

DO HIGHER SALARIES LOWER PETTY CORRUPTION?
A POLICY EXPERIMENT ON WEST AFRICA'S HIGHWAYS¹

Jeremy D. Foltz
University of Wisconsin-Madison
Department of Agricultural and Applied Economics
427 Lorch St., Madison, WI 53706
jdfoltz@wisc.edu

Kweku A. Opoku-Agyemang
University of California, Berkeley
Blum Center for Developing Economies
100 Blum Hall, Berkeley, CA 94720
kweku@berkeley.edu

Abstract

In an ambitious public sector reform experiment, the Ghana government doubled its police officer salaries in 2010 in part to mitigate petty corruption on its roads, while leaving salaries for other officials unchanged. Using unique data on bribes paid from truck trips in West Africa, we evaluate impacts of higher police salaries on petty corruption using a difference-in-difference method. Rather than decrease petty corruption, the salary policy significantly increased the police efforts to collect bribes, the value of bribes and the amounts given by truck drivers to policemen in total. The higher results are stable across alternative specifications. (*JEL K42, R40*)

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Introduction

How can we lower the incidence of petty corruption? Given the weaknesses of institutions in developing countries, reducing corruption has long been a concern to economists and policymakers, and understanding this question is important for improving economic efficiency and outcomes. A recent survey of the emerging literature on corruption and economic incentives (Olken and Pande, 2012) succinctly presents the need for research to tackle the fundamental question confronting policy makers: how to promulgate policies to reduce corruption. Indeed the authors of that review note that in providing policy guidance for an anti-corruption agency they “had more questions to pose than concrete answers.” (Olken and Pande (2012: 481)).

A burgeoning literature suggests that raising the salaries of government officials could reduce their propensity to solicit and accept bribes. At the aggregate country level Van Rijckegehem and Weder (2001) show that countries with higher civil service wages have lower levels of corruption. Recent work on political corruption by Gagliarducci and Nannicini (2013) and Ferraz and Finan (2009) suggests that higher salaries for politicians reduce their levels of corruption. A growing number of laboratory and field experiments have also shown that raising wages or payments to subjects reduces corrupt behavior (e.g., Armantier and Boly (2011) and Van Veldhuizen (2013)). While the political corruption literature is often well identified, the literature on petty corruption of officials suffers from a lack of identification and questions about external validity outside the laboratory setting.

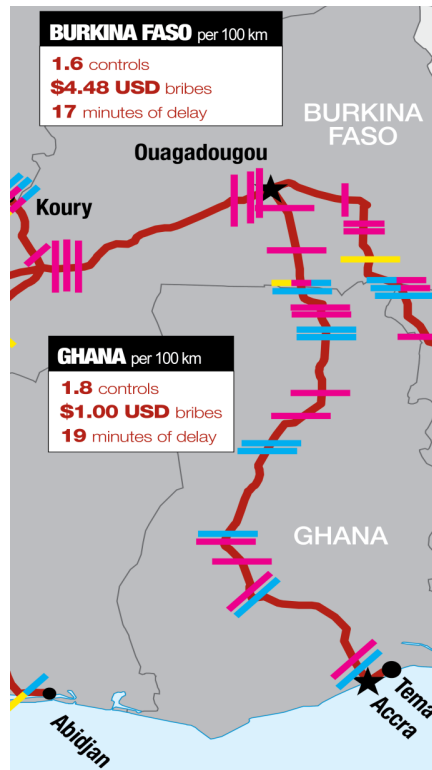
This work exploits one of the most ambitious civil service policy reforms in Africa to ask whether raising salaries for corrupt officials improves or worsens petty corruption outcomes in developing countries. This experiment is important from a policy perspective because

officials' salaries in poor countries are low, creating an identification problem on the origins of petty corruption. On the one hand, petty corruption outcomes such as bribery may be only manifestations of low incomes and corruption would reduce significantly if incomes were raised substantially. On the other, corrupt outcomes might occur independently of income levels and be worsened by a higher “appetite” that higher incomes would bring. Classic economic models show that individuals care about both their absolute and relative incomes. These effects are further complicated by the reality that corrupt officials’ incomes persist in broader environments, so that other agents (e.g. those who must pay bribes to officials) may be aware that certain officials have higher salaries and potentially alter their strategies to reflect changes.

In this work, we use detailed survey data and experimental evidence to study this question in one particular context: bribery and corruption on highways in West Africa. In July 2010, the Ghana Government implemented a “single-spine” salary structure for all police officials (unilaterally doubling their incomes) in an effort to improve officials' living standards and curb highway bribery by said officials. On the other hand, neighboring countries in the West African region left their police salaries unchanged throughout the period, as did other officials within Ghana. Between 2006 and 2012 the United States Agency for International Development (USAID) West African Trade Hub has collected unique data from over 2,100 long-haul truck trips in the sub-region, representing over 45,000 bribe opportunities on the road between Tema, Ghana and Ouagadougou, Burkina Faso. By following bribes paid by the same trucks in different countries as well as aggregate trends in Ghanaian bribe taking using a difference-in-difference methodology, we can identify whether salaries affect both demand for bribes and the amount given by truckers. Figure 1, produced by the West African Trade Hub, shows some of the bribe data collected in a map of the Tema, Ghana to Ouagadougou, Burkina Faso corridor.

Figure 1

Map of the Route From Tema, Ghana to Ouagadougou, Burkina Faso



Source: West Africa Trade Hub. Red and blue bars represent customs and police stops respectively, in their customary or most frequent locations.

The question of incentive-compatible anti-corruption policy is a growing concern for political and development economists as shown by an increasing number of studies focusing on countries such as Indonesia (e.g. Olken (2007); Olken and Barron, (2009)), India (Bertrand, Djankov, Hanna and Mullanaithan (2007)), and Uganda (e.g. Fisman and Svensson (2007)). One study based in Italy highlights the need to disentangle inefficiency from corruption (Bandiera, Prat and Valletti (2009)). Such approaches are nested in the need to improve state capacity as outlined in Rose-Ackerman (2010).

As shown in a map of the roads used by the trucks in our study in figure 1, this research investigates a cross-border aspect of corruption, which has seen relatively little study in the literature. An exception is Zitzewitz, (2012) in which the International Skating Union found that an anti-corruption transparency reform led to more nationalistic bias from within-country judges. No study (to the best of our knowledge) has been able to evaluate policies aimed at lowering petty corruption on highways on an international scale. This gap in the literature persists although Freund and Rocha (2009) show that delays in the time it takes to get goods in and out of ports represents a major deterrent to the level of trade within and among African countries, but especially so for those that are landlocked. This paper also addresses a need to study and evaluate evidence on corruption that occurs across national boundaries. Although high levels of corruption on the truck routes of West Africa are most certainly detrimental to the viability of both exports and imports, international highways are becoming more dominant across the countries of Latin America, Asia and the Middle East. Policy on petty corruption at the international level in these areas may similarly benefit from understanding how petty corruption might transpire even in the context of international trade.

We find that the salary reform worsened petty corruption outcomes rather than improving them, empirically diverging from most of the theoretical models of corruption extant in the literature. The results show that raised salaries for Ghanaian police officers caused the police to increase the effort they put forth to get bribes by 19 percent, the value of bribes taken at each individual stop by between 25-28 percent (~\$0.25), and increases the total amount taken on the road, even while they reduce the number of times they receive a bribe. In other words, the higher salary translates into petty corruption effort becoming more intense. This outcome is mostly explained by complementary behavioral model environments in which the choices of corrupt

officials does not only depend on the material outcome choices, but also on points of orientation to which such outcomes may be compared (e.g. Kőszegi and Rabin 2006). This observation of reference dependence driven corruption choices has implications not only for the discourse on the economic origins of petty corruption, but anti-corruption policy reform. As developing countries attempt to gain from integration within their respective sub-regions, political barriers to trade such as petty corruption may benefit from such behavioral perspectives partly since poverty and self-control may be intertwined (Bernheim, Ray and Yeltekin (2015)).

The remainder of the article proceeds as follows. The second section discusses the single spine salary policy experiment implemented in Ghana. The third section presents some descriptive statistics of the data. The fourth section provides a conceptual framework and develops testable hypotheses. Section five discusses the empirical strategy and results and the sixth section concludes.

2. The Single Spine Salary Structure (SSSS) in Ghana

Civil service salary reform in Ghana, though desired by many, has had a long and tortuous history of fits and starts with little actual reform taking place until recently. Following independence in 1957, corruption in the Ghanaian public service led to both economic and political instability in the 1960s and 1970s and a series of coups into the early 1980s. During that period public pay review interim commissions mandated with harmonizing salary standards in the Ghana Universal Salary Structure (GUSS) post-independence public pay system had difficulties implementing reforms in the context of on going political unrest and instability.

After returning to democracy in 1992, the Gyampoh Commission met during the rule of President Jerry Rawlings to plan and implement the public sector reforms previously envisioned

decades earlier, but the commission disbanded only a year later. Next, in 2000, President Kufour's Ministry of Public Sector Reforms constructed a pay policy to correct existing disparities within the public sector, renamed the Single Spine Salary Structure (SSSS) and announced in 2007. The term "single spine" was inspired by a biological analogy: as all nerves and organs of the human body are connected to a single spinal cord, so would all public workers, irrespective of sector and specialization be connected to a common salary system (Seniwoliba (2014)). Although President Kufuor's Government had intended to implement these public sector pay reforms, his party, the New Patriotic Party (NPP) lost the general elections to the rival National Democratic Congress (NDC) in 2008, again calling into question whether these reforms would ever take place.

The NDC Government issued an announcement in November 2009, pledging to mitigate pay disparities in the public service; implement numerous pay negotiations; and improve productivity through payment channels (Daily Graphic, 2009). To facilitate SSSS implementation, public sector workers were categorized by job similarities with factors influencing categorization including education, skills, training, and career roles. Parliament passed the Fair Wages and Salaries Commission (FWSC) to administer the SSSS in 25 levels. Following negotiations with public sector unions in 2009, the SSSS started implementation in July 2010 with the police service as the first type of civil servant to receive this structure.

2.2 Ghana Police Salary Increases

Everyone is hoping to see the end of corruption, inefficiency and bribery by the police, now that their salaries have gone up.

--Stephen Owusu (2011) *Can Single-Spine Salary For Police Stop Bribery and Corruption?*

The FWSC migrated the Ghana Police Service to the single spine structure on July 1, 2010, leading to a doubling of police salaries. Such a doubling of salaries for the police was unique and not repeated across other civil servant types. Although having other public sectors on the same structure helped harmonize pay standards across sub-sectors, this might have influenced the impression that the SSSS was meant to add more funds to all salaries. When the Ghana Prison Services, Ghana National Association of Teachers, National Association of Graduate Teachers, Civil and Local Government Staff Association Ghana, Ghana Medical Association and others received their pay without the significant pay increases received by police, they either picketed, demonstrated, threatened strike action or actually took such actions.

Two reasons seem to account for Ghana giving a disproportionate rise in salaries exclusively to the police. Historically, the police service has been the least well-paid of all public sector workers in Ghana. Second, it was thought that this measure could curb corruption, as noted in the above media report. Thus, from a public policy perspective one might consider it both fair and the investment with the highest expected return in terms of lowered corruption to give disproportionate raises to the police. However, the SSSS has not been targeted exclusively to the Ghanaian police, although the administrative and efficiency characteristics of the reform meant that staff working in other sectors often had little to gain financially on eventual migration to the SSSS, which may partially explain the strong opposition to police salary increases (Aliu and Fuseini (2014). Other researchers argue that the labor unrest may have occurred because there was little to no educational outreach on the role of the program to harmonize pay scales of various public officials as well as significant delays in SSSS implementation for other types of civil servants in the subsequent stages (Seniwoliba 2014).

By 2014, the SSSS had already become a main source of government expenditure pressure. Ghana's wage bill grew by 47% between 2011 and 2012, representing the highest wage bill growth rate on the African continent, which is a development that has been attributed to the SSSS (McTernan 2013). In the same year, the government wage bill totaled about \$2 billion, with economists in Ghana calling for a delay in further SSSS implementation to reduce the 11% deficit (Daily Graphic, 2014). At the same time however, corruption remained a concern with the Ghanaian public as acknowledged by President John Mahama in his State of the Union address, where he observed that there was no longer any reason for petty corruption since salary concerns had been addressed (Gadugah 2015).

3. Data

This investigation draws on unique data collected by the USAID-West Africa Trade Hub (WATH) project since 2006 from over 2,400 trucks plying the roads in West Africa.² Since 2006 they given surveys to long-haul trucks plying the major truck routes of West Africa. The dataset for this work includes trucks traveling back and forth from Ouagadougou, the capital of Burkina Faso, to the port town of Tema, Ghana, see figure 1 for a map of the route. Drivers of trucks on these routes wrote down the delay, amount paid and the official type each time they paid an average of 27 bribes per trip to seven different types of officials spread out along the nearly 1,000 km of road on this corridor.³

² The WATH corruption data used in this work is available on the WATH website at <http://www.borderlesswa.com/resources/publications>

³ Due to the poor quality of secondary roads, there are few alternative routes or ways for truckers to drive around checkpoints and barriers.

In the dataset, each checkpoint stop for an individual driver represents a data point, which produces some 40,000 useable stops for more than 2,400 drivers on trips in Ghana and Burkina Faso, with 34,869 stops occurring in Ghana. There are seven different types of stops recorded: Customs, Forestry, Gendarmerie, Health, Other, Police, and Unions on the road from Tema in Ghana to Ouagadougou in Burkina Faso. The data also include information on driver and truck characteristics including country of origin of the driver & truck; truck type (tanker, container, general purpose); and truck value. Since over 90% of the stops in Ghana are either customs or police, we use only the data on customs and police stops in Ghana with the addition of the gendarmes (a police force) in Burkina Faso. The results reported are robust to inclusion of the other authority types.

The surveys were given to truck drivers at the beginning of their trips. When the drivers are approached with a survey, an expert in trucking checks their papers and assesses if the papers for the truck and cargo are in order. If they are in correct condition and the truck driver agrees to take the survey, the driver is given a survey to fill out which is then collected at the end of the trip. Only trucks scheduled to drive the whole trip are given surveys to fill out. It is estimated by those that hand out the survey that the trucks with their papers in order represent about one-third of the long-haul trucks on the road. The data therefore represent a selected sample that represents the minimum levels of bribes paid, since the trucks without appropriate papers will be likely to pay higher bribes. Collecting data from trucks whose documentation are confirmed to be in order also minimizes the possibility that a bribe payment can be warranted.

Our data suggest that the total cost of bribes is between \$0.03 and \$0.17 per kilometer, implying that bribes are a non-negligible 1-5% of total costs, and between 2% and 10% of variable costs of a long-haul trip. In addition the data show delays due to petty corruption that

can add up to an extra day in transit. The average bribe paid in Ghana is just under \$1 on average, with the most frequent bribe amount being paid at 1 Ghanaian Cedi (roughly equivalent to \$0.25).

4. Conceptual Framework: Theories of Bribe Taking

We present simple theoretical models that capture multiple potential outcomes from increasing police salaries, including the three major theories from the literature about how raising salaries might change corruption. The first of those theories is the “crime and punishment” or shirking model from Becker and Stigler (1974), in which government officials choose corruption based on a cost benefit analysis that equates corruption returns to their lost potential forgone future income if they get caught. This set up is broadly related to the social norms literature on corruption such as Acemoglu and Jackson (2014) and expresses similar concerns to models of “career concerns”, albeit with different mechanisms (e.g., Dewatripont, Jewitt and Tirole, 1999). The second theory, first formalized by Akerlof and Yellen (1990) is the “fair wage” hypothesis in which officials engage in corruption up to the point that their wage rises to what is considered the fair wage. We add a third possibility to our modeling, developed from the reference dependent utility and target income literatures. In this reference dependent utility model, the salary change affects policemen’s reference income level relative to other civil servants leading to higher levels of corruption. These diverse models therefore yield substitutive predictions to provide a comprehensive understanding on the economic origins of petty corruption. We proceed with a basic framework.⁴

⁴ A fourth possibility is the monopolist model of corruption, in which corrupt officials maximize profits by setting a bribe price to pass on the road (see Schliefer and Vishny (1993) for a model and Olken and Barron (2009) for an application to similar truck data as this study. The appendix A2 explores this possibility and finds no empirical evidence to support such a model in the West African context.

Let there be an official who receives a salary, B , and can choose to engage in corrupt practices by putting in effort, e , which gets him benefit $g(e)$ but induces a cost to him of $c(e, \bar{B})$ where \bar{B} is the official's permanent income received from salary level B . The function $g(\cdot)$ is quasi-concave and $c(\cdot)$ is convex in effort, e , and $c(\cdot)$ is multiplicative in e and \bar{B} as well as strictly increasing in permanent income⁵. While one can think of the benefit $g(\cdot)$ as a monetary benefit, the cost $c(\cdot)$ will come in the form of social stigma and potential penalties including losing one's future income stream. The official will choose the effort⁶ to allocate to corruption to maximize the following utility function⁷:

$$\max_e U = B + g(e) - c(e, \bar{B}) \quad (1)$$

First, if the cost of corruption is independent of salary levels, as would be the case if there is zero probability of getting caught and losing one's job, i.e., $c(e, \bar{B}) = c(e)$, then the optimal level of effort will be determined by the relative marginal costs and benefits of corruption effort⁸. It is easy to see that the optimal effort to maximize utility will be governed by $\frac{\partial g}{\partial e} = -\frac{\partial c}{\partial e}$ and independent of salary levels, B . This establishes our null hypothesis against which we test the other propositions.

⁵ The Becker and Stigler (1974) results are driven by backward induction in a multi-period model. In what follows we use the simplification of using an official's permanent income, which includes the person's discounted future income.

⁶ In his work on corruption in Zaire, Gould (1980) makes the point that corrupt practices require a specific effort of the officials. He finds that poorly paid officials will choose between corrupt practices or moonlighting in a different job, depending on the relative value of corruption in the area to which they are posted.

⁷ We use a linear utility function to match the principle agent literature as well as ease of exposition. The results and propositions would be the same with some common functional forms such as Cobb-Douglas or exponential utility.

⁸ Petty corruption may not always lead to punishment costs, partly because drivers that pay bribes are often themselves at some legal fault. For example, drivers in developing countries often may not have their papers in order. On the other hand, there have been anecdotal cases of properly-credentialed drivers getting bribe-extorting police officers fired in Ghana. The drivers in our study all had their papers in order.

Null Hypothesis: Levels of effort and amounts of bribes are independent of changes in salary levels.

In order to demonstrate the crime and punishment model, we solve (1) for the optimal level of effort assuming that the costs of effort are increasing in one's permanent income $\partial c/\partial e \partial \bar{B} > 0$, as would be the case if one could lose one's job from corruption effort. The first order conditions for the optimal choice of corruption effort will be:

$$e = \begin{cases} 0 & \text{if } g(e) < c(e, \bar{B}) \\ e^* & \text{where } e^* \text{ solves } \partial g/\partial e = \partial c/\partial e \end{cases} \quad (0.1)$$

This leads to the first of the literature's testable conjectures:

Conjecture 1: (Crime and Punishment) A rise in an official's salary will reduce the effort officials put into soliciting bribes and the overall value of bribes.

Proof: First, since permanent income is rising with current income and $c(e, \bar{B})$ rising with \bar{B} , the outcome $e = 0$ will be more likely. Second, since $\partial c/\partial e \partial \bar{B} > 0$ then $\partial e^*/\partial B > 0$.

Next we turn to the fair wage hypothesis, which can be illustrated by adding the following constraint to equation (1):

$$s.t. \quad B + g(e) \geq B^{fw} \quad (0.2)$$

where B^{fw} is the fair wage at which an official believes he is receiving adequate remuneration.

The first order conditions will now be:

$$e = \begin{cases} 0 & \text{if } g(e) < c(e, \bar{B}) \\ 0 & \text{if } B \geq B^{fw} \\ e^* & \text{where } e^* \text{ solves } \partial g / \partial e = \partial c / \partial e \end{cases} \quad (0.3)$$

This leads to the following testable conjecture.

Conjecture 2: (Fair Wages) If the salary increase is large enough to move from an unfair wage to a level above the fair wage, the level of corruption effort and amount of bribes collected will go down.

The reference dependent utility (Kőszegi and Rabin, 2006) and income targeting (Camerer et al., 1997) literatures provide a third potential explanation for how civil servants might change their corruption seeking effort due to salary level changes. In a reference dependent utility framework, civil servants have a kink in their utility function at their income target. If civil servants received an income level that was less than their reference income level then this would impose a utility cost on them that is higher than levels above the reference income. Since the object of interest is total income, salary plus corruption earnings, this distinguishes the reference dependent utility explanation from a fair wages explanation. In addition as set out in Koszegi and Rabin (2006), the reference points may change over time and space.

We modify equation (1) to account for the reference dependence as follows. Let realized income be: $y = we + B$, where we is the monetary returns to corruption (bribe value times effort) and B is salary and for simplicity let the cost of corruption effort be $c(e, \bar{B}) = c(e)$. Civil servant utility will be:

$$Max_e V = \begin{cases} \lambda[u(y) - y^r] - c(e), & y \leq y^r \\ [u(y) - y^r] - c(e), & y > y^r \end{cases} \quad (1.5)$$

where y^r is the target income level and $\lambda > 1$ captures worker aversion to being below their reference utility. First order conditions for this problem produce the following marginal

$$\text{substitution rates: } \begin{cases} \frac{c'(e)}{u'(y)} = \lambda w, & y \leq y^r \quad (a) \\ \frac{c'(e)}{u'(y)} = w, & y > y^r \quad (b) \end{cases}$$

Reference dependent civil servants receive utility benefits of λw for each unit of effort they expend below their income target and a lower value w once their income is above the target level. Solving these equations (a) and (b) in the framework used above gives us three possible regimes for corruption effort depending on corruption effort's returns relative to costs:

$$e = \begin{cases} 0 & \text{if } we + B < c(e) \\ e^* & \text{if } y > y^r \\ e^{**} & \text{if } y \leq y^r \end{cases} \quad \text{with } e^{**} > e^* > 0$$

In the above model if reference income levels y^r are left unchanged by changes in salary, the effects of salary increase should reduce levels of corruption effort in a manner similar to the fair wage hypothesis. Reference dependent utility with no change in the reference income level by civil servants would produce the same result as Conjecture (2) above. We would see that increases in salary that raised civil servants above their reference dependent utility levels would decrease bribe-taking effort. If, on the other hand, the salary increase also increases the

reference income level of the civil servants who received the salary increase, then we would expect to see an increase in corruption effort by civil servants who received a raise.⁹

Conjecture 3: If there are two civil servants and one has a higher reference income level than the other, the one with the higher reference income level will allocate more time to corruption effort.

It is worth noting two features of the above models that are consistent throughout. First, there is in all models scope for the zero bribe effort outcome in which the utility costs of collecting bribes is strictly more than the utility benefit of collecting bribes. We thus should expect to see some situations in which no bribe is collected, irrespective of which model is correct. Second, across all models, the optimal effort to collect a bribe is increasing in the monetary returns to bribe effort, w in our third model. This means that lower returns to bribe efforts by civil servants will reduce their bribe collection effort. This leads to the following conjecture:

Conjecture 4: If a salary increase reduces the monetary returns for an individual civil servant's corruption effort, then we should expect to see the salary increase decrease corruption effort.

A first possibility on how this might happen is that drivers might bargain harder after they heard about the higher civil servant salaries, reducing, w relative to its previous level. A related possibility that might affect monetary returns to bribe effort is if the civil servant on the road has to pay some percentage of his corruption take to a superior officer. If the higher salaries

⁹ We thank an Accra, Ghana taxi driver named Kofi who outlined the ideas and intuition behind this reference dependent utility model for us during fieldwork. As Kofi described it, the salary increase made policemen “more important” people and therefore they needed the kind of high incomes that important people received. Policemen therefore asked for higher bribe amounts after the salary increase in order to receive the type of high income they expected as newly important people. In a bargain between a driver and civil servant, higher initial bribe amounts asked for increase bargaining time, but generally lead to higher bribes paid.

increased this rental rate¹⁰, then we should see a version of Conjecture (4) that is a higher salary might increase rental rates, reduce the monetary returns to corruption effort, and reduce corruption effort.

4.2 Policy Experimental Design

The above four conjectures of the effects are neither mutually exclusive, nor are they necessarily separable. If there is a distribution among officials on the road of different utility functions or different values to the benefit and cost functions, $g(.)$ and $c(.)$, then we may observe different versions of the propositions or an average of them. Nonetheless we can test them using the Ghanaian policy experiment of raising police salaries on July 1, 2010 and leaving other worker's salaries unchanged.

In our policy experiment set up we have civil servants (Ghanaian policemen) who have received a treatment (higher salaries) and other civil servants (e.g., Ghanaian customs agents or Burkinabé policemen) who did not receive such a treatment. We observe these treated and control populations in multiple interactions (~45,000 bribe “opportunities”) with truck drivers across 6 years: 4 years before the experiment (2006 – June 30, 2010) and two years afterwards (July 2010 – 2012). This unique experimental set up allows us to use a difference-in-difference and triple difference approach making use of the variation across civil service type, country and year (Wooldridge, 2010) to test the effects of raises in police salaries on bribes. We can test the effect of the treatment (salary increase) on the amount and levels of bribe taking at both individual stop and national levels, while controlling for truck, truck driver, road, time, and country characteristics.

¹⁰ Note that since the higher salaries in question affect all policemen from top to bottom, it would have to be that the superiors operate with a reference dependent utility for them to raise the rental rate on a road stop on their underlings. Thus this outcome would require superiors to act according to conjecture (3) while underlings acted under conjecture (4).

The key outcome (dependent) variables we will be testing are: effort (the amount of time an official used to ask for a bribe), the amount paid at each stop, the number of stops where no bribe is paid, and the total amounts paid on a road. It is worth noting that effort, bribe values and no-bribe outcomes are all correlated, but not as highly correlated as one might expect. The elasticity of bribe value with respect to effort is between 0.19 and 0.13 depending on specifications. In addition while effort and having no-bribes to pay might logically be negatively correlated, they in fact have a 0.034 statistically significant positive correlation. Specific hypotheses to be tested with this methodology are that the rise in police salaries has: 1) Reduced the effort that policemen put into collecting bribes; 2) Reduced the amount paid in bribes to policemen in Ghana compared to other countries and other civil servant types; 3) Reduced the number of times a truck is stopped and asked to pay a bribe by policemen in Ghana compared to other countries and other civil servant types; 4) That 1), 2) and 3) combined have reduced the overall cost and delays associated with bribery on the roads of Ghana.

4.3 Econometric Model

Our econometric strategy uses a difference-in-difference method to test the effects of the salary policy change for policemen relative to other civil servants. We have three dependent variables of interest, effort expended to collect a bribe (measured in minutes), the value of a bribe collected (measured in CFA francs), and a dummy variable for when no bribes are paid.

Focusing on effort, let Y_{ijt} be the effort expended by a civil servant on truck i at checkpoint j at time t , and let X_{ijt} be the characteristics of a truck, i , stopping at checkpoint j at time t . Our basic equation of interest will then be:

$$Y_{ijt} = \alpha + \beta_1 Police_{ijt} + \beta_2 Salary_Policy_t + \beta_3 Police_{ijt} X Salary_Policy_t + \gamma X_{ijt} + T + \eta_j + \varepsilon_{ijt},$$

(6)

where β_3 is our difference-in-difference parameter of interest, T is a series of time dummies (month and year), η_j are checkpoint specific fixed effects, and ε_{ijt} is a standard error term which we cluster at the truck level in the estimations.¹¹ The equation (6) is first estimated with data from Ghana and provides the difference between effort and bribes paid between policemen and customs officers. We also estimate (6) as linear probability and probit models in which the dependent variable is the number of times a truck is stopped at a roadside checkpoint and leaves without paying a bribe. Versions of (6) are also estimated with the bribe amounts aggregated across j so that Y_{it} represents the average effort or bribe a truck pays on the road in total. Similar estimates are done with the number of stops with no bribe and the total number of stops. All of the aggregated estimates have robust standard errors, rather than clustered errors at the truck level as in the baseline equation.

We then expand the dataset to include the bribes that the trucks paid Burkina Faso, which allows us to estimate (6) as a triple difference panel fixed effects model with truck level fixed effects. Our equation will now be:

$$Y_{ijt} = \alpha + \beta_1 Police_{ijt} + \beta_2 Salary_Policy_t + \beta_3 Police_{ijt} X Salary_Policy_t + T + C + \eta_j + \mu_i + \varepsilon_{ijt}, (7)$$

where the $Salary_Policy$ dummy variables are Ghana specific, C is a country dummy variable, and μ_i is a truck specific fixed effect that controls for differences between trucks. Here the results we obtain will be driven by differences of the bribes paid within a single truck trip,

¹¹ We choose to cluster at the truck level because it is likely to be the source of the greatest heteroskedasticity due to unobservable characteristics. Results presented here are robust to other assumptions about the appropriate clustering of the error term.

although the triple difference-in-difference will be driven by the checkpoint civil servant and policy changes. This fixed effect regression will control for any changes in truck “quality” between before and after the policy change as might happen if the policy change induced truckers to improve the quality or compliance of their trucks with police checkpoints. It also addresses potential biases that might exist in the data collection across time. We also estimate a linear probability and random effects probit version of (7) with the probability of zero bribe paid as a dependent variable.

5. Results

Table 1 shows descriptive statistics for the variables used in the main regressions for the Ghana part of the dataset. As shown across all years the average bribe was paid in 8 minutes and the average bribe was the equivalent of 473 CFA, just under \$1 at the exchange rates of the period.¹² The average truck had 16 stops in the Ghana portion of the trip, with 6.5 stops in Burkina Faso. About 13% of the stops involved no bribe paid and 53% of the stops are with police while the other ones are with customs officers. More than 90% of the drivers are Ghanaian, with half of the trucks having Ghanaian registry, and 15% are oil tanker or container trucks, which are less likely to be carrying illegal cargo than general-purpose trucks.¹³ The data on the Burkina Faso part of the trip shows higher bribe taking effort, higher bribe values and fewer trucks let go without paying a bribe in that country. Police represent a smaller proportion of the stops at only

¹² We use CFA francs which are pegged to the Euro, 1 Euro = 655.957 CFA, as a way to account for differences in inflation across two different countries with different inflation rates. Results are in fact stronger if the Ghana regressions are done in Ghanaian cedis.

¹³ In the appendix we show that the results hold if we restrict the sample to container and oil tanker trucks, which would be less likely to be victims of corruption and therefore potentially less likely to be affected by this salary change.

22% in Burkina Faso compared to nearly half the stops in Ghana. We present parallel trend tests showing the experimental environment in table A1 of the Appendix.

The difference-in-difference effort regressions with effort, the number of minutes that an official spent arguing for a bribe, as the dependent variable are shown in table 2 with standard errors clustered at the level of the 2,147 trucks. The first column with our baseline specification shows that police increased their effort asking for bribes by 1.6 minutes after the salary change relative to customs agents, which is a 19% increase in bribe solicitation effort. The estimate is unchanged by adding in truck characteristics and a dummy variable for whether the day is a holiday as done in column 2. We thus have evidence for the reference dependent utility Conjecture (3), that the salary change raised police income expectations in excess of the income change.

The bribe value difference-in-difference regressions measuring the amount paid of each bribe are presented in table 3, with standard errors clustered at the truck level. They show that the interaction of police and salary policy dummy variables produces about a 119 CFA increase in bribes at each stop across the whole time period. We extend the baseline to include variables describing the truck and driver, whether the particular day the bribe is paid was a holiday, and whether the truck was coming from the port, since many of the return trips are mostly empty trucks. The basic results shown in column 1 hold up with these additional controls and our point estimate of the effect goes up to 126 CFA. Among the control variables, only trucks coming from the port has a significant negative effect, lower bribe values likely due to the empty trucks going to the port having higher propensities to carry illicit goods.¹⁴ The higher magnitudes in

¹⁴ Full regressions are available from the authors on request. In both Ghana and Burkina Faso, long-haul trucks such as these are not allowed to pick up goods or people along the way to either bring to another intermediate point or to the end point. Thus even normally legal goods such as charcoal or pineapples might be illicit for these trucks.

bribes, 25-27% higher, are consistent with the baseline that the higher salaries caused higher corruption effort levels. Thus we find continuing evidence in the bribe value regressions for Conjecture (3) relative to the other Conjectures.

We then proceed to investigate the number of times that a truck is allowed to pass through a road-stop without paying a bribe using linear probability and probit regression frameworks, which provides some measure of the amount of bribe taking. Recall that the models suggest that the incidence of bribes might go down with a rise in salaries, even while effort might go up. Also it is possible that drivers will negotiate more vociferously with civil servants who they know received a recent raise, as in conjecture (4), increasing the possibility that they are let go without paying a bribe. Table 4 shows significant positive effects of the salary policy on whether a policeman allows a truck to pass without paying a bribe. In contrast to our results on the level of payment, these results show that policemen were more likely to let a truck pass without paying a bribe than before the change. The raw data show that before the salary change policemen allowed 10% of the trucks to pass without taking a bribe and that this level increased to 19% of the trucks after the salary policy change. These results are potentially consistent with all of the conjectures set out above in our modeling.

While the above estimates provide evidence for how bribe taking changes within Ghana, it is possible that there are unmeasured trends that could be confounding our data within Ghana. We therefore turn to a triple difference fixed effects estimate in which we estimate the effects of the policy in Ghana relative to the amounts paid to customs agents, gendarmes¹⁵ and policemen in the neighboring country of Burkina Faso, who were not affected by the change. In addition,

¹⁵ In Francophone countries the gendarmes are a type of police force with wider more national mandate than the police as well as a military policing role. Thus the role of the police in Ghana is shared in Burkina Faso jointly by the police and the gendarmes. They would be the equivalent of a cross between the state and military police in the US policing system. Gendarmes represent about 16% of the stops in Burkina Faso.

with the truck fixed effects, we are able to control for potential confounding effects of truck characteristics unobservable in the data, but readily observable to a policeman (e.g., a broken headlight). This can also account for any endogenous differences in the truck fleet that might have occurred after the salary policy change. If for example truck fleets changed the quality of their trucks due to the salary change, the OLS regressions would not be robust to this effect, but the fixed effects would be.

Table 5 shows the panel fixed effects results for the effort and bribe value regressions. The three models with the full dataset show significant effects of the police salary policy relative to Burkina Faso and non-policemen. For the effort regressions we find a consistent estimate of 1.7 extra minutes of effort, although it is only significant at the 10% level. For the bribe value regressions, the extra bribe costs per stop are 159 CFA, which represents a 34% increase in the level of bribes after controlling for truck and country effects. Overall, the panel data results across the board confirm the support for Conjecture (3) that the salary increases will increase both bribe seeking effort and bribe values.

In order to test the number of stops without a bribe in the panel dataset, we estimate linear probability fixed effects and random effects probit models, which is shown in table 6. In all models we find corroborating evidence that the salary change increased the number of trucks that policemen allow to pass without paying a bribe went up after police salaries went up. Thus the evidence is that for each stop, the probability a truck did not have to pay a bribe went up for Ghanaian policemen after the salary change relative to customs officers or Burkinabé policemen. Again, these non-payment results are consistent with all the conjectures from the modeling.

While the previous estimates are done at the level of each individual time a truck is stopped on the road, they do not tell us about how the aggregate price to travel on the road and

number of total stops might change with the Ghanaian police salary change. In order to test those effects the regressions in tables 7 and 8 use data aggregated at the level of a truck trip through Ghana. Table 7 shows the effects of the salary policy on the average effort expended at each stop, the average amount paid in bribes at each stop on the road in Ghana and the percent of stops with no bribe. Consistent with our previous findings, we see that the salary policy increased the average effort at each stop by more than a minute and average amount of bribes paid to each policemen by a statistically significant 109 CFA. This represents a 23% increase in the amounts of bribes paid on the road due to the policy change. We also find that the number of stops without a bribe goes up significantly after the salary policy change.

In order to test the most anomalous of the results, that the number of bribes with no bribe paid went up, we test whether this effect is just at the individual stop level or holds true for the full truck trip. Table 8 shows how the salary policy changes the total number of stops on the road and the total number of stops at which a bribe is paid. The first two columns show that the police salary change increased the number of stops on the road by 0.7 stops, which is an 8% increase over the average of 8.5 stops by policemen in Ghana. This suggests that while the salary increase encouraged policemen to be more likely to let trucks go without paying a bribe, the higher salary also increased the number of police stops. Both of these effects could be interpreted as evidence of policemen doing their job better after the salary increase. It is just that doing the job “better” may also mean collecting higher bribes. The last two columns of table 8 show that the total number of bribes paid on the road, which equals the total number of stops minus the number of stops with zero bribes paid, is unchanged by the increase in police salaries. Thus the result seen at the individual stops in which policemen were more willing to let trucks pass without a bribe after police salaries increased, did not mean truckers paid a smaller number

of bribes. The 8% increase in the number of police stops completely offset the reduction in the number of bribes paid due to policemen letting some trucks pass without paying a bribe. This gives corroborating evidence for conjecture (3): that a salary increase increases bribe effort and bribe values.

The net effect appears to be policemen allocating more effort to collecting bribes and asking for higher bribe values, but also increasing the number of truckers let go without a bribe. To demonstrate that there has been an increase in zero bribes and a reduction of low level (1 cedi) bribes for policemen relative to customs officers in Ghana, figures 2 and 3 show kernel density estimates of the bribe amounts in Ghanaian cedis, with values truncated at 10 to focus the graphical analysis. Figure 2, which shows policemen's bribe taking behavior before and after the policy change, demonstrates an increase in mass at zero and two cedis, with a reduction in one cedi bribes after the policy change. Figure 3 shows that customs officers have a different behavior with bribes reduced after July 2010 and more of them being one cedi rather than two or three. This provides corroborating evidence that the effect of the salary policy change was to increase the effort and value of bribes asked for by policemen, but to slightly increase the number of trucks they let go without paying a bribe.

6. Robustness Checks

The appendix provides robustness checks. We first check whether our difference-in-difference set up exhibits parallel trends, using year time trends and their interaction with the police dummy. Results for data from 2008 forward or 2010 forward show no significant difference in effort between police and customs. Bribe values are significantly different from 2008 forward,

showing a positive trend, while 2010 shows a strong non-parallel trend in bribe values in the opposite direction of our results post January 1, 2010. In table A1b we limit the sample to test parallel trends to one year before the policy change, July 1, 2009 to June 30, 2010, and test monthly rather than yearly trends. Results using monthly trends instead of yearly ones, show non-significant results or results that suggest a bias in the opposite direction of our main findings. In this case effort is significant at a 10% level but in the opposite direction of our findings (negative) and there are non-significant monthly trends for bribe values.

A second robustness check is to limit the data to a period much closer to the actual policy change in order to limit other potential confounding effects either pre or post policy change. Trucks voyaging after July 1, 2009, such as those used in the monthly parallel trends regressions, table A1b, most clearly show parallel trends. It is also potentially the case that our long timeline post policy change is capturing other confounding effects unrelated to our policy change. We therefore run the basic models of effort and bribe values in both OLS and fixed effect panel versions with a restricted time-frame under which the outcomes are least likely to be contaminated by other effects: from July 1, 2009 to December 31, 2011. The results of those regressions are in table A1c and show the same effects as the regressions over a longer period of time.

We take these results as evidence for the validity of our difference-in-difference for the effort regressions. The potentially non-parallel trend in bribe values over the longer time periods suggests some caution might be needed in interpreting the bribe value regressions from Ghana. One should note, however, that if the higher bribes shown post-salary policy change merely follow an existing trend of higher police bribe values then it would still be the case that the salary raise did not reduce bribes. Also the triple difference panel regressions with both

Burkina Faso and Ghana data on the same trucks, which are driven by differences in within truck effects rather than time effects, corroborate the fundamental findings.

A third robustness check is to test whether the results could be described by the model used in Olken and Barron (2009) in which the price paid at each stop is determined in part by the total price paid on the road. As detailed in appendix A2 we find no evidence that this model is the correct specification for bribes on the roads of West Africa.

A fourth robustness check presented in appendix A3 is to limit the sample to container and tanker trucks. Container and tanker trucks are in general “cleaner” in terms of being newer trucks and having fewer violations relative to general-purpose trucks. We therefore re-run the key regressions of the paper with just container and tanker trucks. The results suggest our main results are robust to using only the “best” trucks on the road.¹⁶

In a fifth and final robustness check, we generate a placebo policy enacted one year before the actual policy of interest, on July 1, 2009. The results in appendix A4 show that such a placebo policy using data up until June 30, 2010, the day before the policy’s actual enactment, has no significant effect on any of our variables of interest. We thus do not find any evidence that our findings could be driven by a seasonality effect that might be evident each year in the data as would be the case with our placebo effect. This placebo exercise’s non-significance also provides corroborating evidence of there being parallel trends in the year before enactment of the policy.

¹⁶ Another way to identify the “best” trucks on the road would be to limit the sample to those who had at least one instance on the road of not having to pay a bribe at a stop. The results, available from the authors on request, with this “best truck” sample do not change in magnitude or significance from our main findings.

7. Discussion of Reference-Dependence Results

Since the police extort significantly more bribes following the policy reform relative to other officials, their reference incomes appear to have shifted significantly higher following the increase in wages. While we believe this shift in reference incomes happens at the individual police official level, we provide two potential mechanisms at a broader system or societal level that might also be broadly consistent with our reference-dependence findings. First, it is possible that the higher salaries worsen petty corruption by “professionalizing” the police, which might raise their keenness for corrupt behavior. Such a professionalizing effect might occur because the salary reform package included improved pathways to promotion at the police sector level. The possibility and expectation of higher status may be one indirect driver of reference-dependence, to the extent that better-paid officers feel that they “merit” higher bribes. It might also be the case that promotions within the police are driven by one’s ability to collect bribes at which point more chances for promotion could increase bribe-extracting behavior. Anecdotal evidence from the police, however, suggest that the promotion aspect of the SSSS reform has not actually yet seen implementation. We would thus expect this expected promotion effect to be small or at least diminish significantly over time, an effect not seen in our data.

Another potential mechanism driving reference-dependent consistent behavior may be that better-paid police might face increasing redistributive social pressures from extended family members whose demands might indirectly fuel these bribes. Such a reference-dependent behavior on the part of family members rather than police officers would be consistent with the origins of corruption as a social norm rather than an individual choice per se (see Acemoglu and Jackson (2014)). Although we have no way of directly testing this in the data, such family pressure might be most salient in cases where it is relatively straightforward to extort funds, such

as when trucks on the road do not have appropriate documentation. Family pressures would have to be uncharacteristically strong to drive our results because all of the trucks in this sample had all of their papers in order throughout the research. It therefore appears unlikely that the police behavior that increases bribe-taking behavior is driven exclusively by increased external influences for extorting bribes rather than their own reference dependent behavior.

8. Conclusions

This work has used a policy experiment in Ghana to show that increasing salaries of civil servants can increase bribe taking by those civil servants. The work shows that policemen who received the single spine salary increase in Ghana increased the effort they allocated to collecting bribes in time spent asking for bribes, in the number of checkpoints they operated, the value of bribes they took, the total amount that truckers had to pay on the road, all while they increased the number of trucks let go without a bribe. Their decreasing the number of times they succeeded in getting a bribe could be related to career concerns in which the more often one asks for a bribe, the higher the probability of losing one's job. On the other hand the increased effort and value of bribes taken is consistent with the idea that higher civil service salaries induce civil servants to demand higher bribes through a reference dependent behavioral model.

Since the Ghanaian salary increase experiment took place without a commensurate increase in enforcement of anti-corruption laws, the results here suggest that merely raising salaries without changing the context and incentives within which reference dependent civil servants operate may not have the expected or desired effects on corruption. We demonstrate that raising salaries of corrupt officials can have the consequence of worsening petty corruption,

in contrast to many theoretical and experimental predictions from the literature. The results also call into question the relevance of cross-country studies and laboratory based studies, which have shown that higher salaries or payments reduce corruption. The empirical results presented here suggest that fighting corruption cannot be done by salary policies alone. Further work is warranted to investigate how widespread the effects shown here are or whether they are specific to West Africa. Investigations of corruption may need to consider salary raises with important complementary factors such as increased corruption enforcement as well as more cohesive institutions as part and parcel of the same equation.

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Table 1: Descriptive Statistics

Variable	Observations (# of stops)	Mean	Std. Dev.	Min	Max
Ghana only					
Effort (Minutes per stop)	34,869	8.343	22.92	0	1440
Bribe value in CFA (500 ~ = \$1)	34,869	472.40	1307.46	0	150289
No bribe paid at a stop	34,869	0.1313	0.3378	0	1
Police	34,869	0.5276	0.4992	0	1
Salary Policy	34,869	0.3936	0.4886	0	1
Police X Salary Policy	34,869	0.2114	0.4083	0	1
Container or Tanker Truck	34,869	0.1477	0.3547	0	1
Holiday	34,869	0.1663	0.3723	0	1
Ghanaian Vehicle	34,869	0.5780	0.4939	0	1
Ghanaian driver	34,869	0.9114	0.2841	0	1
Coming from the port	34,869	0.7891	0.4080	0	1
Burkina Faso only					
Effort (Minutes per stop)	12,514	14.60	83.18	0	7170
Bribe value in CFA (500 ~ = \$1)	12,514	1428.4	880.91	0	20000
No bribe paid at a stop	12,514	0.046	0.201	0	1
Police	12,514	0.227	0.419	0	1
Total sample					
Number of Trucks	47,383				
	2,147				

Notes: Effort, bribe values, and no bribe paid at a stop provides the mean for both customs and police stops combined, with the Burkina Faso data also including gendarme stops. Note we do not show the Burkina Faso data for “Container or Tanker Truck”, “Holiday”, vehicle and driver origin, or “Coming from the port” since the means are the same as for the Ghana only portion.

Table 2:**Baseline Effort Regressions**

Variables	(1) Effort	(2) Effort
Police	-1.700*** (0.408)	-1.606*** (0.413)
Salary Policy	-0.618 (0.645)	-0.719 (0.651)
Police X Salary	1.592*** (0.325)	1.592*** (0.330)
Constant	4.758*** (1.583)	6.410*** (1.659)
Year & Month effects	Yes	Yes
Checkpoint fixed effects	Yes	Yes
Truck characteristics	No	Yes
Observations	34,869	34,869
R-squared	0.242	0.244

Notes: Robust standard errors clustered at the truck level are in parentheses. Truck characteristics are tanker or container dummy, driver and truck home country, and a holiday dummy.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

Table 3: Baseline Bribe Value Regressions

Dependent variable is real CFA value of bribe paid at each stop

Variables	(1) Bribes	(2) Bribes
Police	-197.5*** (32.47)	-202.9*** (31.90)
Salary Policy	-28.57 (33.46)	-28.57 (32.49)
Police X Salary	119.0*** (28.71)	125.6*** (28.88)
Constant	555.1*** (60.56)	679.0*** (87.85)
Year & Month effects	Yes	Yes
Checkpoint fixed effects	Yes	Yes
Truck characteristics	No	Yes
Observations	34,869	34,869
R-squared	0.036	0.038

Notes: Robust standard errors clustered at the truck level are in parentheses. Truck characteristics are tanker or container dummy, driver and truck home country, and a holiday dummy.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

Table 4: Probability of paying no bribe (Linear probability & Probit)
 Dependent variable = 1 if no bribe paid

Variables	(1) Linear Probability	(2) Linear Probability	(3) Probit
Police	0.0111** (0.00541)	0.00471 (0.00627)	0.0600** (0.0295)
Salary Policy	-0.0120 (0.0172)	-0.0116 (0.0171)	-0.115 (0.0798)
Police X Salary	0.0494*** (0.0102)	0.0462*** (0.00998)	0.181*** (0.0458)
Constant	-0.00114 (0.0320)	-0.0632* (0.0368)	-1.251*** (0.134)
Year & Month effects	Yes	Yes	Yes
Truck characteristics	Yes	Yes	Yes
Checkpoint fixed effects	No	Yes	No
Observations	34,862	34,862	34,866
R-squared	0.038	0.083	
Log Likelihood			-12968

Notes: Robust standard errors clustered at the truck level are in parentheses. Truck characteristics are tanker or container dummy, driver and truck home country, and a holiday dummy.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

Table 5: Panel Fixed Effects using data from Ghana and Burkina Faso
 Dependent variables are minutes of effort or real CFA value of bribe paid at each stop

Variables	(1) Effort	(2) Effort	(3) Bribe value	(4) Bribe value
Ghana	-2.639 (9.517)	-2.637 (9.517)	167.9 (241.0)	168.2 (240.9)
Ghana X Police	1.435 (1.355)	1.437 (1.355)	-327.1*** (34.30)	-326.8*** (34.29)
Police	-2.484** (1.181)	-2.489** (1.181)	-309.8*** (29.89)	-310.7*** (29.89)
Salary Policy	-2.376** (1.107)	-2.378** (1.107)	94.00*** (28.03)	93.66*** (28.03)
Ghana Police X Salary	1.731* (1.039)	1.730* (1.039)	152.9*** (26.30)	152.8*** (26.30)
Holiday		0.603 (1.671)		101.1** (42.30)
Constant	11.03 (33.61)	10.16 (33.69)	103.0 (850.8)	-41.84 (852.9)
Checkpoint fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	47,383	47,383	47,383	47,383
R-squared	0.071	0.071	0.163	0.163
Number of truck trips	2,147	2,147	2,147	2,147

Notes: Include police, customs and in Burkina Faso gendarmerie stops with robust standard errors in parentheses.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

Table 6: Panel Data No bribe paid
 Dependent variable = 1 if no bribe paid

Variables	(1) Linear Probability fixed effects	(2) Linear Probability fixed effects	(3) Random effects Probit
Ghana	0.0547*** (0.00466)	-0.100* (0.0586)	0.423*** (0.0352)
Ghana Police	0.0257*** (0.00733)	0.0178** (0.00834)	0.327*** (0.0648)
Police	-0.0126** (0.00613)	-0.00559 (0.00682)	-0.237*** (0.0588)
Salary Policy	0.0408*** (0.00711)	0.0415*** (0.00729)	0.360*** (0.0559)
Police X Salary	0.0504*** (0.00638)	0.0477*** (0.00640)	0.191*** (0.0392)
Constant	0.740** (0.296)	0.921*** (0.337)	-1.896*** (0.0915)
Year & Month effects	Yes	Yes	Yes
Checkpoint effects	No	Yes	No
Observations	47,383	47,383	47,286
Number of truck trips	2,147	2,147	2,147
Log likelihood			-13,815

Notes: Include police, customs and in Burkina Faso gendarmerie stops with robust standard errors in parentheses.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

Table 7: Aggregate per trip total bribes and number of stops with no bribe in Ghana

Variables	(1) Effort: Duration at each stop	(2) Values: Avg. Bribe costs on road	(3) Number of stops with no bribe
Police	-0.613 (0.448)	-95.49*** (26.68)	0.0853 (0.0554)
Salary Policy	-4.110 (4.716)	-969.2*** (170.1)	0.261 (0.448)
Police X Salary	1.127** (0.571)	109.1*** (42.23)	0.600*** (0.109)
Constant	11.17*** (0.872)	515.8*** (45.68)	1.321*** (0.243)
Year & Month effects	Yes	Yes	Yes
Observations	4,238	4,238	4,238
R-squared	0.101	0.075	0.156

Notes: Robust standard errors in parentheses.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

Table 8: Aggregate per trip number of stops and bribes paid in Ghana

Variables	(1) Number of stops	(2) Number of bribes paid (Stops – No bribe stops)
Police	0.585*** (0.153)	0.497*** (0.161)
Salary Policy	0.540** (0.221)	0.0973 (0.223)
Police X Salary	0.709*** (0.223)	0.109 (0.235)
Constant	8.435*** (0.379)	7.549*** (0.411)
Year effects	Yes	Yes
Observations	4,236	4,236
R-squared	0.055	0.038

Notes: Robust standard errors in parentheses.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

Figure 2. Graph of Police GH Cedi bribe amounts before and after the salary change

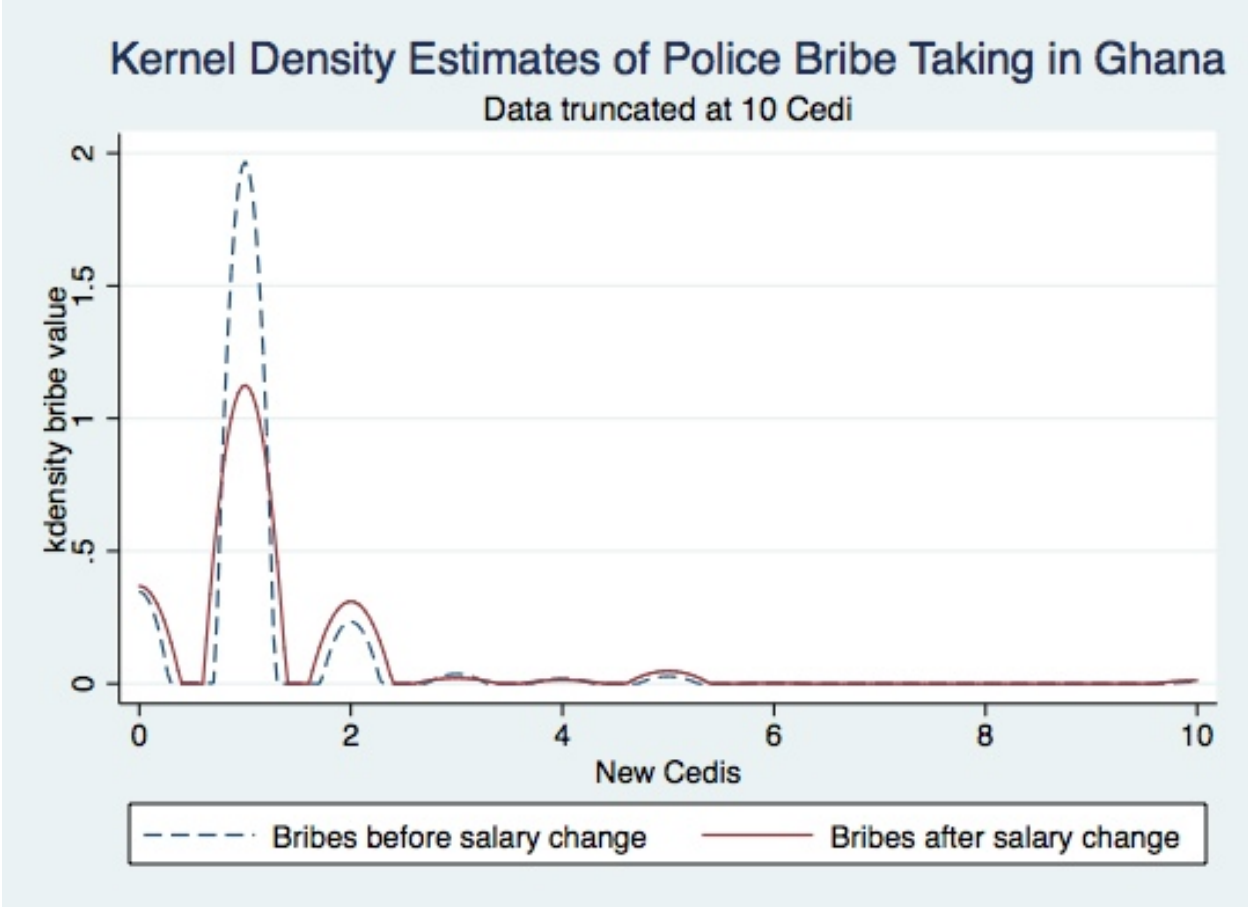
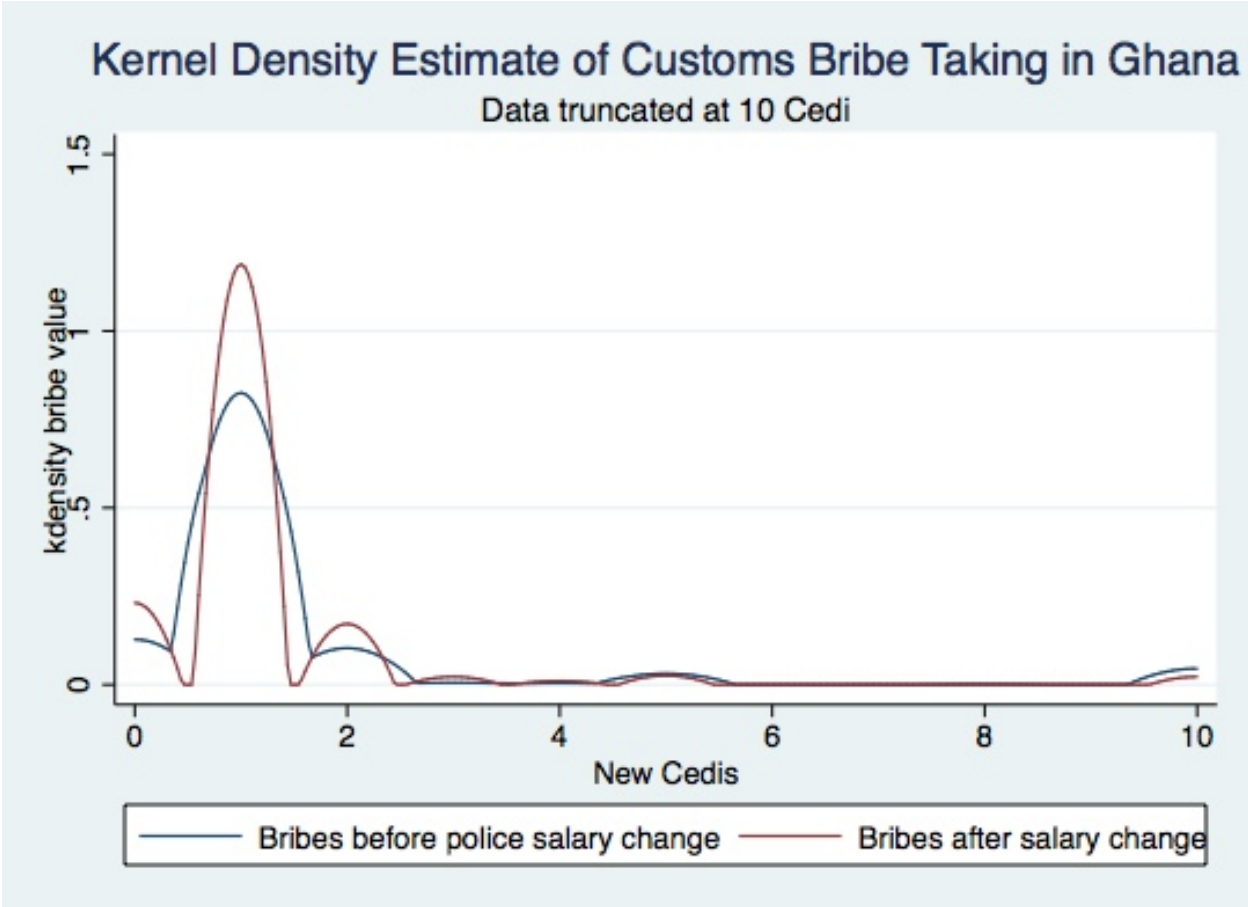


Figure 3 Graph of Custom GH Cedi bribe amounts before and after the salary change



Appendix

A1. Parallel Trends Tests

For the validity of the difference-in-difference specification we need there to be parallel trends in the data prior to July 1, 2010 between effort and bribe values in customs and police stops.

Unlike most studies with little “burn in” period, we have 3 years of data before the policy change as well as almost 2 years of data after the policy change.

In the results shown in table A1, we test parallel trends using year time trends and their interaction with the police dummy. Results for data from 2008 forward or 2010 forward show no significant difference in effort between police and customs. Bribe values are significantly different from 2008 forward, showing a positive trend, while 2010 shows a strong non-parallel trend in the opposite direction of our results post January 1, 2010.

Table A1
Parallel Trends with yearly trends

Variables	(1) Effort (2008- policy change)	(2) Effort (2010- policy change)	(3) Bribe value (2008-policy change)	(4) Bribe value (2010-policy change)
Police	-1,057 (718.6)	-1.906 (2.822)	-99,894*** (38,477)	-163.7*** (54.22)
Police X Year	0.525 (0.358)		49.54*** (19.14)	
Year	-2.610*** (0.420)		-224.3*** (22.35)	
Constant	5,250*** (843.5)	3.138*** (0.521)	450,984*** (44,900)	385.8*** (63.37)
Month effects	Yes	Yes	Yes	Yes
Checkpoint effects	Yes	Yes	Yes	Yes
Observations	16,231	2,948	16,231	2,948
R-squared	0.342	0.182	0.154	0.068

Notes: Robust standard errors in parentheses clustered at the truck level.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

In table A1b, we use monthly trends for the period from July 1, 2009 forward to test parallel trends. These results find no effects of the Police X Month interaction term on bribe values and a negative effect, significant at a 10% level, for the effort regressions. Thus we find reasonable evidence of a parallel trend for the year before our policy change.

Table A1b
Monthly Parallel trends 7/1/09 - 6/30/10

VARIABLES	(1) Bribe Effort	(2) Bribe Values
Police	77.45* (45.43)	-5,732 (4,775)
Police X Month Trend	-0.129* (0.0773)	8.748 (7.960)
Month Trend	0.132 (0.144)	-20.63*** (7.338)
Constant	-76.02 (86.16)	12,708*** (4,387)
Observations	6,922	6,922
R-squared	0.135	0.201

Notes: Robust standard errors in parentheses clustered at the truck level.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

As a robustness check on our basic results we limit the data to a period much closer to the actual policy change in order to limit other potential confounding effects either pre or post policy change. Trucks voyaging after July 1, 2009, such as those used in the monthly parallel trends regressions, table A1b, most clearly show parallel trends. It is also potentially the case that our long timeline post policy change is capturing other confounding effects unrelated to our policy change. We therefore run the basic models of effort and bribe values in both OLS and fixed effect panel versions with a restricted time-frame under which the outcomes are least likely to be contaminated by other effects: from July 1, 2009 to December 31, 2011. The results of those regressions are in table A1c and show the same effects as the regressions over a longer period of time, with the same high levels of significance but slightly smaller magnitudes on all coefficients.

Table A1c
Regressions with data from July 1, 2009 – Dec. 31, 2011 only

VARIABLES	(1)	(2)	(3)	(4)
	OLS effort	OLS bribe value	Panel effort	Panel bribe value
Salary policy	-0.966 (0.846)	-189.1** (74.11)	-4.597*** (0.628)	-211.5*** (45.56)
Police	-0.679 (0.440)	-195.4*** (53.12)	1.656** (0.708)	8.980 (51.31)
Police X Salary policy	0.823** (0.341)	118.5*** (43.44)	1.575*** (0.589)	148.3*** (42.68)
Ghana			2.410 (7.523)	-572.4 (545.5)
Ghana Police			-3.063*** (0.923)	-242.7*** (66.91)
Constant	-0.781 (0.800)	273.9*** (77.94)	5.243 (7.846)	940.7* (568.9)
Year, Month, Checkpoint FE	Yes	Yes	Yes	Yes
Observations	17,628	17,628	23,984	23,984
R-squared	0.259	0.025	0.279	0.148
Number of truck trips			1,131	1,131

Notes: Robust standard errors in parentheses clustered at the truck level for the OLS regressions.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

We take these results in appendix A1 as strong evidence for the validity of our difference-in-difference specification for the effort regressions. The potentially non-parallel trend in bribe values suggests some caution might be needed in interpreting the bribe value regressions from Ghana. One should note, however, that if the post-salary raise higher bribes merely follow an existing trend of higher police bribe values then it would still be the case that the salary raise did not reduce bribes.

A2. Robustness to the Olken and Barron specification

The Olken and Barron specification suggests that log of bribes paid would be a function of the average bribe paid on the road, with an expected coefficient (elasticity) of close to 1 if the pricing of bribes at individual sites responded to the total price to pass on the road (coordinated system). In such a system, unless the salary rise affects the number of trucks on the road we should expect no effect of higher police salaries on the bribes paid.

The corrupt official as monopolist model is a special case of (1) above in which $c(e, \bar{B}) = 0$ and the function $g(e)$ takes a special form, $g(e, Q)$ that is a pricing function quadratic in the number of “customers”, Q . It is easy to see that the optimal effort to maximize utility will be governed by $g(e, Q)$ and independent of salary levels, B ¹⁷. In the Olken and Barron model the log of the price paid in bribes will be a decreasing function of the log of the expected number of stops on the road. If the road stops work as a coordinated monopoly the coefficient on the log of the expected number of stops should be -1, if they are completely uncoordinated then the coefficient would be zero. In addition the results using the aggregate (total) level of bribes on the road would have a zero coefficient on the log of the number of stops if perfectly coordinated or a value of 1 if uncoordinated.

The results in table A2 mimic those in Olken and Barron, with added variables to test the salary policy. We measure the expected number of stops on the road as the number calculated by authority (police or customs), so that an observation at a police stop uses the expected number of stops by police. We then interact this with our key salary policy variable to see if coordination might have changed with the salary change.¹⁸ They show extremely low levels of coordination in “pricing” and a significant effect of the salary policy on bribe values in columns 1, 2 and 3. In column 4 we do not find a significant effect of the salary policy except in its interaction with the number of stops. In columns 1-3 we find an effect of the policy of a between 13% to 29% increase in bribe values, which is consistent with our other results.

Overall, the results in table A2 show that (i) the Olken and Barron model does not fit well with our data and (ii) controlling for the overall expected number of stops on the road does not change our basic result.

¹⁷ Olken and Barron (2009) also have a bargaining model of price setting, which would also have bribe effort and value levels independent of the official’s salary. A number of other models, such as ones with costs of bribe taking unrelated to future income (e.g., fixed fine rates without loss of employment), would also produce our null hypothesis, that bribe taking is independent of salary levels.

¹⁸ Note that there are some endogeneity concerns with using the number of stops since we do show above that the number changes with the salary change, which would bias us in favor of finding an expected stop effect. Since this is a robustness check of our paper’s main result, we do not concern ourselves with this potential endogeneity.

Table A2
Olken & Barron tests

VARIABLES	(1) Log Bribe costs	(2) Log Bribe costs	(3) Log Total bribe costs	(4) Log Total bribe costs
Salary Policy	0.0176 (0.0238)	0.0178 (0.0238)	-0.0631** (0.0278)	-0.0626** (0.0280)
Police	-0.176*** (0.0132)	-0.178*** (0.0132)	-0.0699*** (0.0138)	-0.0699*** (0.0138)
Police X Salary	0.134*** (0.0143)	0.286*** (0.0821)	0.160*** (0.0189)	0.129 (0.114)
Ln(E[Stops per month])	-0.0205** (0.00832)	-0.0151 (0.00931)	-0.0631*** (0.0120)	-0.0645*** (0.0148)
Ln(E[Stop/mo])X Police X Salary		-0.0268* (0.0144)		0.00555 (0.0198)
Constant	5.992*** (0.0762)	5.959*** (0.0806)	6.496*** (0.0975)	6.504*** (0.114)
Year, Month Effects	Yes	Yes	Yes	Yes
Checkpoint Effects	Yes	Yes	No	No
Observations	30,290	30,290	4,146	4,146
R-squared	0.250	0.250	0.190	0.190

Notes: Ln(E[Stops per month]) is the average number of stops on the road that month for the particular authority (police or customs). Results are similar if done with the expected total number of stops on the road instead. Standard Errors are clustered at the truck level in columns (1) and (2) and White's robust standard errors in columns (3) and (4).

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

A3. Containers and Tankers

Container and tanker trucks are in general “cleaner” in terms of being newer trucks and having fewer violations relative to general purpose trucks. We therefore re-run the key regressions of the paper with just container and tanker trucks. The results suggest our main results are robust to using only the “best” trucks on the road.

Table A3

Variables	(1) Effort	(2) Bribe value	(3) No stop Probit	(4) Panel FE bribe value
Police	-1.179*** (0.427)	-288.5*** (106.5)	-0.110* (0.0665)	-307.6*** (45.59)
Salary Policy	4.649*** (1.154)	189.3 (131.5)	-0.413** (0.179)	-594.0*** (164.7)
Police X Salary	1.278* (0.719)	155.7*** (55.03)	1.081*** (0.192)	269.5* (144.9)
Constant	12.97*** (2.789)	188.4 (336.5)	-1.247*** (0.0714)	1,318*** (454.8)
Year, Month, Checkpoint fixed effects	Yes	Yes	No	Yes
Observations	5,149	5,149	5,148	6,856
R-squared	0.376	0.082		0.034
Number of truck trips				295
Log-likelihood			-1662	

Notes: Robust standard errors in parentheses clustered at the driver level.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent

A4 Placebo test

We generate a placebo policy enacted one year before the actual policy of interest, on July 1, 2009. The results in table A4 show that such a placebo policy using data up until June 30, 2010, the day before the policy’s actual enactment, has no significant effect on any of our variables of interest. We do not find any evidence that our findings could be driven by a seasonality effect that might be evident each year in the data as would be the case with our placebo effect. This placebo exercise also provides corroborating evidence of there being parallel trends in the year before enactment of the policy.

Table A4

Placebo test of a policy July 1, 2009 to June 30, 2010

VARIABLES	(1) Effort	(2) Bribe value	(3) Panel FE Effort	(4) Panel FE Bribe value
Placebo policy	-9.259*** (1.162)	71.94 (50.45)	2.641 (2.053)	-243.4*** (37.41)
Police	-2.041*** (0.527)	-236.5*** (38.04)	-6.068*** (1.693)	189.9*** (30.86)
Police X Placebo	0.666 (0.543)	23.08 (22.02)	-0.241 (1.923)	2.064 (35.04)
Ghana			-4.481 (17.54)	575.6* (319.8)
Ghana Police			5.174** (2.056)	-464.7*** (37.47)
Constant	2.220 (1.645)	750.9*** (76.04)	10.48 (46.13)	-328.8 (840.8)
Year, Month, Chckpt FE	Yes	Yes	Yes	Yes
Observations	20,856	20,856	28,656	28,656
R-squared	0.203	0.129	0.044	0.239
Number of truck trips			1,297	1,297

Notes: Robust standard errors in parentheses clustered at the driver level.

* Significant at 10 percent

**Significant at 5 percent

***Significant at 1 percent