Corruption, Bribery, and Wait Times in the Public Allocation of Goods in Developing Countries[1]

by

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Abstract

What are the nexuses between corruption, bribery, and wait times in the public allocation of goods in developing countries? To the best of our knowledge, this question has received scant attention in the extant literature. Consequently, we use queuing theory to analyze models in which a good is allocated publically, first in a non-preemptive corruption regime and then in a preemptive corruption regime. Specifically, for both regimes, we calculate wait times for citizens who pay bribes and for those who don't. Second, we use these wait times to show that bribery is profitable for citizens with a high opportunity cost of time. Third, we show that high and low opportunity cost of time citizens will have dissimilar preferences as far as the corruption regime is concerned. Finally, we conclude with some across citizens and across corruption regimes observations about the value of preemption, the benefit from bribery, and a measure of resource misallocation in the economy.

Keywords: Bribery, Corruption, Queuing Theory, Uncertainty, Wait Time

JEL Codes: D80, H40, O12

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1. Introduction

Economists understand that whenever a principal delegates authority to one or more individuals, opportunities for corruption will arise. Even so, as Mookherjee and Png (1995) have noted, corruption and its impact are particularly severe problems in developing countries. For instance, 80% of the certified public accountants (CPAs) in Taiwan who were interviewed by Chu (1987) admitted to having bribed public tax officials. Smilarly, in India, the Policy Group (1985) estimated that 68% of taxpayers filing tax returns through CPAs had given bribes and that 76% of government tax auditors had taken bribes.[4] The reader will note that these examples all have to do with *enforcement* of one kind or another and today there is a literature on various aspects of enforcement related corruption.[5]

However, without diminishing the salience of enforcement related corruption, it is important to note that in many developing countries, there is a significant amount of corruption pertaining to the public allocation of goods. A key feature of these goods allocation processes is that they involve *queuing* by citizens. In other words, people have to wait in queue to obtain the good that is being allocated by the government. Examples include the distribution of subsidized food such as rice to consumers (see Gunawardana (2000) for a discussion of Sri Lanka), the supply of groundwater for

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4 Similar discussions of corruption in developing countries as diverse as Colombia, Kenya, and Pakistan can be found in Gilbert (1990), Southall (2000), and Afza (2000).

5 For more on this literature, see Alatas (1968), Basu *et al*. (1992), Besley and McLaren (1993), and Mookherjee and Png (1995).

irrigation by means of tubewells (see Wood (1999) for a discussion of the state of Bihar in India), and the provision of banking services (see Woldie (2003) for a discussion of Nigeria). In these and other examples in which citizens have to queue to obtain a publically allocated good, it is always possible—and this is in fact frequently the case—for a corrupt government official to provide service to citizens at different rates. Looked at from a different perspective, it is quite possible that individuals with a high opportunity cost of time will, *ceteris paribus*, be willing to pay a bribe to obtain service relatively speedily. In contrast, individuals with a low opportunity cost of time are more likely to not pay a bribe and wait longer in queue for service.

Despite the widespread existence of queuing in the public allocation of goods in developing countries, the nexuses between corruption, bribery, *and* wait times in the public allocation of goods have rarely been studied formally. In fact, to the best of our knowledge, the only paper that has studied corruption and bribery in the context of an explicit *queuing* model is Lui (1985).[6] In this interesting paper, Lui shows that it is not necessarily the case that government officials will deliberately cause delays in a queue to attract more bribes. To show this, Lui studies a Markovian queue.[7] In other words, in Lui's model, citizens enter the queue in accordance with a Poisson process and the service time is exponentially distributed. Although Lui does calculate the expected wait time of citizens in the queue, this is not the principal thrust of his paper.

We use a more general queuing model than Lui's to study the links between corruption,

6 There is a small literature—see Stahl and Alexeev (1985) and Polterovich (1993)—that has analyzed queuing models of resource allocation in the context of black markets in centrally planned economies. However, the reader should note that this literature has not studied the questions that we are analyzing in this paper.

7 Textbook accounts of Markovian queues can be found in Taylor and Karlin (1998, chapter 9) and in Ross (2003, chapter 8).

bribery, and wait times.[8] Further, unlike Lui (1985), the primary thrust of our paper is on the *differential* treatment by the government official (the server)[9] of citizens who pay bribes and those who do not. To formally model this differential treatment, we classify citizens into two types. Type I citizens are the high opportunity cost of time citizens and these citizens pay bribes to the server. In contrast, type II citizens are the low opportunity cost of time citizens and these citizens do not pay bribes. We analyze two corruption regimes: the non-preemptive regime and the preemptive regime.[10] As a result of the differential treatment of type I and II citizens by the server, these two types of citizens experience different average wait times in queue. A key objective of our paper is to formally derive, for both the corruption regimes, these dissimilar expected wait times for the two types of citizens.

The rest of this paper is organized as follows. Section 2 describes the theoretical framework of this paper in detail. Section 3 derives the expected wait times for the two types of citizens for the non-preemptive corruption regime. Section 4 does the same for the preemptive corruption regime. Section 5 uses the results of sections 3 and 4 and provides some across citizens and across corruption regimes observations about the value of preemption, the benefit from bribery, and a measure of resource misallocation in the economy. Section 6 concludes and discusses ways in which the research of this paper might be extended.

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8 Our model is more general than the Lui (1985) model because the service times in our model are arbitrarily and not exponentially distributed. In the language of queuing theory, Lui (1985) studied a M/M/1 queue and we are studying a M/G/1 queue. See Taylor and Karlin (1998, chapter 9) and Ross (2003, chapter 8) for more on this terminology.

9 In the rest of this paper, we shall use the terms "government official" and "server" interchangeably.

10 These two regimes are delineated fully in section 2 of the paper.

2. The Theoretical Framework

Consider a corrupt government official who is in charge of allocating a specific homogeneous good to the citizens of some developing country. To obtain one unit of this good, citizens must first join a queue and then wait in this queue until it is their turn to be served by this government official. Citizens wanting the good being allocated may be required to pay a uniform amount—for example subsidized rice in urban areas—or the good may be allocated free—for example water from a tubewell during a drought—by the server. This uniform payment, if it exists, will not affect the corruption/bribery/wait time trinity that we wish to analyze in this paper. Therefore, to focus attention on the bribery aspect of the problem, without loss of generality, we shall abstract away from this payment issue in the remainder of this paper.

Any citizen can obtain faster service by paying a bribe to the server. We assume that citizens are heterogeneous in the sense that they either have a high or a low opportunity cost of time. As indicated previously, citizens with a high opportunity cost of time are type I and citizens with a low opportunity cost of time are type II. We suppose that type I citizens pay a bribe to our server to obtain speedier service. In contrast, type II citizens do not pay a bribe and wait longer in queue to obtain service.

There are two kinds of corruption regimes: the non-preemptive regime and the preemptive regime. We consider the non-preemptive regime first. In this regime, type I and type II citizens arrive at the service facility in accordance with independent Poisson processes with rates β_I and β_{II}. It takes a random amount of time to provide service to type I and to type II citizens. Denote the cumulative distribution function of the random amount of time taken to provide service to type I and to type II citizens by $F_I(\cdot)$ and $F_{II}(\cdot)$ respectively. Because type I citizens pay bribes to our server, they are given service priority[11] over type II citizens in the following manner. Service never commences on a type II citizen if a type I citizen is waiting in queue. However, if a type II citizen is already being served and a type I citizen arrives, then the type II citizen continues to receive service until completion, i.e., until the good being allocated publically is received by this type II citizen. In other words, while type I citizens are given service priority, there is *no* preemption once service on a type II citizen has commenced. We can think of this non-preemptive regime as a comparatively weak corruption regime in the sense that although there is preference given to bribe paying citizens, the manner in which this preference affects the wait times of type II citizens is relatively innocuous.

The preemptive regime is rather different. In this case, if a type II citizen is being served when a type I citizen arrives then this type II citizen is knocked out of service. Put differently, the type II citizen's service is effectively preempted. We now have to say something about the status of a preempted or incompletely served type II citizen. In this paper, we suppose that when a preempted type II citizen goes back into service, his or her service commences at the point where it left off when (s)he was knocked out. Relative to the non-preemptive regime, this preemptive regime can be thought of as a strong corruption regime because the server's preference for type I citizens has a direct and strong impact on the wait times of type II citizens.

Type I citizens pay bribes to our server to ensure that they, the individuals with a high opportunity cost of time, do not spend a lot of time waiting in queue to get one unit of the good being publically allocated. The reader will note that the times spent waiting in queue are obviously *random* variables. Therefore, it makes sense to think in terms of the expected wait times for type I and type

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11 In the queuing theory literature, this sort of a queue is sometimes called a priority queue. For more on priority queues, the reader should consult Taylor and Karlin (1998, chapter 9) and Ross (2003, chapter 8).

II citizens. Let us denote the expected wait time of an arbitrary type I and arbitrary type II citizen by T_I^j and T_{II}^j, $j=N,P$, where N denotes no preemption and P denotes preemption. Now, if bribery is to be beneficial to type I citizens, then *a priori*, we would expect $T_I^j < T_{II}^j$ to hold for $j=N,P$. Does this inequality hold? To answer this and related questions, we now derive exact expressions for T_I^j and T_{II}^j, first for the non-preemptive corruption regime and then for the preemptive corruption regime.

3. Non-Preemptive Corruption Regime

3.1. Expected wait time for type I citizens

We begin by defining the concept of work. Following Ross (2003, p. 507), the work in a queuing system at any time t is defined to be the sum of all the remaining service times of all citizens in the system at time t. Let W denote the mean work in a queuing system. Then, from equation 8.42 in Ross (2003, p. 513), it follows that the mean work in our type I and type II priority queue is given by

$$W = \frac{\beta_I E[s_I^2] + \beta_{II} E[s_{II}^2]}{2\{1 - \beta_I E[s_I] - \beta_{II} E[s_{II}]\}}, \tag{1}$$

where $E[\cdot]$ is the expectation operator and the s_i, $i=I,II$, are random variables denoting the service times of our government official (the server). Now, having obtained an expression for the average work in our priority queue, let us compute W_i, the average type i work in our queuing system, $i=I,II$. Using equation 8.43 in Ross (2003, p. 513), we can deduce that

$$W_i = \frac{\beta_i E[s_i^2]}{2} + \beta_i E[s_i] T_i^N, \; i=I,II. \tag{2}$$

We now need to make two definitions. As such, let us define $\bar{W}_i = \beta_i E[s_i] T_i^N$ to be the mean amount of type i work in our queue.[12] In similar fashion, let us define $\hat{W}_i = \beta_i E[s_i^2]/2$ to be the mean amount of type i work in service. To derive T_I^N, the expected wait time in queue for a type I citizen, let us focus on an arbitrary type I citizen's arrival. This citizen's delay in the system is given by the sum of the amount of type I and the amounts of type II work in the system when (s)he arrives. Using this fact, the result that Poisson arrivals see time averages (PASTA),[13] and then taking expectations, we get $T_I^N = W_I + \hat{W}_{II}$. This last equation can be simplified by using equation (2) and the earlier definition of $\hat{W}_{II}$. This simplification gives us

$$T_I^N = \frac{\beta_I E[s_I^2] + \beta_{II} E[s_{II}^2]}{2(1 - \beta_I E[s_I])}. \tag{3}$$

Obviously, for T_I^N to be finite, the denominator of the fraction on the right hand side (RHS) of equation (3) must satisfy the condition $1 > \beta_I E[s_I]$. This completes our derivation of the expected wait time in queue for the bribe paying type I citizen. We now derive the expected wait time in queue for type II citizens who do not pay bribes to our government official.

3.2. Expected wait time for type II citizens

We begin by noting that $W = W_I + W_{II}$. Therefore, using equations (1), (2), and then simplifying, we get

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The reader should note that mean work in the system (W_i) and mean work in the queue $(\bar{W}_i)$ are dissimilar concepts because the system includes the person being served and the people in queue.

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This PASTA property is a well known result in the queuing theory literature. For more on this property, see Wolff (1989, chapter 2).

$$\frac{\beta_I E[s_I^2]+\beta_{II}E[s_{II}^2]}{2(1-\beta_I E[s_I]-\beta_{II}E[s_{II}])}=T_I^N+\beta_{II}E[s_{II}]T_{II}^N. \tag{4}$$

Now, using the expression for T_I^N from equation (3), we can rewrite equation (4). This procedure gives us

$$T_{II}^N=\frac{\beta_I E[s_I^2]+\beta_{II}E[s_{II}^2]}{2(1-\beta_I E[s_I])(1-\beta_I E[s_I]-\beta_{II}E[s_{II}])}. \tag{5}$$

As in section 3.1, once again we need a particular condition to hold to guarantee the finiteness of T_{II}^N. Inspecting the denominator of the fraction on the RHS of equation (5) we see that this condition is given by $1>\beta_I E[s_I]+\beta_{II}E[s_{II}]$. We now discuss the results that we have obtained thus far in sections 3.1 and 3.2.

3.3. Discussion

First, let us focus on the two finiteness conditions. The condition for T_I^N to be finite is that $1>\beta_I E[s_I]$ must hold. The noteworthy thing about this condition is that it is *independent* of the parameters of type II citizens. The reader will note that even though T_I^N, the average wait in queue for a bribe paying citizen, clearly depends on β_{II} and on s_{II} (see equation (3)), the finiteness of T_I^N does not depend on either β_{II} or on s_{II}.

The finiteness of T_{II}^N requires that $1>\beta_I E[s_I]+\beta_{II}E[s_{II}]$ hold. Observe that unlike the finiteness condition for T_I^N, this finiteness condition is *not* independent of the parameters of type I citizens. Now, to understand this T_{II}^N finiteness condition, note that the arrival rate of all type I and type II citizens can be expressed as $\beta=\beta_I+\beta_{II}$ and hence the mean arrival rate of all citizens is $(\beta_I+\beta_{II})/\beta$. In addition, the mean service time of a citizen is $(\beta_I/\beta)E[s_I]+(\beta_{II}/\beta)E[s_{II}]$. Therefore, the finiteness condition for T_{II}^N is simply telling us that the mean arrival rate of all citizens should be less than the mean service rate.

A key question before us now concerns the relative magnitude of the expected wait time in queue for both type I and type II citizens. Comparing equations (3) and (5) we see that the numerator of the fraction that characterizes the expected wait time in queue is the same for both type I and type II citizens. Therefore, we focus on the denominator. Now, using the finiteness condition for T_{II}^N and then comparing the two denominators, we see that $2(1-\beta_I E[s_I]) > 2(1-\beta_I E[s_I])(1-\beta_I E[s_I]-\beta_{II} E[s_{II}])$. This leads us to

PROPOSITION 1: In the non-preemptive corruption regime, citizens who bribe the server experience a lower average wait time in queue than do citizens who do not pay bribes.

Intuitively, we expect bribery to be beneficial to bribe payers. Proposition 1 tells us that this is indeed the case because the high opportunity cost of time or type I citizens end up spending, on average, less time waiting in queue than do the low opportunity cost of time or type II citizens. We now derive exact measures for the expected wait times for both types of citizens when the corruption regime is preemptive.

4. Preemptive Corruption Regime

4.1. Expected wait time for type I citizens

Recall that in this case, if a type II citizen is being served and a type I citizen arrives, then this type II citizen is knocked out of service. Further, when a preempted type II citizen goes back to the server, his or her service commences at the point where it left off when (s)he was knocked out.

As in section 3.1, it is helpful to begin the derivation by focusing on the concept of work. Now note that in this preemptive case, work decreases by one per unit time and then increases by the service time of an arrival even though this arrival may go into service directly. Since a preempted citizen's remaining service does not change when (s)he is preempted, the total work in the queuing system remains the *same* as for the non-preemptive regime analyzed in section 3.

To derive T_I^P, observe that as far as the bribe paying type I citizens are concerned, type II citizens do not exist. In fact, a type I citizen's delay depends only on other type I citizens in the system when (s)he arrives. From this it follows that $T_I^P = W_I$, the amount of type I work in the queuing system. Now, using the argument in the previous paragraph, we can see that in this preemptive regime, the W_I is the same as W_I in the non-preemptive regime (see equation (2)). Therefore

$$T_I^P = \beta_I E[s_I] T_I^P + \frac{\beta_I E[s_I^2]}{2}. \qquad (6)$$

Rearranging terms in equation (6), we get our required expression for T_I^P. That expression is

$$T_I^P = \frac{\beta_I E[s_I^2]}{2(1-\beta_I E[s_I])}. \qquad (7)$$

To ensure that T_I^P is finite, we require, as we did in section 3.1, that the condition $1>\beta_I E[s_I]$ be satisfied. This completes our derivation of the average wait time in queue for the bribe paying type I citizens. We now derive the average wait time in queue for type II citizens who do not pay bribes to our server.

4.2. Expected wait time for type II citizens

This derivation is a little involved and hence we shall proceed by means of four steps. First note that if a type II citizen arrives to find a preempted type II citizen in queue then it is clear that a type I citizen is being served. Now recall that the only difference between this regime and the non-preemptive regime is that in the non-preemptive regime, a knocked out type II citizen is served ahead of a type I citizen, both of whom go before the arrival. This tells us that the amount of work facing the arrival is the *same* in both regimes being studied in this paper. Mathematically, this means that $T_{II}^{P} = T_{II}^{N} + E[additional\ \ time]$, where the additional time refers to the extra time that arises as a result of the possibility of getting knocked out of service.

Second, when a type II citizen is preempted, (s)he does not return to service until all bribe paying type I citizens arriving during the first type I citizen's service have departed the queue, all further type I citizens who arrived during the additional type I service times have departed, and so on. Put differently, each time a type II citizen is preempted (s)he waits back in queue for one busy period in which a type I citizen is being served. Because type I citizens do not really see type II citizens, their busy period corresponds to the busy period of a $M/F_I/1$ queue[14] with mean $E[s_I]/(1-\beta_I E[s_I])$. So, given that a citizen is preempted N times, we have $E[additional\ \ time/N] = NE[s_I]/(1-\beta_I E[s_I])$.

Third, because citizens arrive to queue in accordance with a Poisson process, we can infer that $E[N/s_{II}] = \beta_I s_{II}$ and that $E[N] = \beta_I E[s_{II}]$. Using these two results and the results contained in the previous paragraph, we deduce that

$$E[additional\ \ time] = \frac{\beta_I E[s_I] E[s_{II}]}{1-\beta_I E[s_I]}. \qquad (8)$$

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This means that the arrival process is Markovian, the service times have a cumulative distribution function given by $F_I(\cdot)$, and there is a single server. Also see footnote 8 and the references cited in this footnote.

Finally, using equation (8) along with the finding that $T_{II}^{P}=T_{II}^{N}+E[additional\ \ time]$ enables us to obtain an explicit expression for T_{II}^{P}. That expression is

$$T_{II}^{P}=\frac{\beta_I E[s_I^2]+\beta_{II}E[s_{II}^2]+2\beta_I E[s_I]E[s_{II}](1-\beta_I E[s_I]-\beta_{II}E[s_{II}])}{2(1-\beta_I E[s_I])(1-\beta_I E[s_I]-\beta_{II}E[s_{II}])}. \qquad (9)$$

As in section 4.1, once again we need a specific condition to hold to ensure the finiteness of T_{II}^{P}. Examining the denominator of the fraction in equation (9) we see that this condition is given by $1>\beta_I E[s_I]+\beta_{II}E[s_{II}]$. We now discuss the economic meaning of the results we have obtained thus far in sections 4.1 and 4.2.

4.3. Discussion

The two finiteness conditions are $1>\beta_I E[s_I]$, for T_I^P to be finite, and $1>\beta_I E[s_I]+\beta_{II}E[s_{II}]$, for T_{II}^{P} to be finite. Since these two conditions are the same as the two finiteness conditions discussed in section 3.3, the interpretation of these two conditions is essentially the same as the interpretation given in section 3.3. However, we wish to make two points. First, similar to the non-preemptive regime studied in section 3.1, in the preemptive regime of section 4.1, the finiteness condition for T_I^P is, once again, *independent* of the parameters of type II citizens. Second, unlike the finiteness condition for T_I^P, the finiteness condition for T_{II}^{P} is *not* independent of the parameters of type I citizens.

What can we say about the relative magnitude of the expected wait time in queue for both type I and type II citizens in the preemptive corruption regime? To answer this question, note that equation (9) can be rewritten as

$$T_{II}^{P} = \frac{\beta_I E[s_I^2]}{2(1-\beta_I E[s_I])(1-\beta_I E[s_I]-\beta_{II} E[s_{II}])} + \frac{\beta_{II} E[s_{II}^2] + 2\beta_I E[s_I] E[s_{II}](1-\beta_I E[s_I]-\beta_{II} E[s_{II}])}{2(1-\beta_I E[s_I])(1-\beta_I E[s_I]-\beta_{II} E[s_{II}])}. \quad (10)$$

Now recall from section 3.3 that $2(1-\beta_I E[s_I]) > 2(1-\beta_I E[s_I])(1-\beta_I E[s_I]-\beta_{II} E[s_{II}])$. Next, compare equations (7) and (10). This comparison yields two conclusions. In particular, the first fraction on the RHS of equation (10) is bigger than the fraction describing T_I^P in equation (7). Further, the second fraction on the RHS of equation (10) is positive. Using these two pieces of information together, we are led to

PROPOSITION 2: In the preemptive regime, citizens who bribe the server experience a lower average wait time in queue than do citizens who do not pay bribes.

On an intuitive level, we expect bribery to be beneficial to bribe payers. Proposition 2 tells us that this is indeed the case because the high opportunity cost of time or type I citizens end up spending, on average, less time waiting in queue than do the low opportunity cost of time or type II citizens. We now offer some observations on bribery and corruption in light of the analysis in this paper.

5. Observations on Bribery and Corruption Regimes

Thus far, we have analyzed the average wait times of high and low opportunity cost citizens within a particular corruption regime. It is interesting to conduct such an exercise across the two corruption regimes. First, consider the case of the high opportunity cost of time or type I citizens. We want to compare T_I^N with T_I^P. The relevant equations of interest in this case are (3) and (7). A straightforward comparison of these two equations leads us to the following result.

PROPOSITION 3: For high opportunity cost of time citizens, $T_I^N > T_I^P$. In other words, for type I citizens, the average wait in queue until the good being allocated is received is longer (shorter) in the non-preemptive (preemptive) corruption regime.

In similar fashion, we now consider the case of the low opportunity cost of time or type II citizens. We want to compare T_{II}^{N} with T_{II}^{P}. The appropriate equations of interest in this case are (5) and (9). A direct comparison of these two equations gives us the ensuing result.

PROPOSITION 4: For low opportunity cost of time citizens, $T_{II}^{P} > T_{II}^{N}$. Put differently, for type II citizens, the mean wait in queue until the good being allocated is received is longer (shorter) in the preemptive (non-preemptive) corruption regime.

Given the existence of bribery in our stylized developing country, propositions 3 and 4 together tell us that type I and type II citizens will have dissimilar preferences about the kind of corruption regime that they would like to see in place. In particular, because $T_{I}^{N} > T_{I}^{P}$, high opportunity cost of time citizens will prefer a corruption regime with preemption. In contrast, since $T_{II}^{P} > T_{II}^{N}$, low opportunity cost of time citizens will prefer a corruption regime with no preemption. In this paper, we have studied bribery that is calculated to ensure differential and better treatment by the server in the allocation of the good in question. Given the above "dissimilar preference" result, in addition to this usual bribery, we can expect there to be some wasteful allocation of resources that is designed to increase the likelihood of obtaining one's preferred corruption regime.

In our model, ultimately the government official determines the kind of corruption regime that will be in place. Therefore, we can think of $(T_{I}^{N} - T_{I}^{P})$ and $(T_{II}^{P} - T_{II}^{N})$ as metrics of the value of preemption for each of our two types of citizens. The reader will note that these metrics are expressed in time units. Now, keeping propositions 3 and 4 in mind, if these metrics are small in magnitude then, from the standpoint of citizens, the choice between no preemption and preemption is not much of an issue. Obviously, the reverse reasoning applies if these metrics are large in magnitude.

For a given corruption regime, we can think of $(T_{II}^{N} - T_{I}^{N})$ and $(T_{II}^{P} - T_{I}^{P})$ as time unit measures of the benefit to bribery in our stylized developing country. If these measures are large in magnitude then this means that bribery is profitable and hence, *ceteris paribus,* we would expect bribery to be an ongoing problem. In contrast, if these measures are small then bribery will most likely be less of a social problem. Finally, the reader should note that if we think of bribe paying as wasteful activity in the sense that the resources used to pay bribes could have been used elsewhere in the economy, then we can think of $(T_{II}^{N} - T_{I}^{N})$ and $(T_{II}^{P} - T_{I}^{P})$ as time unit based measures of resource misallocation in the economy.

6. Conclusions

In this paper, we used a queuing-theoretic approach to analyze hitherto unstudied links between corruption, bribery, and wait times in the public allocation of goods in developing countries. We began by examining models in which one unit of a good is allocated publically, first in a non-preemptive corruption regime and then in a preemptive corruption regime. For both regimes, we computed expected wait times in queue for citizens who pay bribes and for those who don't. We then used these wait times to demonstrate that bribery is profitable for type I citizens with a high opportunity cost of time. Next, we pointed out that high and low opportunity cost of time citizens will have conflicting preferences as far as the corruption regime is concerned. Finally, we concluded with some across citizens and across regimes remarks about the value of preemption, the benefit from bribery, and a measure of resource misallocation in our stylized developing country.

The analysis of this paper can be extended in a number of different directions. In what follows, we suggest two possible extensions. First, we studied models with two types of citizens—those with high and those with low opportunity costs of time. An obvious way to extend the analysis in this paper would be to analyze models with *n* types of citizens where *n* is any positive integer. Second, in the queuing models that we studied in this paper, we said nothing about the optimal number of citizens—of either type—that should be permitted to queue. As such, it would be useful to analyze queuing models in which this issue is resolved endogenously. Studies that analyze these aspects of the problem will enhance our understanding of the nexuses between corruption, bribery, and wait times in the public allocation of goods in developing countries.

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