Much Ado about Nothing? Corruption in the Allocation of Wireless Spectrum in India*

Sandip Sukhtankar†
Dartmouth College

August 8, 2012

Abstract

Empirical work on corruption in developing countries suggests that it imposes large efficiency costs. Yet in theory the impact of corruption on firm performance and economic activity is ambiguous: for example corruption may "grease the wheels" of the economy by allowing firms to bypass inefficient regulations. This paper investigates empirically the effect of corruption on economic activity by examining how the corrupt sale of spectrum licenses to ineligible firms affected the wireless telecom market in India. Separating regions into those with a lot of corrupt licenses and those with fewer corrupt licenses, time periods into those before licenses were allocated and those after, and accounting for the potential bias from selection of corrupt firms into high potential growth areas using region-specific trends, I find that the corrupt allocation of licenses had precisely zero impact on the number of subscribers, prices, usage, revenues, or measures of quality. I argue that the resale of licenses to competent firms combined with fierce competition in the telecom sector may have mitigated the potential deleterious impact of corruption.

JEL codes: D45, D73, K42, L96, O10

Keywords: corruption, wireless telecom, 2G scam

*I thank Liz Cascio, Taryn Dinkelman, Paul Niehaus, Chris Snyder, and Doug Staiger for helpful discussions, seminar participants at Dartmouth and the University of Pennsylvania for comments, and Paulina Karpis, Josh Kornberg, Shotaro Nakamura, Medha Raj, and Kevin Wang for excellent research assistance.

†Department of Economics, Dartmouth College, 326 Rockefeller Hall, Hanover, NH 03755. sandip.sukhtankar@dartmouth.edu.

1 Introduction

Developing countries are characterized by corruption, as shown by much recent empirical work estimating the magnitude of bribes paid to government officials for bending or breaking rules as well as the embezzlement of funds from public programs.[1] The illicit nature of such corruption could prove distortionary, with political connections rather than efficiency the prime driver of economic activity (Murphy et al., 1993; Shleifer and Vishny, 1993). Olken and Pande (2012) argue that "the efficiency costs of corruption can be quite severe," citing empirical evidence of the deleterious impact of corruption on firm performance and economic activity.[2] However, in theory corruption could enhance efficiency: the idea that corruption "greases the wheels" of the economy by allowing firms to bypass inefficient regulations is quite old (Leff, 1964; Huntington, 1968). Alternatively, corruption could simply represent a transfer from the government to corrupt officials/firms and have no impact on economic activity; for example, bribery in the process for allocating licenses or permits may be efficient since the most efficient firms can pay the highest bribes (Lui, 1985). Understanding the context in which corruption occurs, therefore, may be key to determining the efficiency impacts of corruption.

This paper investigates empirically the effect of corruption on economic activity by examining how the sale of spectrum licenses to ineligible firms affected the wireless telecom market in India, and in doing so seeks to understand how context matters. In early 2008, the Department of Telecommunications allocated several new licenses to provide wireless telecom service along with wireless spectrum. Subsequent investigations by the Comptroller and Auditor General (CAG) and the Central Bureau of Investigation (CBI) revealed massive irregularities in the allocation process, with then Telecom Minister Andimuthu Raja sent to jail accused of receiving bribes of upto US $ 1 billion to award licenses to favored companies who otherwise would not have qualified for the licenses. The corruption scandal almost brought down the ruling United Progressive Alliance (UPA) government, and has dominated political discourse in India over the past two years.[3] While the licenses were recently rescinded - four years after being awarded - the interim period, especially prior to the widespread outbreak of the scandal in late 2010, provides a fruitful window in which to observe the impact of the corrupt allocation.

This incident of corruption provides an attractive context in which to test for effects

[1] On bribes see Olken and Barron (2009); Svensson (2003); Bertrand et al. (2007); Hunt (2007); on embezzlement see Olken (2006, 2007); Ferraz et al. (2010); Reinikka and Svensson (2004); Niehaus and Sukhtankar (2010), amongst others.

[2] See, for example, Djankov and Sequeira (2010); Fisman and Svensson (2007); Ferraz et al. (2010); Bertrand et al. (2007). In addition, a large literature using cross-country growth regressions (e.g. Mauro (1995)) finds a negative effect of corruption on growth, but these studies have well-known problems with omitted variables bias.

[3] The corruption was discovered as a result of tapped telephone conversations between a corporate lobbyist and the head of a telecom firm.

on economic activity and understand what determines the eventual impact. Corruption here maps well into the Shleifer and Vishny (1993) framework as it involved the "sale of government property for private gain" by a government official. We can test whether this sale was distortionary because inefficient firms received licenses due to their connections, productive because eligibility rules were keeping otherwise efficient firms from receiving them, or neutral. Moreover, the scale of corruption was massive (the most widely cited estimates of the loss to the government are around US$ 44.2 billion[4]), and involved an extremely important sector (telecom) in India's burgeoning economy (Kotwal et al., 2011); the added advantage is the fact that much information about the corrupt sales was revealed ex-post. Finally, since licenses are region-specific, there is variation across regions in the number of corruptly-awarded licenses, and the availability of detailed data across time allows for a simple difference-in-differences approach in testing the effect of corruption.

To determine the effect of these illicitly acquired licenses on the telecom market, I use data on wireless telephone subscribers, prices, revenues per user, as well as quality measures (for e.g. proportion of calls dropped) by operator and region, and aggregate these up to the region level. I use both CAG and CBI characterizations of whether a license was corruptly awarded: the former denotes whether a license was awarded to an ineligible company,[5] while the latter determines whether evidence of wrongdoing by the company has been uncovered. Separating regions into those with a lot of corrupt licenses and those with fewer corrupt licenses (or alternatively those with a greater proportion of corrupt licenses to new licenses awarded), and time periods into those before licenses were allocated and those after, I initially find that both the number of subscribers as well as the average revenues per subscriber are higher in the "more corrupt" areas after license allocation, perhaps suggesting that the corrupt licenses had a positive effect on telecom markets. On the other hand, prices per minute seem to be higher in these areas post allocation. However, it is very likely that more corrupt licenses were awarded in areas with greater potential for future growth and revenues. To account for this confound, I add region-specific time trends to the estimations; once we account for this potential bias, the corrupt allocation of licenses had almost precisely no effect on the number of wireless subscribers or revenues per user. Perhaps the region-specific trends may be conflated with dynamic effects of the allocation (Wolfers, 2006); however, figures 6 and 5 show that such effects, if any, are indistinguishable from zero. The results are robust to expanding the period of study, as well as alternative definitions of corruption and alternative empirical

[4]For comparison, India's total government spending in 2010-2011 was US$ 247.2 billion, see http://indiabudget.nic.in/ub2010-11/bh/bh1.pdf. All conversions are done at the exchange rate valid on the applicable date; for example if a figure refers to January 2008, I use an exchange rate of Rs 40 to the dollar, the average for the month as per www.oanda.com.

[5]A company could be ineligible for two major reasons: 1) on account of misrepresenting its core business and 2) because it did not have sufficient paid-up capital.

specifications.

This result is unsurprising upon noting that the firms that eventually obtained access to these licenses were not actually the firms that received the licenses in the first place. While licenses were initially awarded to firms whose ability to efficiently provide wireless service might have been doubtful (e.g. real estate companies, shell companies with no other physical or human capital), these licenses were subsequently bought – at substantial premia – by firms such as telecom giants Telenor (Norway) and Etisalat (UAE). Thus the insight of Coase (1960) is most applicable here, as the initial allocation of property rights did not matter. In addition, the existence of a number of large players and a competitive marketplace (costs of service and revenues per user have been steadily declining throughout this period) is likely to have mitigated any potential impact of corruption.

Note that this form of allocation did involve distributional consequences in the form of a substantial transfer of resources from the government to corrupt officials and companies; estimates using the premia that the final owners paid suggest that this loss was around US $ 11 billion.[6] Moreover, this paper examines a particular type of corruption, bribery in the sale of government licenses; other types of corruption could have other deleterious effects, for example the breakdown of trust, cronyism, etc, and in this case at least the counterfactual of an economy without any corruption is not possible.

Nonetheless, the results reflect previous debates over the impact of corrupt activity, for example that following the privatization of government enterprises in Russia. While it is generally accepted that the privatization was characterized by cronyism and "sweetheart deals", Shleifer and Treisman (2005) argue that the sold companies subsequently performed very well. More speculatively, such results can perhaps inform a seeming conundrum in the data: on the one hand both macro- (Mauro, 1995) and micro-economic (Olken and Pande, 2012) evidence suggests that efficiency costs of corruption may be high, yet corruption is highest in the fastest-growing middle income countries. While one way to resolve this conundrum is to argue that perhaps these countries would grow even faster in the absence of corruption, another possibility is that corruption is simply a way of doing business in these countries with weak judicial institutions,[7] and as long as markets are competitive corruption is unlikely to impede growth.

The rest of the paper is organized in a straightforward manner: section 2 presents information on the industry and the license allocation procedure, section 3 presents the data and empirical strategy, followed by the results in section 4. Section 5 concludes.

[6]These premia paid also point out the speciousness in the statement by new telecom Minister Kapil Sibal, who argued that selling the licenses at lower prices benefitted the consumer since companies will have passed on these lower prices for service.

[7]Perhaps this reality is best expressed by an official in Mexico: "if we put everyone who's corrupt in jail, who will close the door?" Aridjis (2012).

2 Background

The wireless telecom market in India is extremely large and lucrative, with 900 million subscribers as of January 2012 and a growth rate of 1.1% a month. Total revenues for GSM operators (70% of the market) in the second quarter of 2011 were approximately US $ 3.8 billion,[8] extrapolating to total annual revenues for the entire sector of US $ 22 billion. The fact that landline infrastructure is largely non-existent and declining further increases the importance of the wireless segment of the telecom sector for communications in India. In their review of India's economic liberalization and subsequent growth, Kotwal et al. (2011) suggest that communications technology facilitated a "quantum leap" in the growth of the service sector. It is difficult to overstate the importance of the wireless telecom sector in India: the country has amongst the cheapest, most accessible cell phone service in the world. India's absolute growth in number of subscribers in 2010 was *twice* that of the next closest country (China), with prices per minute of $0.007 over thirty times lower than the most expensive (Japan) (Telecom Regulatory Authority of India, 2012).

Fifteen companies currently provide cellular service, with at least 9 providing coverage nationwide and 3 others providing close to nationwide coverage.[9] Competition for subscribers is fierce, especially after the introduction of mobile number portability. Bharti-Airtel holds the largest market share with 19.6% as of February 2012, but there are 8 companies with a market share of between 5-20%. In comparison, the US has only 4 large nationwide providers combining for almost 95% of the market in 2011, with the two largest providers Verizon (36.5%) and AT&T (32.1%) reaching almost 70% by themselves (http://www.statista.com/statistics/219720/market-share-of-wireless-carriers-in-the-us-by-subscriptions).

The sector was not always this dynamic: prior to 1994, services were provided by a single nationalized monopoly provider, and were widely considered abysmal. After 1994, private providers were allowed to operate, but it was not until new policies (in 1999 and 2002) reduced restrictions on the number of providers that the wireless segment started its real growth path. By the end of 2006, the number of private service providers had expanded to 10, there were 150 million wireless subscribers in India, and growth was exponential.

Given the fast-paced growth, the telecom sector was viewed as an attractive investment opportunity, and a large number of firms wished to enter the market. To operate wireless service, firms need a license from the government, which entitles them to obtain spectrum. The licenses and spectrum are region-specific, spread over 22 regions (or "telecom circles")

[8] COAI data, available at `www.coai.in`.

[9] In descending order of market share, these companies are Bharti-Airtel, Reliance, Vodafone, Idea, BSNL, Tata, Aircel-Dishnet, Uninor, Sistema, Videocon, MTNL, Loop, Stel, HFCL and Etisalat.

across India.[10] In 2007, a process of new license and spectrum allocation was initiated by the Department of Telecommunications (DoT). Licenses awarded through this new process were incremental to existing ones and hence new firms had the opportunity to enter the market. Firms could apply for pan-India licenses, for licenses in particular regions, as well as for either CDMA or GSM spectrum. By October 2007, the DoT had received 575 applications for licenses from 46 companies; while the Telecom Regulatory Authority of India (TRAI) suggested that any applicant who satisfied certain eligibility criteria should receive a license, the amount of spectrum available for distribution was limited, and a rationing mechanism was necessary.

The ensuing process of license allocation led by the Telecom Minister Mr. A. Raja was severely criticized for its blatant arbitrariness and disregard for higher authority (including the Finance Ministry and the Prime Minister).[11] Instead of using an auction to limit the number of entrants and discover the market price of the spectrum, the licenses were sold at fixed June 2001 prices (in January 2008) with arbitrary rules – designed to favor firms connected to Mr. Raja – used to limit the number of licenses allotted. After not processing a number of applications for almost 2 years, on September 24, 2007, the DoT suddenly announced that October 1, 2007 would be the deadline for accepting applications. However, on January 10, 2008, the deadline was ex-post reset to September 25, 2007, allowing the DoT to rule out a number of applicants. Moreover, licenses and spectrum were meant to be allotted on a first-come-first-served basis given the limited availability of spectrum. However, on January 10 at 2:45pm the DoT posted an announcement saying that the current ordering only applied if payment was made between 3:30-4:30pm that day. Applicants were ordered to show up with bank guarantees worth millions of dollars in a matter of minutes; of course this was only possible for those parties who had prior intimation of this rule announcement. Eventually, 122 licenses were allotted to 17 companies across 22 regions; of these, the CAG determined that 85 were allotted to companies that were ineligible on accounting of either misrepresenting their core business or not having sufficient paid-up capital. The CBI has indicted the chairmen of companies that received 61 licenses. Links between these ineligible firms and Mr. Raja have been well documented (Comptroller & Auditor General of India, 2010; Patil, 2011; Times of India, 2010).

Table 1 presents the distribution of these licenses across the 22 telecom regions. The total number of new licenses awarded ranged from 4 in Mumbai and Rajasthan to 7 in

[10]There were previously 23 regions in India, with the metropolis of Chennai considered its own region like Delhi, Kolkata, and Mumbai; however by 2007 the city was absorbed into the region of Tamil Nadu.

[11]Mr. Raja is part of the DMK party, a key supporter of the Congress party-led United Progressive Alliance. With elections a year or so away, and his Congress party with insufficient seats in national parliament to form a government on its own, Prime Minister Manmohan Singh had little leverage over the Telecom Minister. Mr. Raja could thus ignore the Prime Minister's questions about equality and transparency in the spectrum allocation process.

Assam, Jammu & Kashmir, and the North-East region. Every region had at least one license awarded to an ineligible company, with some regions having up to five. I describe below how I categorize the regions into "high versus low corruption" areas. Finally, all licensees (except 3 in Delhi) were eventually allocated spectrum, although this did not necessarily happen immediately; in section 3 I show that the allocation of spectrum - which depended on whether the defense services were able to vacate the spectrum in a given area - was not any faster in more corrupt areas.

The upshot of the process was that all companies who received licenses received them at a substantial discount; a large number of companies received licenses who should not have given current regulations; and many of these companies jumped to the head of the queue for receiving spectrum. For example, Swan Telecom, a complete shell company with no assets or human capital or expertise, paid US $ 384 million for 13 licenses, but subsequently sold equity worth 50% for US $ 900 million. Extrapolating from this equity dilution, the CAG has calculated that the full set of licenses allocated should have been worth US $ 14.4 billion, as opposed to the US $ 3.1 billion actually received by the government. A rather more speculative value of US $ 44.2 billion, calculated by using amounts spent on the April 2010 auction of 3G licenses, has been widely reported in the Indian press and assumed to be the loss to the government.

Given the amounts involved, as well as the attempts by the government to sweep things under the carpet prior to the May 2009 elections, the ensuing scandal when news of the corruption broke out – only after tapped conversations between a corporate lobbyist and a telecom company chairman were leaked to the press – was massive. Coming as it did amongst a spate of other corruption scandals, such as corruption during the Commonwealth Games held in Delhi in 2010, the "2G scam" as it is known in India has dominated political discourse over the last 18 months or so. It spawned the growth of an anti-corruption movement, has already cost Mr. Raja's DMK party state elections in its home state of Tamil Nadu, and also led to losses suffered by the Congress and its UPA allies in state elections across India. Most recently, a Supreme Court order voided the entire license allocation process.(Singhvi and Ganguly, 2012) Amidst this furor, there has been some debate over whether the corrupt allocation has had deleterious effects on the industry at all. For example, the new Telecom Minister Kapil Sibal has suggested that selling licenses at fixed prices benefitted consumers because it led to lower prices for wireless service. Thus this is exactly the question I intend to examine, using data and empirical strategy described in the next section.

3 Data and empirical strategy

The empirical analysis is based on data from the Telecom Regulatory Authority of India (TRAI), the main regulatory body, as well as the Cellular Operators Association of India (COAI) and the Association of Unified Telecom Service Providers of India (AUSPI), industry associations of GSM and CDMA providers respectively. All data are available at the operator level by either month or quarter, and are aggregated to region-month or region-quarter depending on the frequency of reporting for the particular variable. The main outcome variables I consider are the number of subscribers, the average price per minute (including both origination and ongoing charges), the average number of call minutes per subscriber per month, average revenues per subscriber (or total revenues), and measures of service quality such as the proportion of dropped calls, the proportion of calls that connected on first attempt, a measure of voice quality, and the proportion of customer service calls answered within 60 seconds. The number of subscribers, price per minute, minutes used, and quality of service serve as proxies for consumer surplus, while revenues per subscriber proxy for operator performance. The subscriber data are available from 2001 onwards, quality, price, and usage data are available from 2004 onwards, while revenue data are only available from 2005 onwards and restricted to GSM operators.[12] The price and usage data are only available at a higher level of aggregation, with 4 circle "categories" across India. Given that the new 2G license allocation process started in 2007, while 3G spectrum was auctioned in April 2010, I restrict my analysis to the time period between these events (robustness tests expand this period). Table 2 presents summary statistics on these outcome variables, while more details on the compilation are available in the Data Appendix.

These data on the telecom industry are then combined with information on the license and spectrum allocation process from DoT, TRAI, CAG, CBI, as well as a special report compiled by an ex-Supreme Court Justice and commissioned by the Government. A DoT press release has the full list of licenses allotted, while the special report as well as TRAI documents lay out the exact dates on which spectrum was allocated along with amounts. The CAG report documents in detail how individual applicants were ineligible for licenses, either because they misrepresented their primary business – for example, real estate companies with no previous telecom experience received a large number of licenses – or because they did not have sufficient paid-up capital. Using the CAG's determination of whether a firm should not have received a license allows us to test whether current regulations were indeed too stringent, in case these firms did indeed improve efficiency.

[12]Note that subscriber data are available separately from TRAI and the industry associations, and match to a very high degree. Given security concerns around cellphones – they can be used to set off Improvised Explosive Devices (IEDs), for example – the last few years have seen strong efforts in tracking subscriber and usage data, hence the quality of these data is perceived to be very good.

However, it is possible that all ineligible firms were not necessarily "corrupt", in that they did not actually pay major bribes to receive their licences. Fortunately, we can use CBI investigations to determine this corruption: these investigations have revealed the links between some of these ineligible applicants and the Telecom Minister Mr. Raja, following the money trail of illicit payments to a cable television channel in South India (Comptroller & Auditor General of India, 2010; Patil, 2011; Times of India, 2010). While 2 firms receiving 27 licenses were deemed ineligible but were not indicted by the CBI, 1 firm receiving 3 licenses was not considered ineligible but was indeed indicted. Hence I present results below using both CAG and CBI definitions of illegality.

I use these designations of corruptly awarded licenses to determine which regions were "more" versus "less" corrupt. As Table 1 shows, every region has at least 1 firm that received a license illegitimately. The number of illegally obtained licenses varies from 2 in Himachal Pradesh to 5 in Bihar, depending on the CAG or CBI definition of illegality. There is more variation when the proportion, rather than the raw number, of new licenses that were corruptly awarded is considered: between between 0.57 to 1 for companies determined ineligible by the CAG, and between 0.33 to 0.75 for companies with officials indicted by the CBI. Hence I categorize more versus less corrupt regions by the number of corruptly awarded licenses, and also by directly using the proportion of corruptly awarded new licenses, and present results for the two types of corrupt categories separately.[13]

Why do some regions have more corruptly awarded licenses than others? The availability of spectrum in a region of course determines the total number of licenses awarded, while these regions likely also vary in terms of their potential for revenues and revenue growth. Firms are more likely to try and pay bribes to obtain licenses in these attractive regions. The empirical strategy below explains how I account for this potential source of endogeneity.

Separating regions into those with a lot of corrupt licenses (indicated by $Corrupt$) and those with fewer, and time periods into those before licenses were allocated and those after (indicated by $Post$), I estimate the following simple regression:

$$Y_{st} = \alpha + \beta(Post * Corrupt)_{st} + \sum_t Time_t + \sum_s Region_s + \epsilon_{st} \tag{3.1}$$

where Y_{st} corresponds to the number of subscribers, revenues per subscriber, or quality outcomes, and indicators for time periods (either months or quarters) and region serve as controls. I cluster standard errors along two dimensions (region and time) using the multi-way clustering approach suggested by Cameron, Gelbach and Miller (2011) and

[13] Other ways to categorize regions could include the proportion of corrupt new licenses to existing licenses, or the proportion of corrupt new licenses to total licenses. These categorizations are done as robustness tests, and make no difference to the results.

Thompson (2011).

One possible confound is that corrupt areas may simply have received spectrum earlier. To check for this, I adapt a procedure first used by Griliches (1957) to estimate the speed of diffusion of hybrid corn and further adapted by and described in Skinner and Staiger (2007). The idea is to run a logistic estimation of the form:

$$ln(P_{st}/(K_s - P_{st}) = \alpha + \beta Corrupt_s + \delta Time_t + \gamma(Time * Corrupt) \tag{3.2}$$

where P_{st} is the (cumulative) fraction of allocated spectrum received by time t in region s, K_s is the maximum fraction of allotted spectrum received, $Corrupt_s$ indicates a state with a lot of corrupt licenses and reveals the difference in time to first obtaining spectrum, $Time_t$ is a time trend, and the interaction γ tells us whether more corrupt receive their allocations faster. In this case since K_s is 1 for every state, and the initial fraction of allotted spectrum is 0, I cannot simply run a logistic estimation and instead use generalized least squares with a logistic link. Table 3 suggests that corrupt areas are not likely to receive spectrum any faster, neither was the date of first spectrum release any faster. To be conservative, however, I also control for the amount of spectrum currently allocated in the region $(AmtSpectrum)_{st}$:

$$Y_{st} = \alpha + \beta(Post * Corrupt)_{st} + \gamma(AmtSpectrum)_{st} + \sum_t Time_t + \sum_s Region_s + \epsilon_{st} \tag{3.3}$$

A bigger potential problem is that it is very likely that more corrupt licenses were awarded in areas with greater potential for future growth. For example, a graph of the time trend in subscribers already shows a divergence between corrupt and less corrupt regions prior to the license allocation process (figures 3, 4, **??**, **??**, 1, and 2.). This is also true for log subscribers, prices, revenues, and revenues per user - with more corrupt areas growing faster or declining less slowly than less corrupt areas - but not in general true for the quality variables. To account for this confound, I add region-specific time trends as a control:

$$\begin{aligned} Y_{st} = {} & \alpha + \beta(Post * Corrupt)_{st} + \gamma(AmtSpectrum)_{st} \\ & + \sum_t Time_t + \sum_s Region_s + \sum_s Region_s * Time_t + \epsilon_{st} \end{aligned} \tag{3.4}$$

Note that this estimation might conflate any dynamic effects of the license allocation with the region-specific time trends (Wolfers, 2006). To separate out these effects, I include indicators for time periods in the post period in corrupt areas, and run the following estimation:

$$Y_{st} = \alpha + \gamma(AmtSpectrum)_{st} + \sum_{k\geq 1} \beta_k K \text{ periods after allocation in corrupt areas}_{st} \quad (3.5)$$
$$+ \sum_t Time_t + \sum_s Region_s + \sum_s Region_s * Time_t + \epsilon_{st}$$

The coefficients β_k are presented in figures 5 and 6.

4 Results

A first glance at Table 4 suggests that the corrupt sale of licenses had a significant positive effect on the number of wireless telephone subscribers, to the order of 3.5-5 million extra subscribers (or 24-33% of the mean number per region) in the more corrupt regions after the license allocation (Panel A, columns 5 and 8). These results also seem to be true if the proportion of new licenses received illegally in each region is considered rather than a simple categorization into more versus less corrupt regions (columns 2, 5, and 8). However, when region-specific linear time trends are introduced into the regressions, the coefficient drops dramatically, and even turns negative and marginally statistically significant in some cases (columns 3, 6 and 9). This latter result does not hold when the dynamics of the post-allocation period are taken into account: figures 5a and 6a suggest that the difference between more and less corrupt regions was a precisely estimated zero (standard errors on the order of 200,000 or less than 2% of the standard deviation) at least for the first year after the license allocations.

Given that the average numbers of subscribers in corrupt versus less corrupt areas was quite different prior to the allocation of licenses, difference-in-differences estimations will be sensitive to the functional form. Indeed, when the outcome is log subscribers rather than subscribers, corrupt areas do not appear to be significantly different than less corrupt areas post allocation even without the region-specific time trends (Table 5; columns 2, 5, and 8). When region-specific time trends are included in the estimations, the coefficients again drop dramatically to very close to zero.

These results are repeated almost precisely for the case of revenues and average revenues per user. Revenues and average revenues per user might be interpreted as an indicator of profitability of firms in the region. These outcomes are only available for GSM providers, so the results must be interpreted with caution. Moreover, the data are only available on a quarterly basis, so the results are somewhat less precise. Nonetheless, Tables 6 and 7 show that without the region-specific trends more corrupt regions seem to have significantly increased revenues after the allocation, with increases of over 25% seen in Panel A, columns 5 and 8. Adding the region-specific trends results in a drop in the magnitude of the coefficients and reduces statistically significance below generally accepted levels in most cases. The two remaining significant results again disappear when the dynamics of the post-period are taken into account (Figure 6). In fact, a glance at the raw revenues per user data in Figure 3d shows that these are precisely the type of dynamics – a downward trend that then reverses course – that would lead to a spurious positive result on the difference-in-difference indicator with the inclusion of region-specific trends (Wolfers, 2006). Given the reduced number of observations and the lack of data on all firms, these results cannot be bounded with the same precision as those on the number of subscribers.

The corrupt license allocation also does not seem to have affected consumers. Prices paid per minute follow a similar pattern as the subscriber and revenue data shown above, despite the aggregation of data at a higher level (to categories of regions). Without the region-specific trends, prices seem to be higher in more corrupt areas after the allocation, possibly because corrupt firms targeted regions with high and slowly declining prices to begin with. However, with region-specific trends the coefficients drop in magnitude and are no longer statistically significant. Minutes used per subscriber suggest the same story, detailed in Table 9Ḟinally, data on the quality of service provided, such as the proportion of calls dropped or TRAI measures of average voice quality, suggest that more corrupt areas were again similar to less corrupt areas after the license allocation. As Figures 1, 2, 3 and 4 suggest, these outcomes are fairly noisy, and there don't appear to be any easily discernible trends (hence estimations with region-specific trends are not shown here (available on request). Table 8 confirms this interpretation, as there are no significant differences across corrupt and less corrupt areas.

Overall, the estimations suggest that the corrupt allocation had no measurable impact on activity in wireless telecom markets, which runs counter to much of the macro- and micro-economic evidence on the impact of corruption. What might explain this discord? One possibility is that in an environment where corruption is the norm, perhaps the intensity of corruption may not matter, an interpretation that I cannot rule out. Nonetheless, in this case at least it appears that the reason the corruption did not have any impact is that the licenses were sold on to competent firms who eventually provided wireless services. Instead of the government conducting an auction where the highest bidders – likely to be the most efficient firms – won, the auction was conducted by firms who illegitimately received the licenses. (Of course, this secondary auction involved a large loss for the government – about US$ 11 billion by reasonable accounts.) For example, the shell company Swan sold off its licenses to the UAE telecom giant Etisalat. Licenses held by a group of real estate companies (Allianz and Unitech) were eventually purchased by the Norwegian firm Telenor. An additional factor is likely to be the degree of competitiveness in the wireless telecom market, which may have forced these new entrants to provide services efficiently. In the absence of variation in competitiveness, however, these explanations remain merely speculative.

5 Conclusion

A large number of empirical studies have catalogued the extent of corruption in developing countries. Theoretical predictions regarding the potential impact of this corruption on economic activity are ambiguous, with both positive and negative effects possible. A smaller number of macro- and micro-economic analyses estimate the impact of corruption on the economy. While these studies generally find that corruption has a number of negative impacts, a potential discordant note is struck by the coexistence of widespread corruption and fast growth in many middle-income economies.

This paper investigates the impact of the corrupt allocation of wireless licenses and spectrum on activity in the cellular telecom market in India. I find that although many firms received licenses who had no prior experience providing wireless services, this had no measurable impact on the number of wireless subscribers, revenues, prices, usage, or measures of quality. This result is not surprising once we note that the licenses were sold on to other firms better equipped to provide these services. The presence of existing large players and competitive markets may also have played a role in this situation. Thus the initial allocation of property rights did not matter, although the Indian government suffered a massive revenue loss.

References

Aridjis, Homero, "The Sun, the Moon, and Walmart," *New York Times*, April 30 2012.

Bertrand, Marianne, Simeon Djankov, Rema Hanna, and Sendhil Mullainathan, "Obtaining a Driver's License in India: An Experimental Approach to Studying Corruption," *The Quarterly Journal of Economics*, November 2007, *122* (4), 1639–1676.

Cameron, Colin, Jonah Gelbach, and Doug Miller, "Robust Inference with Multi-Way Clustering," *Journal of Business and Economic Statistics*, 2011, *29* (2), 238–249.

Coase, Ronald, "The Problem of Social Cost," *Journal Law and Economics*, 1960, *3*, 1–44.

Comptroller & Auditor General of India, "Issue of Licenses and Allocation of 2G Spectrum," Performance Audit Report 19, Union Government of India 2010.

Djankov, Simeon and Sandra Sequeira, "An Empirical Study of Corruption in Ports," mimeo, LSE 2010.

Ferraz, Claudio, Frederico Finan, and Diana Moreira, "Corrupting Learning: Evidence from Missing Federal Education Funds in Brazil," Technical Report, UC Berkeley April 2010.

Fisman, Raymond and Jakob Svensson, "Are Corruption and Taxation Really Harmful to Growth? Firm Level Evidence," *Journal of Development Economics*, May 2007, *83* (1), 63–75.

Griliches, Zvi, "Hybrid Corn: An Exploration in the Economics of Technological Change," *Econometrica*, October 1957, *25*, 501–22.

Hunt, Jennifer, "How Corruption Hits People When they are Down," *Journal of Development Economics*, November 2007, *84* (2), 574–589.

Huntington, Samuel, "Modernisation and Corruption," in "Political Order in Changing Societies," New Haven: Yale University Press, 1968.

Kotwal, Ashok, Bharat Ramaswami, and Wilima Wadhwa, "Economic Liberalization and Indian Economic Growth: What's the Evidence?," *Journal of Economic Literature*, 2011, *49* (4), 1152–99.

Leff, Nathaniel, "Economic Development through Bureaucratic Corruption," *American Behavioural Scientist*, 1964, *8*, 8–14.

Lui, Francis, "An Equilibrium Queuing Model of Bribery," *Journal of Political Economy*, 1985, *93* (4), 760–81.

Mauro, Paolo, "Corruption and Growth," *The Quarterly Journal of Economics*, August 1995, *110* (3), 681–712.

Murphy, Kevin M, Andrei Shleifer, and Robert W Vishny, "Why Is Rent-Seeking So Costly to Growth?," *American Economic Review*, May 1993, *83* (2), 409–14.

Niehaus, Paul and Sandip Sukhtankar, "Corruption Dynamics: the Golden Goose Effect," Technical Report, UCSD February 2010.

Olken, Benjamin A., "Corruption and the Costs of Redistribution: Micro Evidence from Indonesia," *Journal of Public Economics*, May 2006, *90* (4-5), 853–870.

_ , "Monitoring Corruption: Evidence from a Field Experiment in Indonesia," *Journal of Political Economy*, April 2007, *115* (2), 200–249.

_ **and Patrick Barron**, "The Simple Economics of Extortion: Evidence from Trucking in Aceh," *Journal of Political Economy*, 06 2009, *117* (3), 417–452.

_ **and Rohini Pande**, "Corruption in Developing Countries," *Annual Review of Economics*, 2012, *4* (1).

Patil, Justice Shivaraj V., "Examination of Appropriateness of Procedures Followed by Department of Telecommunications in Issuance of Licenses and Allocation of Spectrum During the Period 2001-2009," Report, Supreme Court of India 2011.

Reinikka, Ritva and Jakob Svensson, "Local Capture: Evidence From a Central Government Transfer Program in Uganda," *The Quarterly Journal of Economics*, May 2004, *119* (2), 678–704.

Shleifer, Andrei and Daniel Treisman, "A Normal Country: Russia After Communism," *Journal of Economic Perspectives*, 2005, *19* (1), 151–174.

_ **and Robert W Vishny**, "Corruption," *The Quarterly Journal of Economics*, August 1993, *108* (3), 599–617.

Singhvi, G.S. and Asok Kumar Ganguly, "Judgment on Writ Petitions No 423 of 2010 and 10 of 2011," Judgment, Supreme Court of India 2012.

Skinner, Jonathan and Douglas Staiger, "Technology Adoption from Hybrid Corn to Beta-Blockers," in "Hard-to-Measure Goods and Services: Essays in Honor of Zvi Griliches," University of Chicago Press and NBER, 2007.

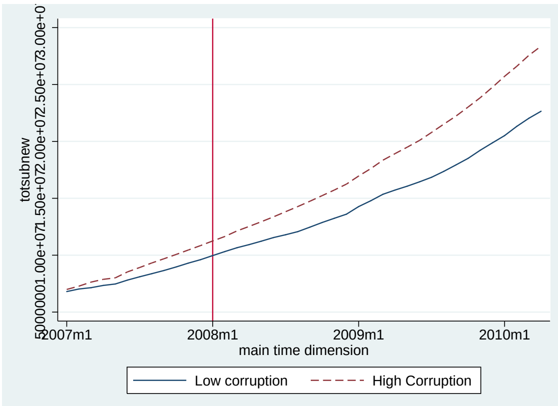
Svensson, Jakob, "Who Must Pay Bribes And How Much? Evidence From A Cross Section Of Firms," *The Quarterly Journal of Economics*, February 2003, *118* (1), 207–230.

Telecom Regulatory Authority of India, "Telecommunications in Select Countries Policies - Statistics," Report, Telecom Regulatory Authority of India 2012.

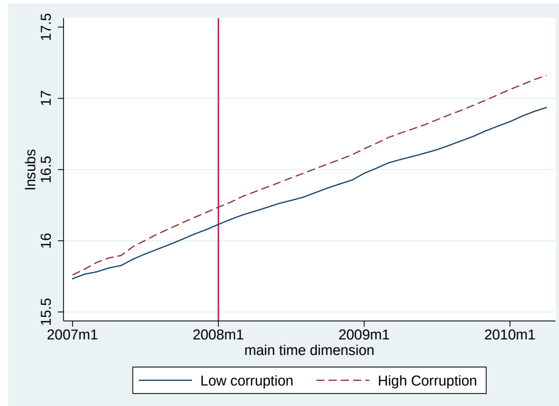
Thompson, Samuel B., "Simple formulas for standard errors that cluster by both firm and time," *Journal of Financial Economics*, January 2011, *99* (1), 1–10.

Times of India, "After CBI Raids, Companies Linked to Raja Put up a Brave Front," December 18 2010.

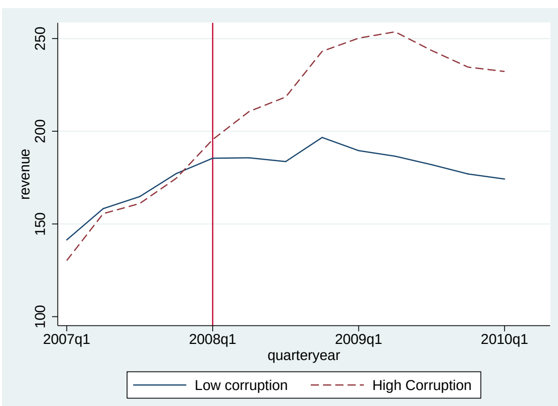
Wolfers, Justin, "Did Unilateral Divorce Laws Raise Divorce Rates? A Reconciliation and New Results," *American Economic Review*, December 2006, *96* (5), 1802–20.



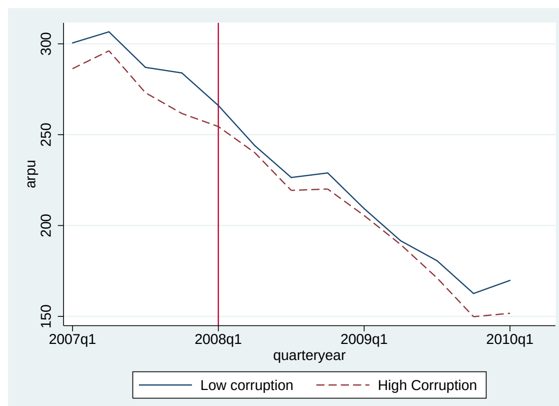
(a) Subscribers



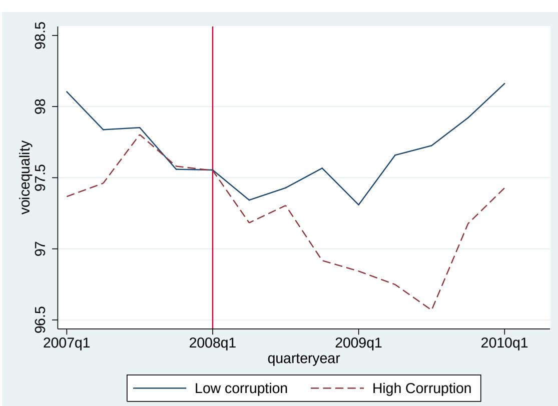
(b) Log Subscribers



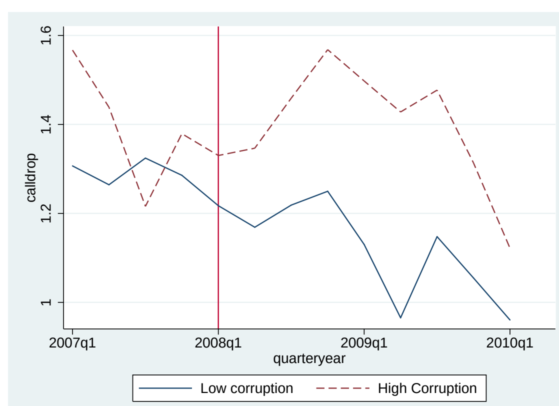
(c) Revenues (Rs 10 Million)



(d) Revenues per User (Rs)

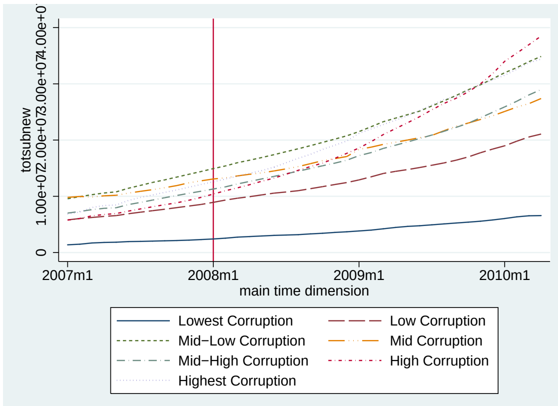


(e) Voice Quality (0-100)

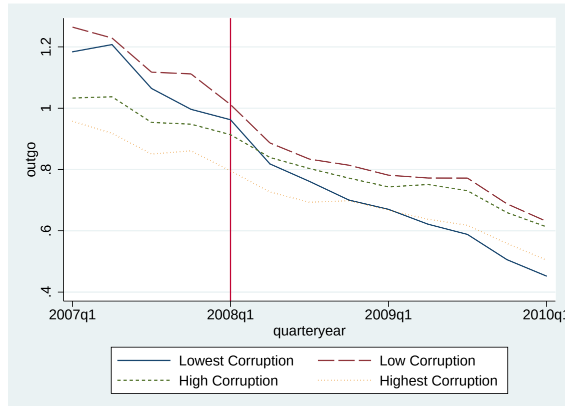


(f) Percent Calls Dropped

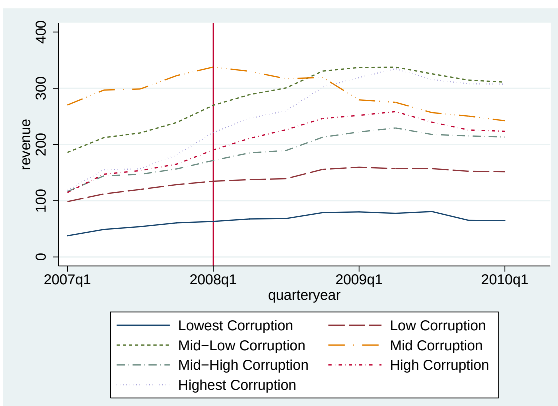
Figure 1: Outcomes over Time in More Corrupt (More Licenses to Firms deemed Ineligible by CAG)/Less Corrupt Areas



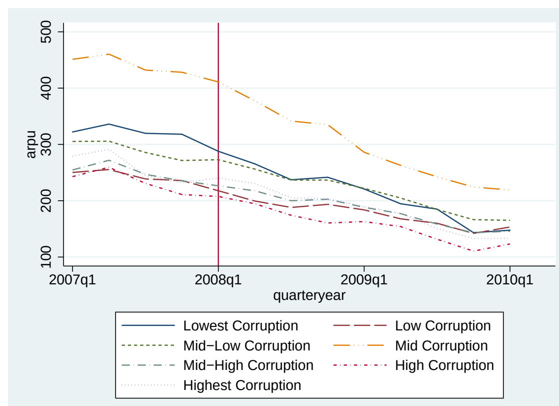
(a) Subscribers



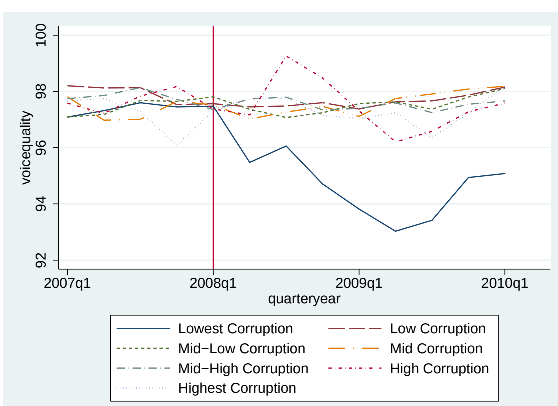
(b) Prices



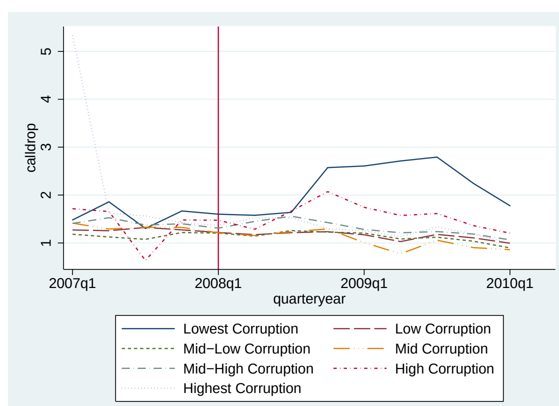
(c) Revenues (Rs 10 Million)



(d) Revenues per User (Rs)

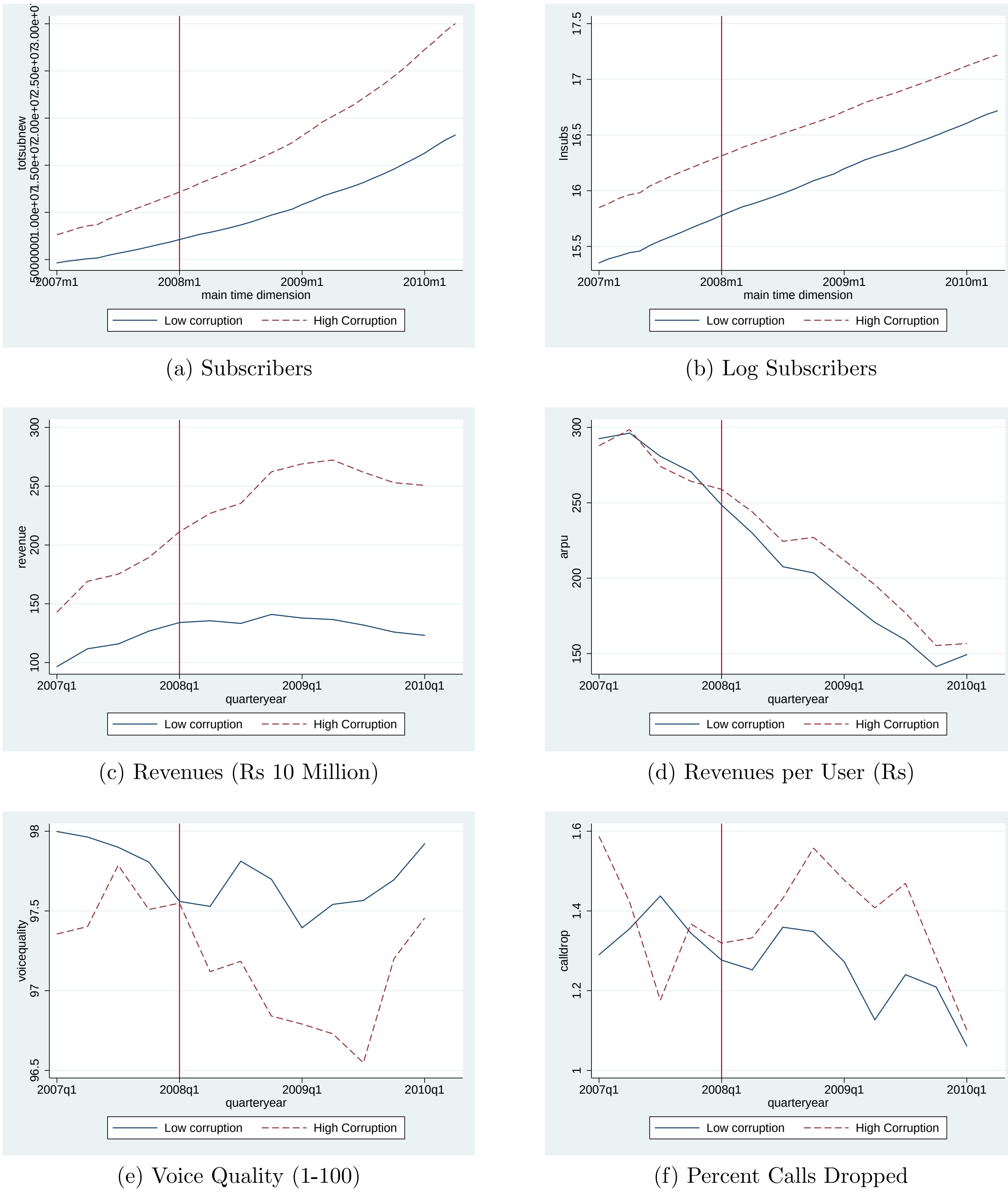


(e) Voice Quality (0-100)



(f) Percent Calls Dropped

Figure 2: Outcomes over Time in Areas by Degree of Corruption (Proportion of Licenses to Firms deemed Ineligible by CAG)



(a) Subscribers

(b) Log Subscribers

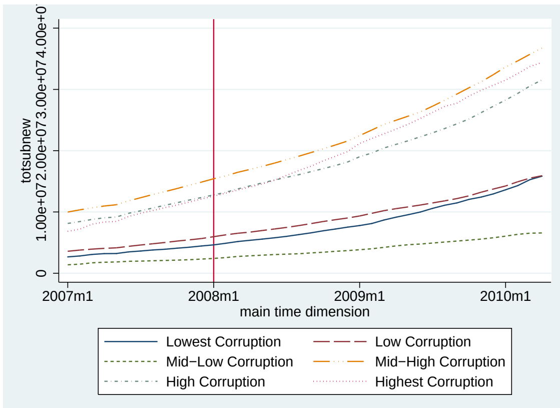
(c) Revenues (Rs 10 Million)

(d) Revenues per User (Rs)

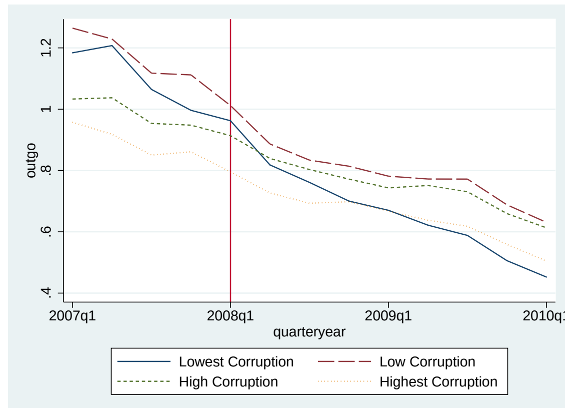
(e) Voice Quality (1-100)

(f) Percent Calls Dropped

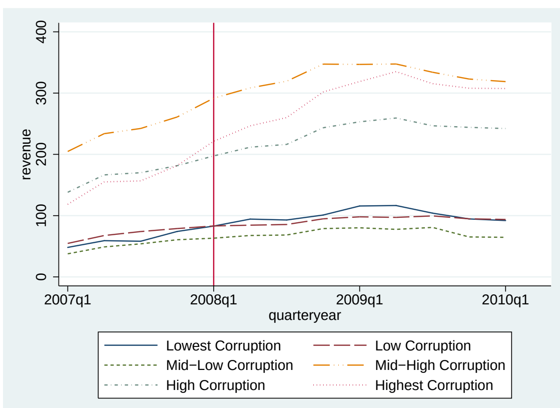
Figure 3: Outcomes over Time in More Corrupt (More Licenses to CBI Indicted Firms)/Less Corrupt Areas



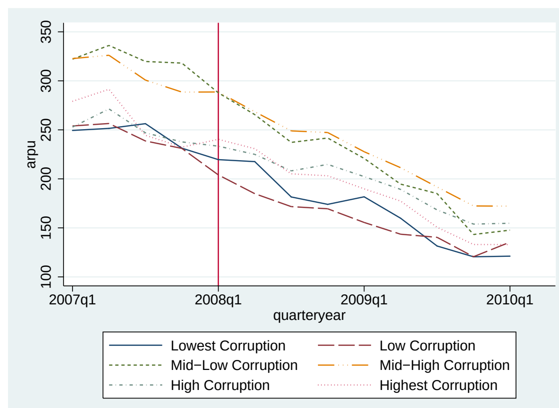
(a) Subscribers



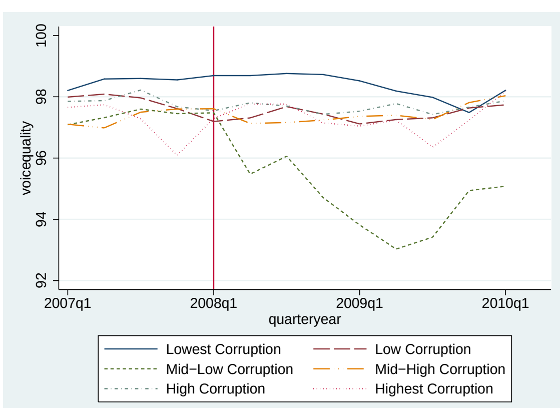
(b) Prices



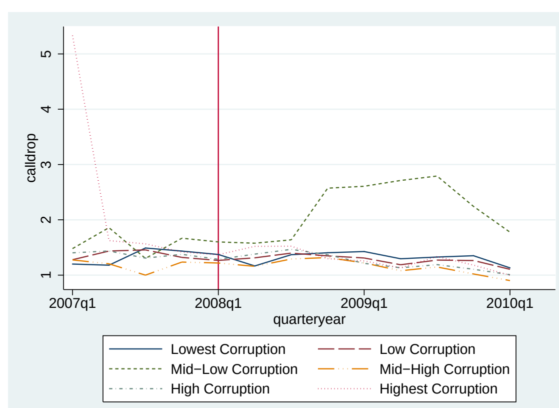
(c) Revenues (Rs 10 Million)



(d) Revenues per User (Rs)

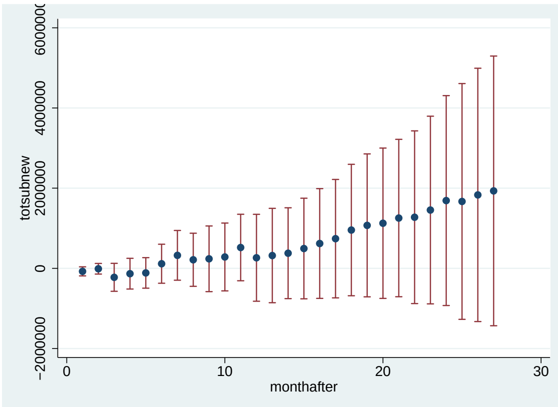


(e) Voice Quality (1-100)

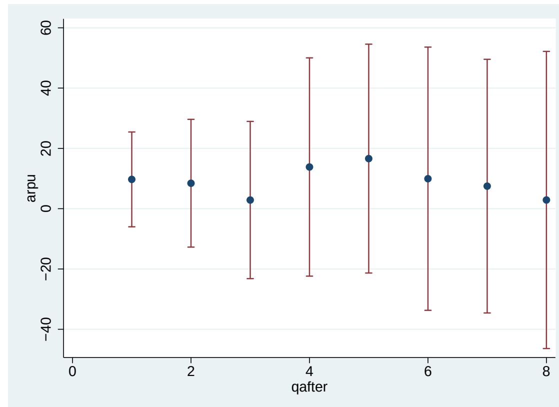


(f) Percent Calls Dropped

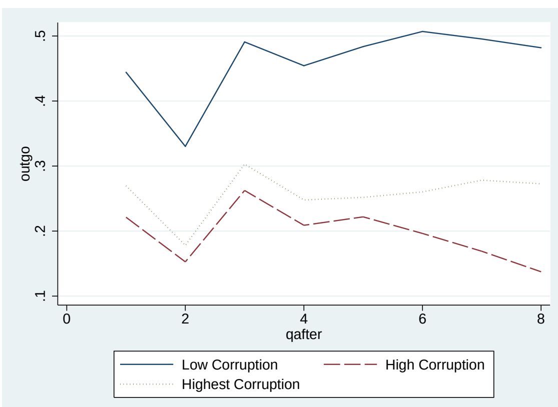
Figure 4: Outcomes over Time in Areas by Degree of Corruption (Proportion of Licenses to CBI Indicted Firms)



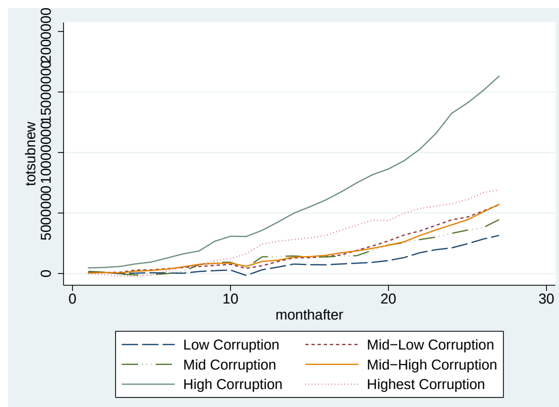
(a) Subscribers



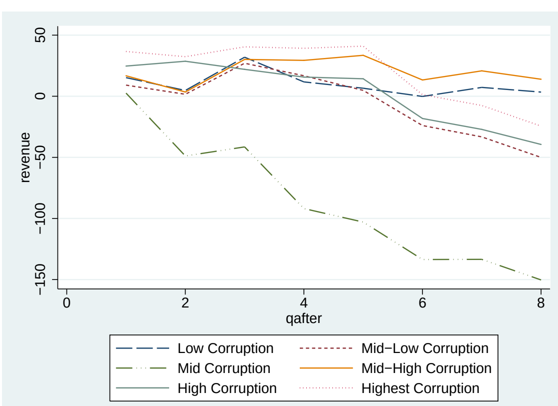
(b) Revenues per User (Rs)



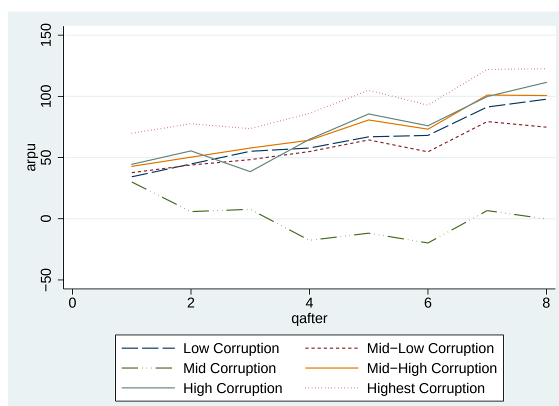
(c) Prices (Rs/minute)



(d) Subscribers



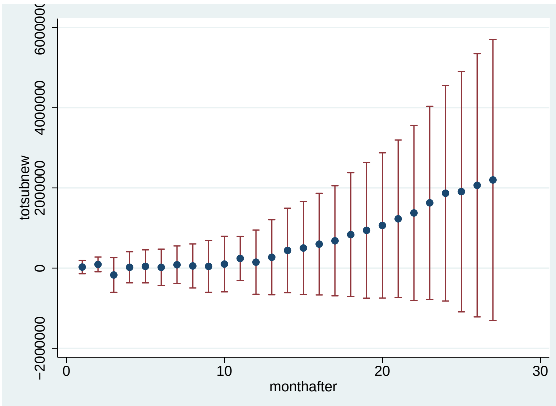
(e) Revenues (Rs 10 Million)



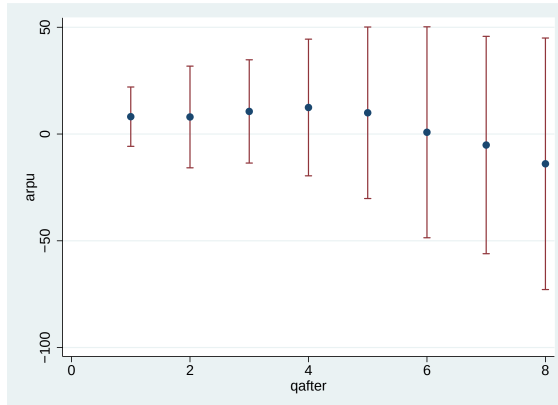
(f) Revenues per User (Rs)

Figure 5: Dynamics of Post Period in Corrupt Areas (CAG deemed Ineligible Firms)

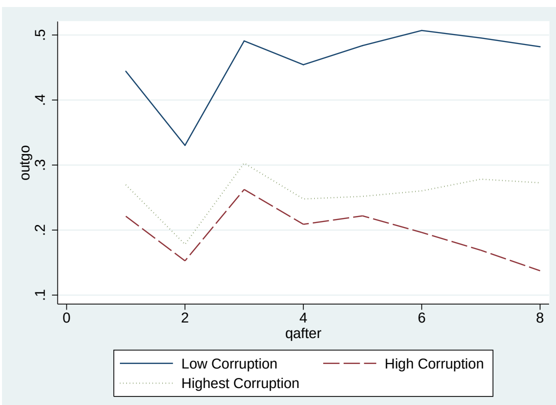
Plots coefficients on indicators for month/quarter post license allocation in corrupt areas. Figures (a) and (b) also plot standard errors. The lowest corruption region is the comparison region in figures (c)-(f).



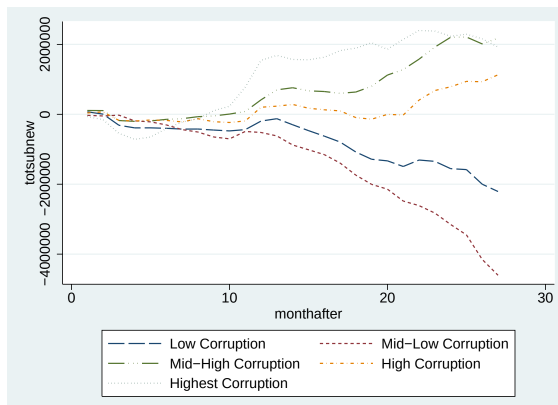
(a) Subscribers



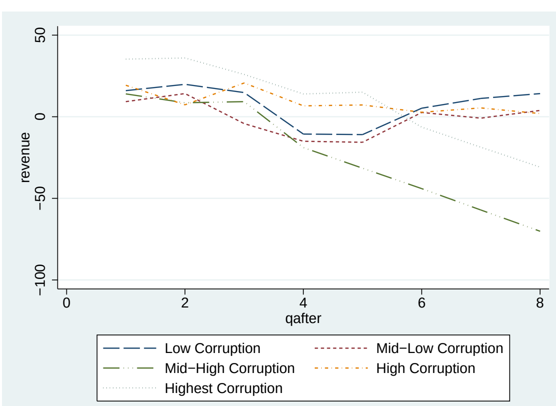
(b) Revenues per User (Rs)



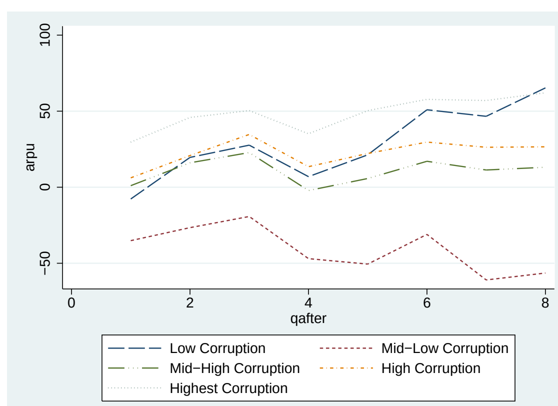
(c) Prices (Rs/minute)



(d) Subscribers



(e) Revenues (Rs 10 Million)



(f) Revenues per User (Rs)

Figure 6: Dynamics of Post Period in Corrupt Areas (CBI Indicted)

Plots coefficients on indicators for month/quarter post license allocation in corrupt areas. Figures (a) and (b) also plot standard errors. The lowest corruption region is the comparison region in figures (c)-(f).

Table 1: Licenses Allocated by Region

	New Licenses Awarded	CAG deemed Ineligible			CBI Indicted			Circle Category
		#	Cat	Prop	#	Cat	Prop	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Andhra Pradesh	6	4	1	0.67	3	1	0.50	A
Assam	7	4	1	0.57	3	1	0.43	C
Bihar	6	5	1	0.83	3	1	0.50	C
Delhi	6	4	1	0.67	3	1	0.50	Metro
Gujarat	5	4	1	0.80	3	1	0.60	A
Himachal Pradesh	5	4	1	0.80	2	0	0.40	C
Haryana	6	4	1	0.67	3	1	0.50	B
Jammu & Kashmir	7	4	1	0.57	3	1	0.43	C
Karnataka	6	4	1	0.67	3	1	0.50	A
Kerala	5	4	1	0.80	3	1	0.60	B
Kolkata	5	3	0	0.60	2	0	0.40	Metro
Madhya Pradesh	5	4	1	0.80	3	1	0.60	B
Maharashtra	6	4	1	0.67	3	1	0.50	A
Mumbai	4	3	0	0.75	2	0	0.50	Metro
North East Region	7	4	1	0.57	3	1	0.43	C
Orissa	6	4	1	0.67	2	0	0.33	C
Punjab	5	3	0	0.60	3	1	0.60	B
Rajasthan	4	4	1	1.00	3	1	0.75	B
Tamil Nadu	6	4	1	0.67	3	1	0.50	A
Uttar Pradesh (East)	5	4	1	0.80	3	1	0.60	B
Uttar Pradesh (West)	5	4	1	0.80	3	1	0.60	B
West Bengal	5	3	0	0.60	2	0	0.40	B

This table shows the number of new licenses awarded for wireless spectrum in the "2G" range across the 22 telecom regions in India, as well as the number of these licenses that were deemec illegitimate by the Comptroller and Auditor General (CAG) and the Central Bureau of Investigation (CBI). "Cat" denotes whether the region is determined to be "high corruption" base on the number of illegitimate licenses. "Prop" shows the proportion of licenses awarded that were considered illegitimate. "Circle Category" is a TRAI grouping of telecom circles.
West Bengal includes the Andaman & Nicobar Islands and Sikkim. North East includes Assam Arunachal Pradesh, Mizoram, Manipur, Tripura, Nagaland, Meghalaya. Tamil Nadu includes Puducherry as well as Chennai. Bihar includes Jharkhand. Madhya Pradesh includes Chattisgarh. Uttar Pradesh (West) includes Uttarakhand

Table 2: Summary Statistics of Main Outcomes

	Mean	Std. Dev.	Obs	Unit	Frequency
	(1)	(2)	(3)	(4)	(5)
Subscribers	15,200,000	10,400,000	880		Monthly
Ln(subscribers)	16.25	0.84	880		Monthly
Revenues/user	226.47	68.71	286	Rupees	Quarterly
Revenues	202.36	127.91	286	Rs 10 million	Quarterly
% calls dropped	1.36	0.49	286		Quarterly
% calls connected	97.85	1.53	286		Quarterly
Voice quality	97.31	1.22	286	Index 1-100	Quarterly
% 1 min response	86.23	5.71	286		Quarterly
Minutes used	447.36	38.52	52	Per month	Quarterly
Price/minute	0.82	0.20	52	Rupees	Quarterly

These summary statistics are for the period January 2007 - April 2010 (Q1 2007 - Q1 2010). "Subscribers" is the total number of wireless subscribers in a telecom region. "Revenues/user" and "Revenues" are subscriber-weighted averages across GSM operators in the region. All other variables are subscriber-weighted averages across all operators in the region. "% 1 min response" is the percentage of customer service calls that were answered within a minute. "Minutes used" are the total number of minutes (incoming and outgoing) per subscriber per month averaged across months in the quarter.

Table 3: Spectrum Allocation was Not Faster in Corrupt Areas

	CAG	CBI
	(1)	(2)
Time	0.572***	0.461***
	(0.134)	(0.0954)
Corrupt	2.119	0.164
	(1.406)	(0.948)
Corrupt x Time	-0.0809	0.0275
	(0.145)	(0.110)
N	352	352

This table presents maximum likelihood estimates of the proportion of spectrum actually distributed to allotted. Each observation is a region-month from Feb 2008-May 2009, the dates of the first and last distributions of new spectrum. "Time" is a linear time trend. "Corrupt" is an indicator for whether the region has a high number of illegitimately allotted licenses as determined by the CAG or CBI.

Table 4: Number of Subscribers

	CAG Deemed Ineligible			CBI Indicted		
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Simple dif-in-dif						
Corrupt	3.748e+06**			4.468e+06***		
	(1.737e+06)			(1.357e+06)		
Post	-2.672e+06			-4.154e+06*		
	(2.068e+06)			(2.489e+06)		
Corrupt x post	-341,868	3.530e+06**	-751,808	1.766e+06	5.184e+06***	-878,676*
	(1.799e+06)	(1.657e+06)	(506,558)	(2.081e+06)	(1.810e+06)	(514,931)
Adj R-squared	0.530	0.921	0.997	0.564	0.927	0.997
PANEL B: Dif-in-dif with proportion new licenses						
Corrupt	-8.460e+06			7.854e+06		
	(8.654e+06)			(8.595e+06)		
Post	-1.911e+07**			-1.434e+07**		
	(7.574e+06)			(5.626e+06)		
Corrupt x post	2.362e+07**	1.021e+07	-5.016e+06*	2.438e+07**	1.790e+07**	-4.338e+06*
	(1.007e+07)	(8.020e+06)	(2.586e+06)	(9.815e+06)	(8.223e+06)	(2.265e+06)
Adj R-squared	0.531	0.919	0.997	0.562	0.923	0.997
Region FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Region x Time	No	No	Yes	No	No	Yes
N	880	880	880	880	880	880

The dependent variable in each column is the total number of wireless telecom subscribers in a region-month. In Panel A, "Corrupt" is an indicator for whether the region has a high number of illegitimately allotted licenses as determined by the CAG or CBI. In Panel B, "Corrupt" is the proportion of illegitimately allotted licenses to all new licenses. In both panels, "Post" is an indicator for months after February 2008.
Standard errors are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table 5: Log Subscribers

	CAG Deemed Ineligible			CBI Indicted		
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Simple dif-in-dif						
Corrupt	0.175			0.476**		
	(0.162)			(0.193)		
Post	-0.152			-0.0888		
	(0.172)			(0.157)		
Corrupt x post	-0.150	0.0860	-0.00406	-0.237***	-0.0386	0.00227
	(0.124)	(0.0974)	(0.0217)	(0.0767)	(0.0746)	(0.0186)
Adj R-squared	0.663	0.992	0.999	0.688	0.992	0.999
PANEL B: Dif-in-dif with proportion new licenses						
Corrupt	-0.268			1.800**		
	(0.925)			(0.837)		
Post	-1.194**			-0.377		
	(0.538)			(0.413)		
Corrupt x post	1.366**	0.318	0.0303	0.351	-0.269	0.0544
	(0.603)	(0.271)	(0.0684)	(0.664)	(0.315)	(0.0732)
Adj R-squared	0.675	0.992	0.999	0.701	0.992	0.999
Region FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Region x Time	No	No	Yes	No	No	Yes
N	880	880	880	880	880	880

The dependent variable in each column is the log of the total number of wireless telecom subscribers in a regio month. In Panel A, "Corrupt" is an indicator for whether the region has a high number of illegitimately allotted licenses as determined by the CAG or CBI. In Panel B, "Corrupt" is the proportion of illegitimately allotted licenses to all new licenses. In both panels, "Post" is an indicator for months after February 2008.
Standard errors are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table 6: Revenues

	CAG Deemed Ineligible			CBI Indicted		
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Simple dif-in-dif						
Corrupt	34.08			55.13**		
	(34.10)			(27.35)		
Post	-73.61**			-80.29**		
	(32.46)			(33.57)		
Corrupt x post	20.70***	51.71**	8.988	32.09***	60.37***	15.97
	(6.035)	(20.68)	(12.56)	(4.629)	(19.53)	(13.79)
Adj R-squared	0.415	0.959	0.991	0.458	0.962	0.991
PANEL B: Dif-in-dif with proportion new licenses						
Corrupt	-252.4***			-200.1***		
	(79.76)			(60.11)		
Post	-186.1			28.43		
	(143.5)			(169.8)		
Corrupt x post	279.5***	81.12	31.23	299.6***	182.1***	54.32
	(90.47)	(73.41)	(36.41)	(75.31)	(59.81)	(40.58)
Adj R-squared	0.405	0.955	0.991	0.429	0.958	0.991
Region FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Region x Time	No	No	Yes	No	No	Yes
N	286	286	286	286	286	286

The dependent variable in each column is subscriber-weighted average revenues for GSM operators in a region-quarter. In Panel A, "Corrupt" is an indicator for whether the region has a high number of illegitimately allotted licenses as determined by the CAG or CBI. In Panel B, "Corrupt" is the proportion of illegitimately allotted licenses to all new licenses. In both panels, "Post" is an indicator for months after February 2008.
Standard errors are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table 7: Average Revenues per User

	CAG Deemed Ineligible			CBI Indicted		
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Simple dif-in-dif						
Corrupt	-69.71***			-79.25***		
	(21.93)			(21.37)		
Post	-15.33			-8.322		
	(42.38)			(34.64)		
Corrupt x post	10.39**	4.635	9.902	24.44***	20.28	20.81**
	(5.184)	(22.70)	(10.56)	(6.807)	(13.76)	(9.083)
Adj R-squared	0.318	0.927	0.979	0.323	0.930	0.980
PANEL B: Dif-in-dif with proportion new licenses						
Corrupt	-139.7***			-147.1***		
	(30.21)			(25.81)		
Post	-177.9**			-149.4		
	(86.65)			(107.0)		
Corrupt x post	105.9**	25.38	21.41	170.0***	102.0**	83.72**
	(41.56)	(56.46)	(37.46)	(36.28)	(50.93)	(41.17)
Adj R-squared	0.343	0.927	0.979	0.327	0.930	0.980
Region FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Region x Time	No	No	Yes	No	No	Yes
N	286	286	286	286	286	286

The dependent variable in each column is average revenues per subscriber for GSM operators in a region-quarter. In Panel A, "Corrupt" is an indicator for whether the region has a high number of illegitimately allotted licenses as determined by the CAG or CBI. In Panel B, "Corrupt" is the proportion of illegitimately allotted licenses to all new licenses. In both panels, "Post" is an indicator for months after February 2008.
Standard errors are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table 8: Prices and Minutes Used

	CAG Deemed Ineligible			CBI Indicted		
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Price per minute						
Corrupt	-0.573			-1.180***		
	(1.180)			(0.294)		
Post	-2.261***			-1.188***		
	(0.533)			(0.218)		
Corrupt x post	3.042***	1.547*	0.519	2.052***	1.216**	0.336
	(0.720)	(0.851)	(0.396)	(0.339)	(0.521)	(0.301)
Adj R-squared	0.851	0.971	0.994	0.850	0.976	0.994
PANEL B: Minutes Used						
Corrupt	-2,124***			-781.3**		
	(699.1)			(336.3)		
Post	-145.9			19.11		
	(279.8)			(149.9)		
Corrupt x post	188.9	-235.6	135.0	-46.23	-253.3	64.29
	(411.5)	(329.3)	(170.5)	(311.3)	(213.1)	(133.4)
Adj R-squared	0.398	0.881	0.963	0.470	0.892	0.963
Region FE	No	Yes	Yes	No	Yes	Yes
Time FE	No	Yes	Yes	No	Yes	Yes
Region x Time	No	No	Yes	No	No	Yes
N	52	52	52	52	52	52

The dependent variable in Panel A is the average price per minute in a circle-quarter, while that in Panel B is the average number of minutes per subscriber per month in a region-quarter. "Corrupt" is the proportion of illegitimately allotted licenses to all new licenses. "Post" is an indicator for months after February 2008. Standard errors are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table 9: Measures of Quality

	Percent Calls Dropped				Voice Quality			
	CAG Deemed Ineligible		CBI Indicted		CAG Deemed Ineligible		CBI Indicted	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PANEL A: Simple dif-in-dif								
Corrupt	0.00772		0.0610		-0.343		-0.422	
	(0.177)		(0.164)		(0.316)		(0.317)	
Post	0.0269		0.0855		-0.124		-0.519*	
	(0.0931)		(0.102)		(0.279)		(0.270)	
Corrupt x post	0.232*	0.0114	0.168	-0.0380	-0.329	0.198	-0.252	0.242
	(0.133)	(0.135)	(0.154)	(0.143)	(0.413)	(0.311)	(0.384)	(0.287)
Adj R-squared	(0.133)	(0.135)	(0.154)	(0.143)	(0.413)	(0.311)	(0.384)	(0.287)
PANEL B: Dif-in-dif with proportion new licenses								
Corrupt	2.336***		1.743**		-3.977*		-2.961*	
	(0.848)		(0.739)		(2.052)		(1.514)	
Post	2.648***		2.922**		-1.775		-3.612***	
	(0.892)		(1.155)		(1.324)		(1.300)	
Corrupt x post	-3.026***	-1.381	-3.040**	-1.613	4.957*	-0.0511	4.734*	0.460
	(1.158)	(0.958)	(1.381)	(1.025)	(2.613)	(1.220)	(2.495)	(1.192)
Adj R-squared	(1.158)	(0.958)	(1.381)	(1.025)	(2.613)	(1.220)	(2.495)	(1.192)
Region FE	No	Yes	No	Yes	No	Yes	No	Yes
Time FE	No	Yes	No	Yes	No	Yes	No	Yes
N	286	286	286	286	286	286	286	286

The dependent variable in columns 1-4 is the average percent of dropped calls in a region-quarter, while that in columns 5-8 is the average voice quality (1-100) in a region-quarter. In Panel A, "Corrupt" is an indicator for whether the region has a high number of illegitimately allotted licenses as determined by the CAG or CBI. In Panel B, "Corrupt" is the proportion of illegitimately allotted licenses to all new licenses. In both panels, "Post" is an indicator for months after February 2008. Standard errors are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table A.1: Data Sources

Variable	Years	Frequency	Sources
Subscribers	2006-2011	monthly	TRAI m; COAI; AUSPI
Revenues/user	2005-2011	quarterly	COAI
Revenues	2005-2011	quarterly	COAI
% calls dropped	2007-2011	quarterly	TRAI q
% calls connected	2007-2011	quarterly	TRAI q
Voice quality	2007-2011	quarterly	TRAI q
% 1 min response	2007-2011	quarterly	TRAI q
Minutes of usage	2007-2011	quarterly	TRAI q
Price/minute	2007-2011	quarterly	TRAI q

Description of sources

TRAI m	Telecom Regulatory Authority of India monthly press reports
COAI	Cellular Operators Association of India website, www.coai.in
AUSPI	Association of Unified Telecom Service Providers of India, www.auspi.in
TRAI q	Telecom Regulatory Authority of India quarterly reports