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The organizational roots of market design failure structural abstraction, the limits of hierarchy, and the California energy crisis of 2000/01

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The Organizational Roots of Market Design Failure

Structural Abstraction, the Limits of Hierarchy,
and the California Energy Crisis of 2000/01

Georg Rilinger



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**The Organizational Roots of Market Design Failure: Structural Abstraction, the Limits of Hierarchy,
and the California Energy Crisis of 2000/01**

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Abstract

Economic sociologists have rarely studied organizational reasons why market design processes fail. Drawing on the organizational literature on mistakes and accidents, the paper identifies such reasons for a fatal design decision during the creation of California's first electricity markets. Designers proposed weak oversight structures even though their models called for active and permanent regulatory control. Sellers like Enron could therefore manipulate the market without fear of detection, prolonging the western energy crisis. A process of "structural abstraction" explains this mistake. Designers were split into three groups that worked in different divisions and relied on local frames to understand the oversight requirements. Each group missed information the others were aware of and arrived at the conclusion that minimal oversight would suffice. Higher levels of the hierarchy should have discovered and resolved these discrepancies. However, these levels considered the issue at a higher level of abstraction. Such structural abstraction made room for ambiguities that obscured the local disagreements.

Keywords: California energy crisis, cognition and hierarchy, economic sociology, market design failure, organizational mistakes

Zusammenfassung

Die Wirtschaftssoziologie hat selten nach organisationstheoretischen Gründen gesucht, um zu erklären, warum Marktdesign fehlschlägt. Dieses Papier verwendet die Literatur zu Unfällen und Fehlern in komplexen Organisationen, um eine fatale Fehlentscheidung zu erklären, die während des Designs der ersten Elektrizitätsmärkte von Kalifornien geschah. Obwohl ihre Modelle aktive und schlagkräftige Kontrollinstanzen verlangten, setzten sich die Designer für ein schwaches, fragmentiertes und temporäres System ein. Dies ermöglichte Energieunternehmen wie Enron, die Märkte zu manipulieren, ohne befürchten zu müssen, entdeckt zu werden, und trug so zur Verlängerung der kalifornischen Energiekrise von 2000/01 bei. Um die Fehlentscheidung zu erklären, schlägt das Papier den Begriff der „strukturellen Abstraktion“ vor. Die Designer waren in drei Gruppen aufgespalten, die in unterschiedlichen Teilen der Organisation arbeiteten und lokalen Interpretationsmustern folgten. Dabei übersah jede Gruppe wichtige Informationen, die den jeweils anderen bekannt waren. Manager auf höheren Ebenen der Hierarchie hätten solche Diskrepanzen eigentlich entdecken und auflösen sollen. Doch sie diskutierten das Problem auf einer höheren Abstraktionsebene. Diese strukturell bedingte Abstraktion führte zu Ambiguitätstoleranz und verschleierte die Uneinigkeiten unter den Akteuren in den Designteams.

Schlagwörter: Marktdesign, Fehler und Unfälle in Organisationen, Hierarchie und Kognition, kalifornische Energiekrise, Wirtschaftssoziologie

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The Organizational Roots of Market Design Failure: Structural Abstraction, the Limits of Hierarchy, and the California Energy Crisis of 2000/01

1 Introduction

Market designers build institutional and computational infrastructures to coordinate the activities of individuals and realize the assumptions of theoretical market mechanisms. If they succeed, the actors follow the logic of these blueprints, and the market produces aggregate outcomes that match designers' objectives. Examples of such "economic engineering" range from markets for environmental protections (Chiu et al. 2015), food donations (Prendergast 2016), and public housing (Waldinger 2021) to healthcare policies (Roth, Sönmez, and Ünver 2005). Even though some commentators express almost boundless optimism for this technique (Posner and Weyl 2018), the practical results have been mixed. While some markets work exactly as promised, others fail to deliver the results predicted by the models. Examples of recent failures are Texas's blackouts in February 2021 (Rilinger 2021a) and Australia's recognition that its Murray–Darling water markets were prone to manipulative behavior that generated severe misallocations (Commission 2021).

Despite the serious consequences, relatively little research has explored the practical reasons for market design failure. Failure here means that the market does not follow the logic of the blueprint and therefore does not produce aggregate outcomes within the margins of error the designers promise. It occurs when the implementation process does not create structures that can enforce the required interactions in the market. Even though economists have pointed out that it would be important to study why implementation processes fail (Duflo 2017; Roth 2018), very little research has taken up this task (Guala and Mittone 2005). In particular, few studies have explored the *organizational* dimension of market design failure. Instead, economic sociologists have largely focused on the role of politics (Breslau 2013; Reverdy and Breslau 2019) and the "epistemic gap" between conceptual design work and implementation processes (Callon 2009; Garcia-Parpet 2007; MacKenzie 2010). But most synthetic markets exist as software environments that designers build, manage, and alter inside organizations (Pardo-Guerra 2019). Accordingly, organizational processes mediate practically all implementation processes and can thus contribute to design failure. To illustrate the utility of an organizational perspective, this paper shows how a process I refer to as "structural abstraction" can explain a case of design failure that resists alternative explanations.

In April of 2000, California's electricity markets experienced drastic price spikes. This was the beginning of the western energy crisis, which would last for the better part of a year and drive the electricity system to the brink of collapse (Sweeney 2002). In col-

lective memory, the crisis has become synonymous with the Enron scandal and the manipulative “games” its traders played in California. But the story is bigger than the fall from grace of one of America’s darling companies. Twenty years of litigation have established that *dozens* of sellers drove up prices by gaming the market software and withholding supply in different ways (Taylor et al. 2015). While multiple, interlocking factors enabled this destructive behavior, California’s weak and fragmented oversight structure is one of the main reasons why this behavior could persist for years. The four monitoring units in California had severe structural disadvantages: they were small, had limited access to data, and had practically no enforcement powers.

From the perspective of market design, this structural flaw is puzzling. The blueprints for the energy markets required that actors conformed to an exceedingly narrow logic of rational behavior. But fundamental characteristics of electricity systems perpetually threatened to undermine this logic. Accordingly, the markets would have required a highly centralized control structure with substantial monitoring and enforcement powers. Yet, design experts explicitly and repeatedly advocated for the creation of the weak and transitory oversight structures. What prompted this design mistake?

Drawing on extensive archival material and in-depth interviews, this paper first considers the standard explanations and then points to an organizational problem to make sense of the decision. The literature on organizational mistakes and accidents has long highlighted how inconsistent frames between divisions of larger organizations can lead to mistakes and accidents (Allison and Zelikov 1971; Turner 1976; Vaughan 1999). In California, three distinct groups of market designers worked on different parts of the implementation process. Consistent with their divergent expertise, they developed distinct interpretive frames to understand the problem of market oversight and devised solutions in terms of their local tasks. From their limited frames, they each concluded that minimal oversight would suffice, missing information the other groups were aware of.

Usually, it would have been the role of hierarchy to detect and resolve such inconsistencies (Joseph and Gaba 2020). However, there are limits to the moderating effect of hierarchy (Jacobides 2007; Vaughan [1996] 2016). For local inconsistencies to be detected and tackled, they have to become salient for issues that managers consider at their level of the hierarchy. However, managers’ organizational location may require them to consider issues at higher or lower levels of abstraction. The same issue can look very different, depending on the organizational location where it is dealt with. At a higher level of the hierarchy, information that may be crucial at the local level may therefore no longer be salient. Mediated by “structural abstraction,” local inconsistencies can therefore systematically fall through the cracks of managerial attention. In California, managers tended to think about market oversight in terms of the market architecture as a whole. This turned the design challenge into an “ill-structured problem” (Turner 1976, 382). It was vague and non-quantifiable and could therefore sustain multiple viewpoints. The subtle differences between the interpretative practices of the design teams therefore did not become salient for the general discussions.

I proceed as follows. In the second section, I discuss the existing research on market design failure and show why research on organizational failure can offer an important new perspective. Then, I discuss the work on organizational failure and develop the theoretical argument of this paper, which identifies structural abstraction as an obstacle to the successful mediation of the division of labor by hierarchy. In the third section, I discuss the data for the case. The fourth section develops the research question. It shows that the blueprint for the California markets would have required a comprehensive oversight structure, but the designers were relatively unconcerned about this function. In the fifth section, I show why the standard explanations do not apply and then discuss the organizational explanation that highlights how the ill-structured nature of the problem on the highest level of the hierarchy obscured the discrepancies between the different subunits. This prevented a solution to the basic problem in the division of labor. The conclusion draws out broader implications for future research on market design failure.

2 Explaining market design failure

Politics and epistemic gaps

Economic sociology has long explored market creation in general (Fligstein and Mara-Drita 1996) and market design in particular (Garcia-Parpet 2007; Guala 2001; 2007; MacKenzie 2007; Samuels 2004). Yet, it has not yet explored in any detail the reasons why market design processes fail. In the neo-institutional tradition (Dobbin and Dowd 2000; Fligstein 2002), scholars view designers' blueprints as epistemic frameworks that structure the terms of political negotiations (Breslau 2013; Reverdy and Breslau 2019). In some situations, designers may be able to leverage the technical details of economic theories to repel the influence of special interests. In others, the designers translate genuinely political questions into technical ones and thus empower special interests (Hitzig 2020). But at heart, market construction is a political negotiation. It is only structured – not determined – by the language of economic engineering (Veal and Mouzas 2019). Indeed, market designers' assertion that it is possible to engineer a market is itself a political move that is meant to secure their influence as an interested party (Nik-Khah and Mirowski 2019). We should therefore expect the final structure to work in the interest of powerful stakeholders rather than according to the blueprints of the designers.

Similarly, research in the social studies of sciences notes how difficult it is to “perform” (Callon 1998) a theory. They show that the translation of theories into reality is a cumbersome, precarious, and complex social process that involves a variety of changes to the social context (Callon 1998; MacKenzie 2007; MacKenzie and Millo 2003). This process is inflected by political interests, material obstacles, and historical path dependencies (Garcia-Parpet 2007). To explain market design failure, these studies point to an epistemic gap between conceptualization and implementation of new mechanisms.

There are always decisions that matter for implementation but are not prefigured in the academic context where designers conceptualize new mechanisms. If these decisions impact the outcomes of the market process, the design is underdetermined and not robust – it has limited external validity. These limits are not visible from within the scientific practice. Since this gap between theory and practice is intrinsic to the work of the designers, it can only be bridged by experience with in vivo market experiments (Callon 2009; Guala and Mittone 2005).

While these two explanations – political influence of stakeholders and the epistemic gap – capture important reasons why market design processes might fail, they are somewhat indeterminate. Practically all market design processes have a political dimension and involve processes of translation. Because sociologists tend to expect failure, they have not frequently analyzed design processes from the perspective of the design project. Instead, they are more interested in understanding which political interests come to be reflected in the final design and how designers go about their design work. But because the use of market design proliferates for a variety of allocation problems and we observe both success and failure, it is useful to identify reasons why market design processes succeed or fail. Here, I follow recent calls to adopt an organizational perspective (Beunza and Ferraro 2019). Since all design work is mediated by organizational processes, this perspective thus allows us to observe mechanisms that explain both success and failure.

Organizational failure and structural abstraction

The organizational roots of accidents and disasters are the subject of a long-standing research tradition (Le Coze 2015; Snook 2002; Turner 1976; Vaughan 1999). Much of this research focuses either on the interaction between technological and organizational factors (Leveson et al. 2009) or on the microprocesses of enacted sensemaking (Weick 1988). Since I am here focusing on the problems of *conceptual* design work and do not have the fine-grained data to reconstruct the ongoing dynamics of sensemaking, I draw on theories that explore the relationship between organizational structure and cognition on the divisional level (Jacobides 2007).

This literature starts with the basic idea that organizations are information-processing entities. The division of labor increases the complexity of information that the organization can process (Beniger 2009; Cyert and March [1963] 2013; March and Simon 1958; Simon 1962). It requires that the organization focuses the limited cognitive resources of its members on different parts of the environment. Local career imperatives, routines, constraints, and cultural norms stabilize local ways of paying attention and acting (Ocasio 1997; Thompson, Zald, and Scott [1967] 2017).

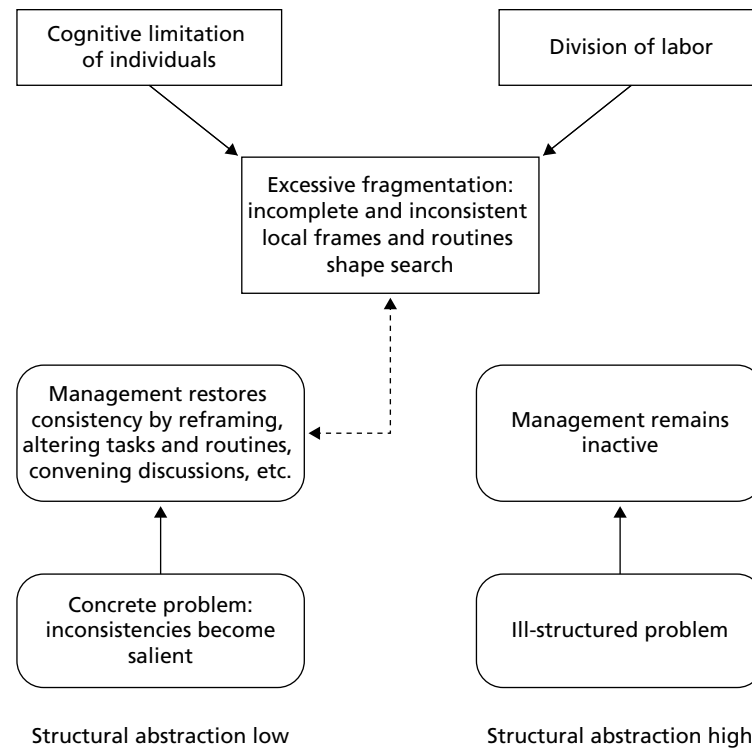
However, these local perspectives can be myopic with respect to the organization's larger goals. For example, Allison's analysis of the Cuban missile crisis stresses the role of dysfunctional politicking between intragovernmental units. As members of different branches of government were trying to increase their spheres of influence, they pushed an agenda that ignored important signals and escalated the crisis (Allison and Zelikov 1971). Diane Vaughan's masterful account of the Challenger disaster shows how cultural differences between departments structured attention in ways that normalized risks and misdirected the flow of signals that could have revealed the problem (Vaughan [1996] 2016). Similarly, Snook's analysis of the friendly fire incident in Iraq showed how local, divisional cultures can begin to drift from standard operating procedures and then normalize this deviance (Snook 2002). Specialization can thus produce and sustain mutually inconsistent interpretative practices that may move into tension with each other.

Such local divergences are a potential problem for any division of labor, and *hierarchies* are often designed to solve the problem (Joseph and Wilson 2018; Thompson, Zald, and Scott [1967] 2017; Weick and Roberts 1993). Higher levels of the hierarchy manage interdependencies between subunits by imposing tasks, allocating funds, setting incentives, and organizing both formal and informal relationships. In particular, managers can resolve tensions between local frames by redirecting members' attention to crucial information they are not aware of, or by reorganizing their task structures. Simon called this the "exception management" function of administration (Simon [1969] 1996).

But hierarchy may not always be able to identify these local problems. One branch of the literature on organizational mistakes and accidents explores such limiting conditions (Farjoun and Starbuck 2007; Jacobides 2007; Oliver, Calvard, and Potočník 2017). For example, feedback cycles between lower and higher levels may fail due to goal conflicts on the lower levels (Hu and Bettis 2018). Other studies point out that managers have cognitive limitations. To become visible, local problems must therefore pass "a cognitive threshold" (Dutt and Joseph 2019; Sullivan 2010). Signals of local problems can get lost as they traverse the different parts of the organization. Diane Vaughan has called this general class of phenomena "structural secrecy" – the way different divisions filter, pass on, and interpret information can engender systematic blind spots (Vaughan [1996] 2016). One mechanism that has rarely been described has to do with the definition of problems at different levels of a hierarchy. I call this the problem of "structural abstraction." Figure 1 illustrates this mechanism.

Higher levels of an organization cannot consider decisions at the same level of detail as local units. By virtue of their integrating role, managers tend to think about problems in ways that bridge the work of divisions. Unless managers are called to a problem as it exists on the local level, they therefore consider issues more abstractly. Abstraction invites ambiguity, which means that design questions can become "ill-structured" (Weick 1998). Such questions are posed in vague and general ways that cannot be quantified and admit of multiple different interpretations and solutions. Since the nature of the question determines the restrictions on acceptable answers, ill-structured questions

Figure 1 Ill-structured problem blocks mediating influence of hierarchy



tolerate inconsistencies in answers much more than questions that arise during more tangible and concrete tasks. If inconsistent interpretative practices generate arguments that fit into the range of acceptable solutions, they do not become salient for the discussion of an ill-structured problem. The gaps between disparate, local frames are then “smoothed over in ways that sustain the illusion of safety” (Weick 1998, 74). Accordingly, they fall through the cracks of managerial attention. The mediating role of hierarchy thus fails where inconsistencies in the responses to a given problem are hidden by high structural abstraction. Conversely, if structural abstraction is low and managers deal with problems that have clear parameters for an answer, inconsistencies between local frames become salient more easily. I will now demonstrate this argument by turning to the puzzle of California’s flawed oversight structures.

3 Data and method

Data

Archival data. This paper uses primary data from three different archives. The creation of California’s oversight structure is documented in dockets of two regulatory bodies:

the Federal Energy Regulatory Commission (FERC) and the California Public Utility Commission (CPUC). Both regulators therefore accompanied the design process at different stages. The federal agency had to approve the market design before the actual construction of the markets began in 1996. Accordingly, there are several dockets that chronicle the process of market design between 1996 and 1998.¹ They deal with the approval and augmentation of plans developed by design committees in California and contain formal filings, responses to questions, evidence, and transcripts of technical conferences. The formal filings reveal the positions of regulators, stakeholders, and market designers who worked for them. Reasoning about the required market monitoring standards and how they might need to be revised is visible in the transcripts.

Submissions to the CPUC cover the same time period but also include earlier debates about the market between 1993 and 1996. They also include exchanges with the Western Power Exchange (WEPEX) process, which organized the work of the different market designers and stakeholders.² While these documents cover much of the same ground, they provide more detail on decision-making processes inside the organization that developed and implemented the design.

The California State Archive in Sacramento contains an extensive collection of material that documents the operation of California's markets by the system operator and the largest auction house for power contracts, the Power Exchange (PX). The design process migrated into these two entities once they assumed legal existence in 1997, turning them into the organizations that implemented, managed, and altered the markets. The record begins in 1998 but contains substantial amounts of documents from the earlier period. The designers continuously tweaked and changed the market structure in reference to the original design and therefore included the older documents in their files. In particular, I draw on meeting information from the board of governors for the two organizations. This material reveals how the higher levels conceptualized and thought about problems on the lower levels of the organization.³ In addition, I draw on technical and "gray" literature by practitioners, which documents the development of market designers' reasoning about the new markets. This involves working paper series connected to the organizations that created the markets, think tank work, and publications in the trade press.

Retrospective interviews. Since archives collect primary sources for their own purposes, they introduce a selection bias into the data. Most of the available material also reflects only formal procedures and not the informal practices surrounding them. Besides rely-

1 In particular the dockets numbers: ER96-1663, ER98-2843, ER96-19, OA-96-28, OA96-193, ER96-222, OA96-76, OA97-632, OA97-604. Accessible on FERC's online filing system, <https://www.ferc.gov/ferc-online/elibrary>.

2 These are dockets R.94-04-31 and I.94-04-032, accessible at the Central Archive of the CPUC in San Francisco.

3 Most of the material is accessible under: ISO Board of Gov. and Com. Meeting Files & Power Exchange Corporate Meeting Files 1997-2000, Dockets R.400.006-R400.009, Box 12 – 14, California State Archive, Sacramento.

ing on more than one archive, the best strategy to get a more comprehensive picture of the design process is to triangulate archival data with semi-structured, in-depth interviews. I therefore conducted in-depth interviews with thirty-six officials engaged with market monitoring at the federal and the state level. On the one hand, I talked to market designers with economics (twelve) and engineering (ten) backgrounds who were part of the design process between 1993 and 1998. On the other, I interviewed fourteen additional employees from the organizations that operated the California markets, the PX and the California Independent System Operator (CAISO). They were economists, lawyers, and administrators involved in the design, operation, and monitoring of the markets between 1997 and 2001.⁴

The interviews lasted, on average, between sixty and ninety minutes and were conducted over the phone, or in person when feasible. The interviews were transcribed and used to supplement the archival material, which provided the primary insights into the processes of market design and regulatory adaptation. However, I only used these interviews for supplementary purposes. Since they were conducted with more than twenty years of hindsight, they suffer from retroactive rationalizations, and recall errors. Yet, they provided important insights into the context of archival findings and helped to better understand informal processes surrounding the design process.

Method

The analysis followed the guidelines for qualitative, historical case studies (Yin 2017). The goal was to reconstruct as closely as possible how the different parts of the market design process were organized and how this related to the decisions about the oversight structure. To handle the vast amount of data, the analysis proceeded in several stages. I began by reconstructing the market features that violated principles of market design and how these violations established stringent oversight requirements. This first established the puzzle for the analysis. With greater focus, I then filtered the archival material for debates about the oversight structure. After identifying the participants in these debates before FERC and the CPUC, I reconstructed what part of the design process they worked on. Along the way, I established chronologies of decision-making, organizational charts and notes on the work culture and the intellectual background of the designers. This revealed (a) that the political explanation did not fit the data and (b) that market designers with distinct expertise worked on different parts of the larger system. While they met and discussed general problems together, their more focused contributions occurred in distinct parts of the larger design effort. I then went through the data to determine how market designers in different parts of the organization engaged with issues that touched on oversight functions.

4 According to the IRB requirements of this study, these interviewees have been anonymized.

In the next step, I reconstructed how designers framed their reasoning about markets in these venues. I went through the documents and gray literature to reconstruct the background understanding that animated the designers' thinking and coded the relevant documents for "definition of competition," "definition of efficiency," "definition of market," "background of expertise," "most important problem," "relation of market to grid," etc. Interviews helped to clarify the contexts of the relevant design documents and the regulatory hearings. I then identified subcodes that sorted the designers into three camps and linked them to different strategies of justification for oversight regimes. When it became clear that there were distinct ways in which the designers concluded that weak oversight would suffice and that these perspectives were inconsistent, I began to wonder why these inconsistencies did not become apparent to regulators and managers. This directed my attention to the role of hierarchy.

In a third step, I began to reconstruct the actions of managers and regulators who organized discussions with designers and assigned the tasks of the different groups. It quickly became apparent that they did not perceive a tension between the advice from different market designers. To understand why, I analyzed their discourses and also searched for instances when problems were discovered to support counterfactual arguments. Gradually, I realized how important the level of abstraction was at which different actors defined the oversight problem. Returning to the regulatory debates, I once again relied on inductive coding to classify how the regulators and CAISO/PX managers debated the problem of oversight. This revealed that structural abstraction had made the problem deeply ambiguous and obscured the intellectual discrepancies between the designers.

Limitations

As a historical case study, this paper has two important limitations. First, even with rich archival sources, historians always work with fragmentary evidence and there is usually no smoking gun. The conclusions drawn from counterfactual arguments can therefore never be absolute. Second, explanations do not aim to find the single true cause of an event. Rather, the decision to favor one over another explanation reflects a judgment about the relative importance of some factors that have been weighed against other factors that may point in different directions. Reality is messy, and there are always multiple different factors that play together to produce events. It is therefore more appropriate to think about the organizational perspective as a *lens* – a way to analyze reality – rather than as the one conclusive account of market design failure in California. The paper distinguishes between political, epistemic, and organizational explanations and isolates the mechanism of structural abstraction as decisive. However, these are *analytical* distinctions that aim to highlight the relative significance of some factors vis-à-vis others. In reality, politics, practical work processes, and organizational logics always exist in conjunction and interweave each other. I do not aim to argue that these other dimensions played no role. Rather, I want to highlight the relative importance of

the organizational factors with respect to the decisions about oversight. In that sense, the empirical analysis serves as an illustration of a theoretical construct rather than as a definitive causal explanation of the energy crisis.

4 Setting: The creation of California's oversight structure

The oversight structure for California's new markets had two levels. On the federal level, FERC was responsible for California's wholesale markets. On the local level, four monitoring units observed the markets during the day-to-day operation. Two were associated with the system operator (CAISO), the organization responsible for grid management. The other two belonged to the PX, a public exchange for electricity futures. After the markets opened in 1998, the local monitoring units quickly developed novel analytical capabilities and detected widespread market power potentials across the entire market. Urgently they began to file reports to FERC and asked them to intervene. But FERC largely ignored the warnings. When the crisis started, the agency treated the price spikes as an indicator of supply shortages and refused to act against sellers of energy. Almost a year into the crisis, the agency finally changed its assessment and began to mitigate the exercise of market power. But at that point, the crisis had already turned into a national disaster.

Since FERC's indecisive behavior prolonged the crisis into 2001, most empirical research has focused on the federal level. The reasons for FERC's hesitant response are complex. The literature has pointed to political rivalries between Washington and California, an outdated and weak legal mandate, regulatory capture, adherence to pro-market ideology, and insufficient resources in terms of personnel, data, and money (Beder 2003; Bushnell 2005; Rilinger 2021b; Wolak 2003). Since most studies explain oversight flaws by focusing on the federal level, few have noticed the weakness of the local level.

Yet, these units had structural disadvantages that prevented them from acting on their insights. Even though they discovered market power potentials as early as 1998, they had no means to act on them. The units were very small. While the external units had only three official members each, the internal units had between seven and twelve employees. They did not have access to all market data and had practically no enforcement power. This prevented them from acting against market manipulations when FERC rejected their warnings. In contrast to FERC, these units and their tasks were built from scratch. Just as in other electricity markets, they could have been equipped with substantial monitoring and enforcement power. But in the regulatory hearings, the designers described the monitoring units as a transitory necessity. During one hearing, Paul Joskow, an economics professor from MIT, presented Pacific Gas & Electric's position on the issue as follows:

Because of the many novel features – because of the proposed structure – and other elements of the California restructuring program as well as the inevitable uncertainties associated with diagnosing market power, the applicants have recommended a three-year monitoring program be put in place to collect data that can be used by interested parties and this Commission.

The monitoring units here appear as advisory bodies that are supposed to collect data for regulatory decision-makers. They are supposed to observe if the markets work as planned, and communicate problems to FERC, which would then affect rule changes to resolve the issue. After the implementation is complete, the monitoring units will play a largely subsidiary role and simply submit annual reports to FERC. They might even become superfluous after the first three years.

When probing deeper into the rationale behind the creation of these structures, it becomes clear that Joskow was not the only designer who held this point of view. They advocated these weak structures as a tool to assuage fears about utilities' potential market power. For example, a designer at San Diego Gas & Electric "proposed that its market-power mitigation measures and [power exchange] operations generally be subject to a thorough monitoring program." In the quote, the monitoring program appears as a tool to ensure the utility's compliance in the new markets – not a central component of the market design itself. The designers assumed that the units could be created "on the fly," as one monitor put it.

And indeed, the monitoring units were built relatively late and without consideration for the rest of the system. Even after the market organizations assumed legal existence in 1997, less than a year before the markets were supposed to open, no one had yet put much thought into the monitoring function. The head of the local market monitoring unit recalled the situation in 1997:

I was a new person joining the team and they said to me: Oh, [the monitoring function] is un-designed. Go and write the protocols and we will get ready to file them. [...] It truly was sort of an afterthought – oh we are missing this, but it is a requirement by FERC, so can you go off and write these? Then we'll file them.

Submissions to the regulatory dockets confirm this retrospective account. In March of 1997, the California parties filed updates on the implementation process with FERC. The description of the organizational structure for the new monitoring units remains vague. The system operator, which housed two of these units, stated obscurely: "As the compliance divisions are formed, they will develop specific guidelines and criteria for identifying market power in their respective markets."

It is rather surprising that the designers neglected the market monitoring function. Of course, the 1990s were a period of unmitigated market optimism. Many politicians and regulators held a religious belief in the healing powers of self-regulating markets. But while the political and regulatory belief in "deregulation" hardly requires any further explanation, the position of market designers is somewhat puzzling.

Economic engineering is neither firmly rooted in any subdiscipline of economics nor economics itself. Different approaches have developed around a set of methodological core commitments. Designers use mathematical techniques of linear and dynamic programming to describe market processes as search algorithms that solve optimization problems under constraints. The trading process must eventually converge on the globally optimal solution to the optimization problem. To ensure that it does, the designers invent organizational structures and institutional rules that can enforce this mechanism (Bichler 2017). These infrastructures set incentives and constrain behavior in ways that force market participants to act as the blueprint requires.

The blueprints for electricity markets are particularly tightly specified because the market process is vulnerable to disruptions. Electricity systems consist of generators that are linked to end users via a transmission system. The task of an electricity market is to find the combination of generators that meets demand in a given hour at least cost and without violating transmission constraints or other reliability criteria (Cramton 2017, 589). This is commonly referred to as the problem of “security constrained economic dispatch.”

Markets cannot help to solve this problem in real time – they do not work fast enough. But they can approximate the solution in advance of real-time operation. All electricity markets are therefore *financial* exchanges that trade obligations on the delivery of energy at future points in time. For example, a day-ahead market trades obligations to deliver energy at particular locations during the next day. An hour-ahead market trades obligations for the next hour, and so on. The trades result in anticipated schedules for the production and consumption of energy at different locations. Market design aims to create market mechanisms that force the trading process to converge on an approximate solution to the security constrained economic dispatch. The system operator can then use the resulting schedules to balance the system in real time.

Since even small mismatches between supply and demand can lead to cascading outages, the markets must produce results that closely match the requirements of the system operator. There is little room for error, which means that the activities of market participants must match the designers’ blueprints very closely. At each point and across all submarkets, buyers must search for the cheapest supplier and suppliers must compete to offer their generation at marginal cost.

However, due to the technical characteristics of electricity systems, market participants do not always have incentives to follow this calculative logic. Electricity flows at close to the speed of light. In addition, there is no way (yet) to store large quantities of electricity efficiently. This means that generators must meet changes in the existing demand instantaneously. Since it can take more than a year to connect a new generator, there is a fixed amount of available capacity that can be deployed to solve this problem. As soon as demand approaches this limit, the cost of production quickly escalates – it first becomes prohibitively costly and then impossible to meet additional demand. Unfortunately, most end users buy their energy from the utilities at fixed, monthly rates. Ac-

cordingly, they do not perceive price fluctuations in the short- to mid-run. They have no way to adjust their behavior to sudden shortages in supply. This means that the consumers – in this case, California’s utilities, who buy energy on behalf of their end users – are extremely vulnerable to price fluctuations.

As the aggregate demand approaches the system’s capacity limits, there are fewer and fewer substitutes for marginal generators. The generators face less competition the fewer substitutes there are. At some point, they are the only ones who can meet the rising demand. Since the demand does not react to price, these generators have the power to increase their prices far above their costs – they gain market power. Depending on the balance of supply and demand in the system, sellers may therefore no longer have incentives to act as the blueprint requires. In that case, the incentives turn the market against the logic of reliable system operation. Due to the interdependencies between power flows, this can happen in a matter of minutes. The system therefore constantly generates incentives to diverge from the market logic that market designers try to enforce. More than in perhaps any other domain of market design, the success of electricity markets therefore depends on *control*.

Designers must carefully monitor the balance of supply and demand and constrain market participants as soon as they gain market power. Specifically, the system operator must be able to freeze prices as soon as market power emerges, or it must be able to disgorge excessive profits after the fact. Ongoing oversight and control are essential because the highly fluid balance of power flows can quickly destroy the incentives that are needed to realize the blueprint at any time.

We would therefore expect the designers to construct the control structure in tandem with the market process and emphasize the need for strong enforcement powers. Yet, designers in California largely neglected the issue, arguing that a transitory monitoring structure with purely advisory status would suffice. Why?

5 Analysis

Existing explanations: Politics and epistemic gaps

Before turning to the problem of structural abstraction, it is worthwhile to return to the existing explanations for market design failure. The first hypothesis is straightforward. It suggests that the market design process is a political negotiation and that the resulting rules reflect political interests in some fashion. On this account, we would expect that the decisions about the monitoring structure were based on political arguments rather than designers’ expertise. Incidentally, market designers themselves often cite this explanation for the problems with California’s markets. Peter Cramton (2003, 1), for example, wrote:

Perhaps the biggest impediment to good design is the fact that the designs [in California] were created by committees of stakeholders. Just as one should be hesitant to fly on an airplane designed by a committee of stakeholders, one should be hesitant to trust electricity designs that are built from consensus among interested parties.

And indeed, research has found that many of the most pernicious design decisions in California go back to negotiations between stakeholders who had little or no training in economics (Sweeney 2002). But while particularly the early design process can be characterized this way, the hypothesis cannot account for the creation of the monitoring structures. Here, regulators asked the designers to testify as independent experts on the issue of oversight and, as outlined above, these experts did not display much concern about the issue. This was not a situation where some political committee decided against the sage advice of market designers. Quite the contrary: market designers, regulators, and politicians agreed about the need for a limited oversight structure. Accordingly, the decision was not based on politics at the expense of designers' expertise.

An alternate version of the first hypothesis is that the professional market designers acted at the behest of special interests. But even if we assume that they did, they should have advocated for a *strong* control structure. The design process was dominated by the three incumbent utilities, whose vast monetary interests were at stake. They also owned the transmission grid and knew how to operate it. It was up to them to figure out how exactly the implementation of the new markets would work.⁵ Most professional market designers worked for the three utilities, which makes it reasonable to suspect that they might have done the utilities' bidding. But these actors had a strong interest in a capable control structure. As buyers, they would have to pay higher prices if sellers could exercise market power. Indeed, the utilities became the primary *victims* during the energy crisis. California's two biggest utilities, Pacific Gas & Electric (PG&E) and Southern California Edison (SCE), were so worried about insufficient oversight that they developed their own internal monitoring units after the markets opened. Because the designers did not simply further the interests of their employers, we can thus disregard the political explanation and move on to the second hypothesis.

The second hypothesis suggests that we are dealing with an epistemic problem. According to this view, the oversight requirements for the new markets lay beyond the purview of designers' expertise. This hypothesis is based on the observation of an epistemic gap between scientific practices to justify new blueprints and the processes of real-world implementations. In short, this argument suggests that the designers had no way to

5 Large industrial customers were another powerful interest group. But I will neglect this group here. In the restructuring process, they mainly cared about options for bilateral contracting because they wanted access to the capacity of independent energy producers. After they shaped the compromise about the basic architecture of the market, they largely left the issue of implementation up to the utilities, including the issue of oversight. Due to the structure of their contracts and the legal specificities of the retail markets, they were largely inoculated against the effects of market power during the crisis.

anticipate the oversight requirements. For that to be the case, the emergence of market power had to be based on interactions between elements that were not represented by the conceptual work of theoretical and experimental market design. Then, the problems with the markets would have been unknowable prior to experience with the construction of the real-world electricity markets in California.

While many of the games that power marketers developed could not have been anticipated, this is not true for market power. The reason why a strong and permanent control structure is necessary derives from the way the supply and demand inelasticities interact with complex power flows on the grid. As outlined above, these dynamics can subvert the incentives required by the blueprint. Early publications in the trade press as well as submissions to the regulatory record suggest that the designers were aware of these issues. That is, even though they were unable to model California's market architecture, the different mechanisms that generate market power were well known. Several market designers published papers that outlined the way market power derives from supply and demand inelasticities (Cardell, Hitt, and Hogan 1997; Garber, Hogan, and Ruff 1994). Some also noted that flows of power on the grid interact with each other to produce market power, leading to the conclusion that "the spatial attributes of generation markets and changing network conditions virtually assure that generation markets will never be perfectly competitive under all system conditions" (Joskow 1997, 135).

There is thus evidence that market designers were aware of the different mechanisms that conspired against California's markets. They knew that electricity markets suffered from demand and supply inelasticities. They knew that this could create market power, and they knew that the transmission system could create "load pockets" where power flows blocked competition. Together, these puzzle pieces add up to the ever-present danger of sudden price spikes, which in turn necessitate substantial levels of ongoing market oversight and control.

Another piece of evidence tilts the scales even further against the "epistemic gap" explanation: *some* market designers *did* put these pieces together and realized that a comprehensive oversight structure would have been required. Unfortunately, it was not the designers who addressed the issue in the regulatory proceedings at the CPUC and FERC. Though they were part of the design process, these experts worked for an independent subcontractor. Rather than enter the regulatory dockets, they decided to try and sell their insights to power marketers whose misdeeds would later become infamous during the Enron scandal. Since Perot Systems had worked on the software integration for the new markets, revelations about these sales efforts caused a scandal and led to a congressional investigation.

To everyone's surprise, the two architects of this "crime school" managed to exculpate themselves during the subsequent hearings. They showed that the problems had not required any knowledge of proprietary information and that all relevant information was freely available to everyone. One engineer explained drily: "That particular game was

developed by Antoine Cournot in the 1850s, roughly, and is taught in every university in the United States. So, it wasn't like a secret." Asked for the reason why these games were possible, he explained that "any system that changes over time, such as markets, must have a control system." But California did not put one in place, because the designers assumed that the markets would unfold exactly as specified by the blueprint. "Everybody was assuming everything was perfect, whereas," the engineer remarked, "I started off with the position that [market conditions] were maybe not so perfect."

The archival record thus suggests two conclusions. First, the market designers did have all the puzzle pieces to understand the problem of market power in electricity systems. This problem implied the need for comprehensive oversight units with substantial enforcement powers. Second, some people did put those pieces together and figured out where the weaknesses of the new design were. Accordingly, we can reject the second hypothesis. The issue was not some inherent limitation of market designers' expertise.

Intellectual fragmentation obscures oversight requirements

I am now turning to organizational explanations for the designers' decision. This explanation has two parts. First, I show that the division of labor in the design process sustained three distinct perspectives on the issue of market oversight. Each perspective made sense in the designers' local contexts of work but obscured crucial information the others were aware of. This led each group to arrive at a flawed perspective on oversight. Second, I show how a process of structural abstraction prevented managers and executives on higher levels of the hierarchy from noting and resolving these inconsistencies.

Division of labor and hierarchy. The technical market design work began in 1995. At that time, the state's three largest utilities created working groups that began to figure out the technical details for the political project of restructuring. The so-called WEPEX process consisted of a steering committee and twelve teams that worked on components of the larger design. As time went by and implementation became more concrete, the committee subdivided and multiplied the teams. Due to enormous pressure from the governor's office, the steering committee had to rush practically every part of the design process. The political apparatus was intent on opening the markets no later than January 1, 1998. With less than three years to go, the steering committee implemented a modularized division of labor with strict hierarchies. The system was split into individual modules that were related according to a larger architecture. Individual teams sorted out how to realize problems in specific modules. Market designers worked primarily in teams that solved technical questions about the implementation of the new market mechanisms. They either joined the proceedings as external consultants on specific questions or as constituent members of the teams themselves. Unless modules were directly related to each other, there was very little interaction between the teams. For example, the Stanford economist Robert Wilson complained publicly about this lack of collaboration (Stoft 1997).

Instead, intermediaries and managers were supposed to integrate work across modules. Each team had one member who reported to these intermediaries and one member who monitored internal progress. Every two to three weeks, the teams had to report back to the steering committee, which then hosted a general debate about the different options and made final decisions.

Market design camps. In this division of labor, market designers formed three distinct camps. The first group consisted of auction designers who developed the “activity rules” for the public exchange markets. Robert Wilson and his team from Stanford University developed the rules. Charles Plott and his colleagues from CalTech (as well as a firm called London Analytics) then used computer-assisted laboratory experiments to test them. These experts worked as outside consultants for the WEPEX process. They viewed markets as deterministic algorithms – closely in line with the optimization logic of market design.

In one of his filings, Robert Wilson outlines the activity rules that describe how bidding can take place in the hourly auction at the power exchange. He writes: “The purpose of the activity rules is to encourage convergence to an efficient outcome while suppressing gaming.” In other words: market design is fundamentally about designing the rules for the market process. If the rules are set right, they will create the correct incentives and the market will converge on the desired outcome. The initial conditions of the market determine the trajectory of its process through different states. This is encapsulated in an early paper on “design principles” where he writes that the most basic principle is “to treat the market design as establishing a mode of competition among the traders. The key is to select a mode of competition that is most effective in realizing the potential gains from trade” (Wilson 1998, 161). Get the incentives right, and you create a “mode” of competition that converges on the desired results.

Since opportunities for gaming often emerge if the rules do not reflect the technical details that shape opportunities for profits, these designers were attuned to the threat that the technical complexity of the electricity industry posed to successful market design. Plott and his team repeatedly recommended “intensive testing” and “iterative improvements to the rule structures.” However, while they were very worried about loopholes that would derive from mismatches between the rules and technical conditions, they thought the place to address these problems was in the design of the market *rules*. This perspective made sense in terms of the teams’ task: Wilson and his collaborators developed the minute scripts for the different steps of the market software. In this context, control was largely a question of setting rules and writing software to enforce them.

The second group consisted of engineers and system operations researchers who mostly worked for the three utilities. Like SCE’s lead engineer Vikram Budhraj, or PG&E’s Ziad Alywan, they typically held engineering PhDs with MAs in economics or system operations but had no direct affiliation with universities. For some tasks, they hired economists and engineers from the Electric Power Research Institute in Palo Alto and Berkeley’s Energy Institute, such as Shmuel Oren, or Stephen Peck. They had expertise

that primarily related to the period of regulated monopolies. Accordingly, they worked on the creation of the system operator and problems that concerned congestion management, integration of grid management, and markets for reliability services.

In contrast to the mechanism designers, these engineers were closely attuned to the fact that any complex system can take on a variety of different states and that only some of these lead to the desired equilibrium. Accordingly, they wanted to create feedback mechanisms that could monitor the ongoing operation of the system and then adjust inputs to keep the system in check. But they reasoned about this control structure in terms of grid management – not in terms of market oversight. Vikram Budhraj stated the central importance of the ISO in a presentation to the CPUC as follows: “This issue of requiring somebody who can perform the integration, coordination, and synchronization between production and consumption is a fact that cannot be controverted.” Once the ISO had the power to coordinate supply and demand in real time, he said, “everything around that is free market, and again, unimpeded by any central control and so forth.” As far as they were concerned, grid management was the center of the system. This was the place where the actual balancing of generators took place, where power flows had to be adjusted and managed. The market appears as a separate sphere that produces inputs for grid management. This center would be carefully protected, but the markets themselves would be “unimpeded by any central control.”

But why did they not think that the markets would require particularly strong oversight? Intellectually, this perception traces to a school of electricity market design that emerged in the engineering departments at MIT and Harvard during the late 1970s and early 1980s (Schweppe et al. 1988; Schweppe et al. 1980). At the time, engineers tried to make vertically integrated utilities more efficient. Economies of scale had largely been exhausted in the industry, and so the focus turned to the relation between the machines. The engineers began to view electricity systems as “homeostatic systems” and tried to increase efficiency by introducing mutual adjustments to the machines that composed the system. If devices that used energy could somehow coordinate their consumption with each other and in relation to the available supply, there would never be a situation where all devices were switched on simultaneously. In that case, the total amount of installed capacity could be reduced. To organize the communication between generators and consuming devices, they quickly argued that a “price” might be used. The price, calculated from a central position, is thus nothing but a tool to summarize the cost of production at different locations at different levels of demand. This orientation carried through.

In California, the engineers implicitly equated the supply function of a generator with the expected behavior of market participants. As an engineer explained during the Perot hearings: “The tools that were used for that analysis [of the potential problems] continued to assume an optimization approach only appropriate to a regulated market.” Under this approach, market participants would continue to act as generators had in the regulated system. They would submit the marginal costs for the generators because they

would mainly try to cover their costs. “As long as I can feed my family, I worry about producing the energy,” an engineer recalled his expectations. By interpreting the market as a signaling device to coordinate between generators and consumers, the engineers missed that market participants would be trying to make money in any way possible.

While the engineers were aware of the dynamic complexity of the electricity system and the need to control its balance carefully, they did not think that the markets would do anything but provide information about this task. Now and then, the markets might be off from the technically correct solution. But they would not actively contradict the reliable operation of grid management. It would be “business as usual.” If problems emerged, so the assumption, they could always just *call* the generators and ask them to change their behavior. In the proceedings, engineers were therefore happy to assure FERC and the public utility commission that technical monitoring would suffice.

Again, this perspective made sense in terms of designers’ tasks in the design process. They were working on linking the grid management of the system with the markets. To the extent that they put control structures in place, these were dedicated to check inputs from software for errors and block inputs that would threaten the technical integrity of the grid. They engaged with the market side of the system only to the extent that it provided inputs for the “scheduling architecture” of the system operator. When they confronted monitoring issues, it usually came down to questions about how they might detect input errors or other extreme values that needed to be filtered out to retain the integrity of grid management.

The last group were economists with a background in industrial organizations who addressed legal questions about industry structure. This included market power as well as architectural issues, such as the correct procedure for settlements. These economists came from California’s public universities, from think tanks and research institutes, as well as from private universities in the east, particularly MIT and Harvard.

In contrast to mechanism designers, they were more attuned to the problem of changing industry conditions and how these might dynamically affect the incentives of market participants. Different from engineers, they saw market actors as players who do anything to use system flaws to their advantage. In their statements, they frequently talk about the market as an evolutionary process, in which constant innovation occurs against the backdrop of competition. As a professor from the University of California put it:

What’s fundamental to understand about markets is they’re not something you can plan. [...] Nobody would have even a year ago envisioned half of the new types of financial and related instruments that were discussed by the various commentators late yesterday afternoon.

Substantively, they focused on problems that could emerge from changes to the underlying industry. Early on during a hearing, Paul Joskow stated that

since electricity cannot be stored, considerable care must be taken in identifying what capacity is competitive under different supply and demand conditions. If demand is very inelastic, market power could be a potential problem even with a relatively large number of suppliers, under certain demand and supply conditions.

This quote illustrates that the economists were aware of the unique supply and demand characteristics in electricity systems and how they might generate market power.

However, in contrast to the engineers and mechanism designers, these experts underestimated the *speed* with which market conditions can subvert the algorithmic logic of the design. In line with the existing literature on electricity systems, they viewed market power largely in static terms. While they were critical of FERC's decision to measure market power with static concentration measures (Herfindahl-Hirschman Index), they still suggested that market power was a relatively stable attribute of the industry structure. To address market power problems, they advocated for companies to divest generation assets or to switch to regulated rates for certain generators at certain times ("must-run contracts"). Since these mitigation measures would play out over longer stretches of time, the economists reasoned that a limited monitoring function would suffice. Should problems emerge, the monitoring institutions could inform FERC, which would then be able to decide if any kind of mitigation was necessary.

Again, this way of reasoning made sense for the role that these analysts played in the design process: they worked in teams that ran market power analyses to evaluate the future industry structure. They also helped to negotiate shifts in the property structure of the industry (divestment issues). In the context of working on these tasks, monitoring issues had to do with how the existing regulatory structure needed to interpret the conditions in the new system – it did not involve the creation of new feedback control cycles of oversight.

In sum, each group arrived at the conclusion that a limited and transient form of market oversight would suffice. Their distinct positions in the division of labor and their intellectual background led to local work cultures that presented the problem of oversight in a different light. Small differences in how the experts thought about the project of market design led to the same conclusion, but on different paths: minimal oversight would suffice. So far, this account is consistent with organizational explanations that highlight how local conditions of work shape myopic perspectives that become routinized and lead organization members to ignore important information (Allison and Zelikov 1971; Jacobides 2007; Snook 2002). But this story is not complete yet. There were multiple structures in place to resolve such problems. Why did hierarchy fail to resolve the inconsistencies between the groups?

Structural abstraction and the limits of hierarchy

The organizational structure of the design process had several safeguards to identify inconsistencies between modules. The WEPEX steering committee met every two to three weeks and teams presented their recommendations. These meetings were “the place where the arguments took place,” as one engineer remembers. Another described the meetings like this: “There would be like fifty people at those meetings. They were huge. And there would be representatives from utilities, the generators, consumers, regulatory bodies ...” Apart from stakeholders, designers from the different camps came together and had a chance to hash out disagreements. The committee set the agenda and focused the discussions.

Similar meetings took place before the CPUC and FERC. After the steering committee arrived at design decisions, the utilities filed reports and tariffs with the two regulatory agencies. These agencies then started processes of collecting and summarizing stakeholder comments, which subsequently became the basis for intensive discussions at “technical conferences” (FERC) or “hearings” (CPUC). Executives and regulators curated the questions that would be up for debate and tried to collect as many viewpoints as possible, aiming for a balanced representation of the different stakeholder interests.

Finally, electricity market designers talked with each other in a tight nexus of academic institutions. In the 1990s, electricity market design was a relatively niche topic and the experts moved in an academic circuit that linked California’s regulatory bodies, utilities, think tanks, research institutes, and universities like Stanford, Berkeley, MIT, and Harvard.

In each of these contexts, managers, executives, and academics considered market oversight and did so in conversation with members of the different market design camps. But for some reason, the disagreements between the designers did not become apparent in these conversations. The process of structural abstraction explains why.

On the level of specific modules, market designers experienced decisions about market oversight as concrete problems that made sense in terms of the local tasks. For example, Charles Plott, an experimentalist who tested Wilson’s market design, had to decide how exactly the market software should evaluate whether traders’ bids conformed to the activity rules. The rules were clear and so was the range of acceptable inputs. To solve the problem, they could simply write software, test whether it worked as required, and move on. Similarly, engineers working on CAISO’s scheduling infrastructure had to identify cases where intermediaries submitted incompatible data and ensure that the results were corrected before they passed them on to the control room. Again, the problem made sense in terms of their local task, and there were clear criteria for a solution.

On the level of the WEPEX steering committee, in regulatory and academic venues, oversight was a more abstract topic. It was the task of the venues to define the overarching vision for the system as a whole. Precisely because they were supposed to align the

work in different modules, their perspective was general. But from the general perspective, the oversight problem was ill-structured. The system composed bilateral contract markets, private exchanges, public exchanges, and markets for certain reliability services (“ancillary services”). All told, there were a dozen separate markets with highly interrelated products – the precise number depends on the definition of the different products. Their relationships did not follow any one design, but mixed features of different proposals. Accordingly, there was no model or a simulation that could have captured these complex interdependencies. Even if there had been, the modeling tools and computational capacities were still limited in the 1990s and no computer could have sorted through the complex permutations of possible behavior. One designer therefore warned against putting too much stock in models on this level of the design process: “While we all like to play with models, we all do, I have – it can be profitable to do it – I have considerable skepticism that we are going to learn nearly as much as some people think from the models.” But verbal reasoning was open to substantial ambiguities. For example, FERC invited experts to a meeting to “further examine and develop appropriate mitigation measures for the initial period of operation and thereafter.” Not bounded by the vague topic, the different panelists spoke about different elements of the problem – the legal relationship between FERC and the system operator, the composition of the governance structure, the information exchange between the system operator and market intermediaries, and so on.

Legal uncertainties and complexities made the issue even less tangible. The creation of electricity markets meant that there was a de facto jurisdictional shift from the CPUC to FERC. The standards FERC used to evaluate the competitiveness of electricity markets had been derived from rules for an industry of regulated monopolies. How exactly these standards would apply to the new market regime was unclear and contested. Accordingly, the legal constraints on the design task were unclear. The issue of market oversight was not clearly bounded, could not be quantified easily, and admitted of multiple different interpretations. It turned into an ill-structured problem at higher levels of the market design process.

This obscured the local inconsistencies at the level of the market design camps. All market designers concluded that minimal market oversight would suffice. They reached this conclusion on different pathways, but these pathways hinged on subtle differences in opinion about the nature of electricity markets, competition, efficiency, and grid management. Because the conclusions did not differ, these subtle differences would have needed to become salient to the discussion at the higher levels of management. For example, executives on the steering committee would have needed to realize that engineers thought about competition as a gentle pressure to submit marginal costs, while economists thought about competition as a precarious achievement against omnipresent incentives to game the system. To reveal these different views, the nature of competition would have needed to become an issue in the discussion. Because there were multiple ways to conceptualize oversight (globally, locally, legally, technically) and derive practical implications from these perspectives, there was never any direct contestation.

Experts stated their opinions about different facets of the problem and disagreed on the level of empirical details. But they did not challenge each other's fundamental understanding of core concepts. The subtle differences between different styles of reasoning never became salient. In other words, the structural abstraction at the higher levels of the hierarchy transformed the issue into an ill-structured problem. The inconsistencies between the local perspectives therefore fell through the cracks of managerial attention.

Of course, the last step of the argument is a counterfactual. In the archival material, we can only see that the executives discussed the oversight question in vague and ambiguous ways. And we can see that the inconsistencies between the designers did not become visible. To back up this counterfactual, it helps to compare this situation to another point in time, when the designers did finally notice the inconsistencies and recognized the need for strict oversight.

Supporting the counterfactual: California's ancillary service crisis

In 1998/99, the first year of market operation, the system operator encountered a strange problem in a small market for contingency services ("replacement reserves"). These problems triggered organizational processes that finally revealed inconsistent perspectives among the different market designers to the executive level. The episode took place almost three years after the events discussed so far. The overlap between the actors is therefore not perfect. I identified only four designers who were part of both episodes. But there are nonetheless important parallels. Just as before, designers with an engineering and economics background approached the issue of market oversight. Just as before, they brought myopic perspectives to bear on the issue. Just as before, management initially did not intervene. But the designers faced a slightly different problem than before – one that did not lead to structural abstraction as it traveled up the hierarchy.

It was May of 1998 when CAISO's operators encountered strange price swings in the market for replacement reserves. Not only did the prices settle on strange numbers like \$9,999 per MWh. Lower-quality services also received *higher* prices than higher-quality services – during times when there was less demand for either of these services. The engineers working on the grid management side of the system could not make head nor tail of these developments and reported their confusion to their superiors. Alarmed by the seemingly irrational behavior of the markets, the governing stakeholder board imposed price caps and asked the monitoring teams to find out what was happening. Soon after they started, it became clear that there would be no easy fix. One monitor remembered that "the ancillary service markets occupied most of my attention for the rest of my time in the ISO."

At first, they could not get the data for their analyses from the internal databases. They collected a confusing mixture of market and system information, much of it amended by manual insertions and edits from different departments. "One of our biggest chal-

lenges at the startup,” one monitor remembered, “was understanding how the market systems themselves produced the data because there was so much of it [...]. A tremendous amount of effort goes into just setting up the database and the analytic tools to drill into that database.” When they finally extracted the required data and tried to assemble it into supply and demand curves for standard econometric analyses, the results made no sense – the behavior continued to appear irrational and did not fit into the expected logic of competitive bidding for supply and demand. Much of the data also did not fit into their models, suggesting that the analytical frameworks were missing important parts of the market process. Just like the engineers in the control room before them, the monitors reported their difficulties to management and the stakeholder board.

Board and management were deeply divided over how to interpret the report. Voices ranged from those that called for patience because “performance deficiencies are simply to be expected” to those who asked to “request that FERC support the market development process” with external assistance. Yet, the managers considered the problem at close proximity to the monitors who dealt with it. They received reports from the monitors that summarized the problem, but the definition of the problem did not change notably. Just like the monitors, the managers had to contend with the fact that the two expert groups could not interpret the data the system generated about the ancillary markets. In a special memo from August 1998, the head of the monitoring unit explained these interpretative issues in detail. In September, the board then asked an independent consultant to present the “key findings of the MSC [Market Surveillance Committee] report.” They then settled on criteria for a solution after they “discussed the basis on which it could confirm a workably competitive market.” In other words, the board here considered a problem that was clearly defined and admitted of quantitative analysis because there was very little structural abstraction.

In the context of this problem, the economists’ inability to apply econometric tools to the data and the engineers’ inability to understand the price swings became visible. It made salient the inconsistencies in their respective points of view. Managers now began to suspect that the two groups both had a flawed approach to the inner workings of the system and created an independent working group. It brought together two economists, two electrical engineers, a lawyer, and three administrators with expertise in data management. The group had the freedom to draw on expertise from other departments. It worked in concert with the MSC, monitoring staff at the PX, and the operations department, with input from other stakeholders. Initially, the cooperation between engineers and economists was difficult because engineers thought the economists “did not understand the grid,” while the economists thought that engineers “did not understand the incentives in markets.”

However, since they both needed to solve the ancillary market issue, they realized that they had to talk to each other. Gradually, the two sides would begin to teach each other what they were missing. The engineers explained what exactly the ancillary services were used for, while the economists explained how minute rule changes could affect

bidding behavior. These discussions often involved little numeric examples and toy models, hashed out with pen and paper, to illustrate basic elements of system functionality (to the economists) and games of strategic interaction (to the engineers). These were later submitted to the stakeholder board and to regulatory oversight committees.

Gradually, it became clear that the operators in the control room drew on the ancillary markets in ways that were “driven by technical requirements rather than price considerations.” This led to demand inelasticities which created opportunities for the exercise of market power. Merging their different perspectives, the team suddenly realized that the markets were constantly pushing up against the requirements for grid management. They developed a new metric for the discovery of market power (“Pivotal Supplier Test”), fixed a variety of gaming opportunities, and urged FERC to expand their jurisdiction.

In sum, a lower level of structural abstraction made the inconsistencies between the engineers and the economists salient to managers. The different perspectives prevented them from understanding the system data. Since this was important to analyze the problem in the ancillary service markets, the interpretative difficulties became visible and significant from the perspective of the stakeholder board. They jumped into action and pushed the teams to reconcile their differences by setting up the interdisciplinary task force. Under substantial pressure and confronted with a concrete problem, designers identified and resolved the differences in their respective points of view. Three years earlier, market oversight was still a purely theoretical problem. It was much more abstract at higher levels of the design process than at lower levels. The inconsistencies between the different camps of designers therefore did not become salient to managers and fell through the cracks of their attention.

6 Conclusion

This paper has asked why market designers advocated for a weak oversight structure during the creation of California’s electricity markets. Neither political factors nor inherent limitations to designers’ expertise can explain why they did not implement a strong control structure. To resolve the puzzle, I examined the organizational structure of the design process and how three groups of designers approached the problem in different divisions of WEPEX. The groups used inconsistent local frames to make sense of the oversight requirements. The executives in the venues for conflict resolution never noticed this problem. Structural abstraction shifted the considerations at the level of management into a register where the crucial differences between the different teams were no longer salient.

The argument contributes to the literature on market construction in two ways. Highlighting the organizational dimension of market design, the paper shows that organizational pathologies can explain market design failure in cases where neither political

nor practical problems of implementation can explain problematic decisions. Here, the literature on organizational accidents and disasters presents a valuable interlocutor and offers many different mechanisms that mediate both success and failure of design experiments. In particular, I have shown that research on “structural secrecy” (Vaughan [1996] 2016) in the hierarchies of complex organizations can explain why inconsistent, local perspectives can persist and shape design processes.

More generally, this paper suggests that the sociological literature on market creation (Fligstein and Mara-Drita 1996) and market design (Breslau 2013; MacKenzie 2010; 2007) should pay more attention to the causes of market design failure. Sociologists and historians tend to reject designers’ engineering perspective as ideological (Nik-Khah and Mirowski 2019). This literature tends to argue that designers are never able – or willing – to act as neutral technocrats. Instead, they are just another group of interested stakeholders in an inherently political negotiation. While this may often be true, it is not *always* true. Otherwise, it would be hard to explain why we see both successful and failed forms of market design. At the very least, the ideology critique should therefore not be the analytical baseline, but one hypothesis among several.

Second, the desire to discredit market design as ideology reflects a widespread disdain for the illiberal implications of technocracy. But rejecting market design by fiat is itself an illiberal move. More importantly, it voluntarily sidelines the sociological perspective in precisely those venues where it could play a useful role to check technocratic dreams of perfect control. In political debates, it does not suffice to claim that another position is ideological. Rather, it is necessary to explain why a given proposal is likely to work or not work as intended. This requires careful examination of the project of market design and how the social conditions of implementation affect designers’ ability to deliver on their promises. In the interest of developing a genuinely critical point of view, it is therefore worthwhile for sociologists to consider the project of market design on its own terms – rather than reject it by fiat.

Apart from offering a new perspective on market design failure, the paper contributes to the literature on accidents and disasters. Many studies find the origins of problems in the relationship between organizational hierarchy and cognition in the division of labor (Jacobides 2007; Joseph and Gaba 2020). Recently, scholars have pointed out the need for research that focuses on the role of conflict in the interplay between cognition and hierarchy (Joseph and Gaba 2020). Here, I have shown that discursive conflict between members from different market design camps was instrumental in reconciling local inconsistencies. What I call structural abstraction precludes precisely this kind of conflict because it generates ill-structured problems that tolerate too many disparate answers. This erodes the basis for conflict.

There are several ways in which future research can build on the findings in this paper. I have focused on a narrow slice of the organizational literature on accidents and disasters. Future research should broaden this link. The literature on organizational accidents usually focuses on industrial disasters. While there are similarities, it is not clear to what extent economic engineering produces the same kinds of problems. While both markets and technical systems are *sociotechnical*, at least some of the challenges to enforce a specific type of market behavior will be different from those to coerce technical objects into functional relationships. We should therefore explore whether the dynamics that stand behind industrial accidents and disasters need to be rethought for the context of economic engineering. Since I have focused on a single organizational mechanism, there is much room for future studies in this vein. One way to approach this task is to examine how the nature of allocation problems affects the features of the market mechanism, and how this variation affects their implementation.

Another area for future research concerns the internal limits of market design. I have shown that different groups of market designers interpret the meaning of mathematical models quite differently. In California, the organizational setup obscured interpretative disagreements between the groups. However, the ambiguity of the models could also cut the other way. Instead of merely hiding interpretative disagreements between experts, the inherent ambiguity of models might hide *internal* contradictions that are covered up by the verbal reasoning surrounding their use. In other words, different interpretations may suggest ways in which a given problem of implementation may be resolved. But it is possible that these interpretations hide contradictions on the conceptual level. For example, an interpretation of the market as an evolutionary mechanism might resolve some problems of implementation, but it may be incompatible with features of the blueprint that can only be realized if it is imagined as an algorithm. In that case, the blueprint is conceptually infeasible, but the interpretative processes that guide its implementation obscure those contradictions. Future research should thus explore both sides in the relationship between theoretical model and organizational processes of implementation. Given that economic engineering proliferates as a technique of governance, a sociology of market design failure will also increasingly become politically important.

References

- Allison, Graham T., and Philip Zelikov. 1971. *Essence of Decision: Explaining the Cuban Missile Crisis*. Boston: Little Brown and Company.
- Beder, Sharon. 2003. *Power Play: The Fight for Control of the World's Electricity*. New York: Scribner.
- Beniger, James. 2009. *The Control Revolution: Technological and Economic Origins of the Information Society*. Cambridge, MA: Harvard University Press.
- Beunza, Daniel, and Fabrizio Ferraro. 2019. "Performative Work: Bridging Performativity and Institutional Theory in the Responsible Investment Field." *Organization Studies* 40 (4): 515–43.
- Bichler, Martin. 2017. *Market Design: A Linear Programming Approach to Auctions and Matching*. Cambridge, UK: Cambridge University Press.
- Breslau, Daniel. 2013. "Designing a Market-Like Entity: Economics in the Politics of Market Formation." *Social Studies of Science* 43 (6): 829–51.
- Bushnell, James. 2005. "Looking for Trouble: Competition Policy in the U.S. Electricity Industry." In *Electricity Deregulation: Choices and Challenges*, edited by James M. Griffin and Steven L. Puller, 256–96. Chicago: University of Chicago Press.
- Callon, Michel. 1998. "An Essay on Framing and Overflowing: Economic Externalities Revisited by Sociology." *The Sociological Review* 46 (S1): 244–69.
- Callon, Michel. 2009. "Civilizing Markets: Carbon Trading between In Vitro and In Vivo Experiments." *Accounting, Organizations and Society* 34 (3-4): 535–48.
- Cardell, Judith B., Carrie C. Hitt, and William W. Hogan. 1997. "Market Power and Strategic Interaction in Electricity Networks." *Resource and Energy Economics* 19 (1): 109–37.
- Chiu, Y. H., J. C. Lin, W. N. Su, and J. K. Liu. 2015. "An Efficiency Evaluation of the EU's Allocation of Carbon Emission Allowances." *Energy Sources, Part B: Economics, Planning, and Policy* 10 (2): 192–200.
- Commission, Australian Competition and Consumer. 2021. *Murray–Darling Basin Water Markets Inquiry*. Canberra, Australia: Commonwealth of Australia.
- Cramton, Peter. 2003. "Electricity Market Design: The Good, the Bad, and the Ugly." In *Proceedings of the 36th Annual Hawaii International Conference (HICSS'03), Vol 2. – Track 2*, edited by IEEE Computer Society, 54.2. Washington, DC: IEEE Computer Society.
<https://dl.acm.org/doi/proceedings/10.5555/820754>.
- Cramton, Peter. 2017. "Electricity Market Design." *Oxford Review of Economic Policy* 33 (4): 589–612.
- Cyert, Richard M., and James G. March. (1963) 2013. *A Behavioral Theory of the Firm*. Eastford, CT: Martino Fine Books.
- Dobbin, Frank, and Timothy J. Dowd. 2000. "The Market That Antitrust Built: Public Policy, Private Coercion, and Railroad Acquisitions, 1825 to 1922." *American Sociological Review* 65 (5): 631–57.
- Duflo, Esther. 2017. "The Economist as Plumber." *American Economic Review* 107 (5): 1–26.
- Dutt, Nilanjana, and John Joseph. 2019. "Regulatory Uncertainty, Corporate Structure, and Strategic Agendas: Evidence from the US Renewable Electricity Industry." *Academy of Management Journal* 62 (3): 800–27.
- Farjoun, Moshe, and William H. Starbuck. 2007. "Organizing at and beyond the Limits." *Organization Studies* 28 (4): 541–66.
- Fligstein, Neil. 2002. *The Architecture of Markets: An Economic Sociology of Twenty-First-Century Capitalist Societies*. Cambridge, MA: Princeton University Press.
- Fligstein, Neil, and Iona Mara-Drita. 1996. "How to Make a Market: Reflections on the Attempt to Create a Single Market in the European Union." *American Journal of Sociology* 102 (1): 1–33.
- Garber, Don, William W. Hogan, and Larry Ruff. 1994. "An Efficient Electricity Market: Using a Pool to Support Real Competition." *The Electricity Journal* 7 (7): 48–60.
- Garcia-Parpet, Marie-France. 2007. "The Social Construction of a Perfect Market: The Strawberry Auction at Fontaines-en-Sologne." In *Do Economists Make Markets? On the Performativity of Economics*, edited by Donald MacKenzie, Fabian Muniesa, and Lucia Siu, 20–54. Cambridge, MA: Princeton University Press.

- Guala, Francesco. 2001. "Building Economic Machines: The F.C.C. Auctions." *Studies in History and Philosophy of Science* 32 (3): 453–77.
- Guala, Francesco. 2007. "How to Do Things with Experimental Economics." In *Do Economists Make Markets? On the Performativity of Economics*, edited by Donald MacKenzie, Fabian Muniesa, and Lucia Siu, 128–62. Cambridge, MA: Princeton University Press.
- Guala, Francesco, and Luigi Mittone. 2005. "Experiments in Economics: External Validity and the Robustness of Phenomena." *Journal of Economic Methodology* 12 (4): 495–515.
- Hitzig, Zoë. 2020. "The Normative Gap: Mechanism Design and Ideal Theories of Justice." *Economics & Philosophy* 36 (3): 407–34.
- Hu, Songcui, and Richard A. Bettis. 2018. "Multiple Organization Goals with Feedback from Shared Technological Task Environments." *Organization Science* 29 (5): 873–89.
- Jacobides, Michael. 2007. "The Inherent Limits of Organizational Structure and the Unfulfilled Role of Hierarchy: Lessons from a Near-War." *Organization Science* 18 (3): 455–77.
- Joseph, John, and Vibha Gaba. 2020. "Organizational Structure, Information Processing, and Decision-Making: A Retrospective and Road Map for Research." *Academy of Management Annals* 14 (1): 267–302.
- Joseph, John, and Alex J. Wilson. 2018. "The Growth of the Firm: An Attention-based View." *Strategic Management Journal* 39 (6): 1779–800.
- Joskow, Paul L. 1997. "Restructuring, Competition and Regulatory Reform in the US Electricity Sector." *The Journal of Economic Perspectives* 11 (3): 119–38.
- Le Coze, Jean-Christophe. 2015. "1984–2014. Normal Accidents. Was Charles Perrow Right for the Wrong Reasons?" *Journal of Contingencies and Crisis Management* 23 (4): 275–86.
- Leveson, Nancy, Nicolas Dulac, Karen Marais, and John Carroll. 2009. "Moving Beyond Normal Accidents and High Reliability Organizations: A Systems Approach to Safety in Complex Systems." *Organization Studies* 30 (2-3): 227–49.
- MacKenzie, Donald. 2007. "Is Economics Performative? Option Theory and the Construction of Derivatives Markets." In *Do Economists Make Markets? On the Performativity of Economics*, edited by Donald MacKenzie, Fabian Muniesa, and Lucia Siu, 54–86. Cambridge, MA: Princeton University Press.
- MacKenzie, Donald. 2010. "Constructing Carbon Markets: Learning from Experiments in the Technopolitics of Emissions Trading Schemes." In *Disaster and the Politics of Intervention*, edited by Andrew Lakoff, 130–48. New York: Columbia University Press.
- MacKenzie, Donald, and Yuval Millo. 2003. "Constructing a Market, Performing Theory: The Historical Sociology of a Financial Derivatives Exchange." *American Journal of Sociology* 109 (1): 107–45.
- March, James G., and Herbert A. Simon. 1958. *Organizations*. New York: Wiley.
- Nik-Khah, Edward, and Philip Mirowski. 2019. "On Going the Market One Better: Economic Market Design and the Contradictions of Building Markets for Public Purposes." *Economy and Society* 48 (2): 268–94.
- Ocasio, William. 1997. "Towards an Attention-Based View of the Firm." *Strategic Management Journal* 18 (S1): 187–206.
- Oliver, Nick, Thomas Calvard, and Kristina Potočník. 2017. "Cognition, Technology, and Organizational Limits: Lessons from the Air France 447 Disaster." *Organization Science* 28 (4): 729–43.
- Pardo-Guerra, Juan Pablo. 2019. *Automating Finance: Infrastructures, Engineers, and the Making of Electronic Markets*. Cambridge: Cambridge University Press.
- Posner, Eric A., and Glen E. Weyl. 2018. *Radical Markets: Uprooting Capitalism and Democracy for a Just Society*. Cambridge, MA: Princeton University Press.
- Prendergast, Canice. 2016. The Allocation of Food to Food Banks. *Booth School of Business Working Papers* 3 (10).
<https://eudl.eu/journal/sg>.
- Reverdy, Thomas, and Daniel Breslau. 2019. "Making an Exception: Market Design and the Politics of Re-regulation in the French Electricity Sector." *Economy and Society* 48 (2): 197–220.

- Rilinger, Georg. 2021a. "The Texas Blackouts and the Problems of Electricity Market Design." *Pro-market Blog*, March 24, 2021.
<http://hdl.handle.net/21.11116/0000-0008-46A1-3>.
- Rilinger, Georg. 2021b. "Who Captures Whom? Regulatory Misperceptions and the Timing of Cognitive Capture." *Regulation & Governance*, published online September 18, 2021, doi:10.1111/rego.12438.
- Roth, Alvin E. 2018. "Marketplaces, Markets, and Market Design." *American Economic Review* 108 (7): 1609–58.
- Roth, Alvin E., Tayfun Sönmez, and Utku M. Ünver. 2005. "A Kidney Exchange Clearinghouse in New England." *American Economic Review* 95 (2): 376–80.
- Samuels, Warren J. 2004. "Markets and Their Social Construction." *Social Research* 71 (2): 357–70.
- Schweppe, Fred C., Michael C. Caramanis, Richard D. Tabors, and Roger E. Bohn. 1988. *Spot Pricing of Electricity*. Boston: Kluwer.
- Schweppe, Fred C., Richard D. Tabors, James L. Kirtley, Hugh R. Outhred, Frederick H. Pickel, and Alan J. Cox. 1980. "Homeostatic Utility Control." *IEEE Transactions on Power Apparatus and Systems*, PAS-99 (3), 1151–63, doi: 10.1109/TPAS.1980.319745.
- Simon, Herbert A. 1962. "The Architecture of Complexity." *Proceedings of the American Philosophical Society* 106 (6): 467–82.
- Simon, Herbert A. (1969) 1996. *The Sciences of the Artificial*. 3rd ed. Cambridge, MA: MIT Press.
- Snook, Scott A. 2002. *Friendly Fire: The Accidental Shootdown of US Black Hawks over Northern Iraq*. Princeton: Princeton University Press.
- Stoft, Steven. 1997. "What Should a Power Marketer Want?" *The Electricity Journal* 10 (5): 34–45.
- Sullivan, Bilian Ni. 2010. "Competition and Beyond: Problems and Attention Allocation in the Organizational Rulemaking Process." *Organization Science* 21 (2): 432–50.
- Sweeney, James L. 2002. *The California Electricity Crisis*. Stanford: Hoover Institution Press.
- Taylor, Gary, Shaun Ledgerwood, Romkaew Broehm, and Peter Fox-Penner. 2015. *Market Power and Market Manipulation in Energy Markets: From the California Crisis to the Present*. Arlington, VA: Utilities Report Inc.
- Thompson, James D., Mayer N. Zald, and W. Richard Scott. (1967) 2017. *Organizations in Action: Social Science Bases of Administrative Theory*. New York: Routledge.
- Turner, Barry A. 1976. "The Organizational and Interorganizational Development of Disasters." *Administrative Science Quarterly* 21 (3): 378–97.
- Vaughan, Diane. 1999. "The Dark Side of Organizations: Mistake, Misconduct, and Disaster." *Annual Review of Sociology* 25: 271–305.
- Vaughan, Diane. (1996) 2016. *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA. Enlarged edition*. Chicago, IL: University of Chicago Press.
- Veal, Gareth, and Stefanos Mouzas. 2019. "Market-Based Responses to Climate Change: CO₂ Market Design versus Operation." *Organization Studies* 33 (11): 1589–616.
- Waldinger, Daniel. 2021. "Targeting In-Kind Transfers through Market Design: A Revealed Preference Analysis of Public Housing Allocation." *American Economic Review* 111: 2660–96.
- Weick, Karl E. 1988. "Enacted Sensemaking in Crisis Situations." *Journal of Management Studies* 25 (4): 305–17.
- Weick, Karl E. 1998. "Foresights of Failure: An Appreciation of Barry Turner." *Journal of Contingencies and Crisis Management* 6 (2): 72–75.
- Weick, Karl E., and Karlene H. Roberts. 1993. "Collective Mind in Organizations: Heedful Interrelating on Flight Decks." *Administrative Science Quarterly* 38: 357–81.
- Wilson, Robert. 1998. "Design Principles." In *Designing Competitive Electricity Markets*, edited by Hung-po Chao and Hillard G. Huntington, 159–83. Boston: Kluwer Academic Publishers.
- Wolak, Frank A. 2003. "Diagnosing the California Electricity Crisis." *The Electricity Journal* 16 (7): 11–37.
- Yin, Robert K. 2017. *Case Study Research and Applications: Design and Methods*. 4th ed. New York: Sage.

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