Criminal Producers, Silent Inspectors, and Surprised Regulators: Explaining California's Unexpected Power Crisis of 2000-2001

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"The massive cover-up by generators is unraveling. The evidence of manipulation unearthed is so overwhelming… just how egregiously and extensively California was plundered, defrauded, and ripped-off by the energy pirates..."
California Attorney General Bill Lockyer[1]

"This evidence… is just the tip of the iceberg… there is a snake under almost every rock one turns."[2]

Abstract

We argue that the California power crisis of May 2000 – June 2001 resulted from strategic capacity withholding by power producers. Withholding information was hidden due to inspectors-producers collusion, and, thus, did not reach the regulators. Inspectors-producers collusion also explains regulators' surprise in the face of the crisis. We suggest deregulated power markets may suffer from this collusion when power demand is high enough. However, when demand is low, producers do not manipulate the market.

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[1] California Attorney General web-site at: http://caag.state.ca.us/newsalerts/2003/03-023.htm.

1. Introduction

During the period May 2000 – June 2001, California underwent a severe power reserve shortage (Sheffrin 2001b). As a result of this shortage, electricity prices rose to unprecedented levels. The reserve shortage impacted more than the price of electricity; it threatened the reliability of California's entire power system: from 1998 to 1999, California declared 17 emergencies, none of which were rated as Stage 3, which requires involuntary curtailments of demand. However, from 2000 to 2001, California declared 265 emergencies, 39 of which were Stage 3 Emergencies. Between November 1, 2000, and May 31, 2001, California power authorities ordered power blackouts and service interruptions on 38 days. These blackouts and service interruptions severely disrupted commerce and compromised public safety, affecting roughly one-third of all Californians.[3]

However, the severe reserve shortage and the resultant crisis were largely *unexpected* prior to 2000 (see, for example, CEC 1997; DOE 1999 and 2001a; Joskow 1997 and 2000).[4,5] Moreover, unlike previous price spikes and reliability problems, observed in other US power markets (see survey at DOE 2001b), these phenomena were not transient or for a few days (or weeks) duration. Rather, they were a persistent series of events, enduring more than a year.

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[2] FERC (2003c, p. 8).

[3] These supply reliability problems included the first rolling blackouts in California since World War II, hitting Northern California on January 17 and 18, 2001, Southern California on March 19 and 20, and throughout the State on May 7 and 8, the same year.

[4] Electricity producers were key players in persuading regulators, politicians, and others that the then (late 1990's) California power capacity was sufficient, and should have been expected to fulfill State needs through 2000 and on. For example, in 1995, Southern California Edison successfully appealed to FERC to block the development of 1,400 megawatts of new capacity, claiming that it would not need this power until 2005 (FTCR 2002, p. 52). Other electricity producers have intervened and slowed the State's licensing of 12 of the 21 power plant proposals since 1997 (ibid.). In 1996, PG&E, the nation's largest utility, estimated that its customers would see their bills drop from the then average of $65 per month to $50 per month in 2001, as an outcome of market deregulation (Greg Lucas, "State Panel Approves Restructure of Electricity Industry." San Francisco Chronicle, 28/8/96, at A13.

[5] Rosen and Sverrisson (1999) and Rudkevich, Duckworth, and Rosen (1998) are exceptional with their early criticism on regulators' ignorance as to the potential danger of strategic bidding in power markets. See also Lave and Perekhodtsev (2001).

Joskow and Kahn (2001) state some changes in supply and demand conditions that "would suggest that prices *should have been expected* to increase..." (ibid., p. 2), such as increases in natural gas prices, and decreases in power imports available to California. Furthermore, the multi-annual increase in power demand resulting from economic and population growth, the development of the High-Tech economy, which consumes huge amounts of electricity (see: DOE 2001a), as well as the gloomy power supply situation in the West in general, and in California in particular – were all common knowledge at least as early as 1998, while the increase in natural gas prices and the decrease in power imports available to California from the North (mainly due to a lack of sufficient amounts of rain in Oregon and Washington) had become common knowledge, at least as early as October 1999.

Hence, if California's power reserve shortage and the resultant power crisis "...should have been expected..." – as Joskow and Kahn (2001) argued, how can one explain the ultimate surprise they caused. Moreover, how can one explain the unrealistic market forecasts and predictions made by various State and Federal regulators and politicians, as well as industry experts, who largely predicted stability for the California power market for 2000-2001, with decreasing production costs and declining electricity prices, in addition to their failure to foresee the upcoming crisis.[6]

The California Deregulation Act (see: Assembly Bill [California] No. 1890) specifically defined the bodies responsible for forecasting electricity supply, demand, and imbalances between generation and transmission:

> It is the further intent of the Legislature to direct the Independent System Operator (ISO) to… be able to secure the generation and transmission resources needed to achieve specified planning and operational reserve criterion[7]

[6] For these expectations see, for example, Joskow (1997; 2000), and California State Assembly (1996). Note that during the entire conference hearing on the Assembly Bill (AB 1890), "not a single word was spoken in opposition" of it (Okenfuss 2001, p. 2).

[7] Assembly Bill [California] No. 1890, Ch. 854, Section 1, C.

> The Commission [the California Public Utilities Commission or CPUC]... seeks the authority needed to give the Independent System Operator the ability to secure generating and transmission resources necessary to guarantee achievement of planning and operating reserve criteria[8]

Furthermore, State rules require power plant operators to notify the California Independent System Operator of “scheduled” or planned shutdowns in advance, and allow the ISO to *monitor and inspect* any unexpected or unplanned shutdown.

In this chapter, we explain the above-mentioned surprise by using a model of crime control in a corrupt regime.[9] We argue that whenever some specific market conditions are fulfilled, namely, when power demand is high enough (i.e., reserves are smaller than some level), power producers may benefit from illegally withholding power capacity from the market,[10] that is, producers may lie – to the regulators, and the consumers – regarding the size of available capacity each producer has, in order to increase their profits.[11] For example, California regulators found a suspicious pattern of producers’ behavior: whenever California declared a Stage 1 Emergency--meaning that electricity reserves dropped below 7% of power demand--plants that did not need repairs were suddenly taken offline (FERC 2001b; 2002b).[12] In order to inspect the (potentially criminal) producers, the Governor and his

[8] Assembly Bill [California] No. 1890, Ch. 895, Article 6, 360.

[9] For the relevant literature see: Rose-Ackerman (1975); Cadot (1987); Basu et al. (1992); Marjit et al. (2000); and Mookherjee and Png (1992; 1994; 1995).

[10] Holding back essential services from consumers, be they residents or businesses, is a form of extortion, violating, among other things, the Federal Power Act (sections 203, 205, and 206), California's Commodity Exchange Act, the terms and conditions of producers’ filed tariffs (with the Federal Energy Regulatory Commission, FERC, the California ISO, and the California Power Exchange), companies’ codes of conduct, FERC standards of conduct, the Secretary of Energy Emergency Orders of December 2000 and January 2001 ("DOE Orders"), as well as numerous State and Federal antitrust and fraud laws, see FERC (2003b).

[11] Potential profits at stack are indeed huge: according to consumer groups’ calculations (see: FTCR 2002), California’s power generators and marketers managed to earn an extra sum of more than $71 billion out of California’s crisis: $8.5 billion came from taxpayers, $40 billion came from ratepayers, and $23 billion were paid through the initial utilities bailout, contained in the 1996 deregulation legislation (see: Assembly Bill [California] no. 1890). See also: “Enron, Dynegy report strong earnings from power trading, especially in West”, Wall Street Journal, October 18, 2000.

[12] Moreover, workers at a Duke power plant submitted evidence to the State Senate that its managers had ordered them to leave units idle and to rapidly cut back power production during severe power shortages for economic rather than operational and maintenance reasons. These workers also argued that managers encouraged them to operate the plant in a way that *would technically damage it*,

regulators appoint inspectors. Whenever the inspector acquires evidence on a criminal activity, and submits it to the regulators, he is entitled to a reward, and the criminal has to pay a fine.[13] However, a common assumption in the literature is that inspectors are corruptible (see, for example, Basu et al. 1992; Marjit et al. 2000), that is, upon acquiring evidence on an illegal withholding of power, the inspector has to choose between reporting the evidence to the regulator and receiving a reward, or colluding with the criminal, and thus receiving a bribe. Collusion between an inspector and a criminal generates corruption (and bribe). Corrupt inspectors are therefore penalized by regulators, whenever evidence on bribery leaks out. In this case, of course, the culprit is also penalized.[14]

In this context, some of the important conclusions reached by the literature are that (i) the inspector has an incentive to enable crime, and that (ii) control of crime in general is not possible. For example, Mookherjee and Png (1995) show that if corruption is initially profitable, an increase in the penalty on the inspector for colluding with a criminal may raise the size of the bribe, rather than reduce corruption. Marjit and Shi (1998) show that an increase in the penalty would reduce the inspection effort carried out by the inspector, resulting eventually in encouraging crime.

We argue that the power regulators were taken by surprise by the severe power reserve crisis over the period May 2000–June 2001 due to collusion between power producers (the criminals) and their inspectors. The inspectors-criminals collusion implies that whenever an

resulting in "legitimate" long off-line periods, which were lucrative for Duke (see: Kimberly Kindy, "Three say company purposely cut power." Orange County Register, June 22, 2001; Lynda Gledhill, "Ex-workers say plant exploited power flow." San Francisco Chronicle, June 23, 2001; Carolyn Said, "Why suppliers get away with huge profits", San Francisco Chronicle, July 2, 2001; and the discussion in section 5, below).

[13] At the peak of the crisis, some consumer groups called on the Governor to seize those power plants, shown to be deliberately kept off-line (see: FTCR 2002, p. 7). Yet, such seizures were never executed.

[14] Basu et al. (1992) study the problem of recursive corruption, or the existence of many (an infinitely large number of) corruptible inspectors ("law enforcers"), who double-inspect each other. However, allowing for recursive corruption considerably complicates the model without altering its main conclusions; see also Mookherjee and Png (1994; 1995).

inspector acquires evidence on market manipulation, he does not deliver it to the regulators. In return, the inspector collects a bribe from the criminal. The regulators, lacking the withholding information, search for the crisis causes and cures in the wrong places. We argue that inspectors and producers may collude when power demand is high enough, that is, reserves are low enough (yet not necessarily in a shortage, see below). However, when power demand is low (reserves are high), producers do not manipulate the market and collusion is eliminated.

We study the conditions for the power producers to commit a crime, that is, to close a technically-operative plant, claiming it suffers some operational difficulties (see note 10), and the conditions for the inspector to act corruptly, that is, to hide the evidence against the criminal in return for a bribe. When both of these conditions are fulfilled, the regulators, lacking relevant information, look for the causes and cures for the crisis in the wrong places. For example, the FERC, the Federal regulator, initially explained California's power crisis mainly as an outcome of polar temperatures in Western US, low stream-flow levels in Western rivers, raising demand for power, and price increases in the California natural-gas markets (FERC 2001a). Only when the first leaks of evidence on crime occurred (by the producers' former employees, see section 5 below), did the regulators manage to locate the central causes for the crisis and react accordingly. However, by this time, the cost to Californians was so high that some believe it may have exceeded the costs emanating from OPEC's two oil shocks of the 1970's (Faruqui et al. 2001).

After analyzing the inspector-criminal game, we proceed to analyze the regulator's behavior. The regulator is assumed to be a Stackelberg leader, choosing the levels of the fines on corruption and crime, and the reward for the crime-reporting inspector before the inspector-criminal game begins. The regulator is primarily interested in decreasing the scope of crime. We show that under some specific conditions, the first-best solution for the regulator's problem is impossible to achieve: the regulator cannot use his position as a Stackelberg leader in order to persuade the inspector to act honestly, and, thus, cannot guarantee a minimal scope of crime. Thus, the regulator has to turn to the second-best option, employing a dishonest inspector. In this case, the corrupt inspector generates a pooling equilibrium in the market: those producers who are better skilled with regards to their crime-disguising abilities commit a crime, while those having lower crime-disguising abilities do not manipulate the market. We obtain the result that the corrupt inspector restricts the level of crime, compared to a case without any inspector; however, he does not report the evidence of crime to the regulator. The corrupt inspector's silence as to the market manipulations explains, in turn, the regulator's surprise in the face of the reserve crises.

The rest of this chapter is organized as follows. Section 2 starts by supplying the regulatory background and the market structure for California's electricity crisis of 2000 and 2001. In section 3 we present the model, focusing on the inspector-producer game. The regulator's behavior is analyzed in section 4. Then, in section 5, we supply some data, which supports the conclusions reached in the previous sections. Section 6 then offers some concluding remarks.

2. Regulatory background and market structure

The California electricity crisis of 2000 and 2001 followed the deregulation initiative of the electricity market in the State, which was signed into law in 1996 (see: Assembly Bill [California] No. 1890). One of the fundamental elements of this initiative was encouraging the State's power utilities to sell off most of their fossil fueled power plants, mainly to independent power producers (IPPs). The utilities remained responsible for power distribution and for supplying the lion's share of retail demand through their universal service obligation as the default power providers.

Specifically, California's three power utilities, Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E), sold-off most of their fossil-fueled generation capacity (15,630 megawatts) to five newly entrant IPPs: Duke, Dynegy, Mirant, Reliant, and a partnership between AES Corp. and Williams Inc.[15] Consequently, during the period we study here, the three utilities remained obligated to supplying the bulk of California's power demand, while their own generation units covered approximately 40% of the demand they faced, which resulted in their dependence on the IPPs' generating capacity (Berry 2003; Lockyer 2004).

Moreover, according to the 1996 deregulation scheme, wholesale prices were deregulated, determined through a uniform price auction, yet retail prices remained regulated and capped. In this case, the IPPs managed to manipulate the market by withholding some of their power capacity (see also section 5 below), in order to create false scarcity in the wholesale market, which increased wholesale power prices and, eventually, their profits.

A Sketch of the Market

Due to the divestiture of most of their fossil-fueled power plants, the three California investor-owned-utilities, PG&E, SCE, and SDG&E, could not supply their customers' demand out of their own generation resources. Thus, they became dependent on the IPPs, which controlled 60% of in-State non-utility power generation. A large and heterogeneous set of other power generators and marketers (the "competitive fringe") controlled the remaining 40% (FERC 2003b, see also Tables 3 and 5 below). The latter group includes, for example, municipal authorities, such as the Los Angeles Department of Water and Power (LADWP), irrigation districts, small power marketers, cogenerators, and power importers (Fox-Penner 2003). The FERC found that some 124 entities other than the "Big Five" IPPs

[15] Williams markets and dispatches the energy made available by AES under the terms of the Tolling

either generated or traded power in California between May 1, 2000 and June 30, 2001 (FERC 2003a).

There are two main bodies of evidence showing that the five big producers coordinated their behavior in the California power markets (Berry 2003; Fox-Penner 2003; Hanser 2003):

1. A set of written agreements between the power producers, designed to enable manipulative trading strategies, and communications between the parties to these agreements. Here is a part of one of these written agreements:

> The parties shall provide to each other market price information and generation availability information, including without limitation… a complete listing of electric system obligations and electric system resources, including without limitation all contracts, agreements and other information pertaining to… resources, system requirements, load forecasts, market prices, and… pre-schedule transactions (Fox-Penner 2003, p. 46)

2. A variety of information-sharing channels that were used in order to facilitate coordination of bidding, withholding, and other practices among the producers. One example of these channels is the Industrial Information Resources, IIR, which was an information service that published, on a subscription basis, the daily outages of power plants in the Western US. The information included prospective as well as current power plant outages data. Nevertheless, subscribers could email the service, requesting immediate information on outages of a competitor's plant, and report back to the subscriber requesting the information.

As for electricity market players other than the "Big Five", it is usually assumed (FERC 2003c) that entities whose power generating capacity is smaller than 60 megawatts, or whose capacity is committed through long-term, firm contracts with other entities, or have the position of net buyers, generally lack either the incentive or the ability to withhold capacity from the market.

Agreement between them, a public document on file with the FERC, see: Williams Energy Marketing and Trading Company (2002).

Thus, we model the California power generating industry as a cartel, which represents the five IPPs. The cartel serves the residual power demand, that is, the State's power demand after subtracting the competitive fringe's supply.

3. The Model

3.1 The framework

In this model, a regulator is concerned with the possibility that power producers are strategically withholding some of their power capacity from the market in order to raise prices and eventually – profits. Therefore, the regulator appoints a market inspector. The inspector's mandate is to investigate unproductive power plants, and to determine whether their (temporary) closure is due to legitimate safety, operation, or maintenance reasons, or is an outcome of manipulative (and criminal) market gaming.[16] As we explained above, we model here the decision of the power-generating cartel to withhold power capacity from the market, that is, to close technically-operative plants, in order to benefit from the monopolistic rent, focusing on its interaction with the market inspector.

We denote the illegally-acquired payoff (the monopoly rent) enjoyed by the power-generating cartel and gained through its withholding of power capacity by closing some of its power plants (in order not to exceed the monopoly production level) as X.[17] Both X and the optimal power withholding are a function of the residual demand the cartel faces in the market, that is, State demand after subtracting for the competitive fringe's supply. Since the fringe's supply is assumed to be inelastic, we simplify by saying that both X and the optimal power withholding are a function of State demand. Here, demand is randomly

[16] See note 10 above.

[17] Note that the cartel may have honestly benefited from X, when some of its plants faced valid safety, operation, or maintenance problems. Also note that X is a net payoff, in the sense that all revenue losses caused by closing the plant are subtracted from the gains acquired.

determined by nature,[18] and is then a common knowledge, observed by both the inspector and the cartel through the day-ahead, hour-ahead, and other markets for power, organized by the California Power Exchange (PX), and the California Independent System Operator, ISO (see AB 1890, and Blumstein et al. 2002). We assume demand may exist at either of two levels. In the high demand scenario (i=high), demand is $Q^D(high) = 1$ (by normalization). In the low demand scenario (i=low), $Q^D(low) = 1 - \sigma$, $0 < \sigma < 1$. The high and low demand scenarios occur with probabilities of $(1-\gamma)$ and γ, respectively. We further assume that σ is high enough, such that when the low demand scenario materializes, the cartel losses most of its market share, and most of its market power, as the utilities are able to provide for most of their power needs through their own capacity and through the competitive fringe's capacity, and, thus, overcome their dependence on the cartel's supply.[19]

Nature also determines the technical state of the plants, which is either “operative”, that is, available for service, or “unworkable”, viz., must be withheld from service for checks and repairs. We denote the probability that the plant’s technical condition will force its temporary closure by θ. θ is calculated based on accumulated operational experience with power plants, manufacturer’s data, etc.[20]

Throughout this chapter, we say that a power plant is “open” whenever its operator bids its capacity onto the market. The plant is said to be open even where there is no demand

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[18] Power demand is influenced by weather conditions, conservation efforts, GDP level, etc. see Borenstein et al. (2000; 2002); CEC (2001); and Chandley et al. (2003).

[19] Remember that electricity supply consists of both base-load capacity and peak-load plants. Base-load plants are built in order to run for long periods of time, serving consumer’s first and basic power needs, which are, in our framework, $(1-\sigma)$. However, peak-load plants are designed for serving the next level of power needs, the “peak-needles", or σ in our framework, see also Mosenson (1999; 2001), and Newbery (2000). In practice, there is a merit order regarding power plants’ dispatch. First, the system uses the base-load plants for serving power demand. Only if the base-load capacity is not sufficient, does the system operator call for the peak-load plants to start generating power. However, when demand gets lower again, the peak-load plants are shut-down.

[20] In order to simplify the model, we assume that θ is the same for all kinds of power plants, whether they are coal or natural gas burning plants, old or relatively new, etc. However, assuming a unique probability for different plants will not alter our conclusions.

for its capacity, and it is producing zero power.[21] The plant is said to be "closed" when its owner does not bid any of its capacity into the market.

We denote the cartel's aggregate profit (i.e., aggregate profit derived from all of its plants) when power demand is low by $\pi(low)$.[22] However, when demand turns out to be high, it earns a higher profit, $\pi(high)$. When demand is high, and the cartel restricts its power supply to the monopoly level, that is, closes some of its plants either due to valid technical problems or as a part of market gaming, it earns a higher payoff, $\pi(high)+X$, where X is the monopoly rent.

The cartel has a large set of power plants. We assume that these plants differ from each other regarding the cartel's ability to avoid detection by the inspector when manipulatively withholding their power capacity. We denote plants with the lowest disguise possibilities as type 1 generators. Generally speaking, a type t generator offers its owner less disguise options than a type t+1 generator, while a type T generator form the upper bound by offering its owner the highest disguise capability. We use ϕ (a real number) in order to index the different generators in the market according to their disguise options. Here, type T generators are indexed by ϕ_T, $0<\phi_T<1$, type t – by ϕ_t, and type 1- by 1. The reasoning is that if generator t offers less disguise options than generator t+1, then $\phi_{t+1}<\phi_t$, $\phi_t \in [\phi_T, 1]$. We denote the probability that the inspector will catch a criminal (i.e., will be able to supply hard

[21] We ignore problems of "economic withholding", or bidding power at prices that exceed its marginal cost, or other relevant opportunity cost, in order to withhold it from the market, and, thus, forcing artificial crisis, which increases profits, see Sheffrin (2001a; 2001b), and FERC (2001c). Note that it is relatively straightforward to perform cost calculations for each power plant, using its efficiency rates, fuel costs, and other relevant costs, as described in von der Fehr and Harbord (1993), in order to detect such a strategy. However, the "physical withholding" strategy (viz., the producer's avoiding from bidding into the market with his full operative capacity, see Berry 2003), which we study, has the advantage for the power producer to be able to disguise his manipulative intentions behind several veils. For example, the plant owner may argue that operating it could have severely harmed the environment due to some technical problems, which accumulated in that specific point of time.

evidence that a power plant was manipulatively withheld from service) by $\phi_t P(e)$, where e is the effort put into investigating a power withholding case, $P(\cdot)$ is a monotonically increasing and concave function, and $P(0)=0$. For example, the probability of catching the T-indexed generator is $\phi_T P(e)$, while the chances of catching the generator, which offers its owner the least disguise options are, naturally, higher, $P(e)$. Effort is costly, and produces disutility to the inspector, which is denoted by $d(e)$. As is reasonable to assume, disutility is monotonically increasing and convex in the effort made, and $d(0)=0$.

We assume the information the inspector has regarding plants' disguise options is incomplete; he knows only the distribution of the plants' disguise capabilities, which we denote by $f(\phi)$, $\int_{\phi_T}^{1} f(\phi)\partial\phi = 1$, but does not know individually the type of a power generator.

In this model, when the inspector observes a suspiciously closed power plant, he invests effort of the magnitude e in investigating the legitimacy of the plant's closure. We denote by χ the rent the cartel gains from strategically withholding the plant from the market. $\chi > 0$ when demand is high, however, $\chi = 0$ when demand is low. After the inspector gathers evidence on capacity manipulation, and the criminal (that is, one of the five large power producers) is brought to a court of law, it has to pay a fine, and its catcher, the inspector, is entitled to a reward. The fine is set at $\alpha\chi$, $1 < \alpha \le \overline{\alpha}$, when the strategically derived rent is positive, and is denoted by F, $F \le \overline{F}$, when the inspector fails to prove a positive rent, derived by the criminal, that is, when demand is low. The fine's upper bound derives from legislative and judicial restrictions on its severity. When the inspector proves that the power industry gained a rent of the magnitude χ, $\chi > 0$, derived from strategic

[22] Note that when power demand is low, closing some of the cartel's plants, either due to operational problems or due to strategic reasons, does not increase its profit, as the market does not demand its capacity.

withholding, his reward is proportional to this rent, $R = r\alpha\chi$, $0 \le r \le \bar{r} < 1$ (the upper bound on the inspector's reward derives from the fact that some of the fine revenues are used to compensate the consumers, who directly suffered from these market manipulations, and to finance a variety of other goals, see: FTCR 2002). If the inspector finds evidence of strategic withholding, which did not actually increase the producer's profits, he is entitled for a fixed reward, $\overline{R}$. However, upon being caught, the criminal may bribe his catcher, deterring him from submitting evidence on crime to the regulators and the court. We assume both fines and bribes to be financed by the cartel, and not individually by the plant owners. Denote the bribe paid to the corrupt inspector by B. The bribe is some percentage of the unpaid fine: when demand is high, $B = b\alpha\chi$, $0 \le b \le 1$, while when demand is low, $B = \beta F$, $0 \le \beta \le 1$. The inspector-criminal scheme may be unraveled with a probability ρ, in which case the inspector will be penalized by the magnitude of I, and the criminal will suffer a penalty of the magnitude C (the source of this leak may be an audit by another governmental agency, the press, or some displeased employees). Following the standard model, we assume ρ is exogenously determined by the social consciousness of the citizens and the alertness and integrity of the judicial system. We further assume that $I = \alpha B$, and $C = \alpha^2 \chi$ when $\chi > 0$, and αF otherwise.[23] Table 5.1 lists the demand-contingent parameters and variables of our model.

We study hereafter the inspector's and the cartel's behavior, when demand realization is high, as it is straightforward to see that when demand is low, the cartel does not strategically withhold capacity from the market, and the inspector's correspondent effort level is zero (formal proof of this argument is given below).

[23] We assume in this section both fine and reward rates to be exogenously determined by the regulator. However, in the next section, we relax this assumption, studying the regulator's decision regarding fine and reward rates.

Table 1. List of demand-contingent parameters and variables

Parameter/ variable Q^d	Cartel's rent	Criminal's fine	Inspector's reward (R)	Inspector's bribe (B)	Inspector's penalty (I)	Criminal's penalty (C)
High	$\chi > 0$	$\alpha\chi$, $1 < \alpha \le \overline{\alpha}$	$r\alpha\chi$, $0 \le r \le \overline{r} < 1$	$b\alpha\chi$, $0 \le b \le 1$	αB	$\alpha^2 \chi$
Low	$\chi = 0$	F, $F \le \overline{F}$	$\overline{R}$	βF , $0 \le \beta \le 1$	αB	αF

Following the crime control literature (see, for example, Marjit and Shi 1998), we assume the criminal, after being caught, engages in conventional Nash-bargaining with his captor, in order to determine the equilibrium bribe rate, b^*:

$$b^* = \text{argmax}_b \left(\alpha\chi - \rho\alpha^2\chi - B\right)\left(B - \rho\alpha B - r\alpha\chi\right) \tag{1}$$

Thus,

$$b^* = \begin{cases} \dfrac{(1-\rho\alpha)^2 + r}{2(1-\rho\alpha)} & 0 \le \rho\alpha < 1 \\ 0 & \rho\alpha \ge 1 \end{cases} \tag{2}$$

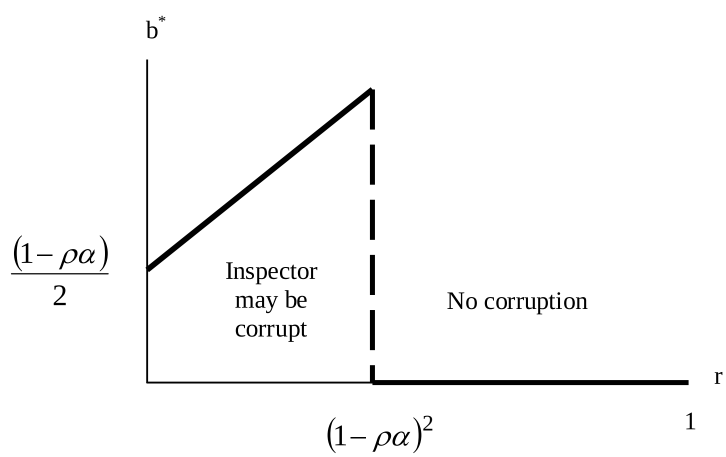
Note that when $\rho = 0$, that is, the probability that the inspector-criminal scheme will be unraveled is nil, the equilibrium bribe rate is $b^* = \frac{1}{2}[1 + r]$. Likewise, when $0 < \rho\alpha < 1$, yet bribe-taking is penalized, but bribe-giving is not, equilibrium bribe rate is higher than the one stated in equation (5.2), $b^* = \frac{1}{2}\left[1 + \frac{r}{1-\rho\alpha}\right]$. Studying equation (1), we get that when

$\rho\alpha \geq \left(1-\frac{r}{b^*}\right)$, corruption is eliminated, that is, the inspector is not interested in being bribed, but rather chooses to act honestly. Similarly, when $\rho\alpha \geq (1-b^*)$, the cartel is not willing to bribe the inspector, as the requested bribe is too high. Three interesting conclusions clearly follow:

1. As long as the probability of unraveling the inspector-criminal scheme, ρ, is not nil, aggressively fining crime and corruption is an effective tool in eliminating corruption, that is, there is an α, $\alpha = Min\left(\frac{\left(1-\frac{r}{b^*}\right)}{\rho}, \frac{(1-b^*)}{\rho}\right)$ that totally eliminates bribing.

2. If corruption is initially profitable (that is, α and ρ are smaller than the critical levels found above), increasing the reward for crime reporting, r, increases the equilibrium bribe rate, b^*, rather than eliminating corruption, as long as $r < (1-\rho\alpha)^2$. However, when $r \geq (1-\rho\alpha)^2$, bribing is eliminated, and the inspector always honestly acts (see Figure 1).

Figure 1. Bribe and reward



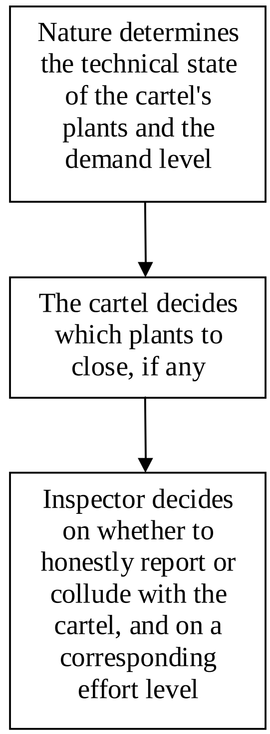
3. When inspector's reward, $r,$ is lower than its corruption-eliminating level, increases in either the fine rate, $\alpha,$ or in the corruption-unraveling probability, $\rho,$ lower the equilibrium bribe rate.

Figure 2 draws the sequence of moves of our game. Nature starts by determining the state of demand (high or low), and the technical state of the cartel's plants (operative or unworkable). Remember that while the real-time state of demand is a common knowledge, each plant's technical state is observed by the plant's owner only, and is then shared between the cartel's members as was described earlier. This private information is the source of the moral hazard problem we study. Observing the real-time state of demand and plants' technical state, the cartel chooses which plants to close, if any. Finally, the inspector has to decide on whether to honestly report the information he gathers, or collude with the criminals, and on a corresponding effort level.

Therefore, the cartel's set of strategies is {manipulate, don't manipulate}, where "manipulate" means "when effective capacity is higher than the monopolistic production level, withhold the difference between the two by closing some plants, claiming the strategically closed plants suffer some technical difficulties", while "don't manipulate" means "never close technically operative plants".

The inspector's set of strategies is {(honest, e_h), (dishonest, e_d)}, where the former means "when acquiring evidence on strategic withholding, report it to the regulators", and a corresponding effort level, e_h, while the later strategy means "when acquiring evidence on strategic withholding, accept the criminal's bribe offer and don't deliver the evidence to the regulator", and a corresponding effort level, e_d.

Figure 2. Sequence of moves



The inspector's incomplete information with regard to plants' disguise possibilities constrains him to choose a uniform effort level. Formally, the inspector chooses his effort level by maximizing his expected payoff function. When the inspector's strategy is always to honestly report manipulation, demand realization is high, and the cartel chooses to manipulate the market, the inspector's payoff function is composed of two elements: the expected reward for crime reporting, and the disutility incurred due to effort exerted:

$$Z(e) = r\alpha\chi\left[(1-\theta)\int_{\phi_T}^{\phi(e)}[\phi P(e)]f(\phi)\partial\phi\right] - d(e)\left[\int_{\phi_T}^{1} f(\phi)\partial\phi\right] \qquad (3)$$

$$= R\left[(1-\theta)P(e)\int_{\phi_T}^{\phi(e)}\phi f(\phi)\partial\phi\right] - d(e)$$

where $Z(\cdot)$ is inspector's expected payoff derived from investigating a suspiciously closed power plant (note that when his investigation shows that the plant is closed for legitimate operation and maintenance reasons, the inspector is not entitled for the reward), and $\phi(e)$ is the index of the plant, which would be just indifferent between committing the crime and not committing it, when faced with a monitoring effort of magnitude e. Thus, the range of integration for the first term in equation (5.3), the expected reward for crime reporting, is bounded by $\phi(e)$, where $\phi(e) \geq \phi_T$. However, the range of integration for the second term, accounting for the inspector's disutility, is from ϕ_T to 1. Inspector's optimal effort would then be e_h, $e_h = \arg\max_e Z(\cdot)$.

However, when demand turns out to be low, inspector's strategy is {honest, e_h}, and the cartel chooses to manipulate the market, the inspector's payoff function is $W(e) = \overline{R}\left[(1-\theta)P(e)\int_{\phi_T}^{\phi(e)} \phi f(\phi)\partial\phi\right] - d(e)$, where $e_h = \arg\max_e W(\cdot)$.

Likewise, when inspector's strategy is {dishonest, e_d}, demand realization is either high or low, and the cartel chooses to manipulate the market, his payoff from investigating a suspiciously closed power plant is composed of three elements, as shown in equation (4): the expected bribe, the disutility incurred due to effort exerted, and the expected fine on corruption, respectively:

$$V(e) = B\left[(1-\theta)\int_{\phi_T}^{\phi(e)} [\phi P(e)] f(\phi)\partial\phi\right] - d(e)\left[\int_{\phi_T}^{1} f(\phi)\partial\phi\right] - \alpha B\left[\rho(1-\theta)\int_{\phi_T}^{\phi(e)} [\phi P(e)] f(\phi)\partial\phi\right] \quad (4)$$

$$= B[1-\rho\alpha]\left[P(e)(1-\theta)\int_{\phi_T}^{\phi(e)} \phi f(\phi)\partial\phi\right] - d(e)$$

The inspector's optimal effort would then be $e_d = \arg\max_e V(\cdot)$.

Finally, when the cartel chooses not to manipulate the market, and demand realization is either high or low, the inspector's payoff when honestly acting is $\left[-d\left(e_h\right)\right]$, while his payoff when choosing (dishonesty, e_d) as his strategy is $\left[-d\left(e_d\right)\right]$.

Let us look now at the cartel's payoff given demand realization, the cartel's strategy, and the inspector's strategy. When demand is high, the cartel chooses to manipulate the market by strategically closing a plant of type t, and is confronted with a dishonest inspector, its expected payoff is composed of four elements: the payoff due to the realization of a high demand state, the monopoly rent achieved due to the strategic closure of the type t plant, the expected bribe paid to the corrupt inspector, and the expected fine paid to the authorities when corruption is unearthed. Specifically, the cartel's expected payoff is:

$$L\left(e_d\right)=\pi\left(high\right)+\chi-B\left[\phi_t P\left(e_d\right)\right]-\alpha^2\chi\left[\rho\phi_t P\left(e_d\right)\right] \tag{5}$$

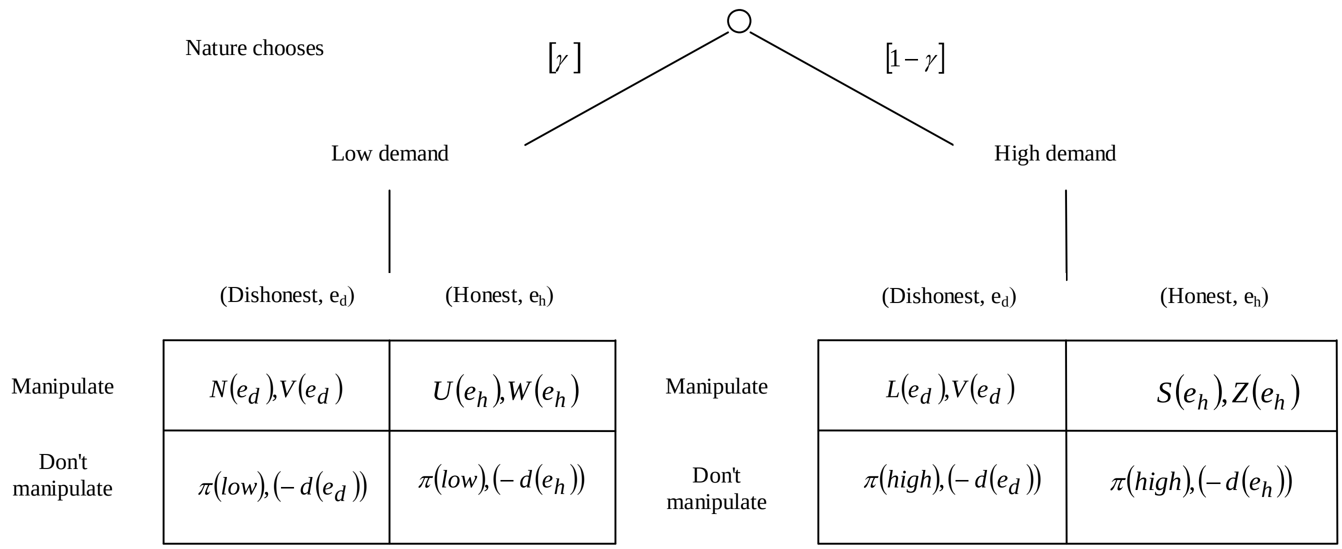
Similarly, when demand is low, the cartel chooses to manipulate the market by strategically closing a plant of type t, and is confronted with a dishonest inspector, its expected payoff is: $N\left(e_d\right)=\pi\left(low\right)-\beta F\left[\phi_t P\left(e_d\right)\right]-\alpha F\left[\rho\phi_t P\left(e_d\right)\right]$.

Alternatively, if the inspector refuses to be bribed, and, thus, chooses a strategy of the form $\left(honest,\ e_h\right)$, demand is high, and the cartel manipulates the market by strategically closing a plant of type t, its expected payoff is:

$$S\left(e_h\right)=\pi\left(high\right)+\chi-\alpha\chi\left[\phi_t P\left(e_h\right)\right] \tag{6}$$

Here, the cartel's payoff is composed of three elements: the payoff due to the realization of a high demand state, the illegally acquired rent, and the expected fine paid when market manipulation is unearthed. Similarly, when demand is low, the cartel chooses to manipulate the market by strategically closing a plant of type t, and is confronted with an honest inspector, its expected payoff is: $U(e_h) = \pi(low) - F[\phi_t P(e_h)]$. Remember that the cartel's payoff when choosing not to manipulate the market is $\pi(high)$ when demand is high, and $\pi(low)$ when demand is low. Players' strategies and payoffs are summed-up in Figure 3.

Figure 3. Strategies and payoffs



3.2 Equilibrium when demand is low

Proposition 1. When demand is low, the cartel does not manipulate the market, and the inspector invests a zero effort in investigating plants' closure.

Proof: It is easy to see that {manipulate} is strongly dominated by {don't manipulate} for the cartel, and thus investing a positive effort level in monitoring plants' closure causes losses to the inspector.

3.3 Equilibrium when demand is high

Given a high demand realization, we study the conditions under which {manipulate; dishonest, e_d>0} is the equilibrium in our game. We start by studying the inspector's behavior. Note that when the cartel chooses not to manipulate the market, the inspector's effort level is zero, as he expects neither a bribe offer from the criminal nor a reward from the regulator. However, when the cartel strategically withholds needed capacity from the market, the inspector chooses to act dishonestly (with e_d>0) if $Z(e)<V(e)>0,$ where $Z(\cdot)$ *and* $V(\cdot)$ are as defined in equations (3) and (4), respectively. Hence, the inspector chooses dishonesty when

$$\frac{b(1\text{-}\rho\alpha)}{r} > \frac{\int_{\phi_T}^{\phi(e_h)} \phi f(\phi)\partial\phi}{\int_{\phi_T}^{\phi(e_d)} \phi f(\phi)\partial\phi}, \quad \forall e_d = e_h,$$

and there exists an e_d, such that $V(e_d) > 0,$ where $\phi(e_h)$ *and* $\phi(e_d)$ are the indices of the cartel's plants, which would be just indifferent between committing the crime and not committing it, when faced with a monitoring effort of the magnitude e_h and e_d, respectively. Otherwise, the inspector either acts honestly (with e_h>0) when $Z(e_h) > 0,$ or makes no effort when $Z(e_h) < 0.$

Note that $\phi(e_h)$ *and* $\phi(e_d)$ are determined by the cartel in the previous stage of the game, as argued in Proposition 2.

Proposition 2. Given a dishonest inspector, plants, whose index of manipulation disguising possibilities is lower or equal to $\frac{1}{\alpha P(e_d)[b+\rho\alpha]},$ may be manipulatively closed, while those for which $\phi_t > \frac{1}{\alpha P(e_d)[b+\rho\alpha]}$ are never manipulatively closed. However, given an honestly acting inspector, plants, whose index of manipulation disguising capabilities, $\phi_t,$ is lower or equal to $\frac{1}{\alpha P(e_h)}$, may be manipulatively closed in order for the cartel to fully exercise its market power, while those for which $\phi_t > \frac{1}{\alpha P(e_h)}$ are never strategically closed.

Proof. **Case 1**. Given a dishonestly acting inspector, the cartel's payoff when manipulating the market, as given by equation (5), must be at least as high as its payoff when choosing not to manipulate, $\pi(high)$, in order for it to manipulatively close some of its plants. Solving for $L(\mathrm{e_d}) - \pi(high) \geq 0$, we get

$$\phi_t \leq \frac{1}{\alpha P(e_d)[b + \rho\alpha]} \tag{7}$$

Case 2. Given an honestly acting inspector, the cartel's payoff, as given by equation (6), must be at least as high as the payoff the cartel enjoys when choosing not to manipulate power supply, $\pi(high)$, in order for it to manipulatively close some of its plants. Solving for $S(\mathrm{e_h}) - \pi(high) \geq 0$, we get

$$\phi_t \leq \frac{1}{\alpha P(\mathrm{e_h})} \tag{8}$$

Q.E.D.

We studied the conditions for the inspector to act corruptly, and then the conditions for the cartel to strategically act. These conditions enable us to reach further insights as to our players' behavior. Hence, in Proposition 3, we argue that inspector's effort level may be positive only when the distribution function of the disguise capabilities of the cartel's plants is a decreasing one. In Proposition 4, we argue that crime cannot be eliminated, as the inspector is interested in the exercise of some extent of crime. Then, we study the effect that the fine rate and the reward rate may have on the inspector's behavior.

Proposition 3. Inspector’s effort level may be positive only when $f(\phi)$ is a decreasing function. Otherwise, the inspector exerts a zero monitoring effort, which, in turn, persuades the cartel to fully exercise its market power.

Proof. Case 1. $f(\phi)$ is uniformly distributed, that is, $f(\phi)=c,\ \forall\phi.$ The inspector’s payoff is given by equation (3) when his strategy is $\left(honest,\ e_h\right)$, and by equation (4) when his strategy is $\left(dishonest,\ e_d\right)$. After integrating equations (3) and (4), we get:

$$Z(e_h)=0.5RP(e_h)(1-\theta)c\left[\frac{1}{[\alpha P(\mathrm{e_h})]^2}-\phi_T^2\right]-d(e_h) \tag{9}$$

$$V(e_d)=0.5B(1-\rho\alpha)P(e_d)(1-\theta)c\left[\frac{1}{[\alpha P(\mathrm{e_d})(b+\rho\alpha)]^2}-\phi_T^2\right]-d(e_d) \tag{10}$$

Deriving both of the equations with respect to e, we get

$$Z'(e_h)=\left(-\frac{RP'(e_h)(1-\theta)c}{2}\right)\left[\frac{1}{[\alpha P(e_h)]^2}+\phi_T^2\right]-d'(e_h) \tag{11}$$

$$V'(e_d) = \left(-\frac{B(1-\rho\alpha)P'(e_d)(1-\theta)c}{2} \right) \left[\frac{1}{[\alpha P(e_d)[b+\rho\alpha]]^2} + \phi_T^2 \right] - d'(e_d) \tag{12}$$

Note that both $Z'(e_h) < 0,\ \forall e_h$, and $V'(e_d) < 0,\ \forall e_d$, respectively, and, thus, both payoff functions monotonically decrease in effort. Hence, $e_h = e_d = 0$. The inspector's zero effort strategy, in turn, persuades the cartel to fully exercise its market power.[24]

Case 2. $f(\phi)$ is an increasing function, e.g., $f(\phi) = \frac{\phi}{A}$, where A is such that $\int_{\phi_T}^{1} f(\phi)\partial\phi = 1$. In this case, we get

$$Z'(e_h) = \left(-\frac{RP'(e_h)(1-\theta)}{3A} \right) \left[\frac{2}{[\alpha P(e_h)]^3} + \phi_T^3 \right] - d'(e_h) \tag{13}$$

$$V'(e_d) = \left(-\frac{B(1-\rho\alpha)P'(e_d)(1-\theta)}{3A} \right) \left[\frac{2}{[\alpha P(e_d)[b+\rho\alpha]]^3} + \phi_T^3 \right] - d'(e_d) \tag{14}$$

Again, both $Z'(e_h) < 0, \forall e_h$, and $V'(e_d) < 0, \forall e_d$, and, thus, $e_h = e_d = 0$. Again, faced with a zero monitoring effort, the cartel fully exercises its market power.

Case 3. $f(\phi)$ is a decreasing function, e.g., $f(\phi) = \frac{A}{\phi^3}$, where A is such that $\int_{\phi_T}^{1} f(\phi)\partial\phi = 1$. In this case, we get

$$Z'(e_h) = RP'(e_h)(1-\theta)A\left[\frac{1}{\phi_T} - 2P(e_h)\alpha \right] - d'(e_h) \tag{15}$$

[24] Note that in this case, we get: $\phi(e_h) = \phi(e_d) = \infty$. This result, of course, does not imply that the cartel withholds all of its capacity from the market, but that it restricts its production to the one that maximizes its profits, given its market power, that is, to the monopolistic production level.

$$V'(e_d) = B(1-\rho\alpha)P'(e_d)(1-\theta)A\left[\frac{1}{\phi_T} - 2P(e_d)\alpha(b+\rho\alpha)\right] - d'(e_d) \tag{16}$$

Hence, the inspector's payoff may increase in his monitoring effort: when his strategy is $\left(honest,\ e_h\right)$, his payoff, $Z(e_h)$, increases in e_h if $\frac{P'(e_h)}{d'(e_h)} > \frac{1}{R(1-\theta)A\left(\frac{1}{\phi_T} - 2p(e_h)\alpha\right)}$, and $\left(\frac{1}{\phi_T} - 2p(e_h)\alpha\right) > 0,$ for some e_h; when he chooses the strategy $\left(dishonest,\ e_d\right)$, his payoff, $V(e_d)$, increases in e_d if $\frac{P'(e_d)}{d'(e_d)} > \frac{1}{B(1-\rho\alpha)(1-\theta)A\left[\frac{1}{\phi_T} - 2P(e_d)\alpha(b+\rho\alpha)\right]}$, and $\left[\frac{1}{\phi_T} - 2P(e_d)\alpha(b+\rho\alpha)\right] > 0,$ for some e_d. Moreover, it is straightforward to see that $Z'(e_h) > 0$ and $V'(e_d) > 0$ are sufficient conditions for $Z''(e_h) < 0$ and $V''(e_d) < 0,$ respectively. Indeed, in our framework, it is reasonable to assume that inspector's payoff may be an increasing and concave function of exerted effort – for initial and small levels of effort (see also Marjit et al. 2000). Q.E.D.

Consequently, the inspector may exert a positive effort level, restraining the least skilled generators from manipulating the market, i.e., reducing crime's scope. However, in our setup, as in the relevant literature, the inspector is not interested in exerting too high an effort, that is, he is not interested in eliminating crime, as argued in the next Proposition.

Proposition 4. It is not possible to totally eliminate crime when demand realization is high.

Proof. Proposition 2 teaches us that the regulator may use the fine rate as a tool for deterring crime, as a higher α causes the cartel to restrict crime's scope – provided that the inspector's effort level is positive and stable (see equations 7 and 8). However, as we can see from the inspector's payoff functions (equations 3 and 4), he suffers losses when crime is eliminated. Thus, he decreases his effort in order to persuade the cartel to commit some extent of crime. Note that when inspector's effort is positive, it pools the cartel's plants into two groups: (i) plants, whose crime disguising indices are lower than $\phi(\mathrm{e})$, which may be strategically closed, and (ii) plants, whose crime disguising indices are higher than $\phi(\mathrm{e})$, which are never strategically closed. We get that the inspector's behavior may decrease the crime's scope, however, the inspector *is not interested* in eliminating crime. Also note that crime can neither be eliminated by the regulator using his second tool: increasing the inspector's reward rate, r. Increasing r may only persuade the inspector to honestly act, that is, not to be bribed. However, an honest inspector – just like a corrupt one – is interested in the survival of crime, as he may expect a positive payoff only when crime is executed.

Q.E.D.

We now turn to study the relation between the inspector's behavior and the fine rate, α, and the reward rate, r. In Proposition 3, we saw that e_h and e_d may be positive only when (i) $f(\phi)$ decreases in ϕ, and (ii) the conditions stated in Proposition 3's Case 3 are valid. Assume that Proposition 3's Case 3 holds. Continue assuming that the plants' distribution function with respect to their disguise capabilities is $\mathrm{f}(\phi) = \dfrac{A}{\phi^3}$, where A is such that $\int_{\phi_r}^{1} f(\phi)\partial\phi = 1$. Looking at equations (15) and (16), we can see that $Z'(e_h) > V'(e_d)$ (and $Z(e_h) > V(e_d)$), $\forall e_h = e_d > 0$, when $r > b(1-\rho\alpha)$, and $(b+\rho\alpha) > 1$, that is, when

$r > (1-\rho\alpha)^2$, or when $\rho\alpha > 1$. In this case, naturally, the inspector honestly acts. However, when $r < b(1-\rho\alpha)$, and $(b+\rho\alpha) < 1$, that is, when $r < (1-\rho\alpha)^2$, and $\rho\alpha. < 1$, we can see that $V'(e_d) > Z'(e_h)$, $\forall e_d = e_h > 0$, and, thus, the inspector corruptly acts. Figure 4 sums our discussion hereto.

Comparing the inspector's payoff when honestly acting ($Z(e_h)$, as depicted in Figures 4.a and 4.c) with his payoff when corruptly acting ($V(e_d)$, as depicted in Figure 4.b), we get that $Z(e_h) > V(e_d)$, $\forall e_h = e_d > 0$, if the condition stated in equation (17) is fulfilled:

$$r > \frac{b(1-\rho\alpha_1)\left[\frac{1}{\phi_T} - 2P(e)\alpha_1(b+\rho\alpha_1)\right]}{\left(\frac{1}{\phi_T} - 2P(e)\alpha_2\right)}\frac{\alpha_1}{\alpha_2} \tag{17}$$

where α_1 is the fine rate existing when the inspector corruptly acts and α_2 is the fine rate existing when the inspector honestly acts.

Another insight deriving from our model is that corruption may encourage crime: using Proposition 2, we get that when $\alpha_1 = \alpha_2$, and the inspector exercises the same effort level when corruptly or dishonestly acting, i.e., $e_d = e_h > 0$, then $\phi(e_d) = \frac{1}{\alpha_1 P(e_d)[b+\rho\alpha_1]} > \phi(e_h) = \frac{1}{\alpha_2 P(e_h)}$, that is, the inspector's dishonesty persuades the cartel to extend market manipulations (i.e., to close even those plants, which offer low manipulation disguising possibilities, and stay open when the inspector honestly acts). Note that the inspector knows that by strategically choosing corruption, he encourages crime, and, thus, the probability for him to catch a criminal and to receive a bribe offer increases.

Figure 4.

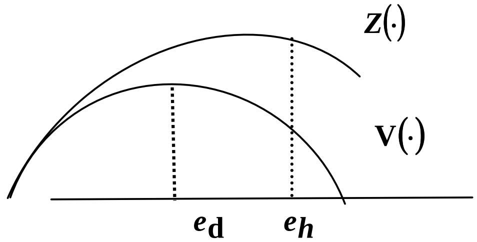


Figure 4.a Inspector's payoff when $r > (1 - \rho\alpha)^2$ and $\rho\alpha < 1$

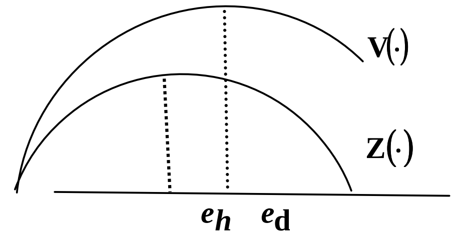


Figure 4.b Inspector's payoff when $r < (1 - \rho\alpha)^2$ and $\rho\alpha < 1$

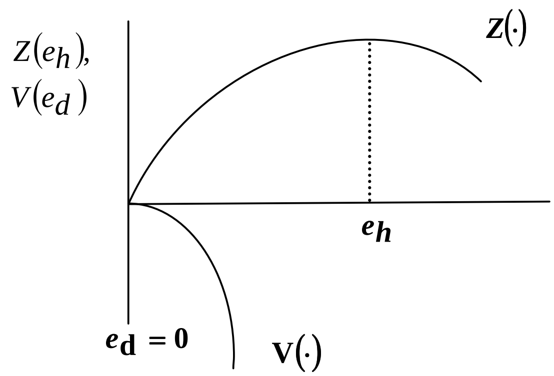
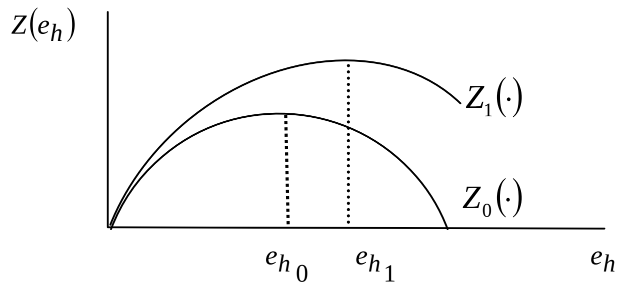


Figure 4.c Inspector's payoff when $\rho\alpha > 1$

The comparative statics of our model also yield some interesting results. When the inspector acts honestly with $e_h > 0$, increases in the reward rate, r; in the monopoly rent, χ, and in the probability that the plant is operative, further increase e_h (e.g., a movement from e_{h_0} to e_{h_1}, respectively, as depicted in Figure 5). However, α's effect on the inspector's effort level is ambiguous, as it both increases the monetary reward, R, yet may lower crime scope by decreasing $\phi(e_h)$. Deriving the inspector's payoff as stated in equation (15) by α, and equalizing it to zero, we get that inspector's effort is at its peak when $\alpha = \frac{1}{4\phi_T P(e)}$. Likewise, when the inspector corruptly acts, his effort level increases in χ and decreases in θ and in ρ, while the affect α *and* r may have on it is inconclusive. Naturally, both e_h

and e_d are expected to decrease when $d(\cdot)$ is more sensitive with respect to effort committed.

Figure 5.



4. The regulator

In the previous section, we modeled the inspector-criminal game, assuming that the fine rate, α, and the reward rate, r, are exogenously given. However, in this section, we relax this assumption, endogenizing the regulator's behavior, that is, his decisions regarding α and r. Specifically, in this section, we model a two stage game, in which the regulator is assumed to be a Stackelberg leader, choosing at the first stage of the game a pair of α and r, in order to minimize the crime scope chosen by the cartel at the next stage of the game. Then, in the second stage of the game, given the chosen α and r, the inspector and the cartel play as described in the previous section.

In the previous section, we saw that the inspector's corruption may encourage crime, and that the regulator may choose a pair of fine and reward rates that guarantees that $e_h > e_d$. Therefore, the regulator desires to persuade the inspector to honestly act. In order to calculate the optimal fine and reward rates, the regulator has to solve the following problem:

$$\underset{\alpha,r}{Min}\ \phi(e_h)$$

$$
\begin{aligned}
&s.t.\ \ Z(e_h) \geq 0 && \text{(Participation constraint)} \\
&Z(e_h) - V(e_d) \geq 0 && \text{(Incentive compatibility constraint)} \\
&\left.\begin{aligned} &1 < \alpha \leq \overline{\alpha} \\ &0 \leq r < \overline{r} < 1 \end{aligned}\right\} && \text{(Legislative and judicial restrictions)}
\end{aligned}
$$

Here, the regulator chooses the levels of α and r that minimize the index of the plant, which would just be indifferent between committing the crime and not committing it, when faced with a monitoring effort (exerted by the honest inspector) of the magnitude e_h, as argued in the previous section. In doing so, the regulator has to make sure that the inspector exerts a positive effort level, thus, guaranteeing him a nonnegative payoff. The regulator also has to choose such a pair of fine and reward that makes corruption non-profitable for the inspector. Naturally, the regulator also has to adhere to legal and jurisdictional restrictions on the fines and rewards.

However, the regulator's problem may be unsolvable, that is, the inspector's incentive compatibility constraint may contradict the last two constraints when both $\bar{r} < (1 - \rho\overline{\alpha})^2$ and $\rho\overline{\alpha} < 1$. In this case, the first-best solution (employing an honest inspector) is impossible, and, thus, the regulator has to turn to the second-best option, employing a bribed inspector. As was described in the previous section, the corrupt inspector's effort and his claim for a bribe from the criminals lower the crime scope (compared to a case without any inspector), thus partially serving the regulator's goal. But the corrupt inspector's silence as to the true nature of the plant's shutdown prevents the regulator from understanding the causes and true nature of the power crises, explaining the regulator's surprise in the face of manipulation evidence that eventually leaks-off. Note that corruption is common when ρ is low enough and/or when the legal restrictions on the size of the fine and reward rates are too high.

In the following section we discuss some available data, dealing with plants' withholding in California over the years 2000 and 2001. We also discuss regulators' response to the plants' withholding.

5. Data and discussion

Throughout this chapter, we argue that the main cause for California's electricity crisis of May 2000 – June 2001 was the manipulative (and criminal) withholding of (technically workable) power plants. This manipulative behavior was, however, not foreseen by regulators. The lock on the stream of hard evidence regarding manipulations, as explained above, caused the regulators to "walk in the dark" regarding causes and cures for the crisis. In this context, we can understand the California Independent System Operator's response to consumers' allegations following the first incidences of outages in the California Bay Area on June 14, 2000, as given in FERC (2000, p. 5):

> The circumstances that led to the rolling outages…confirm the total absence of misconduct…The outage could not have been averted by any actions available to the ISO.

This naive view of producers' market behavior was not limited to the California regulators. In fact, it was also exhibited by the Federal regulator (FERC 2001a, p.4):

> Staff did not discover any evidence suggesting that the audited companies were scheduling maintenance or incurring outages in an effort to influence prices. Rather, the companies appeared to have taken whatever steps were necessary to bring the generating facilities back on-line as soon as possible by accelerating maintenance and incurring additional expenses.

However, the regulators failed to examine what later would appear to be the main cause for the California crisis:

> The audit discussed in this report was not designed to determine whether the companies involved were withholding capacity from the market by refusing to bid or schedule the capacity… (ibid).

In this regulatory environment, crime and corruption could prosper, to the utmost surprise of the regulators. This point is ironically illustrated by a phone conversation, recorded on May 22, 2000 between two of Reliant's employees, which was later used by California's Attorney General in suing Reliant and its partners, see: FERC (2003b, pp. 110-111):

> Employee 1: Hey, guys, you know when we might follow rules? If there's some sort of penalty.
> Employee 2: That's right.
> Employee 1: I would never suggest it, but it seems like the writing would be on the wall…
> Employee 2: You'll let the California rate payers pay.
> Employee 1: That's right. I don't have a problem with that. I have no guilty conscience about that.
> Employee 2: All right, man.

Indeed, examples of severe fraud and antitrust violations in California's power markets that have not been penalized or that were penalized in a disproportional scale – with regards to the damage they bear on the markets – abound. We discuss here only 3 such cases:

(i) Investigation by the Power Exchange Compliance Unit found that Enron deliberately destabilized California's power markets by withholding power capacity and other actions, which took place on May 25, 1999. Tim Belden, the Enron trader responsible for this incident, acknowledged that it was an "experiment" undertaken to check "how the market would react" (FERC 2003b, pp. 111-2). The costs deriving from these actions for California ratepayers and utilities were estimated at $7 million, however, Enron and its investigator reached an agreement on April 28, 2000, stating that Enron pay only $25,000 to defray the investigation costs (ibid).

(ii) A power producer admitted it submitted $600/MW bid – compared to the $37 it had been bidding – in order to "punish" another market participant. The Power Exchange investigator "explained" the producer that this could be construed as an antitrust violation, however, in spite of the producer's admission, the investigator finally closed the case (FERC 2003b, p. 113).

(iii) During January through April 2000, a power producer was found to be manipulatively withholding his capacity. The ISO estimated the total market impact of these manipulations at about $1.5 million, however, no penalties were charged to the manipulator (FERC 2003b, pp. 112-3).

The best example for producers' ironical behavior is also the most surprising and deleterious—from the regulators' naive point-of-view. California regulators signed contracts with power producers, requiring them to make a certain amount of power capacity available (called "reliability-must-run capacity", or RMR). These plants were required to sell their power for a pre-agreed rate, usually no more than $63 per megawatt-hour. However, producers quickly learned that if RMR plants were unavailable, they could sell the needed electricity from other units for up to $750 per megawatt-hour (FERC 2002a, 2002b, 2003a).

Finally, the FERC and other regulators managed to obtain conclusive evidence that some producers have manipulated the market, when officials, working with the producers, were recorded encouraging workers to make plants unavailable:

> If your Unit 4 outage runs long, and if you need more time, we don't have a problem with that…Right now the ISO needs generation…Since we have…they are having to pay a premium to have that on, so that is one reason it wouldn't hurt Williams' feelings if the outage run long (FERC 2002b)

> Yesterday, they ran it (the plant) without schedule, and it did drive the prices back down, so they decided… The prices went to like $185 today, but they decided not to run the peaker, because they were afraid it would drive the price right back

> down…because the ISO potentially needs generation…we are somewhat at a high price there, and if we pick up generation, I think it will kill that price.[25]

Only when this hard evidence regarding criminal withholdings of power plants leaked, did the regulators fully understand the real nature of the crisis that hit their jurisdiction. The main "leak" of hard evidence occurred on May 6, 2002, when lawyers employed with the commodities-trader Enron turned over to Federal regulators three internal memos, revealing that Enron systematically worked in order to create artificial power shortages and congestion bottlenecks aiming at increasing power prices and acquiring super-normal profits.[26]

Furthermore, a coalition of California governmental agencies (California Attorney General, California Public Utilities Commission, and the California Electricity Oversight Board) gathered a comprehensive set of evidence on producers' widespread market gaming and manipulation. They submitted their report to the FERC on March 3, 2003, asking the Federal regulator to order the industry to refund California consumers more than $7.5 billion, without diminishing the State's overall claim for refunds to ratepayers of approximately $9 billion.[27] The evidence that the California parties gathered establishes that each of the five big Californian power producers falsely reported units as being out of service when they were actually available. Specific evidence (Fox-Penner 2003; Hanser 2003) shows that in at least fourteen incidents, spanning about thirty days, all of the "Big Five" reported some of their generating units to be unavailable for service, due to required maintenance or repairs or other limitations, while their internal records proved that these units were, in fact, available.

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[25]Ibid. These recorded conversations are also available at http://feinstein.senate.gov/Releases02/r-tapes1.htm. For transcripts of other recorded phone conversations, in which power producers' officials reported about shutting down power plants in order to generate artificial power shortages see: http://www.ferc.gov/Electric/bulkpower/PA02-2/Transcripts-Reliant.pdf. See also: Carolyn Said, "Why suppliers get away with huge profits", San Francisco Chronicle, July 2, 2001.

[26]For the Enron memos, see: FERC (2002a). Note that the memos show that some other companies were also employing several of the trading strategies described in the memos.

[27]See: "Group Investigating California Energy Crisis Files Evidence Supporting More Than $7.5 Billion in Consumer Refunds", California Attorney General website, at: http://caag.state.ca.us/newsalerts/2003/03-037.htm, and FERC (2003b).

Sheffrin (2001a) reports that physical withholding took place 30% of the hours on average during May-November 2000 period.

In this context, it is worthwhile mentioning Federal regulators' demand to require every load-serving entity to contract for resources equal to 115 percent of its consumers' annual peak load (FERC 2001c). In exchange for fulfilling this requirement, regulators offered power generators an annual capacity payment, designed to compensate them for all their additional costs for the extra capacity, that is, regulators offered producers an annual risk-free increase of about 15 percent to their load-base. This extra payment may have been summed up in some billions of dollars for the Californian power industry. Interestingly enough, the representatives of the ratepayers did not object to this proposed payment. The proposal was objected to by the industry (note that implementing this proposal would have made market gaming much more difficult for the producers).

The data

Figure 6 clearly illustrates that the demand in the power markets in Northwestern America over the years 2000-2001 was 5 to 13 percents higher than its 1993-1999 monthly average. Moreover, Figure 7 shows that hydroelectric generation capacity fell significantly below its average level in previous years, over the period we are studying, due to adverse weather conditions. Remember that the California large power producers, the "Big Five", do not generate hydroelectric power, but fossil fuel based electricity. Hydroelectric power is generated in California mainly by the power utilities, and is also imported into the State from Oregon, Washington, and Southwestern Canada. As a result of both higher regional demand, and lower hydroelectric power supply, the availability of imported power to California severely decreased, the competitive fringe's supply significantly decreased, and the cartel's market power increased. In this case, the cartel could abuse its market power, withholding some of its capacity from the market.

Insert Figures 6-7 here

Indeed, further study of the data on supply-demand conditions at the time of the crisis, and especially at its peaks, supports our arguments, showing that the crisis developed primarily out of the supply side of the market, i.e., producers' withholdings, rather than out of the demand side.[28] Specifically, we argue that although power demand was high and power reserves were low over the period we study, most of the power outages and other supply interruptions were preventable, as they derived from the cartel's profit-maximizing (and in some cases criminal) behavior.

Figure 8 illustrates daily peak demand data for January 2001, the first month of rolling blackouts in California since World War II, which occurred on the 17th and the 18th of January. Peak demand levels during these two days were nearly 10% lower than the peaks of prior years, when there were no blackouts. Note also that January is traditionally a month of low demand, as peak demand generally occurs in the summer months of July and August (see Table 2). More importantly, the previous week, on January 10, 2001, demand was 9% higher, however, there were no blackouts. The next rolling blackouts were in March 19 and 20. Again, these days *were not the days of highest demand* on March (see Figure 9). The third and last series of rolling blackouts occurred on May 7 and 8, 2001. On these days, peak demand was 10% lower than on other days in May, all of which were rolling-blackouts-free (see Figure 10). Table 5.2 shows that monthly peak demand in 2000 and 2001 was 5 to 35

[28] Demand and supply data refers to the California Independent System Operator, or ISO, control area, the jurisdiction in which the California deregulation was implemented, controlled by the three investors-owned-utilities (see: Assembly Bill [California] No. 1980). ISO control area accounts for 75% of California's total power consumption.

percent lower than the 1999 peak (recorded in July, when there were no rolling blackouts, and prices were relatively stable). Therefore, we have to search for the causes of the crisis *on the supply side*, that is, to study producers' behavior.

Insert Figures 8-10 and Table 2 here

Nameplate power capacity in California, including about 5,000 megawatts of imported power from "firm and dependable" sources,[29] during the winter and spring of 2001, was more than 47,000 megawatts (see Table 3). Hence, in the three months, during which Californians suffered from rolling blackouts, the State actually enjoyed nameplate power reserves, which were higher than the level usually required (needed reserves are usually measured around 15-20 percent, see Sheffrin 2001b; Newbery 2000). Therefore, California was not short of *nameplate* power reserves during that period--as is usually argued in the literature (e.g., Borenstein, Bushnell, and Wolak, 2002; Chandley. et al. 2003; FERC 2001a; ISO 2002). Thus, given producers' moral hazard problem, and the presence of corruptible inspectors, it is not surprising that the first rolling blackouts in California's history since World War II hit it in these months of more than adequate nameplate reserves, and that average wholesale prices rose by hundreds of percent, and retail rates rose by 40%.

Insert Figures 11-12 and Tables 3-5 here

Table 4 depicts plant shutdown data for the years 1999-2001. It shows that throughout the entire period of our study (May 2000-June 2001), monthly outages were higher than their

[29] "Firm and dependable" imported power refers to electricity purchased under contracts from Federal agencies, out-of-State resources owned by Californian utilities, and entitlements to Federal resources such as the Hoover Dam. It totally ignores short-term commercial trades, see: CEC (2001, p. 9).

1999 values. However, starting in October 2000, power producers turned to shutting down their plants at levels unparalleled in prior years. For example, unproductive power capacity in October 2000 was more than 4 times higher than in October 1999. Unproductive capacity peaked in April 2001, when more than 35% of California's nameplate capacity (subtracting for imports) was declared “unproductive”. During the seven months period November 1, 2000 to May 31, 2001, average daily quantity of power generation capacity forced or scheduled off-line in California was 28% of the State's nameplate capacity (subtracting for imports). Table 5 shows that an average of 37% of the cartel's collective generation capacity was either declared "out of service" or was not supplied due to some other reasons during blackout and service interruption hours. The California Public Utilities Commission's data reveals that at least some of this capacity was operationally available for power generating, that is, did not experience any operational difficulties.[30] Accordingly, Figures 11 and 12 show that had the five producers bid this available capacity to the California market, at least 14 blackout hours in Southern California and 10 blackout hours in Northern California could have been avoided.

Insert Figure 13 and Tables 6-7 here

The combination of unproductive power plants, rolling blackouts, rising retail prices, and inflated wholesale prices considerably raised the stock prices of energy marketers and wholesalers, which were active in California's power markets. In Table 6, we depict the stock price changes of six such power producers over the ten weeks following the January 17-18 2001 rolling blackouts (the first rolling blackouts in California since World War II). We can see that while main indexes declined in these ten weeks--between 13% (S&P 500), and 39% (Nasdaq 100)--power wholesalers' stocks increased by between 10 and 66 percent,

[30] http://www.cpuc.ca.gov/PUBLISHED/Graphics/23186.PDF.

while AES stock decreased 4 percent. Figure 13 illustrates the enormous profit increases of seven important electricity wholesalers (Calpine, Duke, Dynegy, Enron, Mirant, Sempra, and Reliant) over the period January-June 2001, compared with the same period the previous year. It shows that while Californians were facing rolling blackouts and skyrocketing prices, and the US economy was in a recession (e.g., US corporate profits decreased 12%), the seven electricity wholesalers managed to increase their profits by between 21 and 182 percent.[31]

6. Conclusions

In this chapter, we argued that California's May 2000 - June 2001 power crisis came as a surprise to both State and Federal regulators, as well as to others. We explained that this surprise could have been prevented had the legal and judicial limitations on fining crime and corruption and on rewarding honest crime reporting been less restrictive. Moreover, had the regulators been able to use their power as Stackelberg leaders and choose such rates of fines and rewards that would have persuaded the inspectors to honestly report crime evidence, crime scope could have been minimized. Yet, over the period we study, the regulators did not obtain evidence on market manipulation, and, thus, their response to the fundamental causes of the power crisis was much delayed.

We showed that nameplate power capacity in California, at the relevant time, was not short of the power needs, which were derived from the relevant demand. However, due to limited availability of imported power to the State, a few big California power producers

[31]Figure 13 significantly understates the lucrative impact that the California crisis had on its energy wholesalers, as they do not report their profits separately by State (most of these wholesalers are also represented in other US States, in which profits behavior was relatively stable, and in other countries, see also: Calpine 2002; Dynegy Inc; 2001; Mirant Corp. 2001. See Table 7 for average on-peak power prices in California's Power Exchange market and three other central US markets over the same period). It should be recalled here that more than half of the US States have not yet deregulated their markets. In these markets, prices and profits are set by regulators under rate-of-return regulation. In this context, Figure 13 compares Duke Energy's *consolidated* profits, with its California subsidiary, in order to isolate the California crisis' impact on *Californian* wholesalers.

gained the opportunity to use their market power in order to maximize their profits. Thus, the crisis is explained through profit maximizing, and in some cases, criminal behavior.

Naturally, as we argued in the previous chapters, a well-designed deregulated power market should not solely rely on inspection and sanctioning in order to prevent market manipulation, as inspection and sanctioning can not prevent market manipulations. Rather, it should provide market actors with the proper incentives, such as capacity markets and capacity payments in order to prevent any producer or group of producers from acquiring an extensive market power stance.

Bibliography

Acemoglu, D. and T. Verdier. 2000. "The Choice between Market Failures and Corruption." *American Economic Review* 90: 194-211.

Allaz, B. 1992. "Oligopoly, Uncertainty, and Strategic Forward Transactions." *International Journal of Industrial Organization* 10, 297-308.

Allaz. B. and J-L Vila, 1993. "Cournot Competition, Forward Markets, and Efficiency." *Journal of Economic Theory* 59, 1-16.

Assembly Bill [California] No. 1890, of September 23, 1996, available at: www.leginfo.ca.gov/pub/95-96/bill/ asm/ab_1851-1900/ab_1890_bill_960924_chaptered.pdf.

Baiman, S., J. H. Evans, and N. J. Nagarajan. 1991. "Collusion in Auditing." *Journal of Accounting Research* 29(1): 1-18.

Basu, K., S. Bhattacharya, and A. Mishra. 1992. "Notes on Bribery and the Control of Corruption." *Journal of Public Economics* 48(3): 349-59.

Becker, G., and G. Stigler, 1974. "Law Enforcement, Malfeasance and Compensation of Enforcers." *Journal of Legal Studies* 3: 1-18.

Berry, C. A. 2003. "Prepared Testimony of Carolyn A. Berry on behalf of the California Parties." A Testimony before the Federal Energy Regulatory Commission, available at: http://caag.state.ca.us/newsalerts/2003/ferc/1009.pdf.

Blumstein, C., L.S. Friedman, and R.J. Green, 2002. "The History of Electricity Restructuring in California." CSEM WP 103, Center for the Study of Energy Markets, University of California Energy Institute, Berkeley.

Borenstein, S., J. Bushnell, and F. Wolak, 2000. "Diagnosing Market Power in California's Restructured Wholesale Electricity Market." NBER Working Paper No. 7868.

Borenstein, S., J. Bushnell, and F. Wolak, 2002. "Measuring Market Inefficiencies in California's Restructured Wholesale Electricity Market." *American Economic Review* 92 (5): 1376-1405.

Cadot, O. 1987. "Corruption as Gamble." *Journal of Public Economics* 33(2): 223-244.

California State Assembly. 1996. "Proposed Conference Report No. 1, AB 1890", Assembly Analysis, August 28.

Calpine. 2002. "2001 Annual Report." Submitted to the Securities and Exchange Commission on April 12, available at: http://media.corporate-ir.net/media_files/NYS/CPN/reports/ 2001annualreport.pdf.

CEC. 1997. "The California Energy Plan: Critical Changes – California's Energy Future." California Energy Commission, Sacramento: CA.

CEC. 2001. "Monthly Electricity Forecast: California Supply/Demand Capacity Balances for January – September, 2002." California Energy Commission Staff Report, Sacramento: CA.

Chandley. J.D., C.R. Danner, C.E Groves, C.W. Hamal, A.L. Madian, P. McLeod, J.D. Ratliff, J.L. Scadding, D.J. Teece, R.J. Walther, and G.M. Wilk. 2003. "California's Electricity Markets: Structure, Crisis, and Needed Reforms." LECG, LLC. Berkeley, Ca.

CPUC. 2002. "Report on Wholesale Electric Generation Investigation." California Public Utilities Commission, Sacramento: CA, available at: http://www.cpuc.ca.gov/static/industry/electric/ wholesale+generator+report.pdf.

DOE. 1999. "Supporting Analysis for the Comprehensive Electricity Competition Act." US Department of Energy, Office of Economic, Electricity and Natural Gas Analysis, Washington D.C.

DOE. 2001a. "The Annual Energy Outlook 2001." US Department of Energy, The Energy Information Administration, Washington D.C., available at: www.eia.doe.gov/oiaf/aeo/ overview.html.

DOE. 2001b. "Status of State Electric Industry Restructuring Activity as of April 2001." US Department of Energy, The Energy Information Administration, Washington D.C., available at: http://www.eia.doe.gov/ cneaf/electricity/chg_str/tab5rev.html.

Dynegy Inc. 2001. "2000 Annual Report" available at: http://www.dynegy.com/News&Financials.shtml.

Faruqui, A., H-p. Chao, V. Niemeyer, J. Platt, and K. Stahlkopf. 2001. “Analyzing California’s Power Crisis.” *Energy Journal* 22 (4): 29-52.

von der Fehr, N-H. M. and D. Harbord. 1993. "Spot Market Competition in the UK Electricity Industry." *Economic Journal* 103: 531-546.

FERC. 2000. “Answer of the California Independent System Operator Corporation to CARE Complaint.” Federal Energy Regulatory Commission, Washington D.C. Docket No. EL01-2-000.

FERC. 2001a. “Staff's Report to the FERC on Northwest Power Markets in November and December 2000.” Federal Energy Regulatory Commission, Washington D.C.

FERC. 2001b. “Report on Plant Outages in the State of California.” Federal Energy Regulatory Commission, Washington D.C.,: http://www.ferc.gov/electric/bulkpower/ Public-Feb1.pdf.

FERC. 2001c. “Staff Recommendations on Prospective Market Monitoring and Mitigation for the California Wholesale Electric Power Market.” Federal Energy Regulatory Commission, Washington D.C., Docket No. EL00-95-012,:

http://www.ferc.gov/industries/electric/indus-act/wem /2001/03-09-01.PDF.

FERC. 2002a. ”Initial Report on Company Specific Separate Proceedings and Generic Reevaluations: Published Natural Gas Price Date and Enron Trading Strategies.” Fact-Finding Investigation of Potential Manipulation of Electric and Natural Gas Prices, Federal Energy Regulatory Commission, Washington D.C. Docket No. PA02-2-000.

FERC. 2002b. "Non Public Appendix to Order Directing Williams Energy Marketing and Trading Company and AES Southland to Show Cause." Federal Energy Regulatory Commission, Docket No. IN01-3-000.

FERC. 2002c. ”Standard Market Design and Structure Notice of Proposed Rulemaking." Federal Energy Regulatory Commission Docket No. RM01-12-000.

FERC. 2003a. “Final Report on Price Manipulation in Western Markets, Fact-Finding of Potential Manipulation of Electric and Natural Gas Prices.” Federal Energy Regulatory Commission, Docket No. PA02-2-00.

FERC. 2003b. “California Parties’ Supplemental Evidence of Market Manipulation by Sellers, Proposed Findings of Fact, and Request for Refunds and other Relief.” Federal Energy Regulatory Commission, Docket No. EL00-95-000.

FERC. 2003c. "Staff's Initial Report on Physical Withholding by Generators Selling into the California Market and Notification to Companies." Federal Energy Regulatory Commission, available at:

http://www.ferc.gov/industries/electric/indus-act/wem/2003/WithholdingReport8-1-03.pdf.

Fisher, J. V. and T. P. Duane, 2001, "Trends in Electricity Consumption, Peak Demand, and Generating Capacity in California and the Western Grid, 1977-2000." Power Working Paper 085, University of California Energy Institute at Berkeley.

Fox-Penner, P. 2003. "Prepared Testimony of Peter Fox-Penner on behalf of the California Parties." A Testimony before the Federal Energy Regulatory Commission, available at: http://caag.state.ca.us/newsalerts/2003/ferc/1008.pdf.

FTCR. 2002. “Hoax: How Deregulation Let the Power Industry Steal $71 Billion from California.” The Foundation for Taxpayer and Consumer Rights, Available online at: www.consumerwatchdog.org.

GAO. 2002. “Concerted Actions Needed by FERC to Confront Challenges that Impede Effective Oversight.” United States General Accounting Office, Washington D.C. (GAO-02-656).

GAO. 2003. "Additional Actions Would Help Ensure that FERC's Oversight and Enforcement Capacity is Comprehensive and Systematic." Report to the Ranking Minority Member, Committee on Governmental Affairs, US Senate, United States General Accounting Office, Washington D.C. (GAO-03-845).

Garcia-Diaz. A. and P.L. Martin. 2003. “Strategic Bidding in Electricity Pools with Short-Lived Bids: An Application to the Spanish Market.” *International Journal of Industrial Organization* 21: 201-22.

Gilbert. R.J. and D.M. Newbery. 1994. “The Dynamic Efficiency of Regulatory Constitutions.” *Rand Journal of Economics* 25(4): 538-554.

Hanser, P. 2003. "Prepared Testimony of Philip Hanser on Behalf of the California Parties." A Testimony before the Federal Energy Regulatory Commission, available at: http://caag.state.ca.us/newsalerts/2003/ferc/1010.pdf

ISO. 2000. “Report on California Energy Market Issues and Performance: May-June, 2000.” Special Report, Department of Market Analysis, California Independent System Operator, Folsom: CA.

ISO. 2002. “Did any of Enron’s Trading and Scheduling Practices Contribute to Outages in California?” Prepared by Eric Hildebrandt, California Independent System Operator, Folsom: CA. available at: http://www.caiso.com/docs/2002/11/26/2002112610411219558.pdf.

Joskow, P. 1997. “Restructuring, Competition and Regulatory Reform in The US Electricity Sector.” *Journal of Economic Perspectives* 11 (3): 119-138.

Joskow. P. 2000. “Deregulation and Regulatory Reform in the US Electric Power Sector.” in Peltzman. S. and C. Winston (eds.) *Deregulation of Network Industries: What’s Next?* AEI-Brookings Joint Center for Regulatory Studies, Washington D.C.

Joskow, P. 2001. "California's Electricity Crisis." *Oxford Review of Economic Policy* 17(3): 365-388.

Joskow, P. and E. Kahn. 2001. “A Quantitative Analysis of Pricing Behavior in California’s Wholesale Electricity Market during Summer 2000”, NBER working paper 8157.

Joskow, P. and R. Schmalensee. 1985. *Markets for Power: An Analysis of Electric Utility Deregulation*, Cambridge: MIT Press.

Joskow, P., and R. Schmalensee. 1986. “Incentive Regulation for Electric Utilities.” *Yale Journal on Regulation* 4(1):1-45.

Lave. L B., and D. Perekhodtsev. 2001. “Capacity Withholding Equilibrium in Wholesale Electricity Markets.” Carnegie Mellon Electricity Industry Center working paper, CEIC-01-01.

Lockyer, B. 2004. "Attorney General's Energy White Paper: A Law Enforcement Perspective on the California Energy Crisis; Recommendations for Improving Enforcement and Protecting Consumers in Deregulated Energy Markets." California Attorney General, available at: http://caag.state.ca.us/publications/energywhitepaper.pdf.

Malik, A.S., 1990. “Avoidance, Screening and Optimum Enforcement.” *Rand Journal of Economics* 21 (3): 341-53.

Margit, S., M. Rajeev, and D. Mukherjee. 2000, “Incomplete Information as a Deterrent to Crime.” *European Journal of Political Economy* 16 (4): 763-73.

Margit, S., and H. Shi. 1998. “On Controlling Crime with Corrupt Officials.” *Journal of Economic Behavior and Organization* 34: 163-172.

Mirant Corp. 2001. “Annual Meeting and Proxy Statement.” Available at: http://www.mirant.com/financials/pdfs/proxy_04032001.pdf.

Mookherjee, D., and I.P.L. Png. 1992. “Monitoring vis-à-vis Investigation in Enforcement of Law.” *American Economic Review*

Mookherjee, D., and I.P.L. Png. 1994. “Marginal Deterrence in Enforcement of Law.” *Journal of Political Economy* 102(5): 1039-66.

Mookherjee, D., and I.P.L. Png. 1995. “Corruptible Law Enforcers: How Should They Be Compensated?” *Economic Journal* 105 (428): 145-59.

Mosenson, R. 1999. *Collected Papers on Water and Power Regulation*, (written in Hebrew), Edited in Memorandum for Ran Mosenson by the Budget Division, Ministry of Finance, Jerusalem: Israel, Available at: http://www.mof.gov.il/ron/index.htm.

Mosenson. R. 2001. *Public Utilities Regulation: Pricing and Regulating Water and Power Systems*, (written in Hebrew), Mosenson Family.

Newbery, D.M. 2000. *Privatization, Restructuring and Regulation of Network Utilities*, Cambridge: MIT Press.

Okenfuss, J.W. 2001. “Evaluation of Day-Ahead Market Prices for Wholesale Electric Power in California: A Critique of the Orthodox Theory of Price Determination.” *Oeconomicus* : 87-108.

Pashigian, B.P. 1975. “On the Control of Crime and Bribery.” *Journal of Legal Studies* 4: 311-26.

Patrick, R. H. 2001. "On Mitigating Market Power in Restructured Electricity Markets." NRRI Conference, April 10-11.

Phillips, Jr. C. F. 1993, *The Regulation of Public Utilities – Theory and Practice*, Arlington, Virginia: Public Utilities Reports Inc.

Pope, S. L. 2002. "California Electricity Price Spikes: An Update on the Facts." LECG research paper, http://www.lecg.com/website%5Chome.nsf/OpenPage/Energy-ResearchPapersTestimony.

Power Exchange (California). 1999. "Second Report on Market Issues in the California Power Exchange Energy Markets." The Market Monitoring Committee, Docket No. ER98-2843-006.

Rose-Ackerman, S. 1975. "The Economics of Corruption." *Journal of Public Economics* 4(2): 187-203.

Rosen, R.A., and F. Sverrisson. 1999. "A Comparison of Studies by US DOE and Stone & Webster on the Effect of Electric Restructuring in Colorado." Report No. 99-085, Tellus Institute.

Rothkopf, M. H. 2001. "Control of Market Power in Electricity Auctions." Rutgers University.

Rudkevich, A., M. Duckworth, and R. Rosen. 1998. "Modeling Electricity Pricing in a Deregulated Generation Industry: The Potential for Oligopoly Pricing in a Poolco." *Energy Journal* 19(3): 19-48.

Sheffrin, A. 2001a. "Empirical Evidence of Strategic Bidding in California ISO Real-time Market." Department of Market Analysis, California Independent System Operator.

Sheffrin, A. 2001b. "Preliminary Study of Reserve Margin Requirements Necessary to Promote Workable Competition." Department of Market Analysis, California Independent System Operator.

Shleifer, A. and R. Vishny, 1993. "Corruption." *Quarterly Journal of Economics* 108: 599-617.

Staiger, R. W., and F. A. Wolak, 1992. "Collusive Pricing with Capacity Constraints in the Presence of Demand Uncertainty." *Rand Journal of Economics* 23(2): 203-220.

Sutherland, R. J. 2003. "Estimating the Benefits of Restructuring Electricity Markets: An Application to the PJM Region." Center for the Advancement of Energy Markets, available at: www.caem.org.

Sweeney, J. L. 2002. *The California Electricity Crisis*. Hoover Institution Press: Stanford University.

Tirole, J. 1986. "Hierarchies and Bureaucracies: On the Role of Collusion in Organizations." *Journal of Law, Economics, and Organization* 2(2): 181-214.

Williams Energy Marketing and Trading Company. 2002. "Williams Energy Marketing and Trading Company's Response to the Request to Comment on the California Public Utilities Commission's 'Investigative Report on Wholesale Electric Generation', available at: http://www.williams.com/about/features/docs/cpuc_100102.pdf.

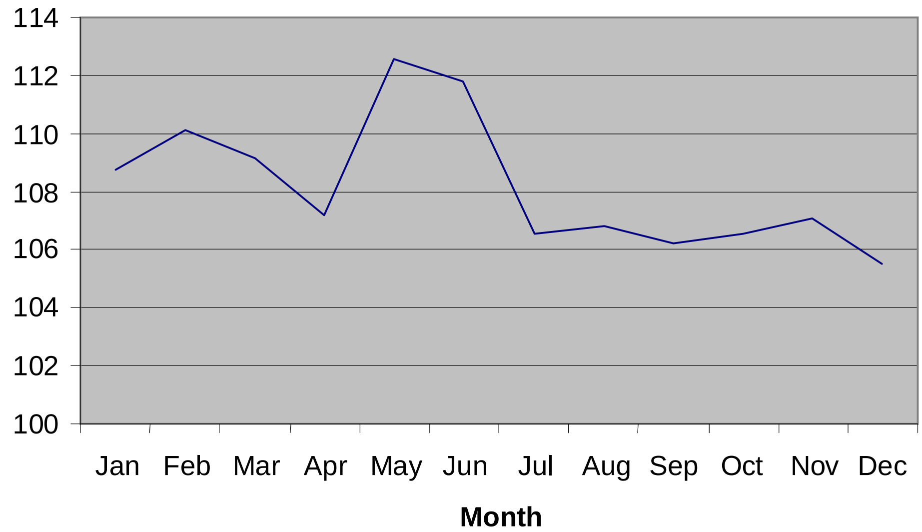
Wilson, R. 2002. "Architecture of Power Markets." *Econometrica* 70(4): 1299-1340.

Wolak, F. A. 2003. "Measuring Unilateral Market Power in Wholesale Electricity Markets: The California Market, 1998-2000." *American Economic Review* 93(2), 425-430.

Wolak, F. A. and R. H. Patrick. 1997. "The Impact of Market Rules and Market Structure on the Price Determination Process in the England and Wales Electricity Market." PWP-047, University of California, Berkeley.

Wolfram, C. D. 1998. "Strategic Bidding in a Multiunit Auction: An Empirical Analysis of Bids to Supply Electricity in England and Wales." *Rand Journal of Economics* 29, 703-725.

Figure 6: Ratio of 2000-2001 monthly power demand in the WSCC to its 1993-1999 monthly average



* The WSCC ("Western Systems Coordinating Council"), which covers the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, the provinces of Alberta and British Columbia in Canada and a small portion of Mexico, is responsible for coordinating and promoting electric system reliability and efficiency in its jurisdiction.

Data sources for Figures 6-7 are: Pope (2002); Western Systems Coordinating Council website, at: http://www.wecc.biz/main.html.

Figure 7: Ratio of 2000-2001 monthly hydro generation In the WSCC to its 1995-1999 monthly average

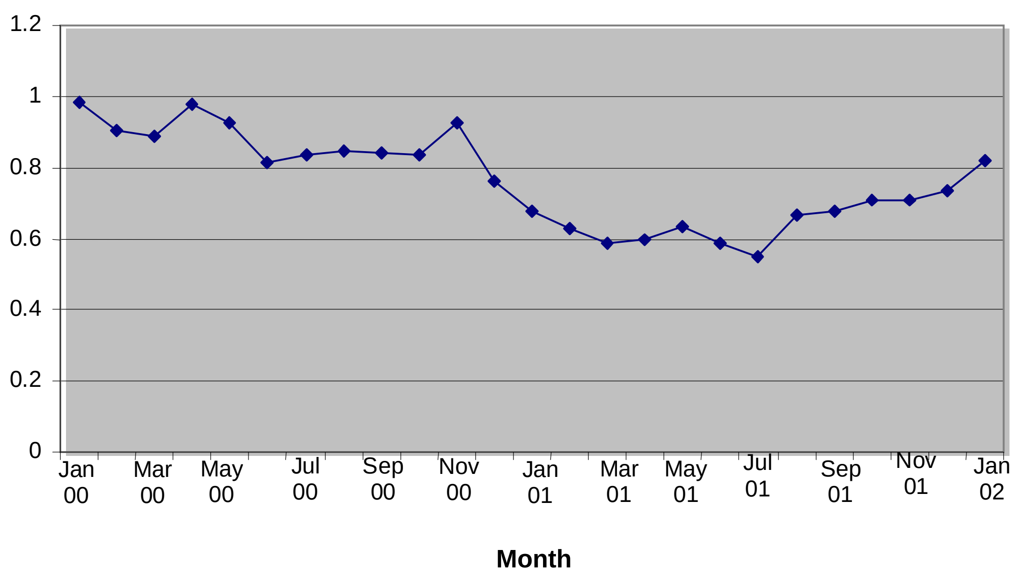
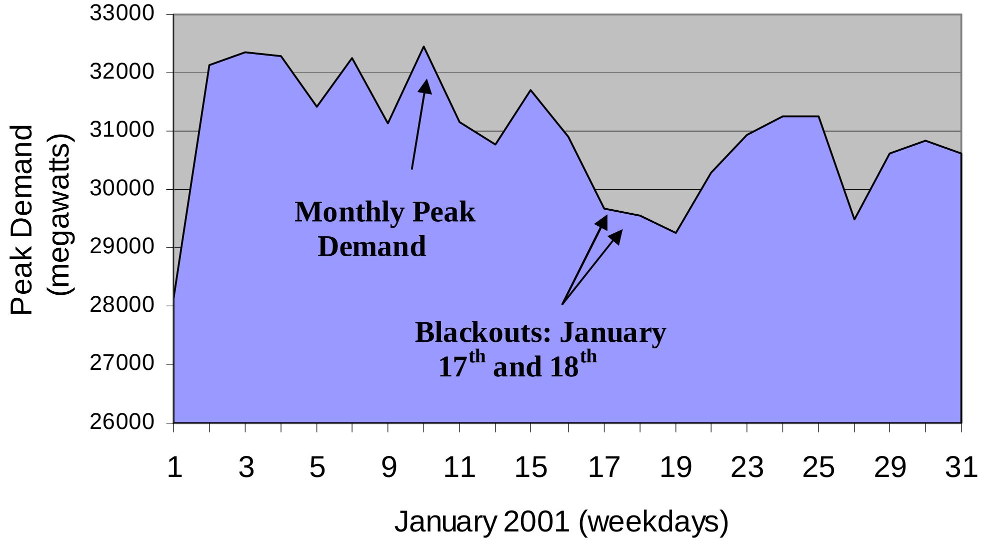


Figure 8. Daily peak demand, January 2001



The sources for Figures 8-10 and Tables 2-3 are: California Energy Commission website, at http://www.energy.ca.gov/; California Independent System Operator website, at: http://oasis.caiso.com/, CPUC (2002); and FTCR (2002).

Figure 9. Daily peak demand, March 2001

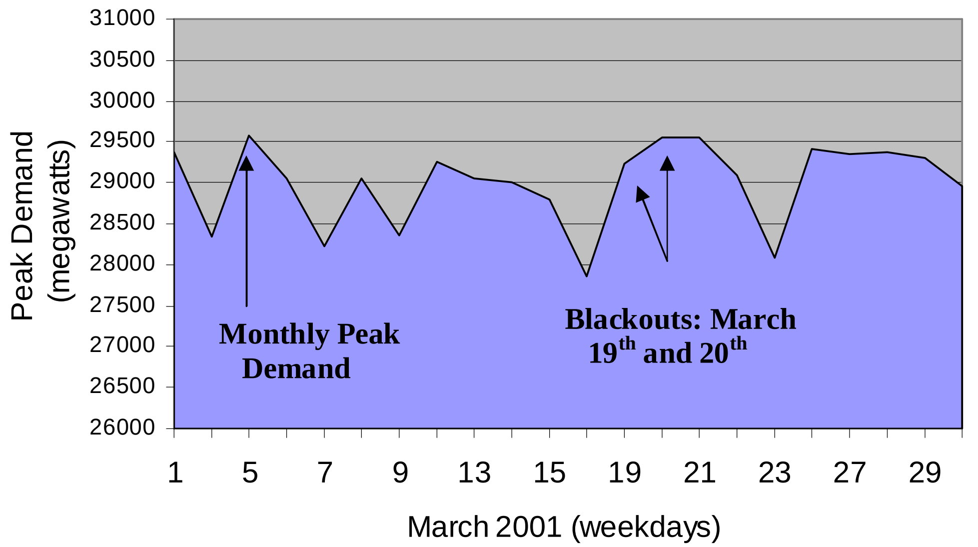


Figure 10. Daily peak demand, May 2001

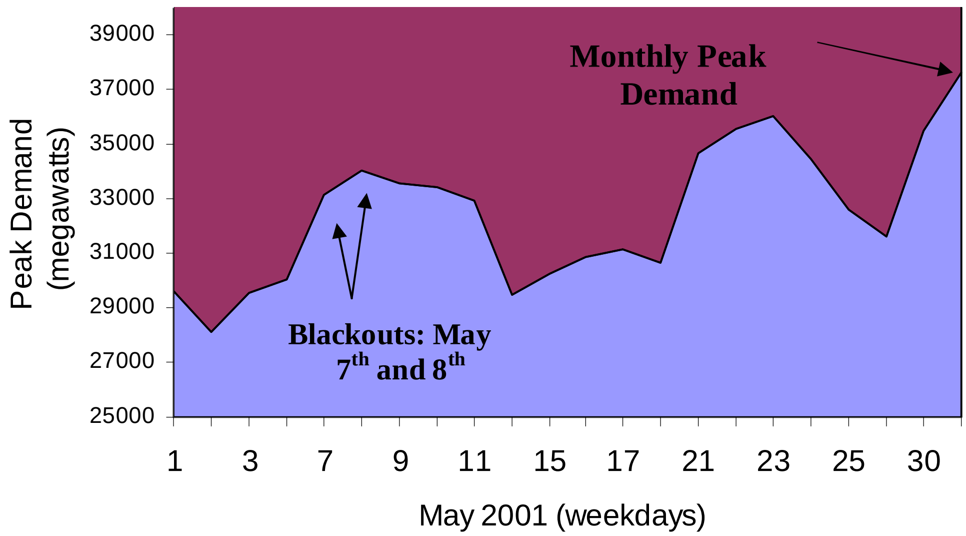


Table 2. Monthly peak demand, 1999-2001
(California ISO Control Area)

	1999	2000	2001
January	31,352	32,675	32,450
February	31.218	32,071	30,414
March	30,951	32,340	29,567
April	31,073	33,013	31,430
May	32,716	39,521	37,633
June	40,896	43,447	39,613
July	45,574	43,334	40,241
August	43,925	43,509	41,155
September	40,088	43,069	37,751
October	36,692	35,542	38,580
November	32,599	33,180	31,867
December	34,319	33,672	33,159

Table 3. Nameplate power capacity in California's ISO Control Area (Winter – Spring 2001, in megawatt)

Electricity Source	**Nameplate Capacity**	**Ownership**
Thermal	19,087	Largely owned by the "Big Five"
Nuclear	4,310	Utility owned
Hydro	11,395	Utility owned
Non-hydro resources	1,448	Largely owned by municipal utilities
"Firm" net imports	5,068	Out-of-State capacity
Dependable qualified facilities	6,366	Largely utility contracts
Total available capacity	47,674	

Table 4. Plant outages in California's ISO Control Area (1999-2001, in megawatt)

	1999	**2000**	**2001**
January	3,068	2,423	**9,940**
February	5,096	3,243	**10,895**
March	5,740	3,389	**13,737**
April	5,739	3,329	**14,911**
May	3,032	4,012	**13,431**
June	1,216	2,683	**6,794**
July	963	2,233	5,044
August	878	2,434	4,229
September	1,195	3,621	5,278
October	1,761	**7,633**	8,805
November	2,988	**10,343**	12,199
December	2,569	**8,988**	11,112

Source: California Energy Commission website, at: http://www.energy.ca.gov/electricity /monthly_off_line.html

Table 5. Power generating capacity and average slacks: The "Big Five"

	Generation Capacity (MW)	Producer's share in California's total capacity (subtracting for imports)	Producer's average capacity either out-of-service or not supplied during statewide service interruptions
Duke	3,366	7.9%	38%
Dynegy	2,518	5.9%	37%
Mirant	3,051	7.2%	41%
Reliant	3,725	8.7%	46%
Williams/AES	2,970	7%	46%
"Big Five"	**15,630**	**36.70%**	**37%**

The source for this Table as well as for Figures 11 and 12 below is California Public Utilities Commission website: http://www.cpuc.ca.gov/PUBLISHED/Graphics/23186.PDF.

Figure 11. Blackout hours, which could have been avoided had producers provided all their available power (Southern California)

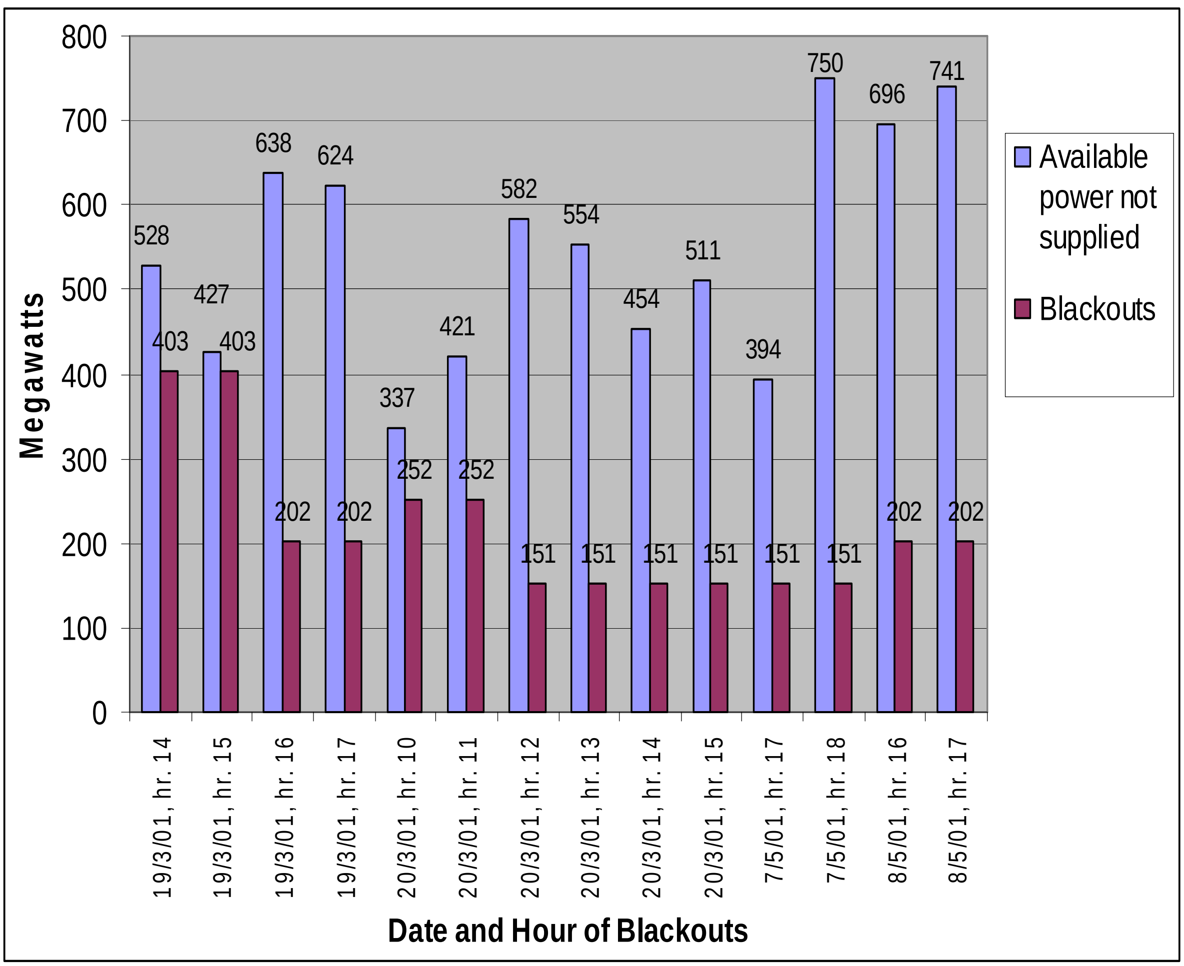


Figure 12. Blackout hours, which could have been avoided had producers provided all their available power (Northern California)

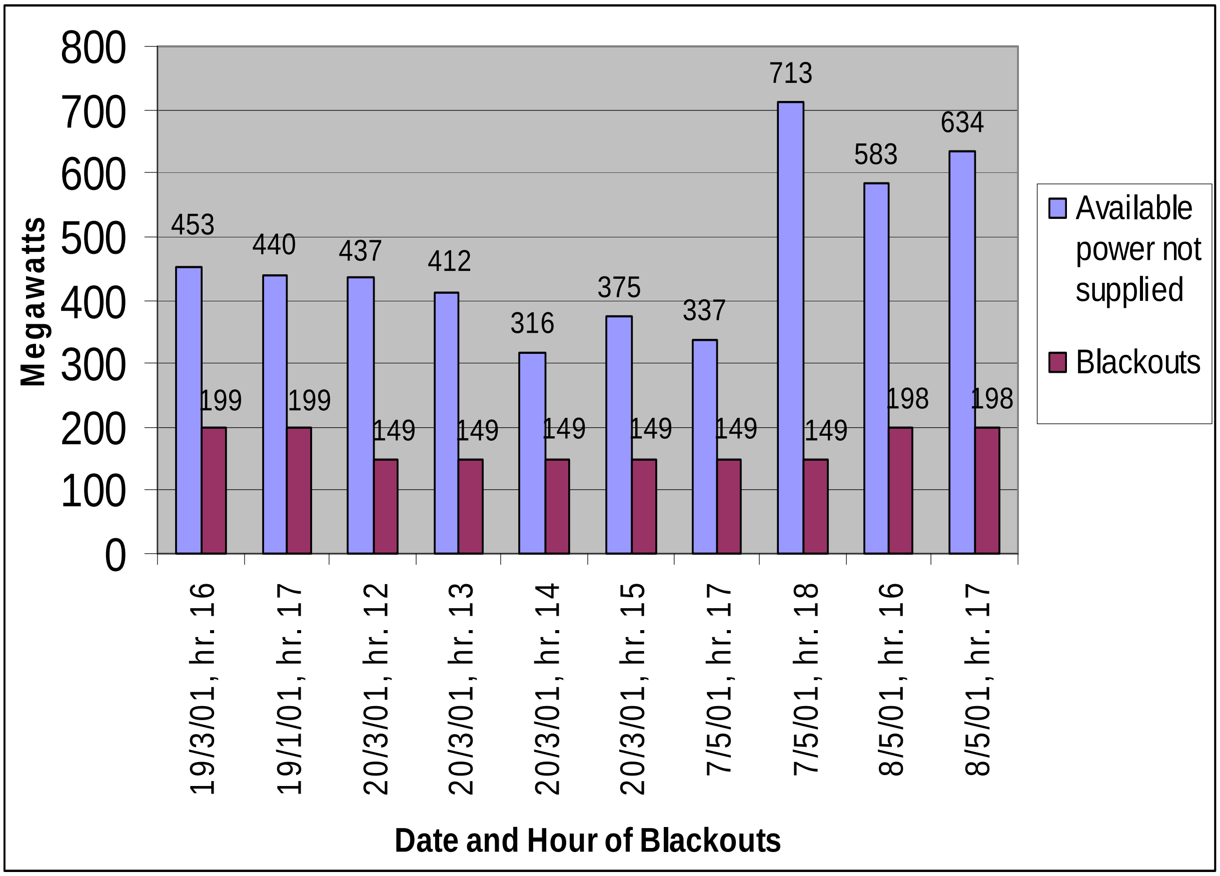


Table 6. Power wholesalers' stocks and main indexes in the period after the blackouts

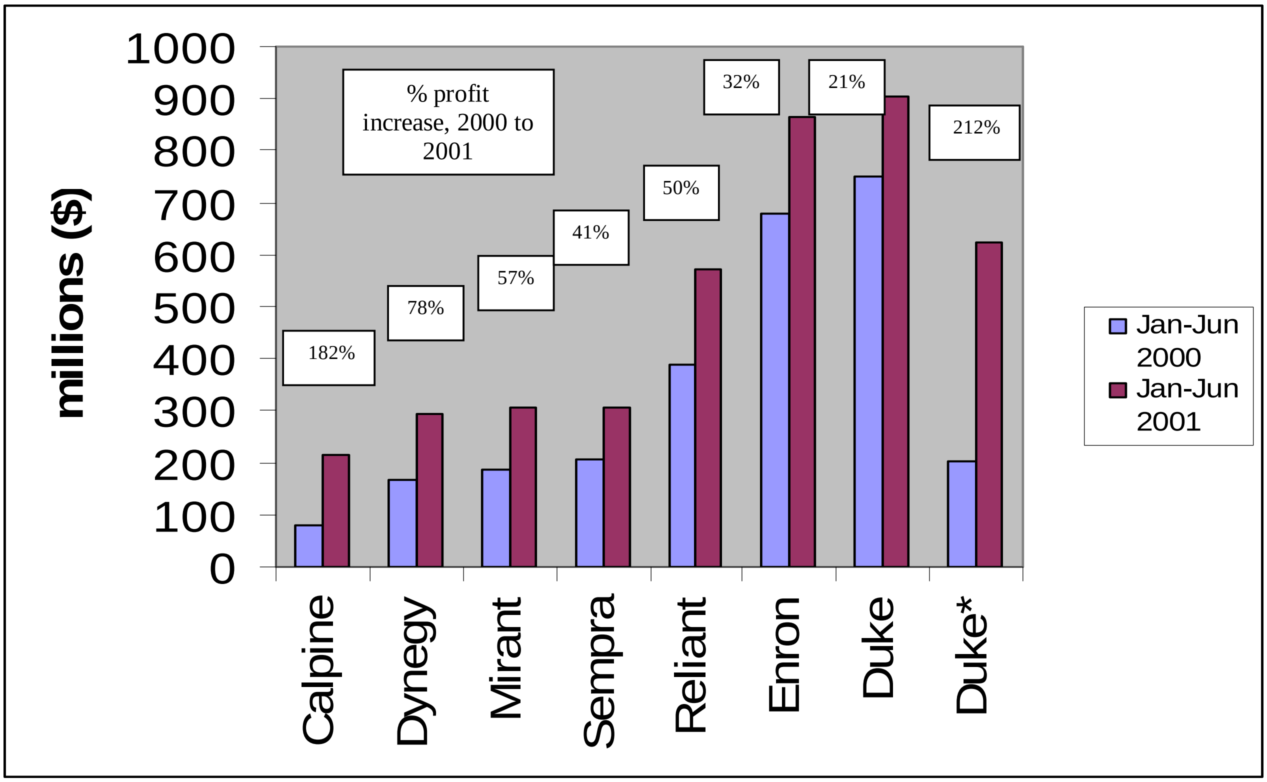
Stock/Index	Change (%), January 17 - March 28, 2001
Calpine	66
Mirant	63
Duke	23
Williams	14
Dynegy	10
AES	-4
Nasdaq 100	-39
S&P	-13

Note that Reliant was listed on the New York Stock Exchange, NYSE, only on May 1, 2001.
The source for Tables 6-7 and Figure 13: FTCR (2002, pp. 29-31); www.finance.yahoo.com; and www.nyse.com.

Table 7. Average on-peak power prices
(Various markets)

Market	Q1 2000	Q1 2001	Change
Midwest (Cinergy Hub)	$24.56	$42.31	72%
Southeast (TVA Hub)	$24.78	$42.79	73%
Mid Atlantic (PJN Hub)	$28.41	$44.29	56%
California (CALPX SP15)	$32.79	$224.24	583%

Figure 13. Reported profits of main power wholesalers



* Data refers to Duke North American Wholesale Energy, which is Duke's California subsidiary.