The Impact of Corruption on Consumer Markets: Evidence from the Allocation of 2G Wireless Spectrum in India*

Sandip Sukhtankar†

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Abstract

Theoretical predictions of the impact of corruption on economic efficiency are ambiguous, with models allowing for positive, negative, or neutral effects. While much evidence exists on levels of corruption, less is available on its impact, particularly on impacts on consumer markets. This paper investigates empirically the effect of the corrupt sale of spectrum licenses to ineligible firms on the wireless telecom market in India. I find that the corrupt allocation had, at worst, zero impact on the number of subscribers, prices, usage, revenues, competition, and measures of quality. I argue that the market-based transfer of licenses to competent firms distinct from original awardees, combined with fierce competition in the telecom sector, may have mitigated potential deleterious impacts of corruption on consumers. These results suggest that the original corrupt allocation did not matter, providing support for the insight of Coase (1959, 1960).

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†BREAD, J-PAL, and the Department of Economics, Dartmouth College, 326 Rockefeller Hall, Hanover, NH 03755. sandip.sukhtankar@dartmouth.edu.

1 Introduction

Theoretical predictions of the impact of corruption on economic efficiency are ambiguous. One such prediction is that corruption "greases the wheels" of the economy by allowing firms to bypass inefficient regulations (Leff, 1964; Huntington, 1968). On the other hand, the illicit nature of corruption could prove distortionary (Murphy et al., 1993; Shleifer and Vishny, 1993). A third view that has received less attention in the literature is that corruption could simply represent a transfer from the government to corrupt officials or firms with no impact on efficiency: bribery in the process for allocating licenses may be neutral since the most efficient firms can pay the highest bribes (Lui, 1985); or efficient resale implies that the initial allocation may not matter (Coase, 1959, 1960).

While much recent empirical work has documented the existence of high levels of corruption in developing countries,[1] evidence of the impact of corruption is less voluminous. The studies that exist suggest harmful impacts on firm performance and economic activity,[2] but evidence of the impact on consumer markets remains limited.

This paper investigates empirically the effect of corruption on consumer markets by examining how the corrupt allocation of licenses to ineligible firms affected the wireless telecom market in India. In early 2008, the Department of Telecommunications (DoT) in India allocated lucrative licenses to provide wireless telecom service. Instead of using an auction[3] to limit the number of entrants and discover the market price, the licenses were sold at fixed June 2001 prices using erratic rules designed to favor firms connected to then Telecom Minister Mr. Andimuthu Raja. Subsequent investigations by the Comptroller and Auditor General (CAG) and the Central Bureau of Investigation (CBI) revealed that Mr. Raja received bribes of up to US $ 1 billion to award licenses to companies who otherwise would not have qualified for them. The ensuing scandal almost brought down the ruling United Progressive Alliance (UPA) government,[4] and dominated political discourse in India for over two years.

This incident of corruption provides a compelling context in which to test for effects of corruption on markets and understand what determines the eventual impact on consumers. The scale of corruption was massive (the most widely cited estimates of the loss to the government are around US$ 44.2 billion,[5] or equivalent to the entire defence

[1]Examples of studies estimating the magnitude of bribes paid to government officials for bending or breaking rules include Olken and Barron (2009); Svensson (2003); Bertrand et al. (2007); Hunt (2007); those documenting embezzlement of funds from public programs include Olken (2006, 2007); Ferraz et al. (2010); Reinikka and Svensson (2004); Niehaus and Sukhtankar (2013a,b), 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.

[3]As Hazlett (2008) suggests, there is widespread recent consensus that market mechanisms are superior to administrative methods in allocating radio frequency spectrum.

[4]See, for example, a front page article from The New York Times titled "Telecom Scandal Plunges India Into Political Crises" from December 14, 2010, amongst many other such commentaries.

[5]For comparison, the total revenue raised from the sale of all spectrum in the United States was US$ 53

budget[6]), and involved an important sector in India's burgeoning economy (Kotwal et al., 2011), one that "typically [has] large and persistent positive spillovers to the entire economy" (Cramton et al., 2011). Much information about the corrupt sales was revealed ex-post. While the licenses were eventually rescinded – four years after being awarded – the interim period, especially prior to the widespread outbreak of the scandal in late 2010, provides a window in which to observe the impact of the corrupt allocation.

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 or productive because eligibility rules were keeping otherwise efficient firms from receiving them. Of course, if licenses and spectrum could be simply bought and sold on a secondary market, these questions would be moot. But in India - like elsewhere - the direct sale of licenses and spectrum is expressly forbidden, and moreover fairly stringent rules govern mergers and acquisitions as well as foreign direct investment (FDI).[7] Whether corruption in the presence of such transfer restrictions affects efficiency is the focus of this paper.

This debate is not merely academic or theoretical: understanding whether corruption hurts efficiency is important given that the often draconian responses to corruption in developing countries – with low state capacity this may involve simply shutting down economic activity – may be worse than the effects of corruption itself.[8] Amidst the political furor in India, some have disputed whether the corrupt allocation has hurt the telecom market.[9]

To examine the consequences of malfeasance in license allocation I rely on a simple difference-in-differences approach, using the variation across regions in the number of corruptly awarded licenses and the one-time allocation of licenses on a single day in January 2008. Differences in the number of corruptly awarded licenses appear to be driven by the use of existing spectrum by the defense forces,[10] a plausibly exogenous

billion (Hazlett and Munoz, 2009), and the sale of third generation ("3G") wireless cellular licenses in the UK and Germany raised a combined US$ 80 billion (Klemperer, 2002).

[6]India's total government spending in 2010-11 was US$ 247.2 billion, as per 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 currency figure refers to January 2008, I use an exchange rate of Rupees (Rs.) 40 to the dollar, the average for the month as per www.oanda.com.

[7]Note that there is a current policy debate over whether resale of spectrum should be allowed, as well as the regulations governing mergers and FDI. See for example TRAI's "Recommendations on Valuation on Reserve Price of Spectrum," published on September 9, 2013.

[8]In India, for example, numerous key defense purchase decisions were put on hold after a bribery scandal related to helicopter purchases was uncovered; in another case, all construction activity in the city of Mumbai ceased after the discovery of previous malfeasance. See "Helicopter bribe scandal threatens India's defense modernization," *Washington Post*, February 15, 2013, and "Indian Official Starts Pulling Up Corruption's Roots in Mumbai," *New York Times*, December 4, 2012.

[9]For example, the new Telecom Minister Kapil Sibal has suggested that selling licenses at fixed prices benefited consumers because it led to lower prices for wireless service.

[10]The total availability of spectrum, which determines the number of licenses awarded in a region, de-

source of variation in the amount of corruption. The availability of detailed data across time allows me to examine the effect of illicitly acquired licenses on wireless telephone subscribers, prices, firm revenues, as well as quality measures (e.g. proportion of calls dropped) aggregated at the regional level. Systematic and comprehensive investigations by two goverment agencies - the CAG and CBI - allow me to examine two separate characterizations of whether a license was corruptly awarded. The former denotes whether a license was awarded to an ineligible company,[11] while the latter determines whether evidence of wrongdoing by the company has been uncovered.

Separating regions into those with many 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 find that outcomes are, in general, no worse in the more corrupt[12] areas after license allocation. The only consistently significant effect seems to be an *improvement* in quality measures, while the impact on the number of subscribers, prices, minutes used, and revenues is statistically indistinguishable from zero, with standard error bounds ruling out large negative impacts. These results are robust to the addition of region-specific time trends to the estimations to account for differential trends in outcomes prior to the license allocation;[13] robust to redefining the post period as that after the allocation of spectrum rather than licenses; and to alternative empirical methods using synthetic control groups. Corruption, then, had at worst zero impact on consumer markets. To the extent that unobserved factors not absorbed by region and time fixed effects and region-time trends may have affected both license allocations and outcomes, these results must be viewed with caution.

In contrast to these results, the existing literature on the impact of corruption on firms finds large negative effects. For example, Fisman and Svensson (2007) find that a one percentage point increase in bribes reduces annual firm growth by three percentage points, while Djankov and Sequeira (2010) find that the "diversion costs" of corruption for each individual firm are on average three to four times higher than actual bribes paid. In a different context, Ferraz et al. (2010) find educational outcomes in corrupt areas to be 0.35 standard deviations lower than those without corruption. In India, and in particular for this scandal, the presumption is that corruption slowed growth; an overview of corruption in India notes that "growth sputtered to a decade low in 2012, with many observers pointing to the corrosive effect of endemic corruption – including a spate of

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pends on its alternative uses: in the Indian context, the main alternative use was by the defense forces for communication. Below I show that the only factor consistently significantly associated with the number of *corruptly allocated* licenses is an indicator for defense priority regions.

[11] A company could be ineligible for two major reasons: 1) on account of misrepresenting its core business, and/or 2) because it did not have sufficient paid-up capital (equity capital from the actual sale of shares).

[12] Note that "more corrupt" does not necessarily refer to the magnitude of corruption in these regions, simply that in these areas there was a greater number or proportion of corruptly awarded licenses.

[13] Adding region-specific trends can be problematic if these are conflated with dynamic effects of the allocation (Wolfers, 2006); Figure 4 shows that such effects, if any, are indistinguishable from zero.

scandals under Prime Minister Manmohan Singh – as a culprit." (Xu, 2013)

The fact that my results are not in line with the existing empirical evidence suggests that the context in which corruption takes place might matter. Two features of the wireless telecom market in India may help us understand this contrast: the fact that licenses were acquired by firms different than those they were allocated to, and the levels of competition in the market. First, despite restrictions on the direct sale of licenses and spectrum, 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, vegetable wholesalers, shell companies with no other physical or human capital), these licenses were subsequently acquired – at substantial premia, through complex arrangements of mergers and acquisitions – by firms such as telecom giants Telenor (Norway) and Etisalat (UAE). Sixty-eight percent of licenses ended up with an entity distinct from the original licensee (Table 7); there were also more mergers in the more corrupt areas (29% of all license-holders merged by December 2010) as opposed to less corrupt areas (23%).

Yet the secondary transfer of licenses is unlikely to explain on its own why corruption did not affect markets in this instance: Milgrom (2001) writes, for example, that "the history of the US wireless telephone service offers direct evidence that the fragmented and inefficient initial distribution of rights was not quickly correctable by market transactions". First, there is no guarantee that the secondary transfers went to efficient firms: if efficient firms are also law-abiding, they would stay away from corruptly acquired assets.[14] Second, costs incurred by the acquiring firms could be passed on to consumers in the presence of monopoly power; for example, anecdotal evidence suggests that monopoly power wielded by coal-mining companies (who also procured licenses to coal mines in a corrupt allocation process) was responsible for efficiency losses in that sector (Times of India, 2012).

Here, the existence of a number of large players[15] and competition in the Indian wireless telecom market also helps explain why negative impacts of corruption were mitigated. With the entry of new firms after the allocation, measures of competitiveness increased dramatically in both corrupt and less corrupt areas: the number of providers almost doubled from an average of 6.6 to 12.2 per region, while the Herfindahl-Hirshman Index (HHI) of market share declined by over 500 points. Regressions of the HHI suggest that, if anything, competition increased more in corrupt areas.

These results cast light on ongoing debates over the impact of corrupt activity. In Russia, for example, the privatization of government enterprises was widely accepted

[14]Indian as well as international law prohibits such acquisitions; for example, the Prevention of Corruption Act (1988) in India, and the International Anti-Bribery and Fair Competition Act (1998) and the Foreign Corrupt Practices Act (1977) in the United States.

[15]There were 4 large firms that held between 55-59% market share in both corrupt and non-corrupt areas.

to have been characterized by cronyism and "sweetheart deals." And yet Shleifer and Treisman (2005) argue that the privatized companies subsequently performed very well. This disagreement points to a broader 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. One possible way to reconcile these facts 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.[16] Under these conditions, as long as markets are competitive and secondary transfers possible, corruption is unlikely to impede growth.

This paper is also related to the extensive literature on the allocation of rights over natural resources in general, and a large subset of this literature on the allocation of radio frequency spectrum.[17] Attaining economic efficiency and raising revenue are the key – sometimes conflicting – goals of the allocation process, with other social goals such as reaching under-served communities or promoting minority businesses sometimes prominent. Given the conditions of thin markets, natural monopolies, and the potential for collusion or corruption in the process (particularly in developing countries), much attention is paid to the form of the allocation process: for example, whether a beauty contest, lottery, or particular type of auction should be used; and whether resale of rights is permitted. While in the Indian case there was no variation in the form of allocation, and direct resale remains forbidden, the incident provides some evidence that corruption in the initial allocation did not matter, thus confirming the insight of Coase (1959, 1960).

While there may have been no direct efficiency consequences, the discretionary allocation at fixed prices 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 $ 14.4 billion.[18] Moreover, this paper examines a particular type of corruption: bribery in the sale of government licenses; other types of corruption could have efficiency as well as distributional costs. Finally, the corrupt allocation may have had deleterious effects on other outcomes that are difficult to measure; for example the breakdown of trust in government, and the discouragement of market actors without political connections.

The rest of the paper is organized as follows: section 2 presents information on the industry and the license allocation procedure, section 3 presents the data and empiri-

[16]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).

[17]See for example, McMillan (1994); Klemperer (2002); Cramton et al. (2011); Hazlett (1990, 2008); Hazlett and Munoz (2009), amongst many others.

[18]Given that consumer surplus in wireless cellular markets is orders of magnitude higher than producer surplus (Hazlett and Munoz, 2009), many if not all economists suggest that raising revenues should be of secondary consideration to achieving economic efficiency (Cramton et al., 2011). On the other hand, lost government revenues imply inefficiency given that taxation is distortionary.

cal strategy, followed by the results in section 4. Section 5 discusses these results and examines effects on market structure.

2 Background

2.1 Market structure

It is difficult to overstate the importance of the wireless telecom sector in India: the country has the cheapest, and possibly the most accessible cell phone service in the world. The wireless telecom market is very large and lucrative, with 900 million subscribers[19] as of January 2012 and a growth rate of 1.1 percent a month. India's absolute growth in number of subscribers in 2010 was *twice* that of the next closest country (China), with prices per minute, at $0.007, over thirty times lower than the most expensive (Japan) (Telecom Regulatory Authority of India, 2012). Total revenues for GSM[20] operators (70% of the market) in the second quarter of 2011 were approximately US $ 3.8 billion, extrapolating to total annual revenues for the entire sector of US $ 22 billion. The fact that landline subscriptions are tiny in comparison (30 million subscribers) 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.

Fifteen companies currently provide cellular service, with at least nine providing coverage nationwide and three others providing close to nationwide coverage.[21] Competition for subscribers is fierce, especially after the introduction of mobile number portability. Bharti-Airtel holds the largest market share with 19.6 percent as of February 2012, but there are eight companies with a market share of 5-20 percent. In comparison, the US has only four large nationwide providers combining for almost 95 percent of the market in 2011, with the two largest providers, Verizon (36.5%) and AT&T (32.1%), reaching almost 70 percent by themselves.[22]

[19] A subscriber corresponds to a telephone number, not an individual. Most measures of "teledensity" simply report the number of subscribers divided by the total population, hence it is difficult to know what actual penetration – the proportion of the population that has a mobile phone – is. For comparison, in 2010 India had a teledensity of 63%, Russia 166%, and the US 90% (Telecom Regulatory Authority of India, 2012).

[20] GSM, or Global System for Mobiles, is one of the two major cell phone transmission systems. The other is CDMA, or Code Division Multiple Access. In India the two systems are allocated slightly different parts of the spectrum. Other than the case of revenues, which are not available for CDMA providers since the CDMA providers' umbrella organization does not make them available, the differences between the two systems do not matter for the practical purposes of this paper.

[21] 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.

[22] `http://www.statista.com/statistics/219720/market-share-of-wireless-carriers-in-the-us-by-subscriptions`, accessed August 8, 2012.

While competitive when compared to other countries, the wireless telecom market can be best described as characterized by "oligopolistic competition." The average HHI for this sector over the analysis period was 2,093. The US Justice Department considers markets between 1,500 and 2,500 points as "moderately concentrated" (U.S. Department of Justice and the Federal Trade Commission, 2010). The main factor of production is a limited natural resource – spectrum[23] – that is best used in discrete, uninterrupted chunks. Next, there are a number of fixed costs that may serve as barriers to entry – the construction of cell phone towers, the setup of marketing and distribution systems for subscriber services,[24] and technological know-how – many of which are subject to large economies of scale. On the other hand, a firm could conceivably rent a tower from a rival, outsource distribution systems, and license technological know-how, and many large Indian conglomerates have the capital to enter this market.

In this context, the entry of an inefficient firm would result in the underuse or disuse of allocated spectrum. The "wasteful use of the spectrum resource" and "uneconomic stock-piling of spectrum licenses" have long been recognized as problems to avoid in allocating spectrum (Melody, 1980). A significant proportion – on average 30 percent of existing spectrum – was auctioned in the new allocation described below. If a new entrant were too high-cost to effectively use allocated spectrum in a market, this might result in slower subscriber growth overall. Moreover, the added pressure on the utilized spectrum might lead to problems with quality for existing providers, who may also charge higher prices. Finally, underused spectrum and licenses might reduce competitive pressure on incumbents, leading to reduced quality and higher prices (Cramton et al., 2011). The analysis below tests whether corruptly allocated licenses led to negative impacts on the number of subscribers and on quality as well as resulted in higher prices. First, however, I describe the allocation procedure and resulting variation in corruption across regions.

2.2 License and spectrum allocation

The wireless telecom sector was not always as dynamic as described in the previous section: 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 limited services, but it was not until new policies (in 1999 and chiefly in 2002) reduced restrictions on the number of providers and the services they could provide that the wireless segment started its real growth path. While at the end of 2002 there were a

[23]Spectrum refers to electromagnetic frequency bands, some of which are reserved for the use of wireless telecommunications. In India, a National Frequency Allocation Plan (last revised in 2008) delineates the use of the electromagnetic frequency spectrum between various users such as the defense forces, police, intelligence agencies, radio and TV broadcasting, energy utilities, airlines, and public and private telecommunications operators.

[24]Ninety-five percent of subscribers in India have prepaid connections, which require constant refills via small retail shops. For comparison, only 15 percent of subscribers in the US are prepaid (Telecom Regulatory Authority of India, 2012).

handful of private service providers and only 6 million subscribers, by the end of 2006 the number of private service providers had expanded to ten, and there were 150 million wireless subscribers in India.

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") across India.[25] In 2007, a process of new license and spectrum allocation was initiated by the DoT. Licenses awarded through this new process were incremental to existing ones and hence new firms had the opportunity to enter the market.[26] Firms could apply for pan-India licenses, for licenses in particular regions, as well as for either CDMA or GSM spectrum. Licenses and spectrum awarded could not be sold on to other entities.

Given that this was the first round of large-scale allocation of spectrum – over 35% of existing capacity was due to be allocated – since the telecom market had really started growing in India, it was eagerly anticipated by potential new entrants. Market growth was predicted to skyrocket, and the sector was young and far from saturated: true to predictions, market size *quintupled* over the next three years.[27] 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 then Telecom Minister Andimuthu Raja was severely criticized for its blatant arbitrariness and disregard for higher authority (including the finance ministry and the prime minister).[28] Instead of using an auction[29] 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 two years, on September 24,

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

[26]The spectrum band to be allocated allowed for second-generation, or "2G" communication, which generally refer to digital (as opposed to analog) voice services and are basically comparable to first-generation communication in terms of revenue possibilities for firms. Third-generation, or "3G" service generally refers to advanced voice and data networks, with far greater revenue potential (Hazlett, 2008).

[27]Incumbents were also extremely worried about new entry, so much so that one (Reliance) tried to set up a fake firm to bid for licenses in order to keep them from competitors (Comptroller & Auditor General of India, 2010).

[28]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.

[29]As Hazlett (2008) suggests, there is widespread recent consensus that market mechanisms are superior to administrative methods in allocating spectrum.

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 and 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 account of either misrepresenting their core business or not having sufficient paid-up capital.[30] 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).

The upshot of the process was that all companies who received licenses did so 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 shell company with no assets, human capital, or telecom 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 $ 17.5 billion, as opposed to the US $ 3.1 billion actually received by the government.[31] 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 taped phone 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 2 and a half years. It spawned the growth

[30] "Paid-up capital" refers to money obtained through the sale of shares by a company, as opposed to debt financing.

[31] The assumptions made in the report were the following: Swan had no other assets, so the full value of the company ($1.8 billion, Rs. 72 billion) was equivalent to the value of the licenses acquired. This value was adjusted for the fact that Swan had 13 high-value licenses (i.e. not representative of all licenses), and then extrapolated to the full set of 122 licenses as well as 35 dual-technology licenses (licenses to operate CDMA services granted to already licensed GSM operators or vice versa). The precise scaling factors used are not available in the report, but other calculations in the report use reserve prices for subsequent auctions as a guide.

of an anti-corruption movement, and was presumably a major reason why Mr. Raja's DMK party lost elections in its home state of Tamil Nadu. Some have also argued that corruption scandals led to losses suffered by the Congress and its UPA allies in state elections across India. Most recently, a Supreme Court order deemed the licenses allocated in the 2007-8 process void, calling on the TRAI to decide on a new procedure to reallocate the 122 licenses (Singhvi and Ganguly, 2012).

3 Empirical strategy

3.1 Variation in corrupt allocation across regions

Table 1 presents the distribution of newly allocated licenses across the 22 telecom regions. The total number of new licenses awarded ranged from four in Mumbai and Rajasthan to seven in Assam, Jammu and Kashmir, and the North-East region, representing in all cases a substantive proportion of new entrants to the market. Every region had at least one license awarded to an ineligible company, with some regions having up to five. All licensees (except three in Delhi) were eventually allocated spectrum, although this did not necessarily happen immediately; in section 3.2 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.

Prior to exploring what determined the variation in corrupt allocations across regions, it would be helpful to define "corrupt." 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. However, it is possible that not all ineligible firms were 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 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 two firms receiving 27 licenses were deemed ineligible but were not indicted by the CBI, one firm receiving three 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. Note that these labels do not necessarily reflect the underlying levels of corruption in these regions: the allocation of licenses was determined centrally, and the exercise in this paper is to examine the impact of the corrupt central allocation. As Table 1 shows, every region has at least one firm that received a license illegitimately. The number of illegally obtained licenses varies from two in Himachal Pradesh to five 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 0.57 and one 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.

Why do some regions have more corruptly awarded licenses than others? A central authority determined the allocation of licenses across regions, conditional on receiving applications. The availability of spectrum in a region determined the overall number of licenses awarded in the region. The total availability of spectrum depends on its alternative uses: in the Indian context, the main alternative use was by the defense forces for communication. In addition, at the time of allocation the amount of available spectrum depended on the amount of spectrum already distributed to pre-existing licenses. Table 2 explores the correlates of licenses awarded. The total number of license awarded in a region was negatively correlated both with the existing number of operators and also with whether the region was a "defense priority"[32] region. None of the other factors that one might associate with the entry of new firms – market growth, concentration, or population – is consistently significantly associated with higher corruption.

The only factor consistently significantly associated with the number of *corruptly allocated* licenses is the indicator for defense priority regions. Defense requirements are a plausibly exogenous source of variation in the allocation procedure across regions, particulary since other economic factors that one might expect to matter are not significantly associated with the corrupt allocation. Of course, this limited exercise does not rule out other unobserved factors that may have affected license assignment. Below I describe the empirical specifications that build on this variation in corrupt license allocation across regions.

3.2 Data and econometric specifications

Economic efficiency in spectrum allocation is defined by Cramton et al. (2011) as "assignment of licenses that maximizes the consumer value of wireless services less the cost of producing those services." While it would be difficult to measure precisely whether the corrupt allocation did or did not achieve the best use of spectrum, data available from the

[32]This is simply an indicator for whether the region i) shares a border with hostile neighbors Pakistan, China, or Bangladesh; ii) is a metropolitan area subject to terrorist attacks; or iii) has major internal civil conflict led by armed Maoists.

telecom regulator and industry associations provide reasonable proxies for consumer value and producer costs. 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. 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 subscriber data are available from 2001 onwards; quality, price, and usage data are available from 2004 onwards; while revenue data are available only from 2005 onwards and restricted to GSM operators. The price and usage data are available only at a higher level of aggregation, with four circle "categories" across India.

These data come 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. Note that subscriber data are available separately from TRAI and the industry associations, and match to a very high degree ($\rho = 0.9977$). 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.

Given that the new 2G license allocation process started in 2007, while the scandal broke in late 2010, I restrict my analysis to the time period between these events.[33] 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. Table 3 presents summary statistics on these outcome variables..

Separating regions into those with a high number/proportion of corrupt licenses (indicated by *Corrupt*) and those with fewer, as described in the preceding section, and time periods into those before licenses were allocated and those after (indicated by *Post*), I estimate the following simple regression:

[33] Robustness tests which expand and contract this period – for example ending the period of study in April 2010, when further auctions for the 3G licenses took place, rather than December 2010, when the 2G scandal definitively broke out – find very similar results.

$$Y_{st} = \alpha + \beta(Post * Corrupt)_{st} + \sum_t Time_t + \sum_s Region_s + \epsilon_{st} \quad (1)$$

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. Region fixed effects account for any time-invariant characteristics that influence outcomes, while time fixed effects account for nationwide time-varying trends.[34] I cluster standard errors along two dimensions (region and time) using the multi-way clustering approach suggested by Cameron, Gelbach and Miller (2011) and Thompson (2011).[35]

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:

$$ln(P_{st}/(K_s - P_{st}) = \alpha + \beta Corrupt_s + \delta Time_t + \gamma(Time * Corrupt) \quad (2)$$

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 high number/proportion 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 regions receive their allocations faster. 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 A.1 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 $(AmtSpectrum)_{st}$:

$$Y_{st} = \alpha + \beta(Post * Corrupt)_{st} + \gamma(AmtSpectrum)_{st} + \sum_t Time_t + \sum_s Region_s + \epsilon_{st} \quad (3)$$

Another potential problem is that pre-existing trends within regions may confound the difference-in-difference analysis. For example, a graph of the time trend in subscribers shows a divergence between corrupt and less corrupt regions prior to the license allocation

[34] Tables A.2 and A.3 in the Appendix also show the basic difference-in-differences estimate without time or region fixed effects.

[35] Note that the number of clusters in some of the regressions may be low: for example, there are 22 regions, 16 quarters, and only 4 telecom circles in the dataset. As a robustness check, I run percentile-t wild cluster bootstraps as suggested by Cameron et al. (2008) in all cases. This does not change inferences drawn from clustering on region or quarter dimensions. It does, however, make a large difference to inference based on clustering at the circle level, which is not surprising since there are only four circle clusters. Hence, for these regressions – ones with price and minutes of use as outcomes – I present the p-values from the percentile-t wild cluster bootstraps instead of standard errors.

process (Figures 1 and 2). This is also true for log subscribers, prices, and revenues – with more corrupt areas growing faster or declining less slowly than less corrupt areas – but not in general true for the quality variables. Moreover, general economic trends do not seem to be different between corrupt and less corrupt areas, as shown in Figure 3. Nonetheless, to account for this potential confound, I add region-specific time trends as a control:

$$
\begin{aligned}
Y_{st} &= \alpha + \beta(Post * Corrupt)_{st} + \gamma(AmtSpectrum)_{st} \\
&+ \sum_t Time_t + \sum_s Region_s + \sum_s Region_s * Time_t + \epsilon_{st}
\end{aligned}
\tag{4}
$$

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:

$$
\begin{aligned}
Y_{st} = \alpha + \gamma(AmtSpectrum)_{st} &+ \sum_{k\geq 1} \beta_k K\ periods\ after\ allocation\ in\ corrupt\ areas_{st} \\
&+ \sum_t Time_t + \sum_s Region_s + \sum_s Region_s * Time_t + \epsilon_{st}
\end{aligned}
\tag{5}
$$

The coefficients β_k are presented in Figure 4.

Despite the evidence presented in the previous section which suggested that defence requirements drove the license allocation, it is possible that other unobserved factors were involved. For example, the corrupt allocation may have been driven by unobserved future potential for growth. To the extent that this potential was predicted by pre-existing trends and fixed regional characteristics – and as the results below suggest, these do indeed have very high predictive power – the inclusion of fixed effects and trends ameliorates some of these concerns. To the extent that unobserved factors beyond these controls may have influenced outcomes, the results below must be interpreted with caution.

4 Results

A glance at Table 4 suggests that the corrupt sale of licenses had no significant effects on the number of wireless telephone subscribers (Panel A, columns 1 and 3). The results are similar if the proportion of new licenses received illegally in each region is considered rather than a simple categorization into more versus less corrupt regions (Panel B, columns 1 and 3). When region-specific linear time trends are introduced into the regressions, the coefficient drops dramatically, and even turns negative (column 4), although the magnitudes are tiny (less than 0.002 standard deviations). The dynamics of the post-allocation period, shown in Figures 4a and 4b, suggest that these trends are not conflating dynamic effects.[36]

While determining whether results are precisely estimated is a somewhat subjective exercise, and the standard errors used are conservative (multi-way clustered at the region and time levels), these results suggest that the difference between more and less corrupt regions was a narrowly estimated zero (standard errors on the order of 200,000 or about 1.5% of the standard deviation, or 1.2% of the mean) at least for the first year after the license allocations. After this period, while the standard errors increase, so does the magnitude of the coefficients. Hence, even at the end of twenty four months after the new licenses were allotted, the 95% confidence intervals allow us to rule out negative effects greater than 0.01 standard deviations.

How did the corrupt allocation affect firm revenues? Revenues might be interpreted as an indicator of profitability of firms in the region. This outcome is only available for GSM providers, so the results must be interpreted with caution. Nonetheless, Table 4 presents some evidence that firms in more corrupt regions seem to have significantly increased revenue levels after the allocation, with increases of 25% seen in Panel A, columns 5-8. This does not seem to be true when the outcome is specified in logs rather than levels (Table A.8). The results also disappear when the dynamics of the post period are taken into account (Figure 4).

The corrupt license allocation also does not seem to have negatively affected consumers. 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. The results indicate that, if anything, quality improved in more corrupt areas after the allocation.

Results on prices paid per minute and minutes used must be interpreted with two caveats in mind: first, the data are aggregated at a higher level (to categories of regions called "circles") and hence coefficients are not directly comparable; and second since there are only four region categories, clustered standard errors can be inappropriate. Table 6 hence shows p-values from a wild cluster percentile-t bootstrap (Cameron et al., 2008) instead of standard errors. The results again suggest that neither prices per minute nor minutes used per subscriber were consistently significantly different in more corrupt circles post allocation.

[36] Given that the average number 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. The log results mostly mirror the levels results: corrupt areas do not appear to be significantly different than less corrupt areas post allocation (Table A.8).

4.1 Robustness checks

The results above are robust to a variety of checks. The first check changes the definition of the post period to the period after spectrum, rather than licenses, is assigned. Spectrum was allocated as soon as it was available; some spectrum may have been vacant at the time of license allocation, while other pieces may have been in use by the defense forces. The advantage of this definition is that it better captures when a firm can actually start operating; moreover, the empirical specification corresponds better to a standard state-level difference-in-differences based on differential timing of policy changes. The disadvantage is that the timing may be endogenous, given that corrupt firms might have been able to influence the spectrum allocation date. In any case, using either the date when the first firm received new spectrum in a region or the date when all firms had received their allotment does not qualitatively change the results described above, as shown in tables A.4-A.7.

A second robustness check changes the empirical methodology used to the synthetic control method developed by Abadie and Gardeazabal (2003) and Abadie et al. (2010). This method for causal inference "provides a data-driven procedure to construct synthetic control units based on a convex combination of comparison units that approximates the characteristics of the unit that is exposed to the intervention." The synthetic control group is constructed using pre-intervention characteristics – in this case I use controls including population, literacy, and state GDP, as well as cumulative spectrum availability in various bands and pre-period outcomes. Since the method is designed for estimating effects in settings where a *single* unit is exposed to treatment, and in this case there are more units exposed to "treatment" rather than "control", I flip the designation of treatment in order to allow for a larger set of potential control units, and also collapse the new treated units into one using simple averaging as suggested by the method's creators.

Figures A.1 and A.3 show predicted outcomes for the synthetic control group (the more corrupt areas in this case) versus the treatment group (the less corrupt areas). As is clear from the figures, the outcomes basically line up exactly post allocation of licenses. This is particularly true in cases where the pre-period outcomes can be precisely predicted. Where pre-period outcomes cannot be precisely predicted, the post-allocation outcomes of the groups are not as well aligned.[37]

[37]Inference in this method is through the use of placebo tests in which the synthetic control method is applied to areas which actually did not receive the intervention. The gap between treatment and synthetic control groups is compared to the gaps between the placebo treatment and synthetic control groups. As Figures A.2 and A.4 show, the actual gap is in fact much smaller than the placebo gaps, suggesting that there is no effect of the corrupt allocation.

5 Discussion and conclusion

Overall, the estimations suggest that the corrupt allocation had, at worst, 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, as well as the perception (in India at least) of the effect of corruption scandals on growth. For example, Mauro (1995) suggests that improving a country's corruption index score by one standard deviation would lead to a 0.8 percentage point increase in the *annual* growth rate of GDP. In the micro-economic literature, Fisman and Svensson (2007) find that a one percentage point increase in bribes reduces annual firm growth by three percentage points; Djankov and Sequeira (2010) find that firms suffer costs on average three to four times higher than actual bribes paid for transport to ports with lower corruption; and Ferraz et al. (2010) show educational outcomes to be 0.35 standard deviations lower in corrupt areas as compared to areas without corruption.

What might explain this discord? First, despite the restrictions on direct sale and transfer of licenses and spectrum, firms who illegitimately received the licenses transferred them to other firms through complex series of mergers and acquisitions. Table 7 tracks licenses from initial allocation to eventual user. It shows, for example, that the shell company Swan was acquired by UAE telecom giant Etisalat. Licenses held by a group of real estate companies (Allianz and Unitech) were eventually obtained by the Norwegian firm Telenor. Eventually, 83 of the 122 licenses allocated (68%) were acquired by other firms through mergers or dilution of equity. Such transfers have occurred in other countries as well, when the initial licensee was not necessarily set up to efficiently provide wireless telecom service: for example, McMillan (1994) recounts the case of an "obscure group" obtaining via lottery a license to provide wireless service on Cape Cod (in the US) and promptly selling it on to Southwestern Bell for a large profit. Since there were more corruptly allocated licenses in more corrupt areas (by definition), there were significantly more mergers in these areas (29% of all licensed entities) as opposed to the less corrupt areas (23%).

However, the transfer of licenses to other firms does not seem sufficient, by itself, to explain why corruption had no impact. Milgrom (2001) writes, for example, that "the history of the US wireless telephone service offers direct evidence that the fragmented and inefficient initial distribution of rights was not quickly correctable by market transactions". There is no guarantee that the firms that obtained licenses through secondary transfers were necessarily efficient: for example, it is possible that efficient yet law-abiding firms may not necessarily wish to obtain corruptly acquired assets. If acquiring licenses and licenses confers monopoly power to the new firms, they may pass on costs to customers: in India, anecdotal evidence suggests that monopoly power wielded by coal-mining companies (who also procured licenses to coal mines in a corrupt allocation process) was responsible for efficiency losses in that sector (Times of India, 2012).

In the case of the 2G allocation, the degree of competitiveness in the wireless telecom market may have forced new entrants to provide services efficiently. As described above, wireless telecom markets in India tend to be characterized by aggressive competition for subscribers. There were 6.6 providers on average per region prior to the new allocation, but by December 2010, following new allocation and consolidation, there were 12.2 providers per region. Of course, some of these new providers could be small and inconsequential, but other more reliable measures also suggest large increases in competition. In both corrupt and non-corrupt areas, the four largest firms only held about 55-59% of market share.

Figure 2b suggests that competitiveness, as measured by the HHI of market share, increased dramatically after the new spectrum allocation in both types of regions, after a brief lag possibly related to the actual handover of spectrum and setting up of new service providers. The HHI dropped from an average of 2,233 points in January 2008 to an average of 1,710 by December 2010, a drop of 23.4 percent. For context, a merger that would increase concentration by 200 points in already concentrated markets would be presumed "likely to enhance market power" and hence come under scrutiny by the US Department of Justice and the Federal Trade Commission. In comparison, a 513-point drop appears to be a substantial increase in competition (U.S. Department of Justice and the Federal Trade Commission, 2010). Meanwhile, the drops in corrupt and non-corrupt regions appear to be relatively similar.

Regression analysis confirms this story. Table 8 shows that the effect of the new allocation on HHI in corrupt regions was basically indistinguishable from that in less corrupt regions. With the inclusion of region-specific trends, it appears as though there was perhaps a small *increase* in competitiveness, although the effect sizes are small. Moreover, Figure 4f suggests that some of this effect might be a conflation of the dynamics, likely related to the lag in HHI decline after the allocation.

A final piece of evidence on competitiveness is provided by data on telecom firm profits around the world (Telecom Regulatory Authority of India, 2012). A comparison of 31 global telecom companies shows that the three Indian companies in the sample are all in the bottom half in terms of profits before taxes, with the best-performing Indian company at number 20 in the rankings. Moreover, the three Indian companies are the top three in the list of companies with the biggest decline in profits in the year 2010.

Thus, the Indian wireless telecom sector was more competitive than wireless telecom sectors in other countries to begin with, and competition increased even further with the allocation of new licenses. The fact that changes in market structure were similar across corrupt and less corrupt regions might at least partly explain why changes in other outcomes were also similar. Overall, in the Indian 2G spectrum case it appears that the Coase theorem (Coase, 1959, 1960) applies – the initial misallocation of licenses was corrected through the secondary market.[38]

In summary, then, this paper has investigated 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 in providing wireless services, this had, at worst, no measurable impact on the number of wireless subscribers, revenues, prices, usage, or measures of quality. The lack of an effect of corruption on consumer markets may be explained by a combination of factors: one potential explanation is that the licenses were transferred to other firms better equipped to provide wireless telecom services, and another may be the presence of existing large players and competition in the wireless telecom market. The same corruption was, however, very costly to the Indian government in terms of lost revenues. Moreover, the ensuing scandal carries with it potential – but not easily measurable – social and political costs associated with decreasing levels of public trust and rising cronyism. Nonetheless, under the conditions of competitive markets and secondary license transfers, the corrupt allocation of licenses to ill-equipped firms did not result in efficiency costs passed on to the consumer, and the initial allocation of property rights did not matter.

[38]It is of course possible that despite the apparent efficient reallocation there were large transactions costs in the transfer. One such cost is delay in starting service. However, these delays were no different for licenses that were reallocated as compared to those that were not, and also no different for the corruptly allocated versus non-corruptly allocated licenses.

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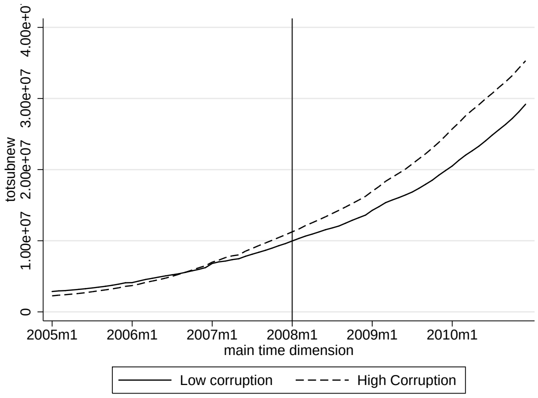
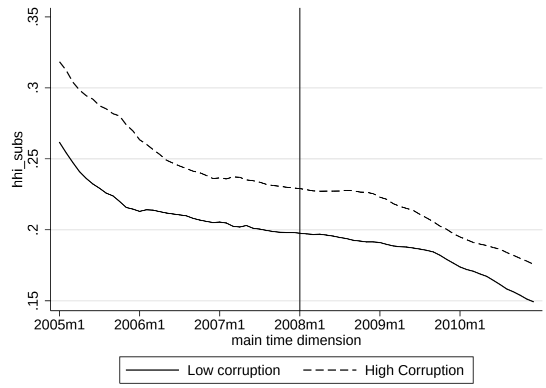
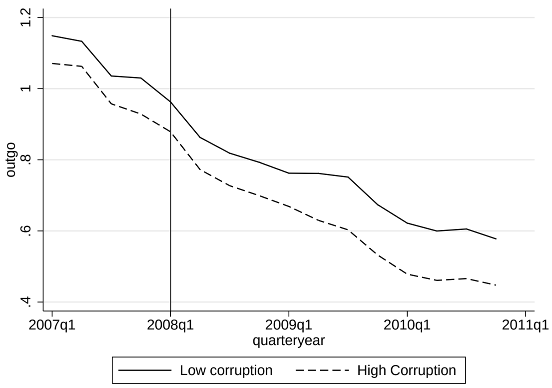


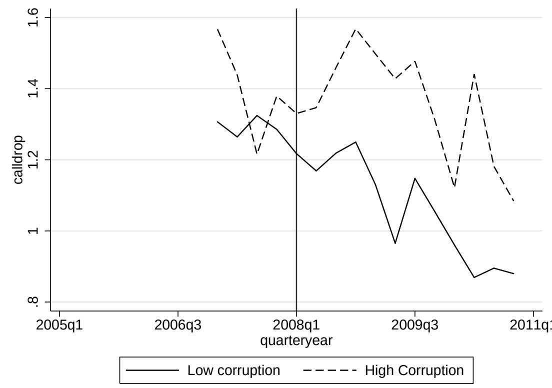
(a) Subscribers



(b) HHI

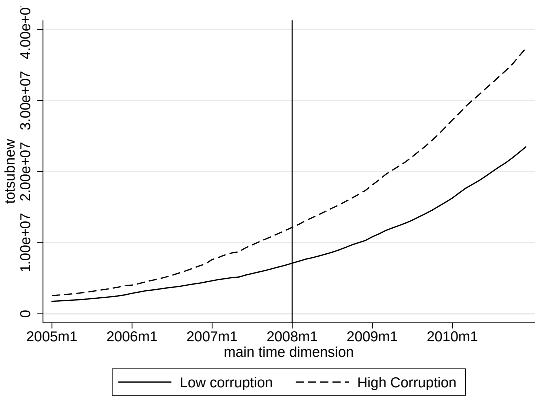


(c) Price (Rs/minute)

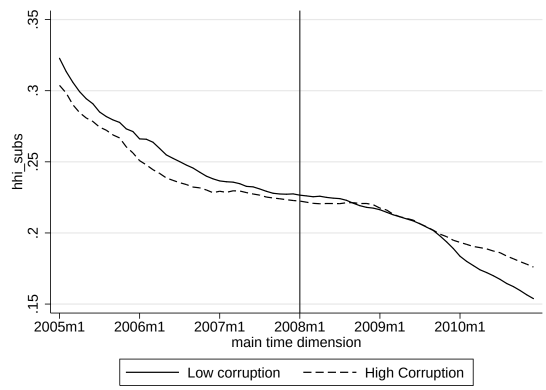


(d) Percent Calls Dropped

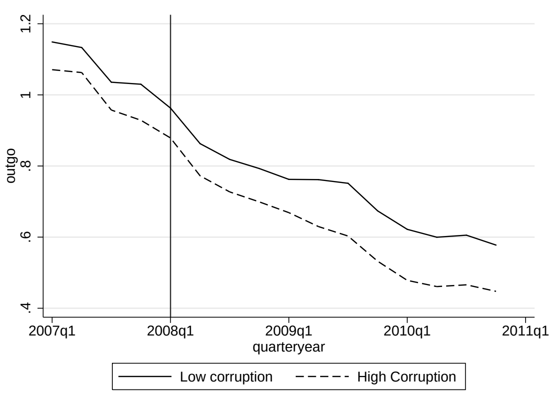
Figure 1: Outcomes over Time in More Corrupt (More Licenses to Firms deemed Ineligible by CAG)/Less Corrupt Areas



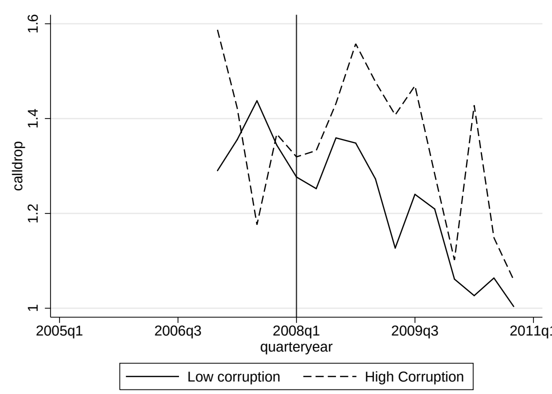
(a) Subscribers



(b) HHI

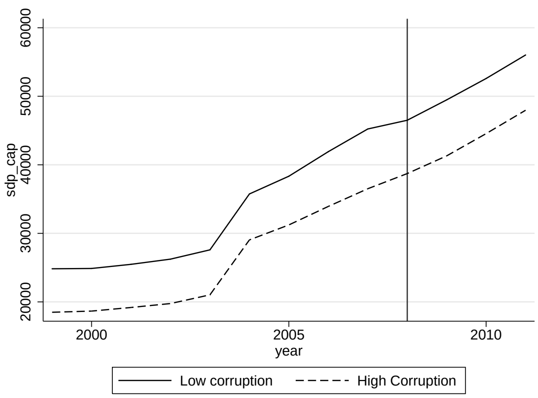


(c) Price (Rs/minute)

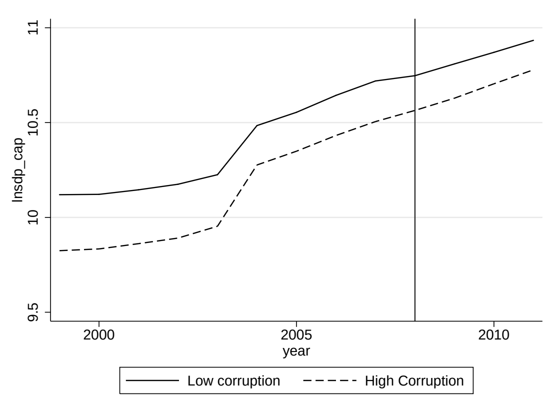


(d) Percent Calls Dropped

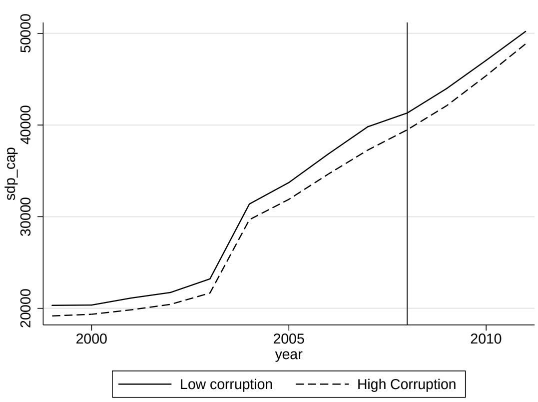
Figure 2: Outcomes over Time in More Corrupt (More Licenses to CBI Indicted Firms)/Less Corrupt Areas



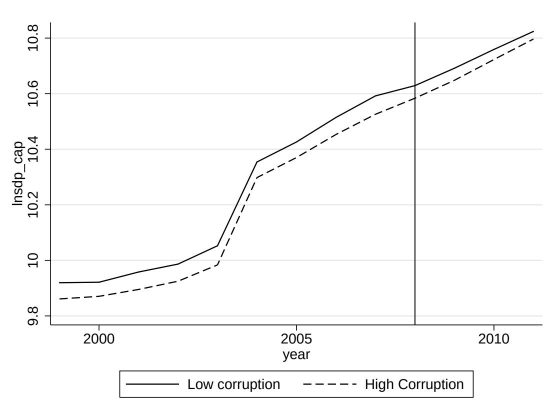
(a) GDP/capita



(b) Log GDP/capita



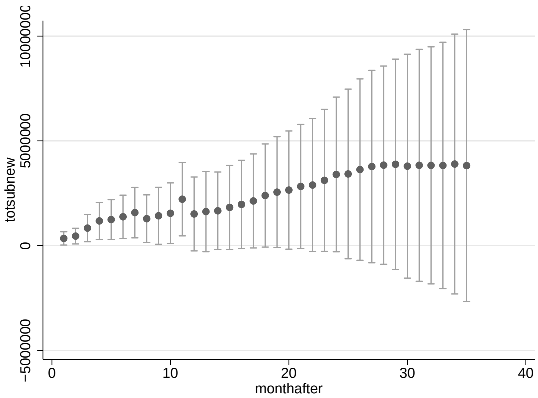
(c) GDP/capita



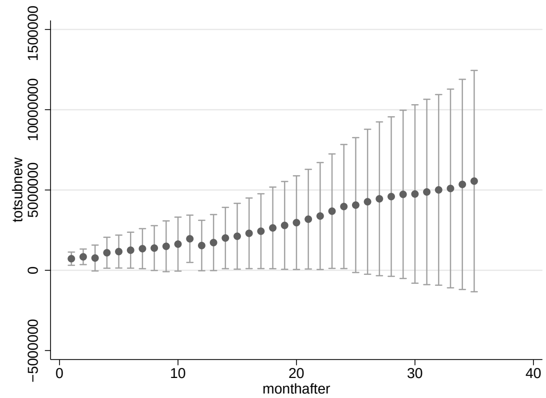
(d) Log GDP/capita

Figure 3: GDP/capita Trends

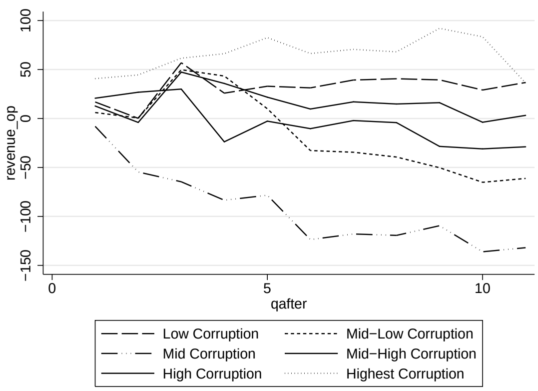
In panels (a) and (b), high corruption refers to areas where relatively more licenses were declared ineligible by the CAG. In panels (c) and (d), high corruption refers to areas where relatively more firms were indicted by the CBI.



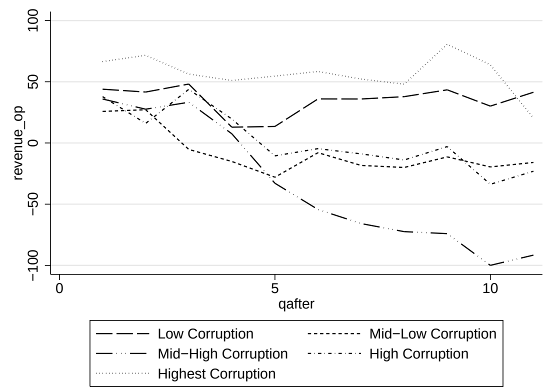
(a) Subscribers



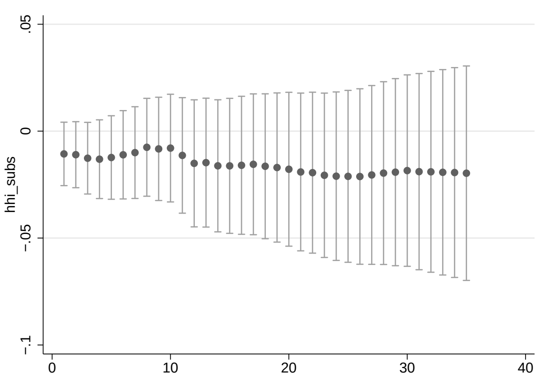
(b) Subscribers



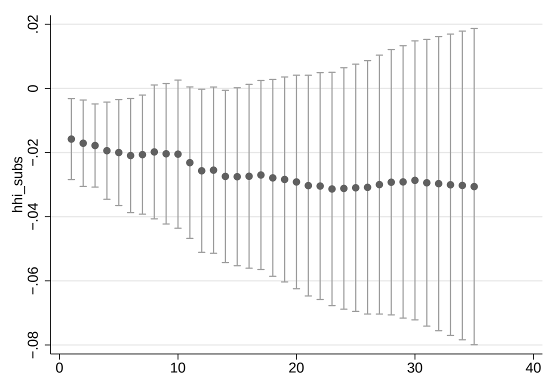
(c) Operator Revenues (Rs 10 Million)



(d) Operator Revenues (Rs 10 Million)



(e) HHI



(f) HHI

Figure 4: Dynamics of Post Period in More Corrupt Areas

Plots coefficients on indicators for month/quarter post license allocation in corrupt areas. Panels (a), (b), (e) and (f) also plot standard errors. In panels (a), (c), and (e), more corrupt areas are those where relatively more licenses were declared ineligible by the CAG, while in panels (b), (d), and (f), they are areas where relatively more firms were indicted by the CBI. The lowest corruption region is the comparison region in panels (c)-(d).

Table 1: Licenses Allocated by Region

	New Licenses Awarded	# of Existing Licenses	Defense Priority	CAG deemed Ineligible			CBI Indicted			Circle Category
				#	Cat	Prop	#	Cat	Prop	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Andhra Pradesh	6	7	0	4	1	0.67	3	1	0.50	A
Assam	7	5	1	4	1	0.57	3	1	0.43	C
Bihar	6	7	0	5	1	0.83	3	1	0.50	C
Delhi	6	7	1	4	1	0.67	3	1	0.50	Metro
Gujarat	5	7	1	4	1	0.80	3	1	0.60	A
Himachal Pradesh	5	7	1	4	1	0.80	2	0	0.40	C
Haryana	6	7	0	4	1	0.67	3	1	0.50	B
Jammu & Kashmir	7	5	1	4	1	0.57	3	1	0.43	C
Karnataka	6	7	0	4	1	0.67	3	1	0.50	A
Kerala	5	7	0	4	1	0.80	3	1	0.60	B
Kolkata	5	6	1	3	0	0.60	2	0	0.40	Metro
Madhya Pradesh	5	6	1	4	1	0.80	3	1	0.60	B
Maharashtra	6	7	0	4	1	0.67	3	1	0.50	A
Mumbai	4	8	1	3	0	0.75	2	0	0.50	Metro
North East Region	7	5	1	4	1	0.57	3	1	0.43	C
Orissa	6	6	1	4	1	0.67	2	0	0.33	C
Punjab	5	8	1	3	0	0.60	3	1	0.60	B
Rajasthan	4	8	1	4	1	1.00	3	1	0.75	B
Tamil Nadu	6	6	0	4	1	0.67	3	1	0.50	A
Uttar Pradesh (E)	5	7	0	4	1	0.80	3	1	0.60	B
Uttar Pradesh (W)	5	7	0	4	1	0.80	3	1	0.60	B
West Bengal	5	6	1	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 deemed 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" based on the number of illegitimate licenses. "Prop" shows the proportion of licenses awarded that were considered illegitimate. "Defense priority" is an indicator for whether the region i) shares a border with hostile neighbors Pakistan, China, or Bangladesh ii) is a metropolitan area subject to terrorist attacks or iii) has major internal civil conflict led by armed Maoists. "Circle Category" is a TRAI grouping of telecom regions (known as "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: Variation in Licenses Across Regions

			Categories				Proportions			
	Number of Licenses		CAG Deemed Ineligible		CBI Indicted		CAG Deemed Ineligible		CBI Indicted	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Existing operators	-0.663***	-0.524**	-0.0578	0.0469	0.00355	0.0306	0.0781**	0.0840**	0.0679**	0.0626*
	(0.203)	(0.210)	(0.151)	(0.147)	(0.143)	(0.166)	(0.0335)	(0.0344)	(0.0287)	(0.0317)
Defense priority	-0.557**	-0.880**	-0.498**	-0.487**	-0.420**	-0.408	-0.00883	0.0286	-0.0186	0.0125
	(0.263)	(0.304)	(0.196)	(0.212)	(0.186)	(0.240)	(0.0435)	(0.0496)	(0.0373)	(0.0458)
Existing spectrum	-0.0129	0.00482	-0.0101	0.00755	-0.00683	-0.000548	-0.000875	0.000966	-0.000783	-0.000659
	(0.0210)	(0.0239)	(0.0156)	(0.0167)	(0.0148)	(0.0188)	(0.00347)	(0.00390)	(0.00297)	(0.00360)
Subscriber growth		0.0366		0.0229		0.0156		0.00195		0.00121
		(0.0344)		(0.0241)		(0.0271)		(0.00562)		(0.00518)
HHI		3.242		4.445*		0.445		0.435		-0.206
		(3.065)		(2.144)		(2.419)		(0.501)		(0.462)
Population		-5.56e-09		2.60e-09		9.82e-10		1.14e-09*		7.38e-10
		(3.67e-09)		(2.57e-09)		(2.90e-09)		(6.00e-10)		(5.54e-10)
R-squared	0.611	0.698	0.277	0.502	0.358	0.514	0.220	0.247	0.378	0.453
N	22	22	22	22	22	22	22	22	22	22

This table presents the correlates of different types of licenses allotted in January 2008 in the 22 telecom regions (or "circles") across India.
The dependent variable in columns 1-2 is the total number of new licenses allocated in a region, in columns 3-4 it is the number of new licenses allotted that were deemed ineligible by the CAG, in columns 5-6 it is the number of new licenses allotted whose recipient company officials have been indicted by the CBI. Columns 7-10 present the proportions of the illegitimately allotted new licenses to total new licenses.
"Existing operators" is the number of licensed cell phone providers in the region in January 2008. "Defense priority" is an indicator for whether the region i) shares a border with hostile neighbors Pakistan, China, or Bangladesh ii) is a metropolitan area subject to terrorist attacks or iii) has major internal civil conflict led by armed Maoists. "Existing spectrum" is the amount of spectrum allotted to current licensed operators.
"Subscriber growth" is the average monthly subscriber growth in the region in the year 2007. "HHI" is the Herfindahl-Hirschman Index for market share in the region in January 2008. "Population" is the total population in the region as per the 2001 census.
Standard errors reported in parentheses. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table 3: Summary Statistics and Balance

	Average	More corrupt	Less corrupt	Test of equality (p-value)	Units
	(1)	(2)	(3)	(4)	(5)
Subscribers	13,200,000	13,500,000	11,600,000	0.97	
	(12,600,000)	(13,400,000)	(7,978,902)		
Ln(subscribers)	15.86	15.82775	15.98328	0.40	
	(1.19)	(1.25)	(0.84)		
HHI	0.23	0.23	0.2	0.08	
	(0.08)	(0.08)	(0.03)		
Revenues	132.03	132.63	129.31	0.55	Rs 10 million
	(94.6)	(99.66)	(67.61)		
Ln(revenues)	4.54	4.51	4.69	0.41	
	(0.93)	(0.98)	(0.67)		
% calls dropped	1.32	1.37	1.12	0.60	
	(0.55)	(0.59)	(0.31)		
Voice quality	97.35	97.26	97.78	0.24	Index 1-100
	(1.2)	(1.28)	(0.59)		
Minutes used	431.05	419.69	442.40	0.17	Per month
	(51.13)	(51.35)	(49.09)		
Price/minute	0.77	0.82	0.71	0.55	Rupees
	(0.21)	(0.19)	(0.22)		

"More" and "less" corrupt refer to regions categorized in column 5 of Table 1. "p-value" is the p-value of the difference in outcomes in regions prior to January 2008.
"Subscribers" is the total number of wireless subscribers in a telecom region (monthly, 2005-10).
"HHI" is the Herfindahl-Hirschman index of market concentration (monthly, 2005-10).
"Revenues" are averages per operator across GSM operators in the region (quarterly, 2005-10).
All other variables are subscriber-weighted averages across all operators in the region.
"% calls dropped" is the percentage of calls that were cut off before speaking subscribers had terminated the call, while "voice quality" is the clarity of the sound transfer in a call measured on an index from 1-100 (both quarterly, 2007-10). "Minutes used" are the total number of minutes

Table 4: Subscribers and Revenues

	Subscribers				Revenues			
	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 x post	647,357	71,220	416,778	-22,149	17.99	25.01*	23.86	28.61**
	(414,917)	(304,027)	(457,242)	(338,081)	(13.71)	(13.67)	(15.17)	(13.87)
Adj R-squared	0.988	0.999	0.988	0.999	0.958	0.974	0.958	0.975
PANEL B: Dif-in-dif with proportion new licenses								
Corrupt x post	123,268	-1.469e+06	1.004e+06	-541,195	31.19	39.82	77.46*	89.04*
	(2.993e+06)	(2.355e+06)	(2.915e+06)	(2.220e+06)	(41.98)	(43.56)	(43.39)	(45.83)
Adj R-squared	0.988	0.999	0.988	0.999	0.957	0.974	0.958	0.974
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region x Time	No	Yes	No	Yes	No	Yes	No	Yes
N	1584	1584	1584	1584	1584	1584	1584	1584

The dependent variable in columns 1-4 is the total number of wireless telecom subscribers in a region-month. In columns 5-8 it is the log of subscribers. 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 in parentheses are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table 5: 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 x post	0.263**	0.148	0.194	0.0772	-0.431	-0.171	-0.275	-0.00657
	(0.106)	(0.149)	(0.135)	(0.147)	(0.381)	(0.398)	(0.368)	(0.374)
Adj R-squared	0.117	0.488	0.100	0.487	0.087	0.568	0.117	0.588
PANEL B: Dif-in-dif with proportion new licenses								
Corrupt x post	-1.655**	-1.842**	-1.665**	-1.994*	3.304*	3.652*	3.336**	3.989**
	(0.743)	(0.926)	(0.831)	(1.056)	(1.961)	(2.022)	(1.685)	(2.021)
Adj R-squared	0.112	0.511	0.102	0.508	0.097	0.568	0.083	0.586
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region x Time	No	Yes	No	Yes	No	Yes	No	Yes
N	352	352	352	352	352	352	352	352

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 quarters after Q1 2008. Standard errors in parentheses are multi-way clustered by quarter as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table 6: Prices and Minutes Used

	Price per minute				Minutes used			
	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 x post	-0.0221	0.0695	-0.0221	0.0695	52.34	53.36	52.34	53.36
	{0.873}	**{0.583}**	**{0.873}**	**{0.293}**	**{0.063}**	**{0.193}**	**{0.063}**	**{0.193}**
Adj R-squared	0.898	0.963	0.898	0.963	0.820	0.848	0.820	0.848
PANEL B: Dif-in-dif with proportion new licenses								
Corrupt x post	2.877	1.360*	1.816*	0.711	-474.8	-47.88	-408.5*	-218.7
	{0.213}	**{0.063}**	**{0.063}**	**{0.173}**	**{0.448}**	**{0.908}**	**{0.068}**	**{0.653}**
Adj R-squared	0.932	0.965	0.937	0.963	0.801	0.824	0.820	0.829
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region x Time	No	Yes	No	Yes	No	Yes	No	Yes
N	64	64	64	64	64	64	64	64

The dependent variable in columns 1-4 is the average price per minute in a circle-quarter, while that in columns 5-8 is the average number of minutes per subscriber per month 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. "Post" is an indicator for quarters after Q1 2008.

P-values from a wild cluster percentile-t bootstrap are reported in parentheses: * < 0.001, ** < 0.05, * < 0.01**

Table 7: Tracing Licenses

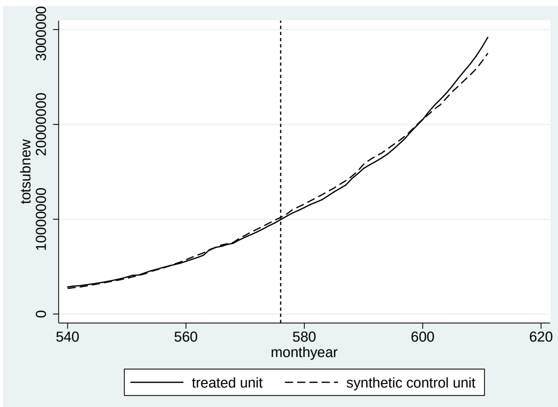
Original Company	Eventual Operator	# New Licenses	CAG deemed Ineligible	CBI Indicted
(1)	(2)	(3)	(4)	(5)
Adonis Projects Pvt. Ltd.	Uninor	6	1	1
Allianz Infratech Pvt. Ltd.	Etisalat	2	1	1
Aska Projects Ltd.	Uninor	3	1	1
Azare Properties Ltd.	Uninor	1	1	1
Datacom Solutions Pvt. Ltd.	Videocon	21	1	0
Hudson Properties Ltd.	Uninor	1	1	1
Idea Cellular Ltd.	Idea	9	0	0
Loop Telecom Private Ltd.	Loop	21	1	1
Nahan Properties Pvt. Ltd.	Uninor	6	1	1
S Tel Ltd.	S Tel	6	1	0
Shyam Telelink Limited	Sistema Shyam	21	0	0
Spice Communications Ltd.	Idea	4	0	0
Swan Telecom Pvt. Ltd.	Etisalat	13	1	1
Tata Teleservices Ltd.	Tata Docomo	3	0	1
Unitech Builders & Estates Pvt. Ltd.	Uninor	1	1	1
Unitech Infrastructures Pvt. Ltd.	Uninor	1	1	1
Volga Properties Pvt. Ltd.	Uninor	3	1	1

This table lists the original recipients of all 122 licenses granted in 2008, as well as the eventual operators of wireless telecom service using these licenses. The shaded rows represent instances where the original and eventual company is the same entity. Note that Tata Teleservices and S Tel both sold equity to other entities but retained over 50%.

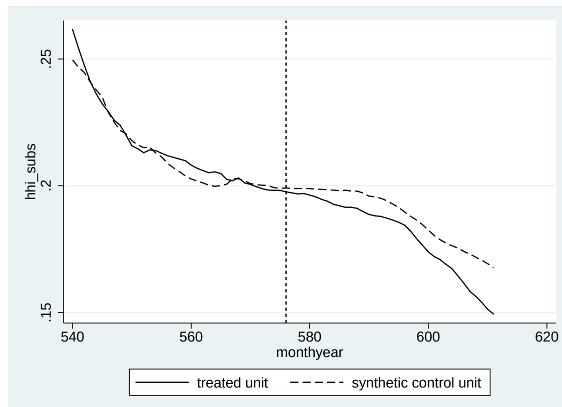
Table 8: HHI

	CAG Deemed Ineligible		CBI Indicted	
	(1)	(2)	(3)	(4)
PANEL A: Simple dif-in-dif				
Corrupt x post	-0.0108	0.00478	-0.0199**	-0.00812
	(0.00989)	(0.0100)	(0.00808)	(0.0107)
Adj R-squared	0.926	0.974	0.927	0.974
PANEL B: Dif-in-dif with proportion new licenses				
Corrupt x post	-0.0921	-0.0389	-0.134*	-0.0760***
	(0.0642)	(0.0272)	(0.0698)	(0.0282)
Adj R-squared	0.928	0.974	0.929	0.975
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Region x Time	No	Yes	No	Yes
N	1584	1584	1584	1584

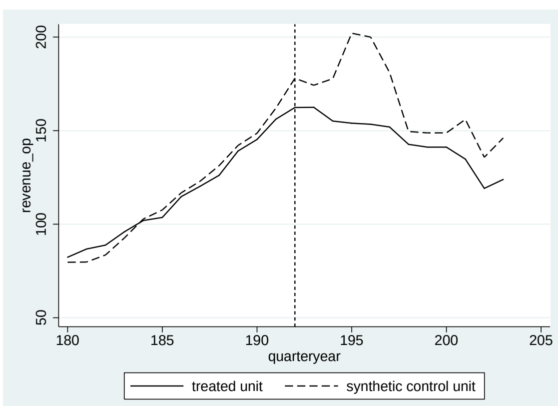
The dependent variable in all columns is the Herfindahl-Hirshman index for market share of wireless subscribers in a region-month. In Panel A, "Corrupt" is an indicator for whether the region has a high number of illegitimately allotted licenses as determined by the CAG or CBI. In Panel B, "Corrupt" 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 in parentheses are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01



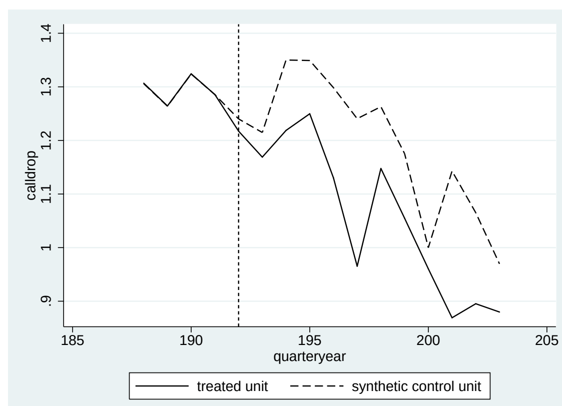
(a) Subscribers



(b) HHI

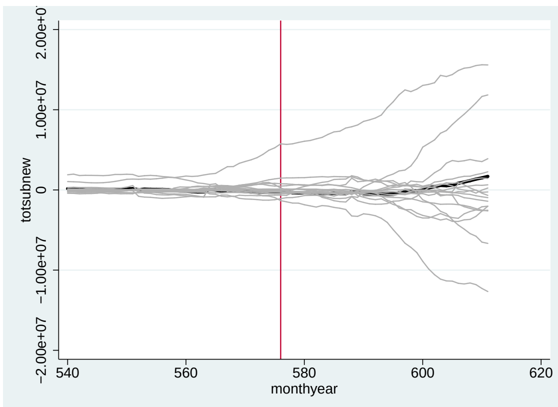


(c) Operator Revenues (Rs 10 Million)

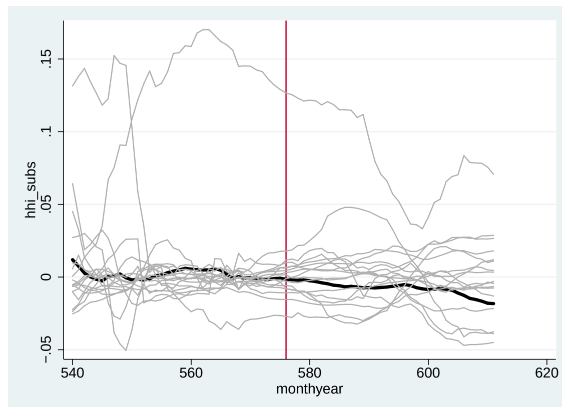


(d) Percent Calls Dropped

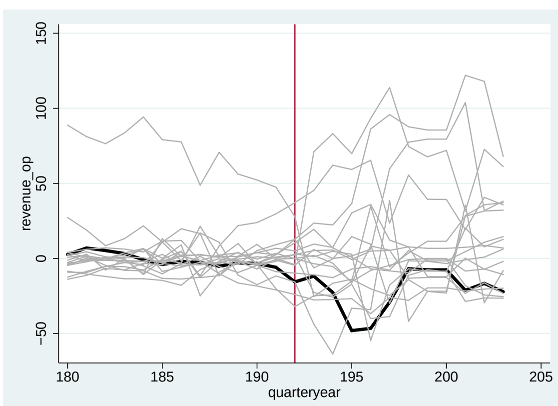
Figure A.1: Comparing Treatment and Synthetic Control Group Outcomes (where control group is areas where more firms were deemed ineligible by CAG)



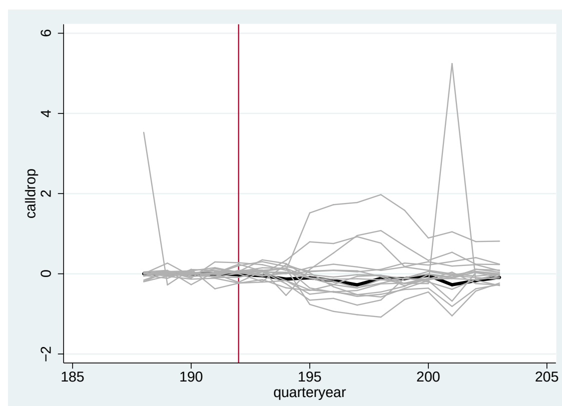
(a) Subscribers



(b) HHI

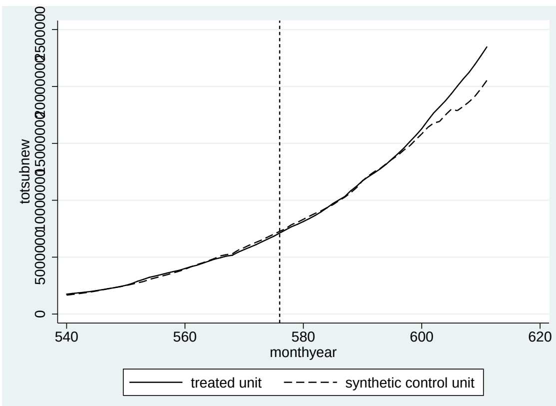


(c) Operator Revenues (Rs 10 Million)

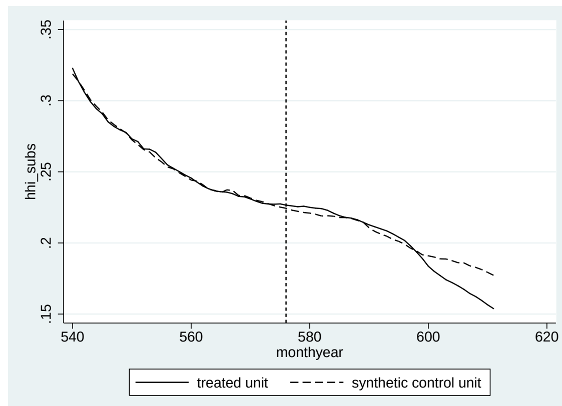


(d) Percent Calls Dropped

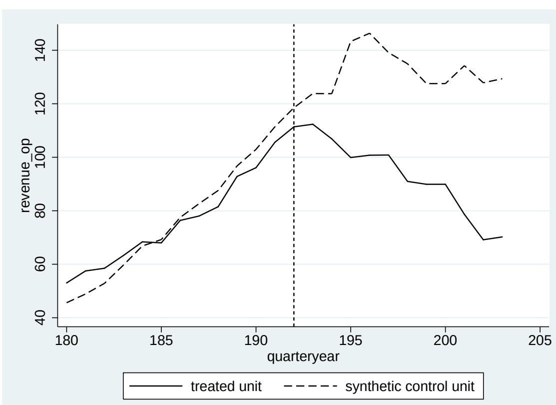
Figure A.2: Synthetic Control Method Inference (CAG): Comparing Treatment-Control Gaps to Placebo Gaps



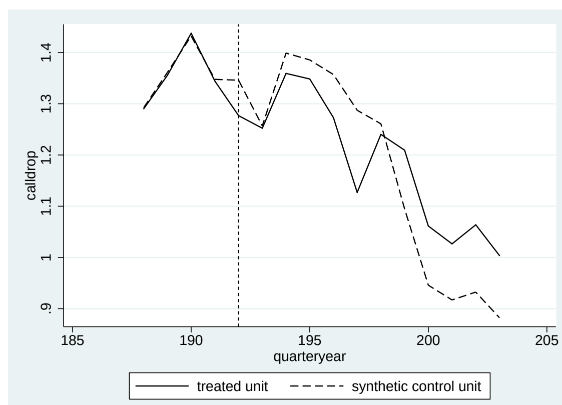
(a) Subscribers



(b) HHI

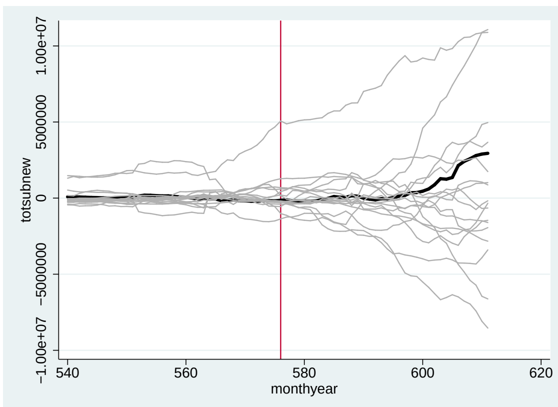


(c) Revenues (Rs 10 Million)

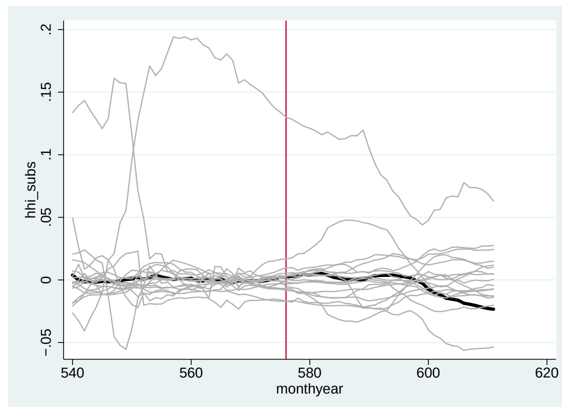


(d) Percent Calls Dropped

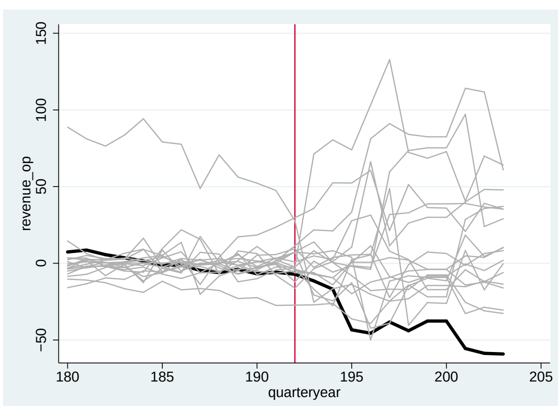
Figure A.3: Comparing Treatment and Synthetic Control Group Outcomes (where control group is areas where more firms were indicted by CBI)



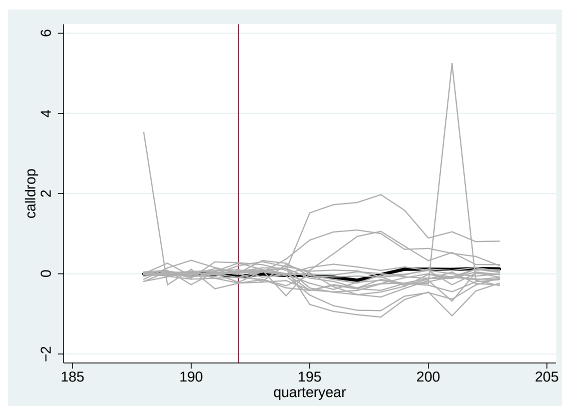
(a) Subscribers



(b) HHI



(c) Revenues (Rs 10 Million)



(d) Percent Calls Dropped

Figure A.4: Synthetic Control Method Inference (CBI): Comparing Treatment-Control Gaps to Placebo Gaps

Table A.1: 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.
Standard errors reported in parentheses.
p-values: *** < 0.001, ** < 0.05, * < 0.01

Table A.2: Basic Difference-in Differences Specification for Outcomes in Tables 5, 6, and 10

	Subscribers		Percent calls dropped		Voice quality		Revenues		HHI	
	CAG	CBI	CAG	CBI	CAG	CBI	CAG	CBI	CAG	CBI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
PANEL A: Simple dif-in-dif										
Corrupt	516,739	2.478e+06**	0.0369	0.000772	-0.181	-0.355	-63.06	76.65	0.0403*	-0.0116
	(1.028e+06)	(1.122e+06)	(0.169)	(0.172)	(0.269)	(0.265)	(96.54)	(95.48)	(0.0208)	(0.0325)
Post	-2.286e+06	-3.840e+06	0.0935	0.174	-0.584*	-0.775**	-234.0**	-249.1**	0.0307	0.00556
	(3.017e+06)	(3.301e+06)	(0.0982)	(0.113)	(0.355)	(0.370)	(96.78)	(98.08)	(0.0200)	(0.0239)
Corrupt x post	3.237e+06	5.921e+06**	0.263**	0.194	-0.431	-0.275	135.9**	179.4***	-0.0125	0.0211
	(2.570e+06)	(2.720e+06)	(0.106)	(0.135)	(0.381)	(0.368)	(60.04)	(50.48)	(0.0150)	(0.0217)
Adj R-squared	0.522	0.557	0.117	0.100	0.087	0.097	0.436	0.498	0.208	0.179
PANEL B: Dif-in-dif with proportion new licenses										
Corrupt	3.635e+06	1.242e+07**	1.715**	1.576	-0.0897	-0.947	74.77	560.0*	-0.187	-0.370***
	(4.169e+06)	(4.943e+06)	(0.869)	(1.137)	(0.747)	(0.953)	(253.4)	(309.7)	(0.154)	(0.140)
Post	-1.637e+07**	-1.625e+07***	1.502**	1.163**	-3.096*	-2.512**	-406.6***	-446.0***	-0.0822	-0.125***
	(7.190e+06)	(5.938e+06)	(0.587)	(0.486)	(1.626)	(1.140)	(113.6)	(103.5)	(0.0652)	(0.0426)
Corrupt x post	2.492e+07**	3.559e+07***	-1.655**	-1.665**	3.304*	3.336**	423.2**	724.8***	0.142	0.278***
	(1.019e+07)	(1.066e+07)	(0.743)	(0.831)	(1.961)	(1.685)	(175.4)	(168.5)	(0.103)	(0.0979)
Adj R-squared	0.545	0.581	0.112	0.102	0.117	0.083	0.071	0.082	0.215	0.293
N	1584	1584	352	352	352	352	528	528	1584	1584

Presents the basic diffference-in-differences specification, with no region or time fixed effects, for the main paper outcomes. The only other control variable included is the total amount of spectrum allocated in the region.
Standard errors in parentheses are multi-way clustered by time as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table A.3: Basic Dif-in-Difs Specification for Price and Minutes Used

	Price		Minutes	
	CAG	CBI	CAG	CBI
	(1)	(2)	(3)	(4)
PANEL A: Simple dif-in-dif				
Corrupt	-0.03	-0.03	9.95	9.95
	{0.61}	**{0.61}**	**{0.59}**	**{0.59}**
Post	-0.28	-0.28	-27.77	-27.77
	{0.52}	**{0.52}**	**{0.01}**	**{0.01}**
Corrupt x post	0.03	0.03	73.57	73.57
	{0.74}	**{0.74}**	**{0.11}**	**{0.11}**
Adj R-squared	0.462	0.462	0.74	0.74
PANEL B: Dif-in-dif with proportion new licenses				
Corrupt	-0.74	-0.75	-133.23	-78.68
	{0.16}	**{0.16}**	**{0.53}**	**{0.15}**
Post	-2.57	-1.22	156.84	124.63
	{0.01}	**{.31}**	**{0.72}**	**{0.50}**
Corrupt x post	3.46	2.03	-278.89	-331.81
	{0.74}	**{0.61}**	**{0.72}**	**{0.40}**
Adj R-squared	0.82	0.812	0.188	0.259
N	64	64	64	64

Presents the basic diffference-in-differences specification, with no region or time fixed effects, for the main paper outcomes. The only control variable included is the total amount of spectrum allocated in the region.

P-values from a wild cluster percentile-t bootstrap are reported in parentheses.

Table A.4: Subscribers

	Levels				Logs			
	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 x post	2.630e+06	2.724e+06	5.017e+06*	2.792e+06	0.227	0.147	0.0549	0.161*
	(2.436e+06)	(1.789e+06)	(2.656e+06)	(1.893e+06)	(0.148)	(0.102)	(0.145)	(0.0912)
Adj R-squared	0.863	0.922	0.869	0.922	0.974	0.985	0.972	0.985
PANEL B: Dif-in-dif with proportion new licenses								
Corrupt x post	7.437e+06	170,964	1.369e+07*	1.132e+06	0.224	0.303	-0.0193	0.427
	(5.321e+06)	(2.171e+06)	(7.441e+06)	(3.216e+06)	(0.151)	(0.228)	(0.252)	(0.312)
Adj R-squared	0.864	0.921	0.867	0.921	0.972	0.985	0.972	0.985
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region x Time	No	Yes	No	Yes	No	Yes	No	Yes
N	1584	1584	1584	1584	1584	1584	1584	1584

The dependent variable in columns 1-4 is the total number of wireless telecom subscribers in a region-month. In columns 5-8 it is the log of subscribers. 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 the region received new spectrum.*** Standard errors in parentheses are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table A.5: 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 x post	0.244*	0.300	0.161	0.255	-0.222	-0.0800	1.254	0.506
	(0.135)	(0.199)	(0.119)	(0.178)	(0.341)	(0.287)	(0.882)	(0.619)
Adj R-squared	0.494	0.529	0.490	0.528	0.569	0.728	0.579	0.729
PANEL B: Dif-in-dif with proportion new licenses								
Corrupt x post	-0.00788	0.380	-0.0549	0.485	-0.0772	-0.292	1.594	0.365
	(0.433)	(0.354)	(0.532)	(0.467)	(0.316)	(0.316)	(1.006)	(0.641)
Adj R-squared	0.487	0.528	0.487	0.527	0.568	0.729	0.579	0.728
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region x Time	No	Yes	No	Yes	No	Yes	No	Yes
N	352	352	352	352	352	352	352	352

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 the region received new spectrum.***

Standard errors in parentheses are multi-way clustered by quarter as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table A.6: Revenues

	Levels				Logs			
	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 x post	110.6	22.25	151.1**	20.42	0.346	0.100*	0.383*	0.0813
	(71.68)	(30.96)	(65.63)	(24.61)	(0.229)	(0.0588)	(0.209)	(0.0602)
Adj R-squared	0.910	0.990	0.915	0.990	0.935	0.981	0.937	0.981
PANEL B: Dif-in-dif with proportion new licenses								
Corrupt x post	105.7	-15.17	258.8	-14.08	0.187	0.218***	0.531**	0.299***
	(122.6)	(18.88)	(193.0)	(22.58)	(0.218)	(0.0830)	(0.258)	(0.113)
Adj R-squared	0.907	0.990	0.909	0.990	0.930	0.981	0.931	0.981
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region x Time	No	Yes	No	Yes	No	Yes	No	Yes
N	528	528	528	528	528	528	528	528

The dependent variable in columns 1-4 is revenues per operator for GSM operators only in a region-quarter. In columns 5-8 it is the log revenue per GSM operator. 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 quarters after the region received new spectrum.***

Standard errors in parentheses are multi-way clustered by quarter as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table A.7: HHI

	CAG Deemed Ineligible		CBI Indicted	
	(1)	(2)	(3)	(4)
PANEL A: Simple dif-in-dif				
Corrupt x post	-0.0158	-0.00184	0.00204	-0.00964
	(0.0168)	(0.00677)	(0.0194)	(0.00604)
Adj R-squared	0.778	0.907	0.776	0.907
PANEL B: Dif-in-dif with proportion new licenses				
Corrupt x post	0.00945	-0.0192	0.0533	-0.0313
	(0.0246)	(0.0221)	(0.0359)	(0.0286)
Adj R-squared	0.777	0.907	0.779	0.907
Region FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Region x Time	No	Yes	No	Yes
N	1584	1584	1584	1584

The dependent variable in all columns is the Herfindahl-Hirshman index for market share of wireless 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 the region received new spectrum.***
Standard errors in parentheses are multi-way clustered by month as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01

Table A.8: Subscribers and Revenues in Logs

	Subscribers				Revenues			
	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 x post	0.0105	-0.0281	0.0307	0.00916	0.0992*	0.0701	0.0141	-0.00617
	(0.0557)	(0.0370)	(0.0471)	(0.0355)	(0.0550)	(0.0661)	(0.0416)	(0.0611)
Adj R-squared	0.994	0.998	0.994	0.998	0.981	0.989	0.981	0.989
PANEL B: Dif-in-dif with proportion new licenses								
Corrupt x post	0.343	0.273*	0.453*	0.384**	0.186	0.148	0.0699	0.0197
	(0.221)	(0.158)	(0.257)	(0.179)	(0.400)	(0.321)	(0.456)	(0.288)
Adj R-squared	0.995	0.998	0.995	0.998	0.981	0.989	0.981	0.989
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region x Time	No	Yes	No	Yes	No	Yes	No	Yes
N	528	528	528	528	528	528	528	528

The dependent variable in columns 1-4 is revenues per operator for GSM operators only in a region-quarter. In columns 5-8 it is the log revenue per GSM operator. 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 quarters after Q1 2008. Standard errors in parentheses are multi-way clustered by quarter as well as region. p-values: *** < 0.001, ** < 0.05, * < 0.01