Economic Inquiry

CORRUPTION, TAX EVASION AND THE ROLE OF WAGE INCENTIVES WITH ENDOGENOUS MONITORING TECHNOLOGY

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The importance of high salaries to circumvent bureaucratic corruption has been widely recognized in the policy debate. Yet, there appears to be much reluctance when it comes to the implementation. In this paper, we argue that deterring corruption through wage incentives may become prohibitively expensive that the government finds it optimal to accept higher net revenues at the expense of honesty. Deviating from the existing literature, we set an endogenous monitoring technology that allows us to capture the dual role of auditing, as a complement with and as a substitute for wage incentives to deter bribery. We find that the government is better-off either completely eliminating corruption or accepting corruption by offering wages lower than the market wage. Offering public wage premium that does not deter bribery is suboptimal. When it is optimal to deter bribery, the government can do it either through wage incentives or monitoring. The role of wage incentives decreases in societies with higher level of dishonesty. (*JEL* D73, H26, J33, J41)

"I am expected to pay for my petrol when I go for official rounds. I am expected to pay for paper, typing, photocopying, even postage. All of this is official work. It adds up to Rupees 6,000 per month. Am I mad to pay it from my pocket? What do they (Islamabad) expect? They know every thing." (Anonymous tax inspector in Pakistan)[1]

I. INTRODUCTION

Offering higher public wages has commonly been viewed as an anti-corruption strategy by many academics, policy makers, and multilateral development agencies. In their seminal paper, Becker and Stigler (1974) show that raising wages along with non-zero audit probability could deter bribery in the public sector. Since then, a vast body of literature, both theoretical as well as empirical shows lower public sector wages as one of the main determinants of bribery (Myrdal 1968; Klitgaard 1988; Tanzi 1997; Goel and Nelson 1998; Van Rijckeghem and Weder 2001). Despite the striking implications in policy debates, wage incentive strategy seems not so common when it comes to its implementation. Real wage declines in the public sector have been common in many countries over substantial periods of time. In a sample of 21 countries, Haque and Sahay (1996) report that real wages fell at an annual average rate of 1.4%. Besley and McLaren (1993) (hereafter BM) offer a theoretical explanation where a net-revenue maximizing government might offer a wage below the market wage and accept corruption of its bureaucrats. In this paper, we extend the BM model by endogenizing the monitoring technology. We share the same results with the BM that deterring corruption through wage incentives may become prohibitively expensive that governments might find it optimal to accept corruption. But contrary to theirs, our results suggest that government is better-off either completely eliminating corruption or accepting corruption by offering wages lower than the

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1. Report of the Task Force on Reform of Tax Administration (2000), Central Board of Revenue, Government of Pakistan.

ABBREVIATION

BM: Besley and McLaren (1993)
GDP: Gross Domestic Product

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market wage. Offering public wage premium that does not deter bribery is suboptimal. Our endogenous monitoring technology goes farther from BM and identifies a trade-off between wage incentives–based and monitoring-based anticorruption strategies where although the latter is expensive it reduces size of the wage that ensures honesty. Further, we show that when bureaucrats' probability of being caught depends on the behavior of their peers then there are multiple equilibria where corrupt and honest equilibrium coexist with same levels of wages and auditing.

There have been a number of studies identifying lower wages as one of the major causes of malfeasant usage of public offices.[2] The argument is that less-paid public officials are more inclined to engage in corrupt practices. When the employees are not well paid, they may look for other avenues to generate additional resources and in most of the cases it would come from a misuse of public offices. For example in Ukraine, Gorodnichenko and Klara (2007) find that public sector employees receive 24–32% less wages than their private sector counterparts. Yet, workers in both sectors have essentially identical levels of consumer expenditures and asset holdings. Moreover, since lower salaries is one of the main determinants of corruption in the public sector, the fundamental response to ensure honesty would be to raise the salaries of bureaucrats above what they could get elsewhere, that is, paying them efficiency wages (Becker and Stigler 1974). The economic logic behind efficiency wages stems from the fact that if there is a probability of detection and punishment, higher salaries would imply higher costs of dismissal. In this way, higher salaries can prevent corruption by imposing an opportunity cost to corrupt public officials. Alternatively, there will be positive incentive effects as with higher salaries; competent and honest people would be willing to join public offices (Klitgaard 1988; Haque and Sahay 1996).[3]

In a theory explaining bureaucratic corruption, BM investigate a possible causality from corruption to lower public sector wages. In line with the structure of Becker and Stigler (1974), they show that there can be situations (under parametric conditions) in which governments may be better-off accepting corruption and offering a wage less than the outside option (capitulation wage). They look at the tax compliance problem where government optimizes its revenues net of administrative costs. In this study, we extend the BM analysis of exploring the trade-off between wage incentives–based anti-corruption strategy and budgetary balances. We consider problems of both moral hazard and adverse selection: moral hazard arises as bribery can not be observed without costly monitoring, and adverse selection, as not all potential tax inspectors can be identified as being corrupt or honest. The government maximizes net revenue and it offers a wage scheme that generates higher revenues net of administrative costs. It can offer three different wage schemes: a wage that is offered in the private sector (reservation wage), which attracts both corruptible and honest agents to join public offices. It can offer a wage higher than the private wage (efficiency wage), which solves the moral hazard problem, that is, it deters bribery. Or it can offer a wage less than the private wage (capitulation wage), which attracts only dishonest agents in tax offices.

We differ from BM in at least three different ways. First and the most important is that as compared to BM, where audit probability is exogenous, we set a monitoring technology that is endogenous. They assume exogenous monitoring of tax inspectors where governments can not influence monitoring efforts. Certainly, this restrains governments' anti-corruption instruments. In practice, there are several examples of crackdowns against corruption with massive efforts in auditing. The "mani-pulite" prosecutions in Italy and crackdowns on judicial corruption in Venezuela are a few of them.[4] For the United States, Alt and Lassen (2014) show that the allocation of prosecutorial resources are endogenously determined and have negative impact on corruption. Di Tella and Schargrodsky (2003) not only report a crackdown on corruption in the public hospitals of the city of Buenos Aires, Argentina during 1996–1997 but also could differentiate different intensities at different phases of crackdown. Second, there is a growing understanding in the literature on corruption deterrence that efficiency of any audit system depends on the environment where public officials are operating. In line with the growing literature on peer-effects (i.e., Lui 1986; Andvig

2. See Myrdal (1968), Klitgaard (1988), Tanzi (1997), Goel and Nelson (1998), Van Rijckeghem and Weder (2001).

3. There is another view dealing with fairness and reciprocity. Their argument is that low paid workers may reciprocate unfair treatment by reducing their productivity, see Scott (2005) for detailed discussion.

4. See Lui (1986) for several examples of crackdowns in China.

and Moene 1990; Tirole 1996), we consider that the effectiveness of any monitoring effort should also depend on the environment of corruption in public offices where a tax inspector operates. Lui (1986) reports that a fundamental observation on corruption is that it becomes very difficult to audit a bureaucrat effectively if many others are also corrupt. By taking this into account, we set an endogenous monitoring technology that depends on two factors with opposing effects; the optimal audit intensity set by the government and a peer-effect of the number of corrupt tax inspectors. We allow government to optimize a monitoring intensity for each wage scheme.[5] Different wage schemes produce different equilibrium levels of corruption and thus the amount of tax revenues that the government receives. In this way, shifting from one wage regime to another changes the relative costs and benefits of monitoring and thus its optimal level.

Second, in BM, there is a complete extortion in the sense that if any tax-paying household faces a corrupt tax inspector, it will have to pay a bribe. In our model, corruption takes place only when a corrupt tax inspector matches with a corruptible tax payer. For any mismatch, there will be no corruption. Furthermore, we also consider the fact that another factor that might influence tax inspectors' corruption decision is the easiness of laundering bribe income. Generally, it can be observed that when there is a probability of getting caught and a penalty associated with it, corrupt tax inspectors may try to remain inconspicuous by altering their patterns of spending and/or by investing their bribe income in a manner different from their legal income. In this way, a costlier laundering would reduce the incentives to be corrupt.

Relaxing the assumptions of exogenous monitoring and complete extortion results in significant qualitative changes in the equilibrium of corruption and the relative performances of different wage schemes. For instance, the wage that deters bribery (efficiency wage) and a wage less than private wage (capitulation wage) would now be endogenous. They would depend on the audit intensity set by the government and the chances of matching between corruptible tax payer and corruptible tax inspector. Thus contrary to BM, in our settings, the wage that solves the moral hazard problem is endogenous, and the government, through audit intensity, can affect the size of this wage. This generates a new tradeoff where increasing monitoring is costly but it reduces the size of efficiency wage needed to deter bribery. In this way, the introduction of endogenous monitoring adds two additional strategies for deterring bribery. Audit can be a complement to wage incentives (i.e., carrot/stick mix) or an independent instrument as a substitute for wage incentives (sheer stick). This has very important implications for anti-corruption campaigns as without offering any wage incentive, the government can still ensure complete honesty by enforcing higher auditing. Both these strategies differ in their implications regarding moral hazard and adverse selection problems: monitoring directly affects the incentives to be corrupt (moral hazard) whereas efficiency wage has an impact on both incentives to be corrupt and selection (adverse selection).

Second, for the equilibrium of corruption, when tax inspectors are paid efficiency wages, in equilibrium all are honest. On the contrary, if they are offered capitulation wages, in equilibrium all tax inspectors are corrupt. The introduction of endogenous monitoring determines the equilibrium of corruption when tax inspectors are offered reservation wages (in BM there is a mixture of both corrupt and honest bureaucrats). Equilibrium depends on monitoring, which in turn depends on the audit intensity and the proportion of corrupt tax inspectors. When audit intensity is high, in equilibrium all tax inspectors are honest, when it is low, in equilibrium there is a mixture of both corrupt and honest tax inspectors. For the intermediate audit intensities, there are multiple equilibria; the equilibrium depends on the proportion of corrupt tax inspectors (i.e., where they coordinate).

Allowing the honest tax payers/inspectors to refuse bribery implies that corruption takes place only when a corruptible tax inspector matches with a dishonest tax payer. This has very significant implications, especially for the efficiency and the capitulation wage scheme as the size of both wages will now depend on the level of honesty. For the capitulation wage regime, even though in equilibrium all tax inspectors are corrupt, the government can still have tax revenues from honest tax-paying households (in BM, the only source of revenues is through successful monitoring). Moreover, the size of efficiency wage increases with dishonesty implying that the results of BM that efficiency wage generates the highest revenues when the level of dishonesty is high are no longer valid. A higher

5. Becker and Stigler (1974) also consider exogenous probability of being caught; however, they report that it must depend on the amount spent by the state on detection.

level of dishonesty would imply higher chances of matching between a corruptible tax payer and a corruptible tax inspector, thus the expected income with corruption would be higher. With higher expected income of corruption, a higher compensation would be required to make corruptible tax inspectors behave honestly.

In contrast to BM results, we find that government is better-off either completely eliminating corruption or accepting corruption by offering wages lower than the market wage. This implies that offering tax inspectors a wage equal to private sector wage and not solving the moral hazard problem is sub optimal in terms of net revenues. Governments can increase their net revenues either by reducing government wages to a level below the outside option and not auditing them or by raising audit intensity up to the level where no one has incentive to be corrupt. This suggests that Ukraine's wage strategy of capitulation wages seems optimal than those of for example Pakistan, India or Latin America where there are public wage premiums[6] but corruption levels are as high as those of Ukraine and tax to gross domestic product (GDP) ratio is low.[7] The range of parameters where accepting corruption dominates deterring corruption increases with tax rate and cost of monitoring, and decreases with the level of reservation wage (outside option). When it is optimal to deter bribery, the government can do this either through incentive-based strategy (carrot/stick mix) or through monitoring. Which of these two is optimal depends on cost of auditing, level of dishonesty, tax base and reservation wage. Opposite to BM results, the role of efficiency wages decreases in societies with higher proportion of dishonest agents. In these societies, wage incentive schemes become prohibitively expensive and the government would opt for a monitoring-based anti-corruption strategy when auditing is less costly, and a capitulation wage policy when auditing is more expensive.

In the following section we describe the economy. Section III looks at the incentives to be corrupt. Section IV sets the government's decision problem while Section V calculates the tax revenues and obtains optimal auditing intensity for each wage regime. In Section VI, there is pairwise net revenues comparison for different wage regimes. Section VII examines the comparative statics and Section VIII concludes.

6. See Gorodnichenko and Klara (2007) for Ukraine, Hyder and Reilly (2005) for Pakistan, Glinskaya and Lokshin (2005) for India, Mizala, Romaguera, and Gallegos (2011) for Latin America.

7. Corruption ranking can bee seen in Transparency International's CPI and Tax to GDP ratios can be seen in Worldbank's Development indicators.

II. DESCRIPTION OF THE ECONOMY

There is a constant population N of infinitely lived, risk-neutral agents. Agents are of two sorts: θN are corruptible and $(1-\theta)N$ are honest. An honest agent regards his integrity as priceless and thus does not offer/take bribe for any material reward. Agents are divided into two groups of citizens—households, of whom there is a fixed measure of n, and to service a population of n potential tax payers, the government requires m tax inspectors (which we normalize to one). Households are differentiated according to differences in their labor endowments that determine their relative incomes and their relative propensities to be taxed. Specifically, we assume that a fraction $\mu \in (0, 1)$, of households are endowed with $\varepsilon > 1$ units of labor (high income) and are liable to pay tax τ, while the remaining fraction $(1-\mu)$ are endowed with one unit of labor (low income) and owe no tax. The government knows μ without knowing which household actually owes any tax. Taxes are collected by tax inspectors on behalf of the government. For simplicity, we assume that tax inspectors are exempt from taxes, that is, they are low income type. Each tax inspector has one unit of labor endowment and is responsible for collecting taxes from n/m households. Corruption arises from the incentive of a tax inspector to conspire with a household to conceal information (the household's income) from the government. In doing so, a tax inspector expects to gain from his acceptance of bribe and a household expects to gain from its evasion of tax. A fraction $\gamma \in (0, 1)$ of tax inspectors are corruptible in this way, while the remaining fraction $(1-\gamma)$ are non-corruptible. There are selection effects and γ can be different from θ (the proportion of corruptible agents). γ is equal to $\theta \in (0, 1)$ if tax inspectors are at least offered a wage equal to their outside option (reservation wage) and $\gamma = 1$ if they are offered a wage less than their outside option.[8] Furthermore, a tax inspector who is corruptible may or may not be corrupt, that is, there are incentive effects. There is a fraction $\lambda \in (0, 1)$ of such tax inspectors who will actually

8. If the government sets public wage below the private wage, no one honest would be prepared to become a tax inspector.

be corrupt, while the remaining fraction $(1-\lambda)$ will stay honest.

A. Corruption

Corruption takes place when a corruptible high income household conspires with a corruptible tax inspector to declare him as a low income household. Each tax inspector is responsible for collecting taxes from n/m households of whom only a fraction μ is high income who owe taxes. Out of taxpaying households, a fraction θ is corruptible. Thus, with probability $\theta\mu$, a corrupt tax inspector matches with a corruptible tax payer who owes tax τ. A corrupt tax inspector demands bribe b to conceal his tax information from the government. Corruption is illegal; a tax inspector who takes bribe may try to remain inconspicuous by hiding his illegal income by investing this income differently from legal income and/or by altering his patterns of spending. These activities typically entail costs in one form or another. For purposes of the present analysis, we make a simple assumption that a tax inspector who is corrupt spends a fraction $\beta \in (0,1)$ of his bribe income to conceal his income. Given this, the total bribe income of a corrupt tax inspector is

$$B = (1-\beta)\, b\theta\mu n. \tag{1}$$

β can be thought of as a parameter measuring institutional quality (i.e., the Rule of law).[9] It can be explained as an indicator representing the cost of laundering illegal income. The closer the β is to 1, the more efficient are institutions, and the more costly would be concealing illegal income.[10]

Each corrupt tax inspector faces a probability p of being caught. We set an endogenous monitoring technology which depends on two factors with opposing effects. First, any probability of being caught must imperatively depend on the government's on-job audit intensity. An intensive auditing would imply higher chances of being detected. Second, tax inspectors usually do not operate on their own but are influenced by their reference groups such as colleagues and friends. It is plausible to imagine that if many of them are corrupt, it is less likely that a corrupt tax inspector will be exposed off. On the contrary, if most of them are honest, it is almost certain that any one who deviates will immediately be identified. Taking both factors into account, we set a monitoring technology

$$p = \sigma(1-\theta\lambda\gamma) \tag{2}$$

where σ is audit intensity set by government. $\theta\lambda\gamma$ is a number of tax inspectors that engage in corruption with a negative sign implying that when many are corrupt, the probability of being caught is lower. This generates strategic complementarity in decision making of tax inspectors. A higher number of corrupt tax inspectors undermine the capacity of internal investigation units, which increases the expected gains for others. The decision of a corruptible tax inspector to be corrupt (honest) will increase (decrease) the incentives for others, which may generate multiple equilibria. We assume that if a conspiracy between a tax inspector and a household is exposed, tax inspector loses all his income (wage plus bribes) and household is forced (legally) to pay its taxes.

B. Households

Households receive income I and their utility is a linear function of their expected income, that is, they are risk neutral. They earn wage w by supplying their labor to private sector. A household with one unit of labor endowment earns a labor income w (private wage) and is exempt from tax. A household with $\varepsilon > 1$ units of labor endowment earns a labor income εw and is liable to pay tax τ. The honest high income households, of whom there is a fraction $(1-\theta)$, do not evade taxes and their after tax income is $\varepsilon w - \tau$. Whereas, the corruptible high income households may or may not conspire with tax inspectors to declare them as low income. If not, then its income is $\varepsilon w - \tau$, and if so, then, its income is uncertain and depends on the probability of being caught and the bribe paid to tax inspector. With probability p their conspiracy is exposed and with probability $1-p$, a household and a tax inspector are successful in their conspiracy. Given this, the expected income of a high income household is

$$E(I;b) = \begin{cases} \varepsilon w - \tau & \text{if } b = 0 \\ \varepsilon w - b - p\tau & \text{if } b > 0 \end{cases} \tag{3}$$

where $b > 0$ implies that the household is involved in corruption.

9. β can be endogenous function of the honest or ex ante honest proportion of society. This would reinforce our results that role of wage incentives decreases in societies with higher proportion of corruptible agents.

10. Although β is interpreted as a cost of concealing bribe income, it can also represent a social cost as bribe is no longer a mere transfer of money from a tax payer to a tax collector.

C. Tax Inspectors

Tax inspectors differ in their behavior in public offices. A fraction $(1-\gamma)$ who are honest, do not demand bribes and earn income w_g by working for the government, where w_g is a wage offered in public sector. While others γ, may or may not be corrupt; if not, their income is w_g, if so, their income is uncertain and depends on the chances of being caught, the bribe they receive, and the cost they incur in concealing their bribe income. With probability p, their conspiracy with high income household is exposed and they lose their income (wage plus bribes). Given this, the expected income of a tax inspector is

(4)
$$E(I;b)=\begin{cases} w_g & \text{if } b=0 \\ (1-p)\left(w_g+B\right) & \text{if } b>0 \end{cases}$$

where B is given by Equation (1).

III. INCENTIVES TO BE CORRUPT

A dishonest high income household will conspire with a corruptible tax inspector and will offer him bribe if its expected income with bribe is at least equal to its income net of tax paid. From Equation (3), the maximum bribe that a high income household may be willing to pay is

$$b^{*}=\tau(1-p). \tag{5}$$

Equation (5) implies that a corruptible household is willing to pay no more than what it expects to save from its tax evasion. Given b^*, a corruptible tax inspector may be corrupt and may exploit his office if doing so earns him higher utility than otherwise. His expected income is given by Equation (4); he would be corrupt only if his expected income with corruption is higher than his income without corruption.

A corruptible tax inspector will only be corrupt if

$$(1-p)\left[w_g+(1-\beta)\,b^{*}\mu n\theta\right]\geq w_g.$$

By substituting in for b^* from Equation (5), and p from Equation (2), the incentive compatibility constraint ICC of a tax inspector becomes

$$\frac{(1-\sigma(1-\theta\lambda\gamma))^{2}\,\tau\mu n\theta(1-\beta)}{\sigma(1-\theta\lambda\gamma)}\geq w_g. \tag{6}$$

A corruptible tax inspector will opt to be corrupt if Equation (6) is satisfied, and if not, he will stay honest. Intuitively, a tax inspector is more likely to be corrupt the less he expects to lose in his legal income if he is caught and the more he expects to gain in illegal income if he is successful in corruption. The strategic complementarity in the decision making of corruptible tax inspectors determines the equilibrium level of corruption. Given the wage, w_g and the audit intensity σ, the incentive compatibility constraint in Equation (6) is a function of the proportion of corruptible tax inspectors who opt to be corrupt, λ. Given this, one can deduce a fraction $\lambda\in(0,1)$ of corruptible tax inspectors who are corrupt. Consider a $\lambda\in(0,1)$ for a given w_g and σ, such that Equation (6) is either satisfied with inequality or is not satisfied at all. Both of these situations can not be an equilibrium: in the first case, some of the corruptible tax inspectors choose not to be corrupt when it pays them to be corrupt, as a result λ would rise until $\lambda=1$. In the second case, some of the corruptible tax inspectors opt to be corrupt while it does not pay them to be corrupt, as a result λ would decline until $\lambda=0$. Thus, there can only be two equilibria where either all corruptible tax inspectors are corrupt or all of them behave honest.

Having said this, we can define two thresholds from the ICC in Equation (6) as a function of the audit intensity σ, $f(\lambda;\sigma)$. Consider first, if all tax inspectors were honest, then $\lambda=0$ and the left-hand side in Equation (6) is $f(0;\sigma)$, which represents the expected gains of corruption given that all other tax inspectors were honest. When $f(0;\sigma)>w_g$, the agent will be corrupt even if no one else is corrupt. Consider now if all tax inspectors were corrupt, $\lambda=1$ and the left-hand side in Equation (6) is $f(1;\sigma)$, which represents the expected gains of corruption given that all corruptible tax inspectors were corrupt. Given this, we can demarcate different equilibrium conditions as

(7)
$$\lambda=\begin{cases} 1 & \forall\ w_g<f(0;\sigma)\equiv\frac{(1-\sigma)^{2}\tau\mu ns}{\sigma} \\ 0 & \forall\ w_g\geq f(1;\sigma)\equiv\frac{(1-\sigma d)^{2}\tau\mu ns}{\sigma d} \\ 0\ \text{or}\ 1 & \forall\ f(1;\sigma)>w_g\geq f(0;\sigma) \end{cases}$$

where $s=\theta(1-\beta)$ and $d=1-\theta^{2}$ are constants.

The equilibrium condition in Equation (7) highlights the role of wage incentives for the determination of corruption. The intuition is that when public sector wages are higher than the expected gains of corruption, even a corruptible tax inspector would stay honest, and when wages are low, every corruptible tax inspector would be corrupt. It is important to note that the thresholds of wage that demarcate equilibria in Equation (7) are endogenous and depend on the audit intensity. Thus a wage that ensures no corruption (efficiency wage) will also be endogenous. A crucial factor for the determination of the level of efficiency wage would be the audit intensity set by the government. Thus, contrary to the previous literature, here, auditing will have a dual role where apart from its direct negative impact on the incentives of corruption, it will also complement with wage incentives.

IV. THE GOVERNMENT'S PROBLEM

As in BM, the objective of government is maximizing its tax revenues net of administrative costs.[11] The government collects taxes from high income households by levying lump-sum tax τ. It employs tax inspectors to work on its behalf and pays them a salary w_g. It investigates tax inspectors with intensity σ, which costs it $c\sigma$ of its aggregate tax revenues $\tau\mu n$.[12] This is in line with the deterrence theory that increasing risk of prosecution requires more prosecutorial resources.[13] Apart from choosing an optimal public wage policy (as in BM model), the government also chooses the optimal audit intensity. Since auditing is costly, the government optimizes it by looking at the additional revenues it fetches and the costs associated with it. Government optimizes audit intensity σ, and offers a wage w_g which yields it higher net revenues. We consider three possible wage strategies for the government. First, it might pay an efficiency wage $w_g = w^e$, which deters bribery and nobody behaves dishonestly. Second, it might pay a reservation wage $w_g = w$ (outside option), which attracts a mixture of honest and corruptible agents to join tax offices. Third, it can pay a capitulation wage $w_g = w^c$, which is below the reservation wage and attracts only corruptible agents.

Corruption takes place when dishonest tax inspector matches with dishonest household who owes tax, τ. With probability $(1-\theta)(1-\lambda\gamma)$, an honest household matches with an honest tax inspector; with probability $(1-\theta)\lambda\gamma$, an honest tax payer encounters a corruptible tax inspector, and with probability $\theta(1-\lambda\gamma)$, a corruptible tax payer meets an honest tax inspector. In all three cases, households declare their true type and submit $\tau\mu n(1-\theta\lambda\gamma)$ taxes. Whereas, with probability $\theta\lambda\gamma$, a corruptible tax payer matches with a corruptible tax inspector and they do not submit taxes. Government sets on-job auditing, and with probability p, a conspiracy of a tax inspector with a corrupt household is exposed; household is forced to pay its tax liability and tax inspector loses his wage and bribe income, B. Government expenditures include wages w_g paid to tax inspectors and cost $\sigma c\tau\mu n$ to audit tax inspectors. Given this, net revenues of the government are

$$(8) \quad NR = \tau\mu n\,(1-\theta\lambda\gamma) + p\tau\mu n\theta\lambda\gamma + pB\theta\lambda\gamma - w_g\,(1-p\theta\lambda\gamma) - c\sigma\tau\mu n.$$

V. TAX REVENUES AND OPTIMAL AUDITING

The government can offer three different wage schemes: reservation wage, efficiency wage or capitulation wage. Government's decision problem is two dimensional: first, it optimizes audit intensity for every wage scheme and then it offers a wage scheme that generates higher net revenues. Consider first the optimization problem when government offers reservation wages, that is, outside option $w_g = w$.

A. Reservation Wages

With a wage equal to outside option, that is, $w_g = w$, there would be a mixture of both honest and corruptible agents who join tax offices. The proportion of corruptible tax inspectors is equal to the proportion of corruptible agents in society, $\gamma = \theta$. From the ICC in Equation (7), the audit intensity that ensures all corruptible tax inspectors stay honest is $\overline{\sigma} \equiv \left(2s + x - \sqrt{4sx + x^2}\right)/2sd$, and the audit intensity below which every corruptible tax inspector is corrupt is $\underline{\sigma} \equiv \left(2s + x - \sqrt{4sx + x^2}\right)/2s$, where $x = w/(\tau\mu n)$ is a ratio of wage bill to tax base. The threshold $\overline{\sigma}$ sets the expected gains of corruption (given that every corruptible tax inspector is corrupt) equal to reservation wage. Thus, for any audit intensity greater or equal to $\overline{\sigma}$, every corruptible tax inspector will behave

11. This is assumed to make our model consistent with the BM. Alternate would be a benevolent government maximizing social welfare. BM, and Haque and Sahay (1996) provide a general discussion on why the government might be maximizing net revenues rather than social welfare.

12. A cost function proportional to $\tau\mu n$ helps us to avoid size effects. Further, we choose linear cost function to get analytical solution, our qualitative results will not change by generalizing it to any increasing cost function.

13. Becker and Stigler (1974) do not explicitly model it; however, they implicitly assume that probability of being caught is function of the governmental resources spent on detection. Alt and Lassen (2014) find that the allocation of prosecutorial resources is endogenous for the United States.

honest irrespective of whether others are corrupt or honest. Similarly, there is a lower bound of audit intensity $\underline{\sigma}$, such that any intensity less than this, the ICC is always satisfied and in equilibrium all corruptible tax inspectors will be corrupt. Furthermore, since there is strategic complementarity in the decision of corruptible tax inspectors, for the intermediate levels of audit intensity there are multiple equilibria. For the same level of audit intensity both the equilibrium where all corruptible tax inspectors are corrupt and the equilibrium where all behave honest coexist.

Given this, when government offers reservation wages, there can be three different equilibria demarcated by audit intensity

(9)
$$\lambda = \begin{cases} 1 & \forall \sigma < \underline{\sigma} \equiv \frac{2s+x-\sqrt{4sx+x^2}}{2s} \\ 0 & \forall \sigma \geq \overline{\sigma} \equiv \frac{2s+x-\sqrt{4sx+x^2}}{2sd} \\ 0 \text{ or } 1 & \text{if } \overline{\sigma} > \sigma \geq \underline{\sigma}. \end{cases}$$

Equilibrium condition in Equation (9) implies that when government offers reservation wages, there can be three different equilibria which further implies that net revenues of government will be different in different equilibria. In the following, we study in detail these three sub cases and their corresponding tax revenues.

Consider first the case where government offers reservation wages and audit intensity is high such that in equilibrium all corruptible tax inspectors are honest.

Reservation Wages with High Audit. When government offers reservation wages and sets a high audit intensity (i.e., $\sigma \geq \overline{\sigma}$) the ICC is never satisfied and in equilibrium all tax inspectors are honest. Government's net revenues in Equation (8) are

$$NR^H = \tau\mu n \left(1 - x - c\overline{\sigma}\right) \tag{10}$$

Reservation Wages with Low Audit. When audit intensity is low (i.e., $\sigma < \underline{\sigma}$), the ICC is always satisfied. In equilibrium all corruptible tax inspectors are corrupt and probability of being caught becomes $p = \sigma d$. In this case, government's net revenues in Equation (8) are

$$NR^L = \tau\mu n d + \sigma d \tau\mu n \theta^2 + \sigma d \left(1 - \sigma d\right) \tau\mu n \theta^2 s - w\left(1 - \sigma d \theta^2\right) - c\sigma\tau\mu n.$$

Increasing audit intensity has both positive and negative effects on net revenues. Positive effects arise from the fact that higher intensity increases probability of being caught and with higher probability of being caught, corruptible households are more inclined toward paying their taxes. Negative effects arise through two different channels; firstly, increasing audit intensity increases total cost of auditing. Secondly, a higher audit implies lower probability of success which in turn implies lower expected bribes ($b = \tau(1-p)$) and thus a lower amount of bribe income confiscated by government. The audit intensity that maximizes NR^L is

$$\sigma^L = \frac{d\theta^2\left(1 + s + x\right) - c}{2d\theta^2 s}.$$

The optimal audit σ^L decreases with cost of auditing and is eventually equal to zero for $c = c_l \equiv d\theta^2(1 + s + x)$. By substituting in for σ^L, the corresponding net revenues are

(11)
$$NR^L = \begin{cases} \tau\mu n \left(d - x + \frac{\left(d\theta^2(1+s+x)-c\right)^2}{4d\theta^2 s}\right) & \text{for } c < c_l \\ \tau\mu n\left(d - x\right) & \text{for } c \geq c_l. \end{cases}$$

Reservation Wages With Intermediate Audit. Consider now the case when audit is at intermediate levels, then, from Equation (9), there are multiple equilibria. Strategic complementarity implies that there can be two equilibria where either all corruptible tax inspectors are corrupt or all behave honest. The equilibrium depends on the coordination of corruptible tax inspectors. If they coordinate on honest equilibrium, there will be no matching with corruptible households and they submit all taxes. When they coordinate on corrupt equilibrium, they conspire with corruptible tax payers and they do not submit taxes. We suppose that the government assigns an ex-ante probability $q \in (0, 1)$ that corruptible tax inspectors will coordinate on honest equilibrium and they will submit all tax receipts.[14] Given this and by $p = \sigma d$, net revenues of the government are

$$NR^I = q\left(\tau\mu n - w - c\sigma\tau\mu n\right) + (1 - q) \times \left(\tau\mu n d + \sigma\tau\mu n d\theta^2 + \sigma\left(1 - \sigma d\right)\tau\mu n d\theta^2 s - w\left(1 - \sigma d\theta^2\right) - c\sigma\tau\mu n\right).$$

14. This probability depicts the relative optimism of government regarding corruption outcome. More optimist governments put higher probability to be in the honest equilibrium. Government's optimism can be driven by the intrinsic characteristics of the society, that is, their culture and norms. What makes government more optimistic can be an important issue to be explored but that is not the focus here.

The audit intensity that maximizes NR^I is

$$\sigma^I = \frac{d\theta^2 (1-q)(1+s+x) - c}{2(1-q)\, d^2\theta^2 s}.$$

For our subsequent analysis, we assume that government a priori assigns a probability $1-q=\theta$ (proportion of corruptible agents in society) that tax inspectors would coordinate on bad equilibrium, that is, $\lambda = 1$. This is imperative as when reservation wage is offered both corruptible and honest agents join tax offices. Government does not know the type of agents but it knows the distribution of type and hence assumes that chances of honest equilibrium are equal to the proportion of honest agents.[15] Given this, the corresponding net revenues are

(12)

$$NR^I = \tau\mu n \left(d - x + \frac{\left(d\theta^3 (1+s+x) - c\right)^2}{4d^2\theta^3 s} \right).$$

PROPOSITION 1. *With* $w_g = w$, $\forall c > c' \Rightarrow \sigma^L < \underline{\sigma}$, *when government sets an audit intensity* σ^L, *in equilibrium all corruptible tax inspectors are corrupt. Similarly* $\forall \theta c' \geq c > c'' \Rightarrow \underline{\sigma} \leq \sigma^I < \overline{\sigma}$, *government sets an audit intensity* σ^I *and* $\forall c > c'' \Rightarrow \underline{\sigma} > \sigma^I$, *government sets an audit intensity* $\underline{\sigma}$, *in both cases, with probability* θ *all corruptible tax inspectors are corrupt.*

Proof. Appendix A □

B. *Efficiency Wages*

We define efficiency wage as a wage that solves the moral hazard problem, that is, when tax inspectors are offered efficiency wage, no one behaves dishonestly irrespective of whether others are honest or dishonest. To find an efficiency wage, we employ standard technique of equating tax inspector's expected income when he is corrupt with the income when he is honest. From equilibrium condition in Equation (9), the wage that deters bribery is $f(1;\sigma)$

$$w^e = \frac{(1-\sigma d)^2 (1-\beta)\,\tau\mu n\theta}{\sigma d}.$$

Since w^e decreases with audit intensity, we set a lower limit where it is at least equal to outside option, $w^e = \max\{w, f(1;\sigma)\}$. When defined in this way, efficiency wage is endogenous and it depends on model parameters especially on audit intensity that is set by the government. This makes it different not only from BM model but to the best of our knowledge different from any other model in tax compliance problem. The comparative statics of efficiency wage can be obtained by differentiating it with respect to different parameters. First, for quite natural reasons, higher the audit intensity is, lower will be the size of efficiency wage. It is important to note that if there is no auditing ($\sigma = 0$), there exists no finite wage that makes tax inspectors behave honestly. Intuitively, when the government does not audit, the probability of being caught is zero, and the expected gains of corruption will always be greater than the expected losses. On the contrary, a higher auditing implies higher probability of being caught and thus a lower expected income of corruption. With lower expected income of corruption, a smaller compensation would be required to make corruptible tax inspectors behave honestly. In this way, auditing complements with wage incentives; that is, the higher the auditing is, the lower will be the required compensation to ensure honesty.

Further, the probability of matching a corruptible tax inspector with a corruptible tax payer increases the size of efficiency wage. Higher chances of matching with corruptible tax payer increase expected bribe income, thus higher compensation would be required to make tax inspectors honest. This implies that efficiency wage will be more expensive in societies with higher proportion of corruptible agents. On the other hand, cost of laundering bribe income β, reduces the size of efficiency wage. With better rule of law, tax inspectors would spend a higher share of their income to remain inconspicuous implying that lower compensation would be required to make them honest.

When government pays efficiency wages, $\gamma = \theta$ and in equilibrium all tax inspectors will be honest, $\lambda = 0$. In this case, government receives all tax revenues $\tau\mu n$. The government's net

15. In an earlier version of the paper we looked at two extreme cases where either $q=0$ or $q=1$. Our qualitative results were unchanged except for the case of $q=1$ where for certain combinations of c, x, β and θ, government was better-off offering reservation wages with intermediate audit. To the best of our understanding this result was generated by the assumption that government is very optimist about the corruption outcome. It needed better justification that when ICC implies corruptible tax inspectors behave honestly only when either they are offered efficiency wages or audit intensity is high, then, what makes government assume that with reservation wages and intermediate audit tax inspectors are going to behave honestly? In such scenario, intermediate audit becomes the threshold of audit beyond which everyone behaves honestly.

revenues with efficiency wages are

$$NR^e = \tau\mu n - \left[\left((1-\sigma d)^2 \tau\mu ns\right)/\sigma d\right] - c\sigma\tau\mu n.$$

Increasing audit intensity increases the probability of being caught which reduces the size of efficiency wage, thus, it increases net revenues. On the other hand, increasing audit intensity requires higher resources for auditing, which implies higher costs, thus, a decrease in net revenues. The optimal audit intensity that maximizes NR^e is

$$\sigma^e = \sqrt{s}/\sqrt{d\,(sd+c)}.$$

Given this, the corresponding net revenues with efficiency wage are

(13)

$$NR^e = \begin{cases} \tau\mu n\left(1+2s-\frac{2\sqrt{s}\sqrt{sd+c}}{\sqrt{d}}\right) & \text{for } c \geq c^* \\ \tau\mu n\left(1-x-c\overline{\sigma}\right) & \text{for } c < c^* \end{cases}$$

where $c^* \equiv \left(\frac{4s^3 d}{\left(2s+x-\sqrt{4sx+x^2}\right)^2} - sd\right)$, see Appendix B.

C. *Capitulation Wages*

The third wage regime occurs when government offers a wage that is lower than a reservation wage. This is a situation when government gives up against corruption and does not attempt to deter bribery. Capitulation wage is a minimum wage at which the expected income of a corruptible tax inspector is equal to his outside option, $(1-p)(w^c+B)=w$. When public sector wage is less than the outside option only corruptible agents are willing to join tax offices and all of them are corrupt implying that $\gamma=\lambda=1$. By substituting in for B from Equation (1) and for $p=\sigma(1-\theta)=\sigma a$, where $a=1-\theta$, expression for capitulation wage is

$$w^c = \left[w/(1-\sigma a)\right] - (1-\sigma a)(1-\beta)\,\tau\mu n\theta.$$

Capitulation wage increases with audit intensity and if there is no audit, it is equal to reservation wage less of bribe income. An intensive audit implies a lower expected bribe income implying a lower capitulation wage. With the same reasoning, capitulation wage will be higher with higher β. Furthermore, it decreases with probability to meet corruptible tax payer, which implies that the role of capitulation wages increases in societies with higher proportion of corruptible agents.[16]

Moreover, contrary to BM where in capitulation wage regime, the only source of revenues is a tax recovered through successful monitoring, here, apart from the successful monitoring, the honest tax-paying households would refuse paying bribes to corrupt tax inspectors and they would submit their true taxes. Given this, government's net revenues with capitulation wages are

$$NR^c = \tau\mu na + \sigma a\tau\mu n\theta - \tau\mu ns\,(1-\sigma a) - \frac{w\,(1-\sigma a\theta)}{1-\sigma a} - c\sigma\tau\mu n.$$

Increasing audit increases probability of getting caught, which increases tax revenues. On the other hand, more intensive auditing requires more resources that increases cost and reduces net revenues. Furthermore, an increase in audit lowers probability of success, which results in lower expected income of bribes. Since capitulation wage decreases with expected bribes; a lower expected bribe income implies a higher capitulation wage to be paid. The optimal audit intensity that maximizes NR^c is

$$\sigma^c = \frac{1}{a} - \sqrt{\frac{x}{\beta\theta a - c}}.$$

Optimal audit intensity σ^c decreases with c, and there exists $c^c \equiv a(\beta\theta - ax)$ such that for cost of audit greater than c^c, it is optimal not to audit. Given this, net revenues with capitulation wages are

(14)

$$NR^c = \begin{cases} \tau\mu n\left(1-x\theta-\frac{c}{a} -2\sqrt{x}\sqrt{\beta\theta a - c}\right) & \text{for } c < c^c \\ \tau\mu n\,(1-x-\beta\theta) & \text{for } c \geq c^c. \end{cases}$$

VI. NET REVENUES COMPARISONS

Having found the optimal audit intensities and net tax revenues for different wage schemes, the next task remains to look at the relative performance of each wage regime in terms of net revenues generation. We do so through a pairwise comparison of a capitulation wage with other wage regimes, by looking at the decision

16. By looking at the capitulation wage, one can see that it may be negative (when the bribe income is higher than the legal income, w). The special case of negative wages can be thought as a sister concept of "tax farming" in ancient Rome. In ancient Rome, tax farmers were often utilized to collect provincial taxes. Tax farmers paid in advance for the right to collect taxes in particular areas. In fact, tax farming was quite profitable, tax farmers used to collect more than what they paid to the government and it became a major investment vehicle for wealthy and influential citizens (Levi 1988).

point where government is indifferent between capitulation wage and other wage regimes. Capitulation wage in Equation (14) generates two different levels of net revenues depending on if it is optimal to audit or not. Consider first the case when it is optimal to audit (i.e., $\sigma^c > 0$), since all tax inspectors are corrupt, auditing will not have any effect on tax compliances as the only tax payers are the honest households. The only positive effect on revenues will come through an increase in the amount of fines collected from corrupt tax inspectors who are caught. Generally speaking, the central idea behind any auditing effort is to increase tax compliances and it can never be just collecting fines. Without loss of generality, we assume that when government offers capitulation wages, it knows that only corruptible agents will be tax inspectors and putting any auditing will not increase tax compliances, it decides not to audit.

A. *Capitulation vs. Efficiency*

By comparing Equations (13) and (14), we get a threshold of c such that both wage regimes generate equal revenues. First, we compare when $w^e = ((1-\sigma d)^2 \tau\mu n s)/\sigma d$; capitulation wages yield higher net revenues than efficiency wages for any $c > c_1 \equiv d(((2s + x + \beta\theta)^2 - 4s^2)/4s)$. The threshold c_1 that demarcates the region where capitulation wages dominate efficiency wages in terms of revenues generation is endogenous and crucially depends on tax rate, outside option, proportion of corruptible agents, and cost of concealing bribe income. The comparative statics can be obtained by differentiating c_1 with respect to x. The lower the x is, the lower is c_1 and the greater will be the region where capitulation wages generate more net revenues than efficiency wages. Since $x = w/(\tau\mu n)$, the impact of the size of reservation wage, w on capitulation and efficiency wage regimes is very straightforward; it has no effect on efficiency wage regime and since capitulation wage increases with w, it implies a negative impact on net revenues in capitulation wage regimes.

Tax rate affects both wage regimes through its direct and indirect channels. The direct effect arises from increase in total volume of tax and the indirect effect takes place through its effect on wages (both on efficiency and on capitulation). The direct effect is positive on revenues for capitulation wage regime as an increase in tax rate increases tax volume. Whereas, for efficiency wages, it has a positive (increase in tax volume) as well as a negative (increase in total cost of auditing) effect on net revenues. The direct positive effect (increase in tax volume) is greater for efficiency wages as compared to capitulation wages as in the later only honest households pay taxes. On the other hand, the indirect effect of increase in tax rate has a negative effect on efficiency wage regime and a positive effect on capitulation wage regime. A higher tax rate implies a higher expected bribe ($b = \tau(1-p)$) that has opposing effects on two wage equations. For efficiency wage, a higher expected bribe implies a higher efficiency wage thus a higher wage bill implying a lower net revenues. Whereas, for capitulation wages, higher expected bribes imply lower capitulation wage (lower wage bill) and thus higher net revenues. By taking into account both direct and indirect affects, an increase in tax rate implies increase in the region of cost c where capitulation wages generates more net revenues than efficiency wage.

Consider now the case when efficiency wage is equal to outside option which is similar to offering reservation wage with high audit intensity. Capitulation wages will yield higher net revenues than efficiency wages for any $c > c_2 \equiv 2sd\beta\theta/\left(2s + x - \sqrt{4sx + x^2}\right)$. The threshold c_2 is endogenous; it increases with x implying that lower the x is, larger will be the region where capitulation wages dominate efficiency wages. A decrease in x (decrease in w or/and increase in τ) increases net revenues with capitulation wages. Since capitulation wage decreases with w, any decrease in w reduces the wage bill and increases net revenues. Whereas an increase in tax rate always increases tax volume and net revenues. For efficiency wages, any decrease in w increases net revenues by directly reducing wage bill. While it has also an opposite indirect impact as a lower w implies a higher audit intensity $\overline{\sigma} \equiv \left(2s + x - \sqrt{4sx + x^2}\right)/2sd$, thus lower net revenues. For changes in tax rate, there are both positive and negative effects on net revenues with efficiency wages. Increase in tax rate increases net revenues on one hand, and increases cost of auditing on the other.

PROPOSITION 2. *There exists* $\widehat{x} \equiv -2s + \sqrt{4s^2 + \beta^2\theta^2}$ *such that* $\forall x \leq \widehat{x}$, *capitulation wages generate higher revenues than efficiency wages* $\forall\, c > c_2$, *and* $\forall x > \widehat{x}$, *capitulation wages generate higher revenues than efficiency wages* $\forall\, c > c_1$.

Proof. Appendix C. □

The immediate implication of Proposition 2 is that not only is there an interplay between honest and corrupt equilibrium but also there is an interplay between policies that achieve honest equilibrium. Government can deter corruption by two different policy instruments. Honest equilibrium can either be achieved by wage incentives, that is, government pays efficiency wages with some positive audit intensity (carrot–stick mixed strategy), or by sheer stick strategy where it pays outside option but puts intensive audit which forces all corruptible tax inspectors to behave honestly. What distinguishes one policy option from the other in terms of net revenue generations is the level of x. For any $x < \widehat{x}$, government always generates higher net revenues by sheer stick strategy than wage incentives strategy.

By comparing these two strategies that ensure honest equilibrium with capitulation wage strategy where all tax inspectors are corrupt, which strategy brings higher net revenues crucially depends on endogenous thresholds of cost of auditing. For any cost less than c_2, sheer stick always generates higher net revenues than capitulation wages, and it is optimal (in terms of higher net revenues) for government to deter corruption. While for any cost greater than c_2, it is optimal for government to give up against corruption and offer capitulation wages. On the other hand, when $x > \widehat{x}$, government will generate higher revenues with wage incentives than with sheer stick. In comparison with capitulation wages, government will go for corruption deterrence for any cost of audit less than c_1, and it will give up against corruption if cost is greater than the threshold c_1.

Moreover, it is important to note that the threshold $\widehat{x}$ that demarcates sheer stick strategy from wage incentives increases with the proportion of corruptible agents in the society, θ. The role of sheer stick strategy increases in more corruptible societies as compared to relatively less corruptible ones. Whereas, the role of incentive-based strategies increases in less corruptible societies.

B. Capitulation vs. Reservation

Consider first the case of reservation wages with low audit where in equilibrium all corruptible tax inspectors are corrupt.

Low Audit. For reservation wages with low audit in Equation (11) there are two different levels of net revenues depending on whether it is optimal to audit or not. Consider first the case when there is no auditing. Capitulation wage always yields higher net revenues than reservation wages for any $\theta > \beta$. Whereas in the case with positive level of optimal audit, i.e., $\sigma^L > 0$, there exists a threshold $c_3 \equiv d\theta^2 \left[1 + s + x - 2\sqrt{(1-\beta)(\theta-\beta)}\right]$ such that capitulation and reservation wages yield equal net revenues. And for any $c > c_3$, capitulation wages generate more net revenues than reservation wages.

PROPOSITION 3. *For $\sigma^L = 0$, capitulation wages yield higher net revenues than reservation wages for any $\theta > \beta$. For $\sigma^L > 0$, there exists $\widetilde{x} \equiv \left[\left(s - \sqrt{(1-\beta)(\theta-\beta)}\right)^2\right] / \sqrt{(1-\beta)(\theta-\beta)}$ such that $\forall\ x > \widetilde{x}$, capitulation wages always yield higher net revenues. And $\forall x < \widetilde{x}$, capitulation wages yield higher net revenues $\forall\, c > c_3$, whereas reservation wages yield higher net revenues $\forall\, c < c_3$.*

Proof. Appendix D. □

When it is costly to audit tax inspectors such that it becomes optimal for government not to audit, capitulation wage regime generates more revenues than reservation wages when the proportion of corruptible agents θ is greater than the cost of concealing bribe income β. In countries with endemic corruption, this condition seems satisfied. Since corruption takes place by a matching of corruptible households with corruptible tax inspectors, higher θ implies higher chances of matching hence of corruption. In other words, corruption is more likely a feature of the societies with higher θ. On the other hand, it should be easier to conceal bribe income when there is a wide-spread corruption. Thus higher θ is associated with lower β and vice versa.

Intermediate Audit. By comparing Equations (14) with (12) we have an endogenous threshold $c_4 \equiv d\theta^2 \left[\theta\left(1 + s + x) - 2\sqrt{s}\sqrt{\theta-\beta}\right)\right]$ such that capitulation and reservation wages with intermediate audit generate equal net revenues and $\forall\, c > c_4$ capitulation wages generate higher net revenues.

High Audit. When the government offers reservation wages and puts high audit, it is the same case when $w^e = w$ (sheer stick). For any $c > c_2$, capitulation wages yield higher net revenues than reservation wages with high audit.

VII. COMPARATIVE STATICS

In the previous section we established that depending on cost of auditing, tax rate, outside option and proportion of corruptible agents in society, there are configurations where government is better-off offering capitulation wages and accepting corruption. In this section, we put all results together and see when it is optimal for a government to prefer one wage regime over others. Each wage regime is associated with a different level of corruption and three different levels of corruption can be an outcome depending on if reservation, efficiency, or capitulation wage is offered. When efficiency wages generate higher net revenues than other wage regimes, government offers efficiency wages and in equilibrium there is no corruption. On the other hand when capitulation wages generate higher net revenues, government gives up against corruption, and in equilibrium all tax inspectors are corrupt. The third scenario is when reservation wages generate higher net revenues, then, there is a mixture of both corruptible and honest tax inspectors joining tax offices. In this case, corruption would depend on the level of audit intensity; there is no corruption with high audit, there is a corruption with probability θ with intermediate audit, and all corruptible tax inspectors are corrupt with low audit.

For subsequent analysis, we assume that $\theta > \beta$. This implies that when it is costly to audit such that $\sigma^L = 0$, government is always better-off offering capitulation wages than reservation wages with low audit.

PROPOSITION 4. *Government is better-off either completely eliminating corruption or accepting corruption by offering capitulation wages. Reservation wages with low and intermediate audit are always dominated either by efficiency wages or by capitulation wages.*

Proof. Appendix E □

This implies that offering tax inspectors a wage equal to private sector wage and not solving the moral hazard problem is sub optimal in terms of net revenues. Governments can increase their net revenues either by reducing government wages to a level below the outside option and not auditing them or by raising audit intensity up to the level where no one has incentive to be corrupt. This has very important policy implications as when governments are unable to ensure honesty, that is, when efficiency wage is too high or audit intensity is not so high, then they are better-off cutting the public wage rents. In many developing countries including Latin America,[17] India,[18] and Pakistan,[19] there is a wage premium associated with public sector and on average public servants are paid more than their private counterparts. Surprisingly, many of these countries are ranked very high in corruption and are having lower tax to GDP ratio. For example, according to World Development Indicators published by the Worldbank, Pakistan's tax to GDP ratio was 10.1 in 2012 and was ranked 139 out of 174 in Transparency International's Corruption Perception Index in 2012. Whereas for India in 2012 tax to GDP ratio was 10.7 and was ranked 94 out of 174 in Corruption Perception Index 2012. Van Rijckeghem and Weder (2001) estimate that for India efficiency wage is 19 times that of private sector. On the other hand, in many countries in transition such as Ukraine[20] on average public sector wage is less than private sector which seems the case of capitulation wages. Interestingly, Ukraine is ranked more corrupt than Pakistan and India, that is, 144 in Corruption perception index 2012 but has almost twice as high tax to GDP ratio than Pakistan, that is, 18.3 in 2012.

For the comparison of efficiency wages with capitulation wages, results depend on the level of x.

PROPOSITION 5. $\forall \quad x \in (0, \hat{x})$; *efficiency wages are dominated by other wage regimes,* $\forall\, c \in (0, c_2)$*, reservation wages with high audit yield highest net revenues,and* $\forall\, c > c_2$*, capitulation wages yield highest net revenues. And* $\forall \quad 1 \geq x > \hat{x}$; $\forall\, c \in (0, c^*)$*, reservation wages with high audit yield highest net revenues,* $\forall\, c \in (c^*, c_1)$*, efficiency wages yield highest net revenues,* $\forall\, c > c_1$*, capitulation wages yield highest net revenues.*

Proof. Based upon Proposition 2. □

When x is low which for a given population of taxable households μn, implies a lower w or/and higher tax rate τ, efficiency wages are either dominated by capitulation wages or by reservation wages with high audit. From the policy perspective, when reservation wage (outside option) is low or/and tax base is high, government generates

17. Mizala, Romaguera, and Gallegos (2011).
18. Glinskaya and Lokshin (2005).
19. Hyder and Reilly (2005).
20. Gorodnichenko and Klara (2007).

higher revenues by offering reservation wages with high audit when auditing is less costly, and by offering capitulation wages when auditing is more costly.

When x is high which for a given population of taxable households μn, implies a higher w or/and lower tax rate τ. In this case when cost of auditing is less than or equal to c_1, government is better-off eliminating corruption and when cost of auditing is greater than government will be better-off giving up against corruption. For eliminating corruption, it has two policy options; sheer stick and wage incentives (carrot/stick mix). When cost of auditing is lower than or equal to c^*, government would be better-off offering reservation wages and controlling corruption through higher auditing, and for any cost of audit $c \in (c^*, c_1)$, offering wage incentives would be the dominant strategy. Thus for low cost of auditing reservation wages with high audit, for intermediate cost of auditing efficiency wages and for high cost of auditing capitulation wages would be the dominant wage strategy.

Which of these two scenarios (low or high x) is more likely depends on the level of dishonesty, that is, proportion of the corruptible agents, θ. The threshold $\hat{x} \equiv \theta[-2(1-\beta) + \sqrt{4(1-\beta)^2 + \beta^2}]$ that demarcates these two scenarios increases with θ. Thus higher the dishonesty is, higher will be $\hat{x}$, and more likely would be a scenario where efficiency wage strategy is dominated by other wages. This implies that the role of efficiency wages decreases in societies where the proportion of corruptible agents is higher. In these societies, wage incentive schemes would be very expensive and governments should opt either a sheer stick policy when monitoring is less expensive or a capitulation wage policy when monitoring is expensive.

VIII. CONCLUSION

We evaluate the common conviction that efficiency wage can be used as an incentive device to eliminate malfeasance in the government and its cost-effectiveness. Our focus remains on one branch of the government, that is, tax department, which may comprise corruptible tax inspectors who cause tax compliance problems. We explore for a budget balancing government that when it will launch anti-corruption strategy and would it be cost effective to offer wage incentives to combat corruption. Apart from efficiency wage, we add reservation wage (outside option) and capitulation wage (a wage less than outside option) in the basket of wage strategies for the government. We have an endogenous monitoring technology, which depends on government's audit intensity and the number of corrupt tax inspectors. Furthermore, we add the role of rule of law through the cost of laundering bribe income.

Endogenous monitoring technology implies that equilibrium level of corruption not only depends on public remuneration scheme but also on the level of audit intensity and the number of other corrupt tax inspectors. For wage incentives to be a viable anti-corruption strategy, it must be accompanied by a non-zero audit intensity. When government offers efficiency wages and capitulation wages, there is a unique equilibrium where all tax inspectors stay honest and all are corrupt, respectively. For reservation wages, the equilibrium depends on the monitoring technology. For a higher audit intensity, all tax inspectors stay honest, and for a lower audit intensity, all corruptible tax inspectors are corrupt. For the intermediate levels of audit intensity, there are multiple equilibria. Depending on the proportion of corrupt tax inspectors, corruptible tax inspectors can be corrupt or can stay honest.

Since auditing is costly and the effectiveness of monitoring depends on the number of other corrupt tax inspectors, there are situations where government is eventually better-off (in terms of revenues) giving up against corruption. Our results suggest that government is better-off either completely eliminating corruption or accepting corruption by offering wages lower than the market wage. This implies that offering tax inspectors a wage premium or even equal to private sector wage and not solving the moral hazard problem is sub optimal in terms of net revenues. Governments can increase their net revenues either by reducing government wages to a level below the outside option and not auditing tax inspectors or by raising audit intensity up to the level where no one has incentive to be corrupt. This suggests that Ukraine's wage strategy of capitulation wages seems optimal than those of for example Pakistan, India, or Latin America where there are public wage premiums but corruption levels are as high as those of Ukraine and tax to GDP ratio is low. When it is optimal to deter bribery, the government can do this either through incentive-based strategy (carrot/stick mix) or through monitoring. Which of these two is optimal depends on cost of auditing, level of dishonesty, tax base, and reservation wage. The role of efficiency wages decreases in societies with higher proportion of dishonest agents. In these societies, wage incentive schemes become prohibitively expensive and the government would opt for a monitoring-based anti-corruption strategy when auditing is less costly, and a capitulation wage policy when auditing is more expensive.

APPENDIX A

Proposition 1 corresponds to the equilibrium condition Equation (9). Given the optimal audit intensities, we can now deduce conditions such that there exists an equilibrium where all corruptible tax inspectors are corrupt, and where all corruptible tax inspectors are corrupt with probability θ. From Equation (9), the equilibrium where all corruptible tax inspectors are corrupt exists when the audit intensity is lower than the threshold $\underline{\sigma}$. Since σ^L decreases with c, there exists a $c' \equiv d\theta^2\left(1 - s + \sqrt{4sx + x^2}\right)$ such that $\sigma^L = \underline{\sigma}$. $\forall c > c' \Rightarrow \sigma^L < \underline{\sigma}$ and there exists an equilibrium where all corruptible tax inspectors are corrupt. Similarly the equilibrium where all corruptible tax inspectors are corrupt with probability θ exists for $\overline{\sigma} > \sigma^I \geq \underline{\sigma}$. σ^I decreases with c where as both $\overline{\sigma}$ and $\underline{\sigma}$ do not depend on c. There exists $\theta c' \equiv d\theta^3\left(1 - s + \sqrt{4sx + x^2}\right)$ such that $\overline{\sigma} = \sigma^I$, and $\forall c > c' \Rightarrow \overline{\sigma} > \sigma^I$. Similarly there exists $c'' = d\theta^3\left(1 - s - d\left(2s + x - \sqrt{4sx + x^2}\right)\right)$ such that $\sigma^I = \underline{\sigma}$, and $\forall c > c'' \Rightarrow \sigma^I > \underline{\sigma}$.

APPENDIX B

Since efficiency wage is $w^e = \max\{w, f(1;\sigma)\}$, for $\sigma = \overline{\sigma}$, $w = f(1;\sigma)$ and for any $\sigma < \overline{\sigma}$, $f(\sigma) > w$. Given the optimal audit σ^e, we can deduce a precise condition which demarcates w and $f(1;\sigma)$ in terms of size. Since σ^e decreases with c and $\overline{\sigma}$ does not depend on c, there exists a $c^* \equiv \left[\left(\left(4s^3 d\right) / \left(2s + x - \sqrt{4sx + x^2}\right)^2\right) - sd\right]$ such that for $c = c^*$, $\sigma^e = \overline{\sigma}$ and for any $c > c^*$, $\sigma^e < \overline{\sigma}$ implying that $f(1;\sigma) > w$.

APPENDIX C

We prove that there exists $x = \hat{x} \equiv -2s + \sqrt{4s^2 + \beta^2\theta^2}$, such that $c_1 = c^* = c_2$ and for any $x > \hat{x}$, $c_1 > c^* > c_2$.

Proof. $c_1 \geq c_2$

$$\frac{d\left((2s + x + \beta\theta)^2 - 4s^2\right)}{4s} \geq \frac{2sd\beta\theta}{2s + x - \sqrt{4sx + x^2}}.$$

$$4s^2 + 4sx + x^2 + 2x\beta\theta + 4s\beta\theta + \beta^2\theta^2 - 4s^2 \geq \frac{8s^2\beta\theta}{2s + x - \sqrt{4sx + x^2}}.$$

$$\left(2s + x - \sqrt{4sx + x^2}\right)\left(4sx + x^2 + 2x\beta\theta + 4s\beta\theta + \beta^2\theta^2\right) \geq 8s^2\beta\theta.$$

$$x \geq \hat{x} \equiv -2s + \sqrt{4s^2 + \beta^2\theta^2}.$$

Proof. $c^* \geq c_2$

$$\frac{4s^3 d}{\left(2s + x - \sqrt{4sx + x^2}\right)^2} - sd \geq \frac{2sd\beta\theta}{2s + x - \sqrt{4sx + x^2}}.$$

$$4s^2 - \left(2s + x - \sqrt{4sx + x^2}\right)^2 \geq 2\beta\theta\left(2s + x - \sqrt{4sx + x^2}\right).$$

$$4s^2 - \left(2s + x - \sqrt{4sx + x^2}\right)\left(2\beta\theta + 2s + x - \sqrt{4sx + x^2}\right) \geq 0.$$

$$x \geq \hat{x} \equiv -2s + \sqrt{4s^2 + \beta^2\theta^2}.$$

Proof. $c_1 \geq c^*$

$$\frac{d\left((2s + x + \beta\theta)^2 - 4s^2\right)}{4s} \geq \frac{4s^3 d}{\left(2s + x - \sqrt{4sx + x^2}\right)^2} - sd.$$

$$(2s + x + \beta\theta)^2 \geq \frac{16s^4}{\left(2s + x - \sqrt{4sx + x^2}\right)^2}.$$

$$(2s + x + \beta\theta)\left(2s + x - \sqrt{4sx + x^2}\right) \geq 4s^2.$$

$$x \geq \hat{x} \equiv -2s + \sqrt{4s^2 + \beta^2\theta^2}.$$

Hence for any $x > \hat{x}$, $c_1 > c^* > c_2$ and for any $x < \hat{x}$, $c_2 > c^* > c_1$.

APPENDIX D

From Equation (9), the equilibrium where all corruptible tax inspectors are corrupt exists when the audit intensity is lower than the threshold $\underline{\sigma}$. Since σ^L decreases with c, there exists a $c' \equiv d\theta^2\left(1 - s + \sqrt{4sx + x^2}\right)$ such that $\sigma^L = \underline{\sigma}$. $\forall c > c'$ $\sigma^L < \underline{\sigma}$ and there exists an equilibrium where all corruptible tax inspectors are corrupt. We have seen that capitulation wages and reservation wages generate same net revenues for any $c = c_3$, and for any $c > c_3$, capitulation wages generate higher net revenues. Thus when $c_3 \leq c'$, capitulation wages always generate higher net revenues than reservation wage with low audit, when comparing these two thresholds.

Proof. $c' \geq c_3$

$$d\theta^2\left(1 - s + \sqrt{4sx + x^2}\right) \geq d\theta^2\left(1 + s + x - 2\sqrt{(1-\beta)(\theta-\beta)}\right).$$

$$\sqrt{4sx + x^2} \geq 2s + x - 2\sqrt{(1-\beta)(\theta-\beta)}.$$

$$x\sqrt{(1-\beta)(\theta-\beta)} \geq s^2 - 2s\sqrt{(1-\beta)(\theta-\beta)} + (1-\beta)(\theta-\beta).$$

$$x \geq \widetilde{x} \equiv \frac{\left(s-\sqrt{(1-\beta)(\theta-\beta)}\right)^2}{\sqrt{(1-\beta)(\theta-\beta)}}.$$

Thus for any $x \geq \widetilde{x}$, $c' \geq c_3$ and capitulation wages will always generate higher net revenues than reservation wages with low audit. Whereas when $x < \widetilde{x}$, capitulation wage generates higher net revenues $\forall\, c > c_3$.

APPENDIX E

This proof is based on two pieces; first, reservation wages with low audit is either dominated by efficiency wages or by capitulation wages, and second, reservation with low audit generates higher net revenues than reservation wages with intermediate audit.

From our previous results, capitulation wages generate higher net revenues than reservation wages with low audit for any $c > c_3$ and higher than efficiency wages for any $c > c_1$. And when $c_1 > c_3$, reservation wages with low audit is dominated by efficiency wages $\forall\, c < c_3$, and by capitulation wages $\forall\, c \geq c_3$.

$$c_1 \geq c_3$$

$$\frac{d\left((2s+x+\beta\theta)^2-4s^2\right)}{4s} \geq d\theta^2 \times \left(1+s+x-2\sqrt{(1-\beta)(\theta-\beta)}\right).$$

$$xd + \frac{x^2+2\beta\theta x}{4s} + \frac{4s\beta\theta+\beta^2\theta^2}{4s} \geq \theta^2 \times \left(1+s-2\sqrt{(1-\beta)(\theta-\beta)}\right).$$

Since LHS increases with x and is minimum at $x=0$, whereas RHS does not depend on x thus, if above condition holds for $x=0$, it will always hold for any $x>0$. Consider now $x=0$

$$\frac{4s\beta\theta+\beta^2\theta^2}{4s} \geq \theta^2\left(1+s-2\sqrt{(1-\beta)(\theta-\beta)}\right).$$

By substituting in for $s=\theta(1-\beta)$ and simplifying it, we get

$$\frac{\beta^2}{1-\beta} + 8\theta\sqrt{(1-\beta)(\theta-\beta)} \geq 4(\theta-\beta) + 4\theta^2(1-\beta).$$

$$\frac{\beta^2}{1-\beta} \geq 4\left[(\theta-\beta)+\theta^2(1-\beta)-2\theta\sqrt{(1-\beta)(\theta-\beta)}\right].$$

This always holds for any $\theta > \beta$. Thus reservation wages with low audit is dominated by efficiency wages $\forall\, c < c_3$, and by capitulation wages $\forall\, c \geq c_3$.

Second, as we show below that with reservation wages net revenues with low audit are always greater than with intermediate audit (NR^I curve lies below NR^L curve in NR, c space) then if reservation with low audit is dominated by efficiency or capitulation wages, reservation wages with intermediate audit will also be dominated by them.

$$NR^L > NR^I$$

$$\tau\mu n\left(d-x+\frac{\left(d\theta^2(1+s+x)-c\right)^2}{4d^2\theta^2 s}\right) > \tau\mu n \times \left(d-x+\frac{\left(d\theta^3(1+s+x)-c\right)^2}{4d^2\theta^3 s}\right)$$

$$c(1-\theta) > 0.$$

This is always true for any $c>0$ and $\theta<1$.

APPENDIX F

LIST OF PARAMETERS

n = number of households
m = number of tax inspectors
$N = n + m$, total population
ε = labor endowment
μ = fraction of high income households
θ = proportion of corruptible agents in society
γ = proportion of corruptible tax inspectors
$\gamma\lambda$ = proportion of corrupt tax inspectors
τ = tax
b = bribe
β = cost of concealing bribe income
p = probability of being caught
σ = audit intensity
w = wage offered in private sector
w_g = wage offered by government
w^e = efficiency wage
w^c = capitulation wage
c = cost of audit
$x = \frac{w}{\tau\mu n}$, ratio of wage bill to tax base
$s = \theta(1-\beta)$
$d = 1-\theta^2$
$a = 1-\theta$

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