4)). This means that not only are prices responding endogenously, but they appear to be more consistent with decentralized, rather than centralized, price setting.

It is possible, of course, that the coefficients in Columns (1) – (4) of Table 2 could be confounded by other factors with similar time trends to the military withdrawal. To investigate this, we use the fact that there were large reductions in the number of checkpoints on the Aceh portion of the Meulaboh road, but only very small reductions in the number of checkpoints on the Aceh portion of the Banda Aceh road. The Banda Aceh observations therefore let us control for unobserved time trends in the prices charged by police in North Sumatra. Specifically, in column (5), we add the trips on the route from Banda Aceh- Medan, and then include a common cubic polynomial of the trip date to control for common time trends.[21] The resulting elasticities

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[21] Naturally, in Panel B we also include a dummy for which route the trip was on; such a dummy is not necessary in Panel A because Panel A already includes checkpoint fixed effects, which implicitly capture the route fixed effect.

are somewhat higher than the elasticities estimated using only the Meulaboh data (-0.808 for average payments at checkpoints and -1.107 for total payments). This 'difference-in-difference' strategy therefore provides further evidence that prices respond endogenously to the withdrawals, but in this specification we can no longer tell definitively whether the endogenous price responses are consistent with centralized or decentralized price-setting.

### *4.2.2. An alternative empirical approach: changes within individual districts*

Thus far, the evidence presented has focused on changes that occurred in North Sumatra province. An alternative empirical approach, which allows us to also examine changes that occur within Aceh province itself, is to examine how the total cost of passing through *each district* changed as troops were withdrawn, taking advantage of the fact that the withdrawal of troops occurred at different times in different districts.[22] The key advantage of this approach is that, since a given trip passes through a total of ten districts, we can include trip fixed effects. This allows us to control completely flexibly for time trends and unobservable characteristics of each truck and driver. However, since trip fixed effects absorb the overall general equilibrium changes in the prices estimated above, this analysis tells us only how the allocation of bribes within a trip shifted as a result of the military withdrawal, rather than the impact on the overall bribe level.

To examine this, we estimate the following regression:

$$LOGPAYMENTS_{di} = \alpha_i + \alpha_d + \beta LOGEXPECTEDPOSTS_{di} + \varepsilon_{di} \qquad (7)$$

where $LOGPAYMENTS_{di}$ is the log of the total amount of payments made by driver *i* to pass through district *d*, $LOGEXPECTEDPOSTS_{di}$ is the log expected number of checkpoints in district (*kabupaten*) *d* encountered during trip *i* (calculated analogously to $LOGEXPECTEDPOSTS_i$ in equations (5) and (6) above), $\alpha_i$ is a trip fixed effect, and $\alpha_d$ is a set

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[22] Districts are they key sub-provincial administrative units in Indonesia, and both the police and the army are organized district-by-district. District borders are shown as solid black lines in Figure 1.

of district × direction of travel fixed effects.[23] Each observation is now a district × trip, and since a trip on either route passes through a total of ten districts there are now ten observations for each trip.

Since the regression in (7) examines the relationship of the total payments in a given district to the expected number of checkpoints *in that district*, the mapping between centralized, decentralized, and exogenous price setting and the predicted regression coefficients is slightly different than for equations (5) and (6) above. Specifically, if the bribes charged at checkpoints were centralized within districts – certainly a plausible hypothesis, given that the military and police command structure is organized by district – the military withdrawal of troops from a given district should not affect the amount (or share) of bribes collected in that district, so the elasticity of total payments in a given district with respect to the number of checkpoints in that district would be 0. If there was exogenous pricing, or if checkpoints did not adjust their prices with respect to the number of checkpoints in their district (and, instead, adjusted their prices only with respect to the total number of checkpoints on the road), then given the inclusion of trip fixed effects the elasticity of total payments to pass through a district with respect to the number of checkpoints would be 1. If there was decentralized price setting and the predictions in 4.1.1 hold within a district, the elasticity of total payments in a district with respect to the number of checkpoints in that district should be between 0 and 1. This would be the case, for example, if there are some local trips that do not go the entire long-distance route, but only travel on a subsection of the route.

The results are presented in Table 3. Column (1) of Table 3 presents the results from estimating equation (7) using OLS and data from the Meulaboh route, with fixed effects for each

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[23] Note that the log-log form implicitly drops district-trip observations with no checkpoints. We have re-estimated this equation in levels, and find qualitatively similar effects, suggesting that dropping the 0s does not substantially affect the results.

trip and for each district × direction of travel. Column (2) presents the results from re-estimating equation (7) instrumenting for $LOGPOSTS_{di}$ with the log number of troops remaining in the district.[24] Columns (3) and (4) repeat the estimation using data from both routes. Standard errors are clustered simultaneously on two dimensions, district × quarter and trip.[25]

Both the OLS and IV estimates (0.663 and 1.522, respectively, on the Meulaboh route, and 0.586 and 0.786, respectively, using data for both routes) are statistically distinguishable from 0. Moreover, the OLS estimates of 0.663 and 0.586 are significantly different from 1. This means that not only do prices respond endogenously to the *total* number of checkpoints on the road, but they also adjust to take into account the number of checkpoints in their particular portion of the road. This provides further evidence rejecting centralized price setting in favor of decentralized price setting and, more generally, further evidence that market structure affects equilibrium price levels.

### *4.2.3. Magnitudes and efficiency implications*

The estimated elasticities of prices with respect to the number of checkpoints suggest that the impact of endogenous price responses to market structure is quite large in magnitude. To see this, it is useful to consider how the changes in prices that occurred in response to the military withdrawal might have varied under alternate market structures.

As a baseline, note that preliminary interviews conducted in March 2005, i.e., before our survey began but while the military was still at full strength, found that on average truck drivers

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[24] The instrument, LOGTROOPS, includes army (TNI), militarized police (BRIMOB), and police (POLRI). The first-stage estimate is that the elasticity of the number of checkpoints in the district with respect to the number of troops in the district is 0.48, with an F-statistic of 1.80.

[25] The most general clustering would be to allow for clustering on district and trip. However, since there are only ten districts, the asymptotics of cluster may not be valid, which is why we cluster on district × quarter (i.e., three month period) and trip. Note that all of the withdrawal of troops occurs during one quarter, so is fully captured by this clustering approach. An alternative approach is to treat the data as a time-series within each district, and use Newey-West (1987) standard errors to capture serial correlation within districts. Computing standard errors in this way, and allowing for autocorrelation with up to ten lags, produces similar standard errors to those shown in the tables.

reported stopping and paying bribes at an average of 90 police and military checkpoints on each trip along these two routes, whereas in the post-withdrawal period, we found that truck drivers stopped at an average of 18 checkpoints.[26] Applying the estimate from Column 1, Panel A, Table 2 that the elasticity of the average price at a checkpoint with respect to the total number of checkpoints is -0.55, the reduction in military checkpoints from an average of 90 to an average of 18 (an 80% reduction) reduced the cost of payments at checkpoints by about 51%.[27]

To estimate the efficiency gain from this reduction in checkpoints, we need an estimate for the price elasticity of demand for trucking with respect to the bribe price. Since we do not observe this directly, we infer it from a related elasticity – the short-run price elasticity of demand with respect to the fuel price – for which there are available estimates.[28] These estimates imply that the 51% reduction in bribes associated with the military withdrawal would result in an increase in trucking of about 1.2 percent. Based on estimates from the weigh station at Seumedam and trucking firms on Meulaboh, we estimate that in early 2006 there were an average of about 6,000 truck trips per month on the Banda Aceh route and about 800 truck trips per month on the Meulaboh route. Even assuming the reduction in payments was the same on both routes, this would imply that the annual reduction in deadweight loss associated with the

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[26] Even if the total number of checkpoints in the pre-period is mismeasured, the qualitative differences between different market structures discussed below will be unaffected.

[27] To see this, note that if the number of checkpoints is equal to the expected number of checkpoints, we can transform equation (5) to be $LOGTOTALPAYMENTS_i = \alpha + X_i^{'}\gamma + (\beta + 1)LOGTOTALCHECKPOINTS_i + \varepsilon$. Thus, the relationship between the log of total payments on the route and the log of the total number of checkpoints on the route is equal to (-0.55+1)=0.45. This, combined with the 80% reduction in checkpoints, yields the estimate in the text.

[28] Specifically, assume the price elasticity of demand with respect to fuel is $\varepsilon_f$, and assume that the elasticity derives from the marginal cost of a trip, rather than fuel per se. Then, given that expenditures on fuel average about Rp. 1,500,000 for a given trip, a change in bribes of $\Delta b$ will result in a reduction in trucking of

$$\varepsilon_f \left( \ln\left(1,500,000 + \Delta b\right) - \ln\left(1,500,000\right) \right) \approx \varepsilon_f \frac{\Delta \beta}{1,500,000}$$

Estimates of the short-run price elasticity of demand for diesel fuel in developing countries are surveyed by Dahl (1994), who finds a wide range. For the calculations here, I use a recent estimate of -0.10 from Pakistan, which seems most comparable to the Indonesian setting (Pitafi 2004). We have been unable to obtain data on monthly diesel sales in Indonesia with which we could estimate this elasticity directly.

military pullout was equal to only Rp. 257,500,000 (US $28,000).[29] By contrast, once again assuming the reduction was the same on both routes, the estimated change in annual rents received by corrupt officials is much larger – Rp. 14,513,000,000 (US $1,580,000).[30] The reason the efficiency cost is relatively low, and the change in rents is relatively high, is that the estimate of demand we use is quite inelastic.

How would these estimates have differed under alternative market structures? If prices were centralized, there would have been no price or quantity response to the change in market structure. The change in dead-weight loss, as well as the change in rents, would have been zero. If prices were exogenous, the reduction in revenues would have been linear in the reduction in troops, as the increase in prices in response to the pullout estimated in Table 2 would not have occurred. In that case, the military withdrawal would have reduced payments at checkpoints by about 80%, rather than 51%, and the estimated change in deadweight loss and rents would have been substantially larger. The fact that the checkpoints in North Sumatra responded to the military withdrawal by raising prices therefore offset part of reduction in bribes that would have been expected due to the military withdrawal.

### *4.3. Empirical evidence on sequential bargaining*

#### *4.3.1. Bargaining vs. fixed prices*

The second prediction from the theory is that, in the presence of bargaining and hold-up, bribes should be increasing later in the trip. Before we can investigate that prediction, however,

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[29] To see this, note that there were 6800*12 = 81,600 trips annually after the military withdrawal. This, plus the 1.2% figure calculated in the text, implies that the military withdrawal resulted in an extra 979 trips over the course of a year. The change in deadweight loss is approximately equal to $\frac{1}{2}\Delta P \Delta Q + \Delta Q P_{post}$, where $P_{post}$ is the amount of bribes charged in the post period. The average amount paid in the post-period is Rp. 173,000, and the 51% reduction implies that $\Delta P = Rp.180000$. Substituting $\Delta Q = 979$, $\Delta P = Rp.180,000$, and $P_{post} = Rp.173,000$ yields the figure in the text.

[30] This is equal to the change in rents received, Rp. 180,000, multiplied by the number of trips that would have taken place each year in the pre period (6,800 * 12 / 1.012).

we must first establish that bribes are in fact determined through some type of bilateral bargaining process rather than being purely fixed in advance. To test for this, we examine whether the prices paid at the checkpoints vary with two objective factors that would presumably increase the bargaining power of the officer at the checkpoint.

First, we examine the price impact of whether the officer at the checkpoint is brandishing a gun. Holding a gun increases the officer's bargaining power for a variety of reasons – it signals his willingness (or, perhaps, taste) for inflicting physical punishment, it can be used to beat people, and it could be used to shoot a truck that drove away from the checkpoint. Second, we examine the number of officers who are visible at the checkpoint. Having more officers at the checkpoint allows an officer to spend time harassing a particular truck driver without worrying that he will be unable to stop subsequent trucks that come down the road while he is engaged. Having more officers around as backup may also increase the confidence of the officer bargaining with the truck driver. Anticipating this, truck drivers might be willing to offer more when many officers are visible at the checkpoint.

To test for bargaining, we estimate the following regression:

$$LOGPRICE_{ci} = \alpha_i + \alpha_c + GUN_{ci} + NUMOFFICERS_{ci} + \varepsilon_{ci} \tag{8}$$

As in equation (5), each observation is a checkpoint on a particular trip. Note that (8) includes fixed effects for the trip ($\alpha_i$), and fixed effects for the checkpoint × direction of travel × month ($\alpha_c$), and that we now include all of the data (i.e., data from both routes and both provinces). We adjust standard errors for clustering at the checkpoint level. We are thus examining whether, holding characteristics of the checkpoint, time trends, and the trip constant, greater bargaining power on the part of the officer manning the checkpoint leads to higher prices.

The results, presented in Table 4, support the idea that increases in the observable bargaining power of the officer lead to higher bribes paid. The results in Column (1) of Table 4 indicate that if the officer has a gun visible, the average payment increases by about 17 percent. Each additional person visible at the checkpoint increases the payment by about 5 percent.

Of course, it is possible that these higher prices in response to the officer's bargaining power reflect higher prices set ex-ante, rather than the result of bargaining per se. To test for bargaining more directly, we also collected data on how the transaction physically took place. In 87 percent of cases, the driver simply hands over an amount, and the amount is accepted by the officer with no discussion; active negotiation occurs in only 13 percent of cases. As shown in Column (2) of Table 4, the officer having a gun and the number of people at the checkpoint not only increase the price; they also substantially increase the probability that the truck driver and the officer manning the checkpoint engage in some type of active negotiation over the price to be paid. For example, the officer having a gun increases the probability of negotiations by 4 percentage points, or 45 percent above the baseline level. In a full information bargaining model, of course, these characteristics should affect the equilibrium price, but should not affect the number of rounds of bargaining required to reach the equilibrium price. The fact that these characteristics affect the number of rounds of bargaining in addition to the equilibrium price suggests that there is some uncertainty as to the impact of these characteristics on the bargaining power of the officer manning the checkpoint, which can be resolved through negotiation discussions. This provides more direct evidence that, indeed, the price paid is set at least in part through bilateral bargaining.

### *4.3.2. Sequential bargaining and increasing prices*

Given the presence of bargaining, we can test the implication of Section 4.1.2 that prices should increase as the trip gets closer to the end. To examine this empirically, we take advantage of the fact that we observe trips in both directions on both routes. We can therefore examine the dynamics of payments along a trip, conditioning out both trip fixed effects and checkpoint fixed effects.

To do this, we take the checkpoints in the order in which they are encountered on a trip, and assign them percentile scores from 0 (the first checkpoint) to 1 (the last checkpoint). We average across all trips in a given month to obtain the mean percentile score for each checkpoint – i.e., at what point in the trip is that checkpoint usually encountered – for both directions. Each checkpoint will therefore have two mean percentile scores for a given month – one for when the trip is going from point A to point B, and one for when the trip is going from point B to point A.[31]

We estimate the following regression at the checkpoint-trip level:

$$LOGPRICE_{ci} = \alpha_i + \alpha_c + \beta MEANPERCENTILE_{ci} + \varepsilon_{ci} \tag{9}$$

where $\alpha_i$ is a trip fixed effect and $\alpha_c$ is a checkpoint × month fixed effect. A positive coefficient $\beta$ indicates that the price is increasing as the trip progresses. We estimate equation (9) separately for each route, clustering standard errors at the checkpoint level. We also present the results nonparametrically. To do this, we estimate (9) with LOGPRICE as the dependent variable and with only the fixed effects $\alpha_i$ and $\alpha_c$ as the independent variables. We then take the

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[31] By allowing the percentile for each post to vary month-by-month, we ensure that we are not confounding the direction effect with the change in composition of posts due to the military withdrawal. Computing the mean percentile for the post for the whole sample, rather than month-by-month, produces similar results.

residuals from that regression, and perform a nonparametric Fan regression of the residuals on $MEANPERCENTILE_{ci}$.

Figure 4 shows the nonparametric Fan regression, and Table 5 presents the regression results from estimating equation (9). In both sets of results, the data from the Meulaboh route shows prices clearly increasing along the route, with prices increasing 16 percent from the beginning of the trip to the end of the trip. This is consistent with the model outlined above, in which there is less surplus early in the route for checkpoints to extract.

The evidence from the Banda Aceh route is less conclusive, with no clear pattern emerging – the point estimate in Table 5 is negative but the confidence intervals are wide, and the non-parametric regressions in Figure 4 show a pattern that increases and then decreases. One reason the model may not apply as well here is that the route from Banda Aceh to Meulaboh runs through several other major towns (Lhokeusamwe and Langsa, both visible on Figure 1). If officials cannot determine whether a truck is going all the way from Banda Aceh to Medan or stopping at one of these intermediate destinations, the upward slope prediction may be much less clear.[32]

Using the model, we can use the estimated slope on payments along the route to back out the implied relative bargaining power of the officer and truck driver. Specifically, the model implies that the slope of the payment with respect to the checkpoint number is $\log\left(1-\alpha\right)$, where $\alpha$ is the relative bargaining power of the officer at the checkpoint.[33] This implies that the slope with respect to the percentile (i.e., what we estimate in (9)) will be equal to $\log\left(1-\alpha\right)N$, where

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[32] Another potential reason is that there are fewer checkpoints on the Banda Aceh route. Since *N* is much smaller, the predicted slope on the percentile of the post's location should also be much smaller.

[33] To see this, take logs of equation (18) in Appendix A, and note that $\log b_n = -n\log\left(1-\alpha\right)+k$. This implies that the coefficient of a regression of logprice on the post number, *n*, would be equal to $\log\left(1-\alpha\right)$.

$N$ is the number of checkpoints. If we take the model seriously, the estimates from the Meulaboh route imply that bargaining power of the officers at the checkpoints is extremely low – the implied $\alpha$ is only 0.005. This very low bargaining power of officers at checkpoints is consistent with the fact that average payments – between US \$0.55 and US \$1.10 – are quite small.

## 5. Can corrupt officials price discriminate?

The analysis above suggests that corrupt officials respond to market forces in determining the level of bribes they charge. However, this does not necessarily imply that we can fully treat corrupt officials just like firms in the marketplace. In particular, the fact that corruption is illegal means that there may be very substantial restrictions on the types of contracts that corrupt officials can offer relative to what standard firms can do. This section examines whether the fact that bribes are illegal is sufficient to preclude price discrimination.

### *5.1. Price discrimination based on observable characteristics*

In the simple model in Section 4.1, we assumed that the demand function, $q(P)$, was uniform across trucks. If, however, there are observable characteristics that are correlated with different willingness to pay (and hence different $q(P)$ functions), then profit-maximizing officials will charge higher bribes to those trucks with characteristics that indicate a greater willingness to pay (or equivalently, to those trucks with characteristics that indicate a less elastic demand function).

To explore whether this type of third-degree price discrimination exists in pricing bribes, we examine the correlation between the prices paid at particular checkpoints and the observable characteristics of trucks that we would predict, *a priori*, to be correlated with higher or lower willingness to pay. Figure 5 presents the results of non-parametric locally weighted Fan regressions of the average price paid per checkpoint on two observable characteristics – the age of the truck and the average cargo value per ton.[34] Figure 5 reveals that trucks older than about 12 years pay substantially lower prices, though this accounts for only about 6 percent of the trucks in our data. Trucks with low value cargo also pay substantially less; prices fall off precipitously below about Rp 5,500,000 / ton (US $600, or 15.5 on the log scale shown in the figure, which is the 43rd percentile in the value distribution).

To verify the patterns shown in Figure 5, we estimate a price-discrimination equation. The key advantage of the regression-based approach is that we can include checkpoint fixed effects interacted with month fixed effects, to take into account the fact that different trucks carrying different cargo may have traveled on different routes or at different times. Specifically, we estimate the following equation:

$$LOGPRICE_{ci} = \alpha_c + X_i^{'}\beta + \varepsilon_{ci} \tag{10}$$

where each observation is a checkpoint-trip, $X_i^{'}$ are characteristics of the truck $i$ and $\alpha_c$ are checkpoint × direction of travel × month fixed effects. We include data from both provinces and both routes. Standard errors are simultaneously clustered at both checkpoint level and trip level.

The results are reported in Table 6. Since the total value of truck contents was only available for a subset of trips, in column (1) we use dummy variables for different types of cargo (which were available for all trips), whereas in column (2) we explicitly include the cargo value (which limits the sample to those trips where the cargo value was reported). The results are consistent with Figure 5, showing both the decreasing (and concave) relationship between truck age and price paid. The results in column (2) also show the increasing relationship between cargo value and payments, although the result is not statistically significant. The results indicate higher payments for agricultural produce, which may potentially be more time sensitive to transport

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[34] Though the average value per ton is not directly observable, the type of cargo is, and it is commonly known which types of cargo have higher or lower unit values.

than other cargo, and for steel, which is often of questionable legality. A joint F test of all characteristics shown in the table reveals that these characteristics are jointly significant at the 1 percent level, indicating the presence of substantial heterogeneity in prices that appears to be correlated with trucks' ability to pay. These results are in the same spirit as Svensson (2003), who also found that firms with higher ability to pay do in fact pay higher bribes.

The social welfare consequences of price discrimination at checkpoints depend on whether the total amount of corruption is affected by the ability to price discriminate. If the total amount of corrupt revenue from bribes at weigh stations is fixed (for example, through some type of political constraint), allowing third-degree price discrimination unambiguously reduces the dead-weight loss from corruption (Baumol and Bradford 1970 - see Appendix A for details). The analogy here is to the Ramsey tax problem – with third degree price discrimination, officers can extract a greater share of the revenue from those truckers whose demand is less elastic, thus increasing overall efficiency. If, however, we assume that the officials at weigh stations are not subject to a revenue constraint, so that they can adjust prices to maximize revenue, then the welfare effects of third-degree price discrimination are theoretically ambiguous, and depend on the specific shape of the demand curves.[35]

### *5.2. Weigh stations and second-degree price discrimination*

A second type of price discrimination can occur when there is asymmetric information between firms and customers. In this context, for example, there may be unobserved heterogeneity in the fixed cost firms must pay for each trip, and thus in the willingness of truck drivers to pay to be overweight. In such a situation, officials at weigh stations could potentially introduce a non-linear pricing scheme to extract additional revenue from truck drivers with a

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[35] If demand curves are linear, then allowing third-degree price discrimination and allowing total revenue to adjust decreases efficiency (Schmalensee 1981). With more general demand curves, however, Schmalensee shows that the welfare impact of third-degree price discrimination is ambiguous.

higher willingness to pay to be overweight. These non-linear pricing schemes should feature quantity discounts, so that the marginal bribe required for each additional ton the truck is overweight decreases as the number of tons overweight increases (Maskin and Riley 1984).

An example of exactly this type of second-degree price discrimination can be found at the Gebang weigh station, located in North Sumatra province on the Banda Aceh – Medan route, where officials at weigh stations have set up the bribe schedule as a menu of two-part tariffs. If trucks simply arrive at the weigh station, they pay a high marginal cost for being overweight – regressions indicate that they pay approximately Rp. 11,000 (US $1.20) per ton overweight for each ton over ten tons overweight, plus a fixed fee of approximately Rp. 170,000 (US $18.50). However, if before they leave Medan they purchase a date-stamped coupon from a criminal organization for about Rp. 150,000 (US $16.30), when they arrive at the weigh station they can turn the coupon in and pay a flat fee of approximately Rp. 50,000 (US $5.50) to the weigh station attendants, for a total payment of Rp. 200,000 (US $21.70), regardless of how overweight they are. Facing this schedule, drivers more than 16 tons overweight should prefer the high fixed-fee, low marginal-cost scheme, whereas those less than 16 tons overweight should prefer the low fixed-fee, high marginal-cost scheme.

Figure 6 shows non-parametric locally-weighted regression estimates of the prices truck drivers pay at Gebang (including the price of the coupon), separately depending on whether they have purchased the coupon or not. The patterns visible in Figure 6 confirm that the existence of two very different pricing schedules with a break-even line around 16 tons.

Table 7 investigates which trucks select into which fee schedule. Column (1) of Table 7 shows, quite surprisingly, that while heavier trucks are more likely to select into the high fixed cost, low-marginal cost fee schedule, this effect is not statistically significant, and relatively small in magnitude – moving from not being overweight at all to being 25 tons overweight, close to the maximum reported, is associated with only an 8 percentage point higher probability of choosing the high fixed cost, low-marginal cost fee schedule. However, column (2) indicates that those with higher unobserved fixed costs (in the forms of higher salaries for drivers) are much more likely to select into the high fixed cost, low marginal cost fee schedule. Moreover, those drivers who get paid more also tend to carry heavier loads, so that in column (3), when we instrument for truck weight with the log of the driver's salary, we now get a much larger (and statistically significant) coefficient on truck weight.[36]

One way to reconcile all these results is to assume that drivers have some uncertainty about the amount their truck actually weighs. Since they have to decide whether or not to buy the date-stamped coupon before they depart Medan (and, therefore, before they reach the first weigh station), they decide based on whether they are generally overweight or not. This would explain why factors that predict whether they are overweight – such as the driver's salary – have more predictive power than the actual weight of the truck.[37] This uncertainty could also explain why there are two two-part tariffs, rather than a single non-linear tariff; in the presence of ex-ante uncertainty about the weight of the truck and risk-averse truck drivers, this system of multiple two-part tariffs can actually produce more revenue that a simple non-linear tariff payable at the weigh station (Clay, Sibley and Srinagesh 1992, Miravete 2005). The contract offered is therefore most like that offered on cell phone plans in the United States, where users who face an uncertain amount of usage have to select ex-ante whether they prefer a high-fixed fee, low marginal cost contract or a low-fixed fee, high-marginal cost contract.

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[36] Of course, the driver's salary is by no means a perfect instrument; rather, the point is that we have demonstrated a characteristic that is related to a fixed cost of a trip and correlated both with a driver being overweight on average and his decision to purchase the coupon.

[37] It is also possible that there is classical measurement error in the driver's estimate of the truck's weight reported to the surveyor, in which case using IV would also increase the point estimates.

The type of second-degree price discrimination practiced at the Gebang weigh station, while it may be revenue maximizing for corrupt officials, exacerbates the inefficiencies caused by corruption at weigh stations. In particular, quantity discounts further decrease social efficiency by moving from a linear (or even possibly convex) bribe schedule to a concave bribe schedule – exactly the opposite of the true social costs from driving overweight.

The pricing scheme of the Gebang weigh station is, in a sense, a possibility result – it demonstrates that very sophisticated pricing contracts can emerge for corrupt activity. Just because this type of two-part contract occurs at Gebang, however, does not mean that it will emerge everywhere, and in fact, an interesting question is why this system of two-part contracts occurs only at the Gebang weigh station, and only heading towards Aceh.[38] Understanding the precise circumstances that enable these complex arrangements to evolve is an important direction for future work.

## 6. Conclusion

This paper has examined the degree to which corrupt officials behave like firms. We accompanied truck drivers on 304 trips transporting goods to and from the Indonesian province of Aceh. During these trips, we observed a total of more than 6,000 bribes and other illegal payments to police, military officers, and officials at weigh stations, or about 20 such payments per trip. Total illegal payments averaged about 13% of the cost of each trip, more than the total wages received for the trip by the truck driver and his assistant.

Using this data, we showed that the patterns of bribes paid conform to predictions of standard models of pricing behavior from industrial organization. During the period under study,

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[38] One potential reason it has not emerged at Seumedam is that, as discussed above, Seumedam received more intense scrutiny as it was part of a pilot project, so operating these more complex bribe contracts may not be feasible. Moreover, in all of the routes except the route from Medan – Banda Aceh, most trucks travel as part of an organized convoy. As a result, virtually all of the trucks on these routes have already paid a fixed fee for the journey, which may make offering the type of contracts offered at Gebang more difficult.

the military staged a staggered withdrawal from Aceh province as part of a peace agreement with the GAM rebel group. We document that this withdrawal led to a dramatic reduction in the number of checkpoints at which trucks in Aceh had to stop to pay bribes. In response to this, we show that average bribes paid at checkpoints on the remainder of the route increased, consistent with double-marginalization in a chain of decentralized monopolies.

We also take advantage of the fact that we observed each payment directly to examine how bribes are negotiated. Prices are not posted, nor do corrupt officials typically ask for a given amount; instead, most of the time the truck driver simply offers an amount to the officer at the checkpoint, who decides whether to accept it or to decline and ask for a higher price. Although the vast majority of initial offers are accepted, we show that the equilibrium amount paid nevertheless reflects the relative bargaining power of the two parties. For example, factors that increase the bargaining power of the officer manning the checkpoint, such as whether he is brandishing a gun, and the number of officers who are visible and could provide backup if trouble arose, increase the equilibrium payment. Given the presence of bargaining, we then show that bribes paid per checkpoint increase as the trip nears its destination, consistent with ex-post hold-up along a chain of monopolies.

Finally, we showed that, even though corruption is illegal, complex systems can evolve in order to achieve greater levels of price discrimination. We document the existence of price discrimination based on observable characteristics, such as age of the truck and the cargo being carried, so that trucks with characteristics that indicate higher willingness-to-pay are indeed charged higher bribes. Moreover, we show that at one of the four weigh stations on the route, a criminal organization appears to have partnered with weigh station officials to introduce a menu of two-part tariffs. This suggests the barriers posed by the fact that corruption is illegal are not sufficient to prevent complex pricing schemes involving multiple transactions.

The results here have several implications for anti-corruption policy. First, the double-marginalization shown here implies that decentralized corruption can result in higher bribes charged than if corruption was centralized. If that is the case, tackling corruption at the top of an organization could actually lead to increases in bribes , if the number of bribe takers on the ground remains the same but their coordination system is undermined. Second, it suggests that in many cases, simple policies such as limiting the number of police or other bribe takers may lead to less corruption. This is particularly true when the current equilibrium involves bribes that are paid to traffic police regardless of whether a law is broken, as it is here. This was not *a priori* obvious – for example, if pricing was centralized, prices would have simply adjusted and the policy would have had no effect. There could also have been entry of criminal organizations to extract bribes at checkpoints instead of the police. While the results suggest that the simple policy of reducing the number of traffic police is partially effective at reducing bribes, endogenous responses from remaining police officers partially offset the gains obtained by having fewer officers on the streets.

Although the economic mechanisms identified in this paper are likely to be general, the degree of centralization or decentralization of bribes will clearly vary according to the context. For example, a pilot survey conducted by the authors in March 2005 on the road between Jakarta, the capital of Indonesia, and Bandung, the capital of nearby West Java province, found that – in contrast to Aceh – the vast majority of extortion payments made by truck drivers on the Bandung – Jakarta route were in the form of routine monthly payments to police officials and affiliated criminal organizations, with relatively little collected at checkpoints. One interpretation of this phenomenon is that the corrupt officials in West Java had managed to centralize collection of bribes precisely in order to overcome the double marginalization problem demonstrated in this paper. Understanding the circumstances that allow corruption to be coordinated in this way is an important direction for future research.

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## Appendix A: Proofs

*Proof of claims in Section 4.1.1:* First, to show that $\frac{\partial P}{\partial n} > 0$, note that from equation (3) we know that, in equilibrium, $\varepsilon(P) = -n$. It follows directly from the implicit function theorem that if $\varepsilon'(P) < 0$ then $\frac{\partial P}{\partial n} > 0$.

Second, we are interested $\frac{\partial \frac{P}{n}}{\partial n} = \frac{n\frac{\partial P}{\partial n} - P}{n^2}$. Using the implicit function theorem on (3), we can see that $\frac{\partial P}{\partial n} = \frac{-1}{\varepsilon'(P)}$, so $sign\left\{\frac{\partial \frac{P}{n}}{\partial n}\right\} = sign\left\{-\frac{n}{\varepsilon'(P)} - P\right\}$. Using the fact that $\varepsilon(P) = -n$ in equilibrium, we know that $sign\left\{\frac{\partial \frac{P}{n}}{\partial n}\right\} = sign\left\{\frac{\varepsilon(P)}{\varepsilon'(P)} - P\right\}$. So, to show that $\frac{\partial \frac{P}{n}}{\partial n} < 0$, we need to show that $\frac{P\varepsilon'(P)}{\varepsilon(P)} > 1$. Recall that $\varepsilon(P) = \frac{q'(P)P}{q(P)}$, which implies that $\varepsilon'(P) = \frac{q''(P)P + q'(P) - \left[q'(P)\right]^2 P}{\left[q(P)\right]^2}$. So, we need to show that

$$\frac{P\varepsilon'(P)}{\varepsilon(P)} = \frac{P\frac{q''(P)P + q'(P) - \left[q'(P)\right]^2 P}{\left[q(P)\right]^2}}{\frac{q'(P)P}{q(P)}} > 1$$

, or equivalently, that $\frac{q''(P)P}{q(P)q'(P)} + \frac{1}{q(P)} - \frac{q'(P)P}{q(P)} > 1$. Since $-\frac{q'(P)P}{q(P)} = n > 1$, it suffices to show that $\frac{q''(P)P}{q(P)q'(P)} + \frac{1}{q(P)} > 0$, or, equivalently, that $\frac{q''(P)P}{q'(P)} + 1 > 0$. For this to be true it is sufficient that $q''(P) \le 0$ since $q'(P) < 0$.

*Proof of claims in Section 4.1.2:* To solve the model, we take the set of payments $p_i$ as fixed, start at the last checkpoint, and work backwards. At the last checkpoint *N*, if an agreement between the officer manning the checkpoint and the truck driver is reached, the surplus from reaching an agreement is 1 - $p_N$. This is because the cargo is now worth 1 if the trip is completed as opposed to 0 if it was confiscated, but $p_i$ must be paid to the boss of the checkpoint. The officer manning the checkpoints therefore receives $\alpha(1 - p_N)$, and the truck driver retains the surplus $(1-\alpha)(1-p_N)$. The total bribe we observe includes the amount the officer keeps and the amount he will pass on to his boss, i.e., $b_N = (1-\alpha)p_N + \alpha$.

At the previous checkpoint (*N*-1), a similar bargaining game takes place, except that now, the surplus from agreement is reduced by the amount that will have to be paid at checkpoint *N*. Applying this logic and working backwards, the total surplus the driver retains after passing checkpoint *n* is

$$(1-\alpha)^{N-n+1} - \sum_{j=n}^{N}(1-\alpha)^{j-n+1} p_j \tag{11}$$

and the bribe paid at checkpoint *n* is

$$b_n = \alpha\left[(1-\alpha)^{N-n} - \sum_{j=n+1}^{N}(1-\alpha)^{j-n} p_j\right] + (1-\alpha)p_n \tag{12}$$

Given that these are the bribes that will be paid in equilibrium, the demand curve is now based on the total bribes paid, i.e.

$$q\left(1-\left(1-\alpha\right)^{N}+\sum_{j=1}^{N}\left(1-\alpha\right)^{j} p_{j}\right) \tag{13}$$

Knowing this, the bosses at checkpoints choose their prices to maximize the revenue they receive. The first-order condition for the boss at checkpoint *n* is

$$q\left(1-\left(1-\alpha\right)^{N}+\sum_{j=1}^{N}\left(1-\alpha\right)^{j} p_{j}\right)=p_{n}\left(1-\alpha\right)^{n} q'\left(1-\left(1-\alpha\right)^{N}+\sum_{j=1}^{N}\left(1-\alpha\right)^{j} p_{j}\right) \tag{14}$$

Defining *P* to be the total price, we have that

$$\frac{1}{\left(1-\alpha\right)^{n} p_{n}}=-\frac{\varepsilon\left(P\right)}{P} \tag{15}$$

Note that as $\alpha \to 0$, so that the officer has no bargaining power, (15) reduces exactly to the first-order condition in the simpler model, i.e., the condition in equation (3).

We can now show the results given in the text. First, to show that total bribe paid is increasing as the trip goes along, note that from (15), in equilibrium the expression $\left(1-\alpha\right)^{n} p_{n}$ must be constant for all checkpoints *n*. This immediately implies that $p_n$ is increasing with *n*. Using this fact, equation (12), combined with the fact that all $p_n$ are positive, implies that the total bribe paid at each checkpoint is also increasing in *n*.

What remains to show is that the double-marginalization effects demonstrated in Section 4.1.1 still arise in this more complex framework. First, we want to show that $\frac{\partial P}{\partial N}>0$. To do this, note that from (15) we know that each price can be written as

$$p_{n}=-\frac{P}{\left(1-\alpha\right)^{n}\varepsilon\left(P\right)} \tag{16}$$

Substituting into (13), we can see that the total price paid is equal to

$$P=1-\left(1-\alpha\right)^{N}-\sum_{j=1}^{N}\frac{P}{\varepsilon\left(P\right)}=1-\left(1-\alpha\right)^{N}-\frac{PN}{\varepsilon\left(P\right)} \tag{17}$$

Applying the implicit function theorem to (17), we get that $\frac{\partial P}{\partial N}>0$ if $\varepsilon'\left(P\right)<0$, which was assumed. Finally, we need to show that prices at individual checkpoints decrease with *N*. Taking each checkpoint as fixed, consider the case where we add a checkpoint to the end – i.e., we increase *N* and see what happens to prices at checkpoint *n*. Substituting (16) into (12) and rearranging terms, we see that

$$b_{n}=\frac{1}{\left(1-\alpha\right)^{n}}\left[\alpha\left(1-\alpha\right)^{N}+\left(\alpha\left(N-n\right)-1\right)\frac{P}{\varepsilon\left(P\right)}\right] \tag{18}$$

As *N* increases, we know that $\left(1-\alpha\right)^{N-n}$ decreases. Also, we just showed that as *N* increases *P* increases. Since $\alpha<\frac{1}{N}$ by assumption, $\left(\alpha\left(N-n\right)-1\right)<0$, so the whole second term will be decreasing in *N* if $\frac{\partial \frac{P}{\varepsilon\left(P\right)}}{\partial P}>0$, or equivalently, if $\frac{\partial \frac{q\left(P\right)}{q'\left(P\right)}}{\partial P}>0$. Taking derivatives, a sufficient condition is that *q* is concave, i.e., $q''\left(P\right)<0$, although once again a weaker condition that *q* is not too convex is sufficient.

Second, consider the case where we add a checkpoint to the beginning of the trip, i.e., we add a checkpoint at 0. For a given checkpoint *n*, all of the terms in (18) remain the same except *P*, which we know increases. By the same logic as before, this implies that $b_n$ decreases. Since adding a checkpoint either before or after a checkpoint *n* decreases the bribe paid at *n*, we can conclude that adding an additional checkpoint decreases the price at all existing checkpoints.

*Proof of claims in Section 4.3:* At the last checkpoint, the surplus from agreement is $1-b_1$, where $b_1$ is pre-determined. Nash bargaining therefore implies that $b_2=\alpha\left(1-b_1\right)$, so the final payoff to the driver is equal to $1-b_1-\alpha\left(1-b_1\right)$. At the first checkpoint, Nash bargaining implies that

$$b_1=\arg\max_{b_1}\alpha\ln\left(b_1\right)+\left(1-\alpha\right)\ln\left(1-b_1-\alpha\left(1-b_1\right)\right) \tag{19}$$

i.e., that $b_1=\alpha$. Substituting in for $b_1$ at the second checkpoint yields that $b_2=\alpha\left(1-\alpha\right)$, so $b_2<b_1$. Solving the equivalent problem in 3 periods checkpoints yields $\left\{b_1=\alpha, b_2=\alpha\left(1-\alpha\right), b_3=\alpha\left(1-\alpha\right)^2\right\}$, so it is still the case that $b_j>b_k$ if $j<k$.

*Proof of claims in Section 5.1:* We want to minimize dead-weight loss such that we raise a fixed amount of revenue *R*. Suppose there are two types, i.e., we want to solve

$$\min_{p_1,p_2}\int_{p_1}^{0}q_1\left(p\right)dp+\int_{p_2}^{0}q_2\left(p\right)dp \text{ s.t. } p_1q_1\left(p_1\right)+p_2q_2\left(p_2\right)=R \tag{20}$$

Writing down the Lagrangian for this maximization problem, taking derivatives, and re-arranging the derivatives of the Lagrangian with respect to $p_1$ and $p_2$ immediately yields the result that, at the optimum,

$$\frac{q_1^{'}\left(p_1\right)p_1}{q_1\left(p_1\right)}=\frac{q_2^{'}\left(p_2\right)p_2}{q_2\left(p_2\right)} \tag{21}$$

i.e., the prices are set such that the elasticities of demand for the two types are equal. Since this is also precisely the rule used in third-degree price discrimination, we can conclude that third-degree price discrimination minimizes the dead-weight loss if revenue remains equal. In fact, for any amount of revenue to be raised, third-degree price discrimination, which equates the elasticities for the two types of goods, is the most efficient way to raise that amount of revenue.

## Table 1: Summary statistics

| | (1)<br>Both Roads | (2)<br>Meulaboh Road | (3)<br>Banda Aceh Road |
|---|---|---|---|
| Total expenditures during trip (Rp.) | 2,901,345 | 2,932,687 | 2,863,637 |
| | (725,003) | (561,736) | (883,308) |
| Bribes, extortion, and protection payments | 361,323 | 415,263 | 296,427 |
| | (182,563) | (180,928) | (162,896) |
| Payments at checkpoints | 131,876 | 201,671 | 47,905 |
| | (106,386) | (85,203) | (57,293) |
| Payments at weigh stations | 79,195 | 61,461 | 100,531 |
| | (79,405) | (43,090) | (104,277) |
| Convoy fees | 131,404 | 152,131 | 106,468 |
| | (176,689) | (147,927) | (203,875) |
| Coupons / protection fees | 18,848 | - | 41,524 |
| | (57,593) | (0) | (79,937) |
| Fuel | 1,553,712 | 1,434,608 | 1,697,010 |
| | (477,207) | (222,493) | (637,442) |
| Salary for truck driver and assistant | 275,058 | 325,514 | 214,353 |
| | (124,685) | (139,233) | (65,132) |
| Loading and unloading of cargo | 421,408 | 471,182 | 361,523 |
| | (336,904) | (298,246) | (370,621) |
| Food, lodging, etc | 148,872 | 124,649 | 178,016 |
| | (70,807) | (59,067) | (72,956) |
| Other | 140,971 | 161,471 | 116,308 |
| | (194,728) | (236,202) | (124,755) |
| Number of checkpoints | 20 | 27 | 11 |
| | (13) | (12) | (6) |
| Average payment at checkpoint | 6,262 | 7,769 | 4,421 |
| | (3,809) | (1,780) | (4,722) |
| Number of trips | 282 | 154 | 128 |

Notes: Standard deviations are in parentheses. Summary statistics include only those trips for which salary information was available. All figures are in October 2006 Rupiah (US $1 = Rp. 9,200)

## Table 2: Impact of number of checkpoints in Aeh on bribes in North Sumatra

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | OLS | OLS | OLS | IV | OLS |
| *Panel A: Log average payment at checkpoint* | | | | | |
| Log expected checkpoints | -0.545*** | -0.580*** | -0.684*** | -0.788*** | -0.808*** |
| on route | (0.157) | (0.167) | (0.257) | (0.217) | (0.196) |
| Sample | Meulaboh | Meulaboh | Meulaboh Pre-Press Conf. | Meulaboh | Both Routes |
| Truck controls | No | Yes | Yes | Yes | Yes |
| Common time effects | None | None | None | None | Cubic |
| Observations | 1941 | 1720 | 1069 | 1720 | 2715 |
| Test elas = 0 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| Test elas = -1 | 0.00 | 0.01 | 0.22 | 0.33 | 0.33 |
| *Panel B: Log total payments* | | | | | |
| Log expected checkpoints | -0.736*** | -0.695*** | -0.643*** | -0.782*** | -1.107** |
| on route | (0.064) | (0.069) | (0.237) | (0.131) | (0.444) |
| Sample | Meulaboh | Meulaboh | Meulaboh Pre-Press Conf. | Meulaboh | Both Routes |
| Truck controls | No | Yes | Yes | Yes | Yes |
| Common time effects | None | None | None | None | Cubic |
| Observations | 161 | 144 | 90 | 144 | 249 |
| Test elas = 0 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| Test elas = -1 | 0.00 | 0.00 | 0.14 | 0.10 | 0.81 |

Notes: Panel A presents the results from estimating equation (5), where each observation is a payment at a checkpoint, the dependent variable is the log payment at the checkpoint, the sample is limited to North Sumatra province only, all specifications include checkpoint × direction of travel fixed effects, and robust standard errors are in parentheses, adjusted simultaneously for clustering at the checkpoint and trip level. Panel B presents the results from estimating equation (6), where each observation is a trip, the dependent variable is log total payments in North Sumatra province, and robust Newey-West standard errors allowing for up to 10 lags are included in parentheses. In both specifications, truck controls are dummies for 6 types of contents, log driver's monthly salary, truck age and truck age squared, and number of tons truck is overweight; these characteristics are examined in more detail in Table 6. The instrument in column (4) is the log number of troops remaining in Aceh in the districts covered by the Meulaboh route. Log expected checkpoints uses only variation from Aceh province; the details of how this variable is constructed are in the text. Column (5) is the difference-in-difference specification, including both routes and a common cubic in time. Note that column (5) of Panel B also includes a dummy for route.
* significant at 10%; ** significant at 5%; *** significant at 1%

## Table 3: Impact of number of checkpoints on total payments in district

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | OLS | IV (troops) | OLS | IV (troops) |
| Log expected checkpoints in district | 0.663*** | 1.522*** | 0.586*** | 0.786** |
| | (0.081) | (0.390) | (0.082) | (0.359) |
| Sample | Meulaboh | Meulaboh | Both Routes | Both Routes |
| Observations | 1090 | 1026 | 1435 | 1363 |
| Test elas = 0 | 0.00 | 0.00 | 0.00 | 0.03 |
| Test elas = 1 | 0.00 | 0.18 | 0.00 | 0.55 |

Notes: This table presents the results from estimating equation (7), where there is one observation for each district encountered on each trip, the dependent variable is the log of total amount paid in bribes in district, and where trip fixed effects and district × direction of travel fixed effects are included. The instrument in columns (2) and (4) is the log number of troops remaining in district. Robust standard errors are in parentheses, adjusted simultaneously for clustering at the district × quarter and trip level.
* significant at 10%; ** significant at 5%; *** significant at 1%

## Table 4: Bargaining vs. fixed prices

| | (1) | (2) |
|---|---|---|
| | Log Payment | Negotiate dummy |
| Gun visible | 0.166*** | 0.042*** |
| | (0.056) | (0.015) |
| Number of people at Checkpoint | 0.047*** | 0.017*** |
| | (0.009) | (0.004) |
| Observations | 5260 | 5281 |
| Mean dep. Var | 8.49 | 0.13 |

Notes: This table presents the results from estimating equation (8), where there is one observation for each payment at a checkpoint, and where with trip fixed effects and checkpoint × direction × month interval fixed effects are included. Robust standard errors are in parentheses, adjusted for clustering at the checkpoint level.
* significant at 10%; ** significant at 5%; *** significant at 1%

## Table 5: Sequential bargaining and increasing prices

| | (1) | (2) |
|---|---|---|
| Mean percentile | 0.145*** | -0.178 |
| | (0.045) | (0.225) |
| Sample | Meulaboh | Banda Aceh |
| Observations | 4190 | 1089 |

Notes: This table presents the results from estimating equation (9), where there is one observation for each payment at a checkpoint, and where with trip fixed effects and checkpoint × month interval fixed effects are included. Robust standard errors are in parentheses, adjusted for clustering at the checkpoint level.
* significant at 10%; ** significant at 5%; *** significant at 1%

## Table 6: Price discrimination

| | (1)<br>Log payment | (2)<br>Log payment |
|---|---|---|
| *Contents of truck* | | |
| Steel | 0.326*** | |
| | (0.123) | |
| Construction materials | -0.060 | |
| | (0.045) | |
| Food | 0.042 | |
| | (0.035) | |
| Agricultural produce | 0.092 | |
| | (0.058) | |
| Manufactured goods | -0.212*** | |
| | (0.061) | |
| Empty bottles | -0.121 | |
| | (0.451) | |
| Log cargo value per ton | | 0.039 |
| | | (0.030) |
| *Other characteristics* | | |
| Log driver's monthly salary | 0.024 | 0.040 |
| | (0.031) | (0.039) |
| Truck age | 0.063*** | 0.030 |
| | (0.022) | (0.029) |
| Truck age (years) | -0.003** | -0.001 |
| | (0.001) | (0.002) |
| Tons overweight | -0.001 | 0.006** |
| | (0.003) | (0.003) |
| Observations | 4636 | 2179 |
| F stat on joint test of all listed characteristics | 29.12 | 7.78 |
| P val of joint test of all listed characteristics | 0.00 | 0.05 |

Notes: This table presents the results from estimating equation (10), where there is one observation for each payment at a checkpoint, and where checkpoint × direction × month fixed effects are included. Robust standard errors are in parentheses, adjusted simultaneously for clustering at both the checkpoint and trip level. F stat and P val refer to a joint test of all listed coefficients.

* significant at 10%; ** significant at 5%; *** significant at 1%

## Table 7: Who selects into high fixed cost contract?

| | (1) | (2) | (3) |
|---|---|---|---|
| | OLS | OLS | IV |
| Tons overweight | 0.003 | | 0.039** |
| | (0.010) | | (0.019) |
| Log driver's monthly salary | | 0.305** | |
| | | (0.119) | |
| Constant | 0.495*** | -4.018** | 0.074 |
| | (0.138) | (1.760) | (0.210) |
| Observations | 47 | 47 | 47 |
| R-squared | 0.00 | 0.09 | |

Notes: This table reports the result of a linear probability model that estimates $COUPON_i = \alpha + X_i^{'}\beta + \varepsilon_i$, where *COUPON* is a dummy for whether a given trip *i* purchased the coupon and thus selected into the flat-price system. Each observation is a trip, and the sample is restricted to all trips on the Medan – Banda Aceh route headed in the direction of Banda Aceh, as coupons are only for sale on this route and only for this direction of travel. Column (1) and (2) are estimated as linear probability models using OLS; column (3) is estimated as a linear probability instrumental variables model using 2SLS where the instrument is the log driver's monthly salary. Non-linear probit and instrumental variables probit models produce qualitatively results. Robust standard errors are in parentheses. All columns drop two outliers – the highest observation on weight and the highest observation on salary. Including these observations strengthens the statistical significance of the results in columns (2) and (3).

* significant at 10%; ** significant at 5%; *** significant at 1%

**Figure 1: Routes**

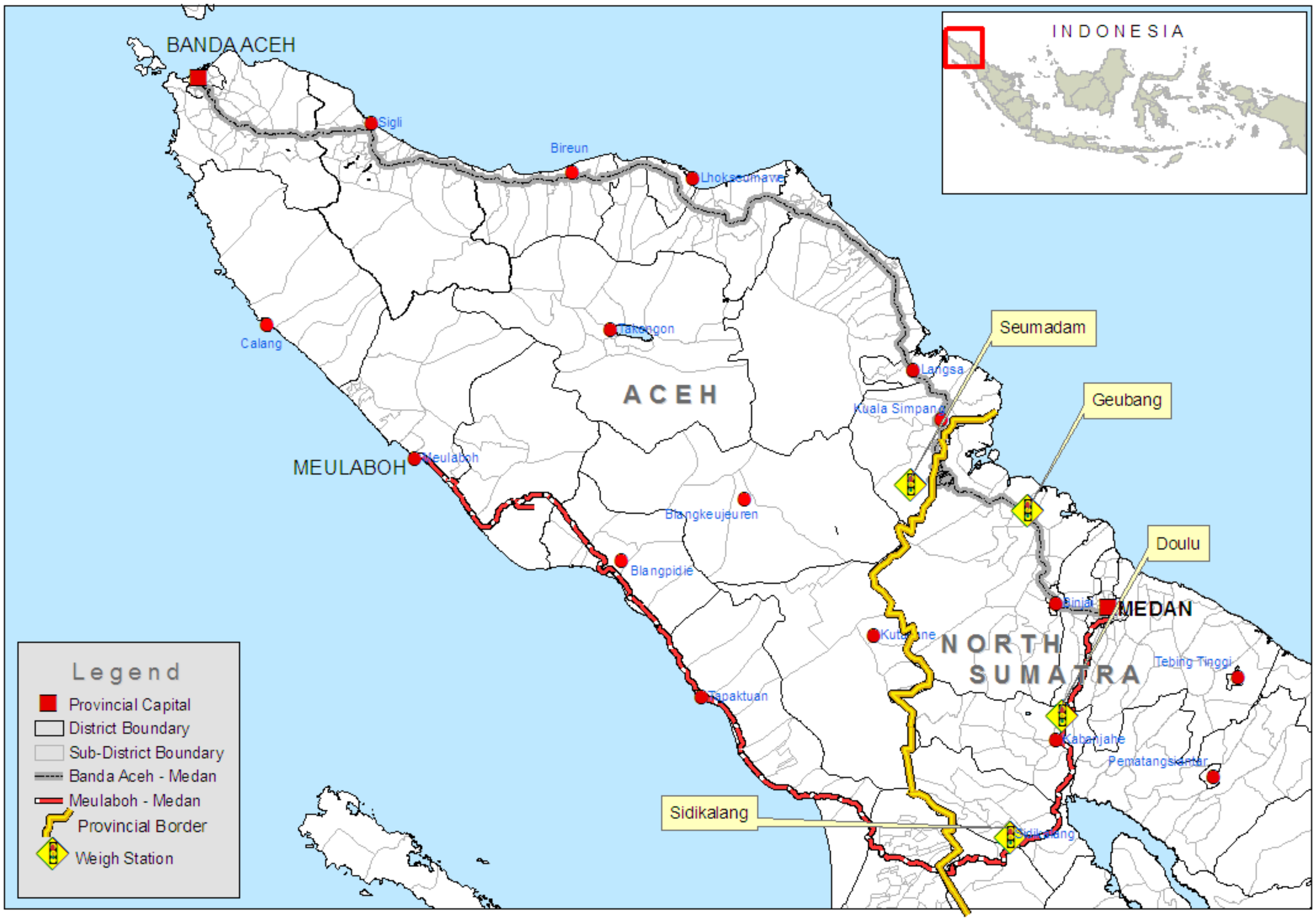
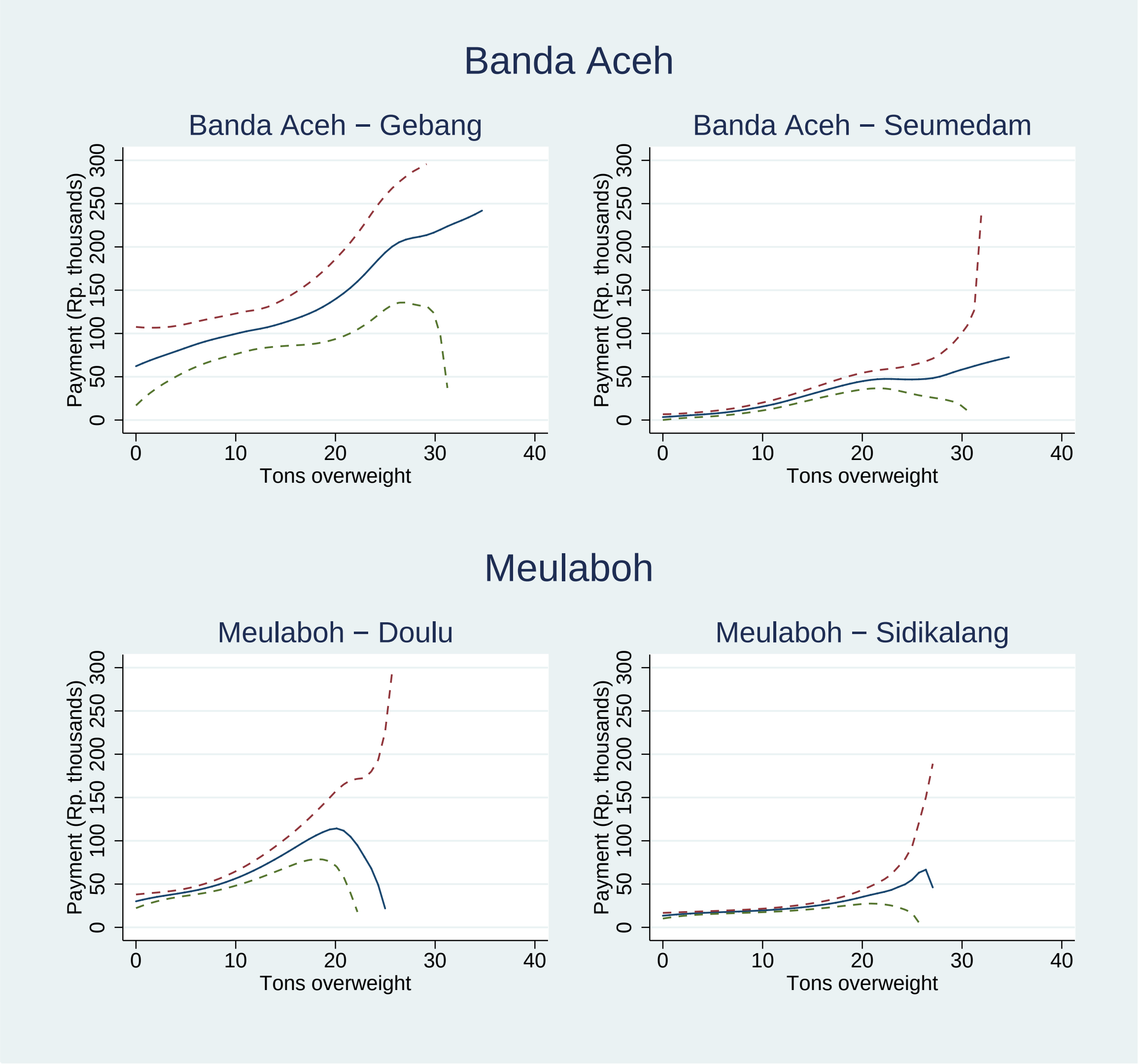
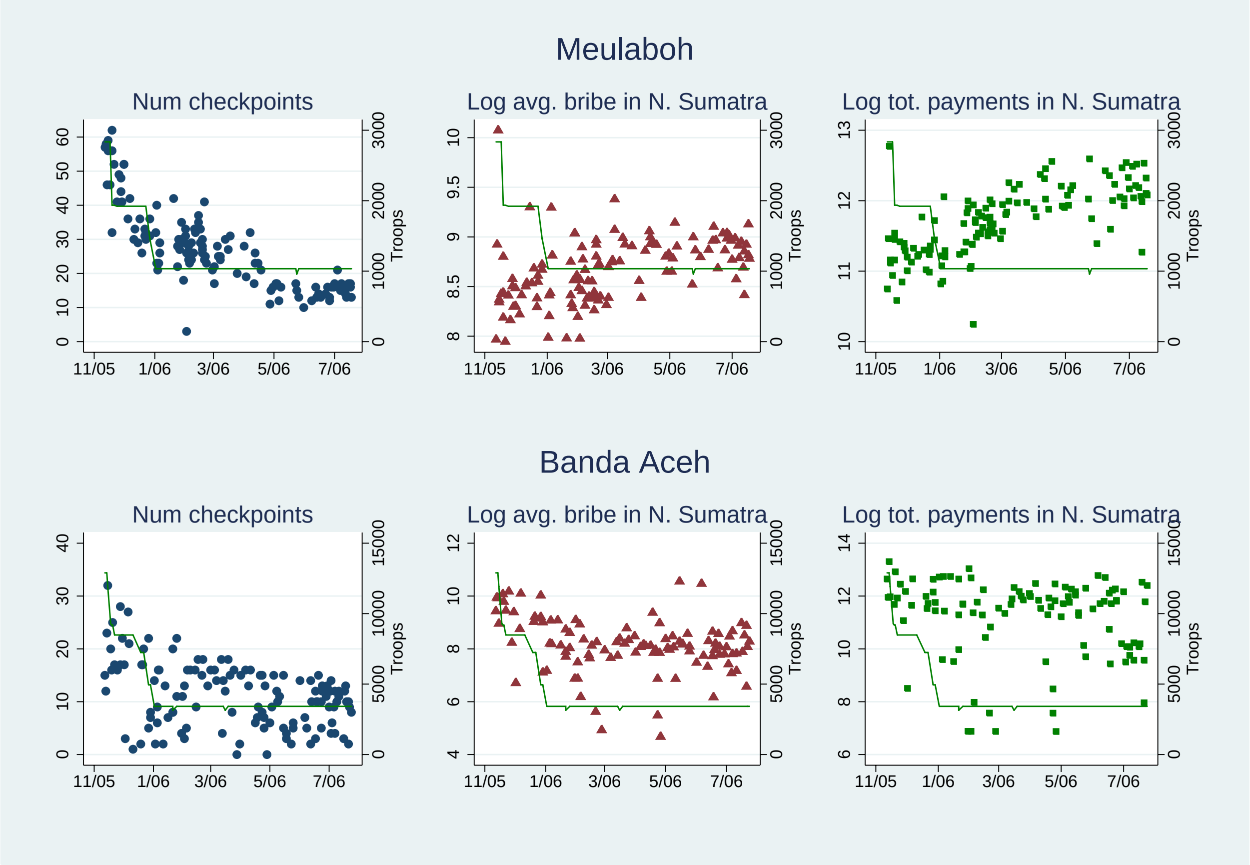


**Figure 2: Payments at weigh stations**



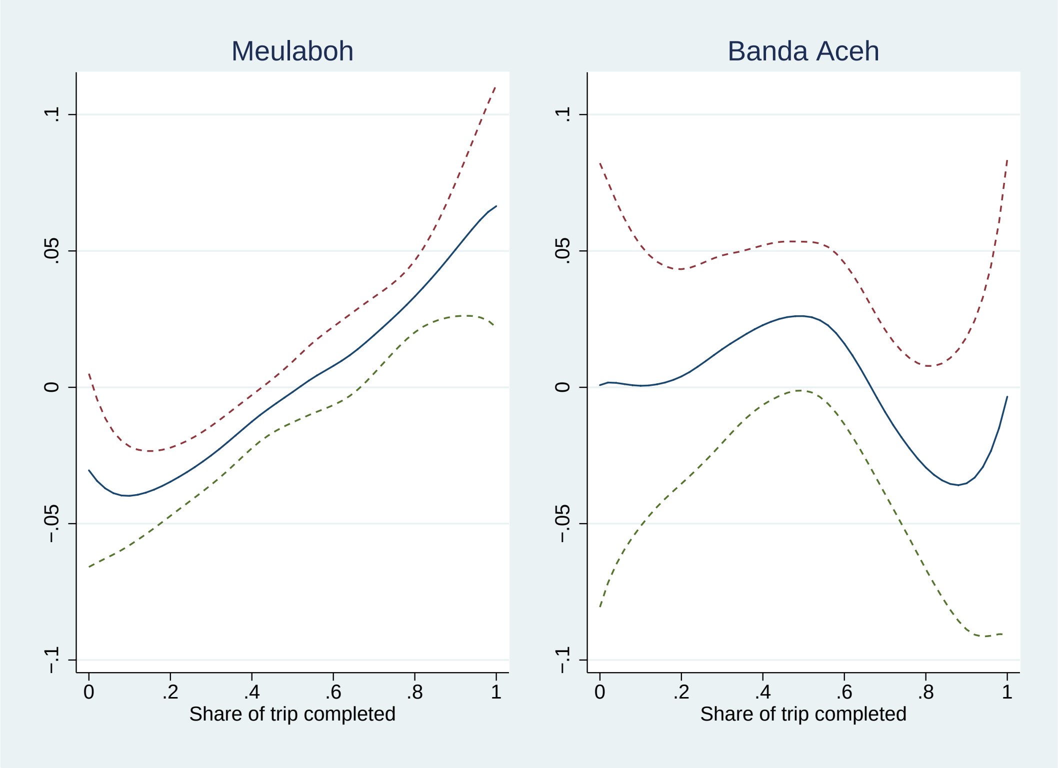
Notes: Each graph shows the results of a non-parametric Fan (1992) locally weighted regression, where the dependent variable is the amount of bribe paid at the weigh station and the independent variable is the number of tons the truck is overweight. The bandwidth is equal to one-third of the range of the independent variable. Bootstrapped 95% confidence intervals are shown in dashes, where bootstrapping is clustered by trip. When the dashed lines are not shown, it indicates that the 95% confidence interval exceeds the y axis of the graph.

**Figure 3: Impact of troop withdrawals**



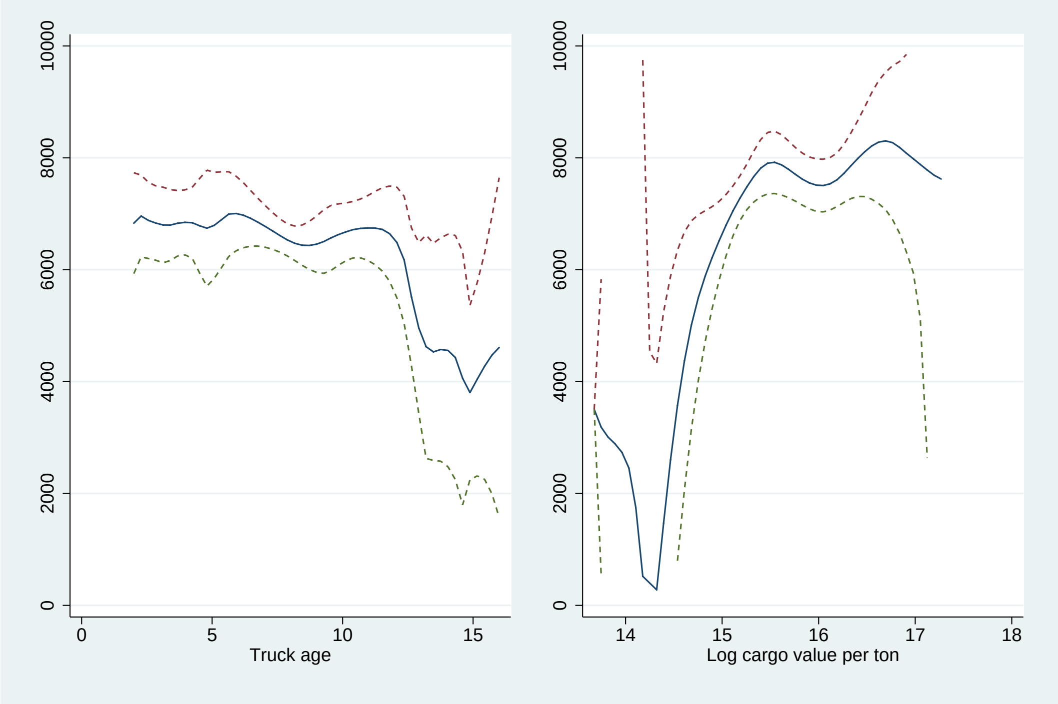
Notes: Each observation is a trip. Dots in the left column show the number of checkpoints encountered on the trip. Triangles in the center column show average prices paid at checkpoints in North Sumatra province on the trip. Boxes in the right column show the log of total payments made in North Sumatra province, including payments at weigh stations. The top panel shows trips on the Meulaboh road; the bottom panel shows trips on the Banda Aceh road. The solid line indicates the number of troops and police stationed in Aceh province at the time the trip began.

**Figure 4: Payments by percentile of trip**



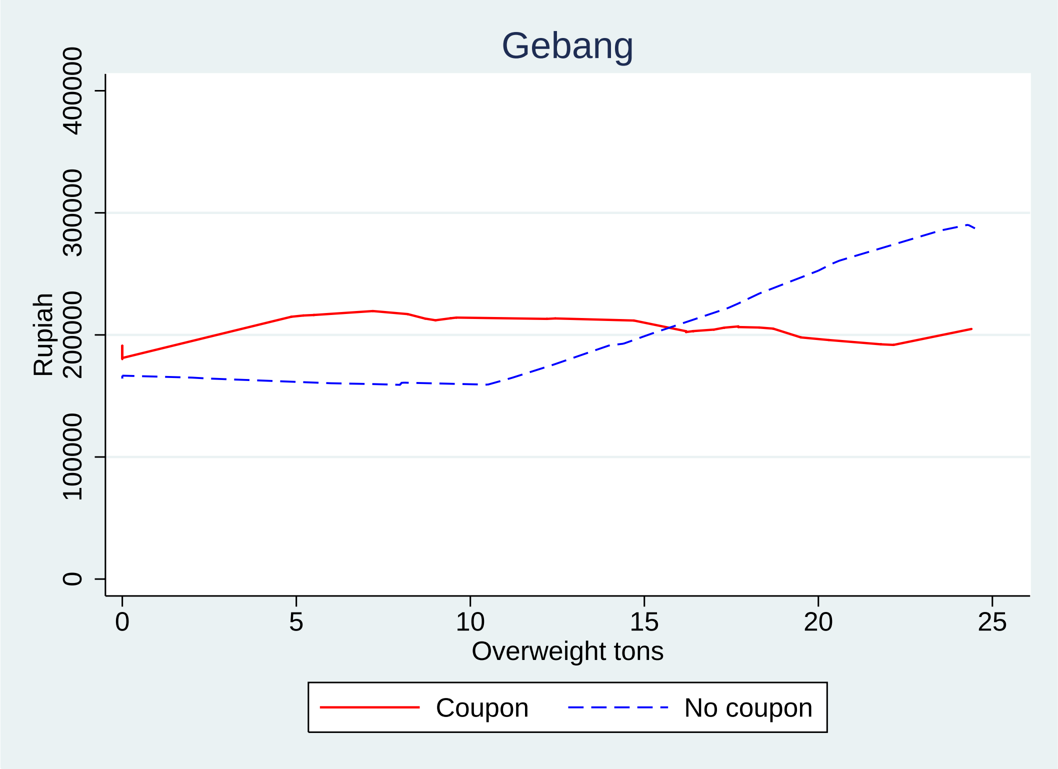
Notes: Each graph shows the results of a non-parametric Fan (1992) locally weighted regression, where the dependent variable is log payment at checkpoint, after removing checkpoint × month fixed effects and trip fixed effects, and the independent variable is the average percentile of the trip at which the checkpoint is encountered. The bandwidth is equal to one-third of the range of the independent variable. Dependent variable is. Bootstrapped 95% confidence intervals are shown in dashes, where bootstrapping is clustered by trip.

## Figure 5: Price discrimination on observable characteristics



Notes: Each graph shows the results of a non-parametric Fan (1992) locally weighted regression, with the bandwidth equal to one-fifth of the range of the independent variable. The dependent variable is the price paid at the checkpoint, and the independent variable is shown In the x axis (truck age in the left panel and log cargo value per ton in the right panel). Bootstrapped 95% confidence intervals are shown in dashes, where bootstrapping is clustered by trip. When the dashed lines are not shown, it indicates that the 95% confidence interval exceeds the y axis of the graph.

## Figure 6: Payments at Gebang weigh station



Notes: The figure shows the results of two locally-weighted Fan regressions of the total amount paid at the Gebang checkpoint and (if applicable) in purchasing the coupon on the amount overweight. The solid line shows the total amount paid for those who purchased the coupon, and the dashed line shows the total amount paid for those who did not purchase the coupon. We cannot reject that slope of coupon line is zero, but can reject that slope of no coupon line is zero and can reject that two slopes are equal at the 95% level. Note that this regression drops one observation that was more than 30 tons overweight, and all observations from one surveyor who did not record whether the truck had paid the coupon or not.