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Keywords Hayek, Texas blackout, scarcity pricing, retail electricity competition

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Abstract

Was the Texas blackout a market failure or regulatory failure? The economist Hayek has been adduced in support of both views. Hayek would have approved the competitive Texas system, including ERCOT. His likely view on the scarcity pricing framework is less clear, and the recent regulatory implementation of the "circuit breaker" was problematic. There is now a need to revise the scarcity pricing framework in the light of recent events, and to reflect ever-changing market conditions.

February's "big freeze" in Texas and the ensuing power outages revealed the physical and economic complexity of the electric system, as well as its vulnerability. While the event was a result of highly unusual weather, questions arise as to whether the outages and high prices reflect market failure or regulatory failure, what lessons should be learned, and how to avoid such outcomes in future.

Some immediate political reactions blamed the growth of renewables and sought to exonerate the natural gas sector and its regulation; other commentators blamed competition. Both reactions proved incorrect. According to the bill analysis of Senate Bill 3, "The most consequential and repeatedly mentioned problems include a lack of weatherization, a lack of oversight, a breakdown of communication, and failures of coordination within and between state regulatory agencies." Distinguished and experienced energy economists and former electricity regulators have provided measured analyses of the causal factors and potential remedies.[3]

The present paper was stimulated by an exchange between Bradley and Schubert (on Facebook and LinkedIn) on the Texas electricity system, the Electric Reliability Council of Texas (ERCOT), and the recent blackout, summarized at Bradley (2021). Bradley said, "this is a planning failure … government failure writ large", that "the Texas blackout calls for abolition of ERCOT and repeal of state and federal laws governing electricity", and calls for "a true free-market order". Schubert countered that "What we have in ERCOT is the closest approximation to a free market that can be had, given the unavoidable reliability constraints associated with a meshed AC power grid."

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[2] Research Professor and Co-Director, Institute for Regulatory Law & Economics, University of Colorado-Denver.
[3] See, e.g. Cramton (2021), Giberson (2021), Joskow (2021), Hogan (2021), Wood et. al. (2021).

Interestingly, both parties invoke the thinking of the distinguished economist F. A. Hayek. In general, Hayek argued for free markets, but his reasons for doing so are distinctive and important. The conventional static welfare economics approach saw, and still sees, competition as a means of achieving efficient prices, outputs and methods of production. In contrast, Hayek saw prices as decentralized signals providing information that enabled markets to coordinate participants. Further, competitive markets embody a dynamic "feedback process" enabling market participants gradually to learn and adjust their actions to better achieve their objectives. Competition is thus a rivalrous discovery process taking place over time.

If the ERCOT approach was "the closest approach to a free market that can be had" given the physical reality of an interconnected electric network, does this approach mean periodic serious outages? Or is there is a better and even more market-focused way to organise an electricity sector and to reduce or deal with outages? Hayek does indeed have ideas to contribute.

We suggest here that the Texas approach to the electricity sector in general embodies competitive market principles that Hayek's analysis would have supported. His likely view of the specific role of the scarcity pricing mechanism, designed by the Public Utility Commission of Texas (PUCT) and implemented by ERCOT, is less clear. On the one hand, it has encouraged necessary investment without having to introduce a capacity mechanism that would have been inconsistent with his concept of market process. On the other hand, its actual implementation in February has raised questions about regulatory competence to operate it. Is it still appropriate when residential customers have direct access to the wholesale market? Could it usefully be modified when market and technological conditions, and environmental policy considerations, are evolving so rapidly? Hayek's particular concept of competition seems a helpful insight to inform ongoing development and reform.

1. Hayek's approach to competition

By the 1930s, formal neoclassical economic models of markets focused on static, short-run equilibria and addressed the question of resource allocation in a context of given (implicitly assumed known) preferences, costs, and resource endowments. In contrast, Hayek's seminal article "The Use of Knowledge in Society" (1945) argued that static resource allocation is not the fundamental economic problem; rather, the problem is the coordination of the actions and plans of people who possess not only different plans, but also "private knowledge" about their own preferences, opportunity costs, and situations.[4] Private knowledge includes contextual knowledge of "time and place," which is difficult to communicate and to aggregate. Total knowledge is scattered throughout the system, in the minds of the participants. The price system is an effective, decentralized way to access some (albeit not all) of that private knowledge and turn it into information that is available to others. As a result, prices tend to coordinate production, consumption, and investment decisions while also providing incentives for discovery and innovation.

But full coordination – or equilibrium – is typically not achieved. Prices, products, opportunities and opportunity costs are always changing. Customers change their minds as they

[4] For more recent discussion see Kiesling (2015, 2018).

find alternative products or suppliers that they prefer to their existing ones. Entrepreneurs find through profit and loss signals that they must lower prices to compete with rivals, or alternatively should better deploy their skills and capital in other products or industries. Prices and profits provide the signals that enable everyone to learn, adapt, reallocate, and innovate. Competition is thus an open-ended rivalrous discovery process, taking place over time. And the resulting coordination is not an explicitly planned outcome but is instead an example of emergent order in a complex system (Hayek 1967).

Hayek's view was that competition was the most effective way to discover and utilize new information. As noted when he was awarded the Nobel Prize in 1974, "[Hayek's] guiding principle when comparing various systems is to study how efficiently all the knowledge and all the information dispersed among individuals and enterprises is utilized. His conclusion is that only by far-reaching decentralization in a market system with competition and free [of] price-fixing is it possible to make full use of knowledge and information." [5]

Hayek therefore resisted arrangements and regulations that prevented or restricted competition. He saw certain activities of government as "part of its effort to provide a favourable framework for individual decisions" (Hayek 1960, p. 223). But he was pragmatic rather than dogmatic, and accepted that some government provision (e.g. roads) was appropriate where it was "either impossible or difficult to charge the individual beneficiary for them" (p. 223). "But though government may at any moment be best qualified to take the lead in such fields, this provides no justification for assuming that this will always be so and therefore for giving it exclusive responsibility" (p 223). Similarly, some regulation might be necessary (e.g. building regulations) (p. 226).

He mentioned "the requirement of protective measures in the transmission of high-tension electricity" as one of several illustrative government duties that "undoubtedly demand that the authorities be given some discretion in applying general rules" (p. 225). His primary concern was "not state enterprise as such but state monopoly" because that restricted liberty, which in turn restricted discovery, innovation, and the coordination potential of the competitive market (p. 224). He also saw a role for regulatory policy, albeit in terms of providing an appropriate environment rather than as conventionally understood in terms of specific directions.[6]

Hayek does not seem to have pronounced specifically on the ownership, organisation or regulation of the electricity industry: so, what would he have made of arrangements in Texas?

[5] Press release, NobelPrize.org. Nobel Media AB 2021, 17 May 2021
https://www.nobelprize.org/prizes/economic-sciences/1974/press-release/

[6] "If man is not to do more harm than good in his efforts to improve the social order, he will have to learn that in this, as in all other fields where essential complexity of an organized kind prevails, he cannot acquire the full knowledge which would make mastery of the events possible. He will therefore have to use what knowledge he can achieve, not to shape the results as the craftsman shapes his handiwork, but rather to cultivate a growth by providing the appropriate environment, in the manner in which the gardener does this for his plants." (Hayek 1974)

2. Hayek and the Texas electricity sector

Texas has promoted electricity competition, and limited regulation, more than any other state in the US. About 85 percent of its customers are served by privately-owned enterprises, the other 15 percent by municipalities or cooperatives. In 1997 the legislature explicitly committed to a policy of customer choice and competition rather than regulated monopoly.[7] Accordingly, Texas vigorously restructured the electricity sector (excluding municipalities and cooperatives) to facilitate competition - for example, by requiring integrated utilities to unbundle into separate generation, wires and retail companies. No entity was allowed to own more than 20 percent of installed generation capacity in the ERCOT market. These measures established flourishing wholesale and retail competitive markets. Apart from the municipalities and cooperatives, there are no longer vertically integrated incumbent utility companies, hence no regulated default tariffs for their continued provision of retail service (Schubert & Adib 2009; Schubert et al. 2009; Adib et al. 2008).

Texas has rejected an administered capacity mechanism operating outside of the energy market and actively designed its wholesale market to provide adequate capacity without undue regulatory intervention (more on this below). It has introduced locational energy price signals to inform decisions on new generation. It has introduced an element of competition for major transmission expansions (Competitive Renewable Energy Zones or CREZ). Wherever possible it uses negotiated settlements, agreed between companies, customer groups and other interested parties, rather than regulatory direction, to resolve issues such as charges for the use of monopoly networks.

Are there other options for electricity competition? Primeaux (1975, 1985) documented a handful of US towns with "direct electric utility competition" insofar as rival electric utility companies each ran lines through the streets. However, most of these duplications no longer survive. In the UK, retail competition via open access was proposed in 1983 and implemented in 1990, precisely to achieve the benefits of such direct electric utility competition for retail customers, without the inefficient duplication of transmission and distribution lines. Technological change since the 1980s has made wholesale and retail markets feasible, although the wires networks currently largely retain the economies of scale and scope that characterize a natural monopoly. One benefit of the Texas model is the extent to which it "quarantines the monopoly" (Kiesling 2014).

Hogan has explained the case for competitive electricity markets in terms that Hayek would endorse.[8] The Texas electricity sector has been described as "The most robust competitive

[7] "The legislature finds that the production and sale of electricity is not a monopoly warranting regulation of rates, operations, and services and that the public interest in competitive electric markets requires that, except for transmission and distribution services and the recovery of stranded costs, electric services and their prices should be determined by customer choices and the normal forces of competition." Public Utility Regulatory Act (PURA) §39.001(a).

[8] "A core idea of an electricity market that relies on market incentives for investment is that these incentives appear through the largely voluntary interactions of the participants in the market. A main feature of the market would be prices determined without either administrative price caps or other interventions that would depress prices below high opportunity costs and leave money missing. The real-time prices of electric energy, and participant actions, including contracting and other hedging strategies in anticipation of these prices, would be the

market in North America" (Adib & Zarnikau 2006, p. 383), and as "the most durable choice model" (Kim 2006, p. 360). Perhaps only Alberta and Australia (the National Electricity Market or NEM) have slightly less regulated or more free-market forms of electricity sector than Texas. Given the economics and physics of a shared alternating current network, this "quarantine the monopoly" approach may be the most market-based feasible arrangement. It thus seems likely that Hayek would have approved of – indeed, would have recommended – the present arrangements in Texas, including the role of ERCOT. There might be a caveat, however, about the nature and implementation of the scarcity pricing mechanism, particularly in light of recent events.

3. The scarcity pricing framework in Texas

ERCOT's present scarcity pricing mechanism is indeed a regulatory intervention in the market, designed to increase the wholesale clearing price at times of shortage. Price can rise up to a system-wide cap of $9,000 per MWh, about 300 times the $20 - $40 level of wholesale prices in recent years. Indeed, if the transmission system is congested, the combination of energy locational marginal cost pricing (LMP) and scarcity pricing of reserves can yield prices above $9,000 in constrained locations.

The design of the scarcity pricing mechanism in Texas was very thorough, preceded by numerous thoughtful and informed analyses.[9] Implementation and subsequent adjustment included testing the proposed parameters against a variety of previous weather and demand scenarios.

The aim was primarily to address the perceived problem of "missing money". An "energy only" market, if operated under a typical offer cap (for example, limiting bids to marginal operating costs of existing plant), would provide insufficient incentive to build and maintain enough capacity to meet demand at times of particular shortages.[10] This problem was exacerbated by inelastic demand and a lack of demand participation in the market. In some cases also, regulatory obligations on the Independent System Operator (ISO) to avoid load curtailment led to greater use of operating reserves, which muted the scarcity price signals.

The options for addressing the "missing money" problem fall into three categories.

One option is to raise or remove the offer cap, allowing generators to raise their bids above marginal operating cost at times of scarcity, to recover the "missing money". A perceived problem with that approach is that "generators may misjudge and make their offers too high,

primary drivers of decisions in the market. The principal investment decisions would be made by market participants, and this decentralized process would improve innovation and efficiency… . [I]f it would be easy for planners and regulators to lay out the trajectory of needed investment for the best portfolio of generation, transmission and demand alternatives, then electricity restructuring would not be needed." (Hogan 2005, p. 7).

[9] E.g. Hogan (2005), Oren (2005), Adib et al. (2008), Joskow (2008), Hogan (2013).

[10] "The missing money problem arises when occasional market price increases are limited by administrative actions such as offer caps, out-of-market calls, and other unpriced actions. By preventing prices from reaching high levels during times of relative scarcity, these administrative actions reduce the payments that could be applied towards the fixed operating costs of existing generation plants and the investment costs of new plants. The resulting missing money reduces the incentives to maintain plant or build new generation facilities." (Hogan 2013, p. 65)

and their supply might not be taken in a high price market" (Hogan 2013, p. 69). Another problem is the conflict with mitigating market power.[11]

A second option, sometimes called a resource adequacy approach, is to impose some installed capacity (ICAP) requirements, to "arrange additional payments to those who offer capacity up to some estimated level of total capacity needed to meet projected reliability requirements." (Hogan 2013 p. 67) These payments would recover the missing money. However, defining the required amount and location of capacity is difficult and the resulting markets are prone to manipulation.[12] In addressing these problems, "resource adequacy approaches become increasingly detailed and increasingly prescriptive to the point of severing the connections between major investment decisions and energy market incentives" (Hogan 2005 p 1).

A third option involves "incorporating first principles of economics and reliability to design the prices and related parameters of an operating reserve demand curve [ORDC]" (Hogan 2013, p. 66). The ORDC is intended to reflect the system operator's demand for reserves. This ORDC is added to the energy demand curve, with the resulting combined curve intersecting the bid-in generation supply curve at a higher price, typically much higher when demand is at or near the limit of available generating capacity. There is then a system-wide offer cap, or maximum wholesale rate, at a relatively high level, in principle reflecting the Value of Lost Load (VOLL).

In Texas, an "energy-only" framework began to be developed around 2005, eventually incorporating a complementary "reliability adder" (Hogan 2005, fn 9). In 2011, following several periods of load curtailment, the PUCT debated establishing a minimum reserve margin. Failing to agree, and to help relieve the pressure to "do something", it decided to significantly increase the size of the reliability adder during times of shortage, and to establish a timetable to raise the offer cap. Thus, in October 2012, the PUCT confirmed that "the maximum wholesale rate will rise from $4,500 a megawatt hour now to $5,000 in June 2013, $7,000 in June 2014 and $9,000 in June 2015." Following a further paper from Hogan, in 2013 the PUCT received and subsequently accepted ERCOT's draft proposal to implement the ORDC (Baldick et al. 2021 S 3.3.2).

At least until the Texas blackout of February 2021, informed opinion in the sector seemed to be moving in a similar direction. Capacity mechanisms elsewhere in the US were proving to be more problematic and expensive than expected, and a scarcity pricing mechanism seemed to have some merit. Thus, Hogan (admittedly an early proponent) commented that, among the reforms that would be important for the future electricity system, "First and foremost is better

[11] "The observation of high scarcity prices would be difficult or impossible to distinguish from the exercise of market power. It will be difficult for regulators to maintain a hands-off policy that defends a high offer cap when scarcity conditions arise. And the expectation that regulators of the future may not have the ability to preserve the policy will inevitably dampen incentives for investment today in anticipation of this future." (Hogan 2013, p. 69)

[12] "It is difficult to properly define the capacity product, determine the amount and location of capacity needed many years ahead, and integrate diverse products that blend capacity and energy in a variety of configurations. Experience has shown that forward capacity markets, with their preset procurements, are subject to manipulation by generators and loads. … This leads to requirements for capacity market regulations on offers and performance, bid mitigation, and other complications. The problems are fundamental. It is not easy to build a good forward capacity market model based on first principles." (Hogan 2013, p. 68)

scarcity pricing. The example of the Electric Reliability Council of Texas (ERCOT) market stands out as guiding the way" (Hogan 2018). Others took a similar view, with ISO New England adding a Pay For Performance element[13] and other capacity markets adding an ORDC to the scarcity price, to make their existing scarcity pricing adders more robust.[14]

4. Hayek and the scarcity pricing framework

We can use Hayek's market process framework to analyze these three options.

As regards the dangers of removing an offer cap, Hayek would not have been convinced of the need for an offer cap in the first place. Nor would he have been persuaded that generators would misjudge the market and pitch their bids too high: generators, like other market participants, would soon learn, and those that did not would gradually be replaced by those that did. He would have agreed with the concern about the potentially distorting effect of regulatory intervention to curb market power, although as noted his preference would have been to limit such a regulatory role. Offer caps were standard practice in the newly developing US wholesale markets, including in Texas, but one suspects Hayek would have argued for relying instead on the development of competition over time, increasingly including various demand-side alternatives, to limit any excess pricing.

Hayek would not have recommended a capacity mechanism that focuses primarily on generating capacity, takes major decisions away from the competitive market participants, and thereby reduces the scope for learning and market coordination. Again, Hogan (2005) well articulates a concern that Hayek himself could have written.[15]

This leaves the approach adopted in Texas, or similar approaches, which aim to increase wholesale market prices during supply shortages in an orderly and systematic way so that decisions about investment in capacity can be left to the market. Hayek would have appreciated the thought that went into designing the ORDC in Texas. But regarding the precise detail of the scarcity pricing provisions and the "circuit-breaker", he would probably join Bradley (2021) in asking "Why $9,000 per MWh – and for so long?"

Neither the concept or calculation of the ORDC curve nor the associated $9,000 system-wide offer cap reflect a sense of dynamic market process, of knowledge discovery. In principle the calculation is based on a static neoclassical welfare economic equilibrium rather than on any

[13] "Pay for Performance Capacity Market Incentives Implemented as of June 1, 2018, at https://isonewswire.com/2018/06/11/pay-for-performance-capacity-market-incentives-implemented-as-of-june-1-2018/.

[14] E.g. as being implemented in PJM 20210407-mic-info-only-operating-reserve-demand-curvesordc.ashx (pjm.com) and as recommended by the market monitor for MISO 2020 State of the Market Report (potomaceconomics.com)

[15] "A central concern of the growing doubts about the direction of development in administrative installed capacity markets is the loss of this critical reallocation of decisions away from regulators and towards market participants. The increasing scope, increasing detail and increasingly longer horizons of ICAP programs establish an evolutionary path with no end in sight. It is not the capacity construct per se that should be of concern. For example, operating reserve capacity requirements are an essential part of electricity systems. Rather it is the scope, duration and detail of mandatory ICAP obligations that are imposed by the central planner, and the corresponding shift of the locus of investment risks decisions away from the market with the decisions made under the central plan and the risks assigned back to captive consumers." (Hogan 2005, pp. 7-8)

concept of competitive process. In practice the focus has been on the marginal cost of a natural gas-fired peaker generation plant rather than on any value to customers, and "the VOLL was set at $9,000 because that was where the offer cap was going to be set by 2015 under the PUCT's prior order" (Baldick et. al. 2021, p. 50). But VOLL varies by customer and over time, and the uniform administered VOLL used is at best a rough approximation in the absence of an active demand side.

A regulatory body effectively imposing a single uniform administered price, however calculated, is incompatible with Hayek's emphasis on the informative nature of market prices and the importance of markets for enabling flexibility and learning. In retrospect, the regulatory problems in updating the scarcity pricing mechanism, and implementing it at times of stress and in changing market and political conditions, were underestimated. So it is an open question whether Hayekwould have been willing to accept, as a practical matter, that this approach was preferable to the practically available alternative of a more conventional capacity mechanism, or whether he would have held out for the first option of no offer cap.

5. The Texas blackout

In February 2021 Texas experienced severe and extensive electricity outages, lasting nearly a week. The causes of the outages lie beyond the present paper. Suffice it to note, as mentioned, that they were less simplistic than initially claimed.

Were the outages evidence of market failure, regulatory failure, or both? Schubert (per Bradley 2021) says "private companies and regulated pipelines failed, in part, because they and the Texas Legislature didn't value the negative interactions between the gas and power segments that led to a cascade of outages during a 1 in 30 cold snap." This assessment may imply both market failure and regulatory failure.

However, it seems that no one – in the market sector or in the regulatory bodies (the PUCT for electricity and the Texas Railroad Commission (RRC) for natural gas) - expected the particular set of extreme climatic developments that actually occurred, not least the freezing up of natural gas supply. In retrospect, perhaps they should have considered a wider set of scenarios, reaching back to events in 1989 as well as in 2011 and perhaps earlier, and taken appropriate measures to winterize power plants and natural gas facilities, as the FERC-NERC report after the 2011 winter storms had recommended.[16] But the specific extreme cold and the gas supply problems were not previously regarded even as a low probability event to consider in scenario analysis, and were not considered at all in the historical 10-year data window used for ERCOT winter resource adequacy planning. Looking only at that particular and quite unexpected aspect, it is difficult to argue unambiguously for either market failure or regulatory failure.

The blackouts do not appear to provide evidence that the scarcity pricing mechanism had failed in its prime aim of ensuring sufficient generating capacity. In February 2021 sufficient generation capacity was expected to be available to meet demand, had it been able to generate.

[16] Report on Outages and Curtailments During the Southwest Cold Weather Event of February 1-5, 2011. Federal Energy Regulatory Commission/North American Electric Reliability Corporation, at https://www.ferc.gov/sites/default/files/2020-04/08-16-11-report.pdf.

Also, generators have spent time and money ensuring that their generating units would be available to operate during traditional times of grid stress, and forced outage rates have indeed dropped during the *summer* peak.[17] Once the extreme climate event had occurred, and was occurring, there seems to have been no suggestion that generators failed to provide what capacity they had available. ERCOT's operational avoidance of a cascading failure, while drastic, seems to have been judged appropriate in the circumstances (albeit with some criticism, valid or otherwise, of ERCOT's public communications).

Admittedly electricity prices were at the high offer cap level of $9,000/MWh for much longer than ever before. Some would argue that this is precisely what was to be expected, because the extent of the capacity shortage was greater, and longer lasting, than ever before, and was not inconsistent with expectations and previous experience.

However, there were two novel features of the February blackout, namely, the impact on individual residential customers and the regulatory controversy about the appropriate level and duration of the offer cap. These features would raise further questions for Hayek about the present scarcity pricing mechanism.

6. Residential access to wholesale electricity prices

A major concern about energy-only markets was that regulators or legislators would feel the need to step in to mitigate high prices that might seem excessive but that were necessary to induce sufficient investment in new capacity. This problem would be avoided with generators bidding at cost, and a scarcity mechanism in place (using an ORDC). There would be occasional very high prices, but market participants could hedge against the risks involved.[18]

Hogan (2005) had recognised the possibility that inadequate hedging, particularly for small customers, might create pressures for regulators to intervene. However, this concern could be addressed, if desired, by mandatory hedging for such customers.[19] Indeed, some of the capacity mechanism jurisdictions, those with limited retail competition, have imposed forward contracting obligations on incumbent utilities as default providers, but Texas has not done so. The issue seems to have become less important over time: Hogan (2013, p. 74) merely comments that there is nothing to prevent the market from hedging.

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[17] E.g. "The improvement in operational reliability from the events of February 2011 to January 2014 is largely attributable to better scarcity pricing." Commissioner Kenneth W Anderson, "The Reliability Triad's Second Leg: Operational Reliability, The Texas Market Based Approach", Presentation for Public Utility Law Conference, August 8, 2014.

[18] "Both generators and loads would be hedged through the forward contracts. Hence, there would be limited exposure to the volatile spot prices. These volatile prices and the price duration curve … would be critical to success of the energy-only market, but the limited exposure to high prices should not provide a critical mass of political pressure to induce further intervention in the market" Hogan (2005, p. 18).

[19] "Without sufficient hedges supplied through forward contracts the loads would be too exposed to volatile spot prices and this, in turn, would create inevitable pressures for regulators to intervene when scarcity appeared. This intervention would be a political challenge for regulators and would create associated regulatory uncertainty that would undermine investment." (p 26) So, "if there is no load hedging program in place, then this would be a focus of a regulatory decision to either accept reliance on voluntary forward contracting as politically sustainable or turn attention to mandatory load hedging for some of the customer classes." (p 33)

Until a few years ago, the extreme and long-lasting outages in February 2021 would have been just as controversial as they actually were, except that the scarcity pricing mechanism might have passed without particular comment. Previously, when the scarcity pricing mechanism was discussed and introduced in Texas, the only parties liable to pay or receive wholesale prices were generators and retail providers, traders, and some large commercial and industrial customers who had opted to buy at wholesale price. These parties could be assumed to understand the market and the scarcity pricing process and risks involved, and to be able and willing to hedge the possible price risks to the extent they judged reasonable. The operation of the scarcity pricing mechanisms would have had no immediate impact on actual residential customers.

But retail competition brought innovation. A new provider, Griddy, entered the market with a new product, having realised, in a Hayekian fashion, that it could enable residential customers to buy at wholesale price, plus a small monthly administration fee. Another smaller retailer, Evolve Energy, acquired by UK retailer Octopus Energy in September 2020, also offered direct wholesale access as one of its three products.

Customers buying at wholesale prices enjoyed lower bills for some years. Griddy has said that its 29,000 customers in early 2021 had saved more than $17m since 2017. However, with the unexpected freeze in February 2021, and the increase in wholesale prices to the level of the $9,000 cap, these customers suddenly, unexpectedly and very exceptionally, found their daily bills very much higher than usual. According to Griddy, "Prior to the unprecedented market events that resulted in prices staying at $9,000 per megawatt hour for 87.5 hours, the real-time electricity price had only reached that level for a total of 3 hours since 2015." The impact was severe: HB 16 bill analysis said that the wholesale spot price increased more than 10,000 per cent. Some customers reported monthly bills over $15,000 (although this was surely very exceptional).[20]

Not surprisingly, the high bills and the associated customer complaints immediately hit the media. There were complaints about ERCOT communications, and concerns expressed to the PUCT about price gouging,[21] and representations to ERCOT and the PUCT about the operation of the scarcity pricing cap. Griddy recommended its customers switch provider.[22]Its website even suggested some names and contact details. However, some retail providers were not open for business at the weekend, others were not interested to take on new customers when wholesale prices were so much higher than their own retail prices. Nonetheless about two-

[20] Seth Blumsack, https://theconversation.com/whats-behind-15-000-electricity-bills-in-texas-155822 The article calculates that a large household with a lot of electric heating could have seen an increase from around $30 in that week to $4500. Exelon has said that many customers saw electricity bills that were almost 100 times their usual amount. We understand that most bills involved were below $4500 – which was still extremely high, of course.

[21] "A caller noted that NBC had been reporting customers receiving bills of up to $10,000 and didn't believe the PUCT should allow "price gouging" during such a disaster." PUCT emergency open meeting, February 19, 2021, King Energy Consulting Newsletter. Pulse Energy suggested that "Obviously, in any other industry, this would be considered price gouging during an emergency" PUCT Project 51812, number 9, February 20, 2021, filed February 22.

[22] "Prices are looking to stay at record rates over the next couple of days due to the polar vortex. Unless you are a Griddy energy-saving expert, we recommend you immediately switch to another provider." https://www.texasmonthly.com/news-politics/griddy-argues-it-championed-consumers/

thirds of Griddy's customers reportedly left.[23] Octopus Energy launched a Bill Forgiveness Plan capping its prices at the Texas average price (12.20c/kWh compared to the cap of $9/kWh) for any usage between February 13th – 19th, and picked up the remaining millions of dollars cost itself. The former deputy Chair of ERCOT's Board of Directors said that "the communications of both Griddy and Octopus were exemplary" (Cramton 2021).

7. Prohibition or restriction?

But matters did not rest there. About a hundred bills on electricity issues were introduced into the Texas Legislature, at least two of which proposed to protect customers from these exceptionally high wholesale prices. In particular, House Bill HB 16 proposed to prohibit retail electric providers from offering a wholesale indexed product – one in which the price "includes a direct pass-through of real-time settlement point prices" - to a residential or small commercial customer. According to the House Research Organization, bill supporters argued that exposure to the risk of such high prices was detrimental to residential customers, that some customers were misguided about the associated risks, and that residential customers did not have the expertise to weather the fluctuation of electricity rates.

Bill critics argued as follows: "[CS]HB 16 would inappropriately eliminate a product from Texas' competitive electricity market, which should be treated the same as other markets that carry significant risk, such as the stock or real estate markets. The Legislature should allow companies to continue to offer wholesale indexed products to all customers with certain consumer protection mechanisms in place. Rather than banning wholesale indexed products, the bill should mandate better disclosures from companies and should require plans to cap a customer's exposure to wholesale electricity prices, protecting customers from high electricity bills that result from prolonged high wholesale rates."[24]

The bill analysis gave as the justification: "That type of [wholesale indexed] plan simply attributes too much risk to expect average consumers to manage." The same and only point was made in testimony on the bill by a former Executive Director of the PUCT, now representing an electric industry trade organisation.

This logic implies that if average consumers cannot manage the risk in a particular type of plan, no one should be allowed to offer such a plan to any consumers. Would such a restriction be tenable in the competitive market generally? It implies also that average consumers have no ability to learn from experience. Rival retail providers may have welcomed the prevention of this type of plan, which had hitherto proved lower priced, but it seems quite inconsistent with the legislature's commitment to competition over the past two decades.

Whether Hayek would have described a uniform imposed regulatory price of $9,000 as price gouging, or as what he called "true coercion", is an interesting question. Hayek surely would have agreed completely with the bill critics above. The retail providers offering wholesale

[23] "Amid blackouts Texas scrapped its power market and raised prices. It didn't work", Russell Gold and Katherine Blunt, *Wall Street Journal*, February 25, 2021 https://www.wsj.com/articles/texas-power-regulators-decision-to-raise-prices-in-freeze-generates-criticism-11614268158?page=1

[24] House Research Organization, bill analysis HB 16 (2nd reading), March 30, 2021.

prices could and would have explored with customers a variety of consumer protection measures, to find which they preferred. Ironically, Griddy had already developed a price insurance product that it planned to roll out on March 1, 2021. But HB 16 prohibited such a competitive discovery process, to the advantage of existing competitors and to the detriment of customers. HB 16 passed both Houses with hardly any dissent, and became law with the Governor's signature on 27 May 2021, to take effect on 1 September 2021.

As it happens, on 24 May 2021 a much more comprehensive bill SB 3 also passed both Houses, introducing many new provisions to address the system reliability problems revealed by the outages. Several of its provisions have been endorsed by former Texas electricity regulators (Wood et al. 2021), including a requirement for better demand forecasting and broader scenario analysis. One provision provided an alternative to HB 16: it prohibited offering wholesale products to residential customers *unless* "the product caps the monthly average all-in price per kilowatt hour of electricity charged to the customer at a maximum of 200 percent more than the monthly average price of electricity in Texas during the same month for the prior year, as determined by monthly electric power industry reports required by the U.S. Energy Information Administration". (This reflected a suggestion made by Octopus Energy in testimony on HB 16.) There was also an obligation to advise the customer of the maximum monthly average price for the next six months.

From Hayek's perspective, the SB 3 restriction was not ideal, because it effectively forces all wholesale pass-through customers to pay for a hedge against an extended period of high scarcity prices. It thereby penalises those customers who would be able and willing to reduce electricity consumption at such times. It also discourages other measures such as energy efficiency, and restricts innovation and discovery. However, SB 3 was much preferable to HB 16 because it offered a publicly acceptable form of protection for many customers while still leaving scope for providers to offer this generally cheaper product and to explore additional options.

Unfortunately, the enrolled SB 3, later signed by the Governor, deleted that particular provision, leaving HB 16 to completely prohibit wholesale price products for residential customers. Hayek would have deplored this prohibition. A fear is that the Texas power crisis "has set the move towards dynamic pricing back by a decade".[25] Is there any hope for a constructive PUCT interpretation of "direct" pass-through so that products with indirect pass-through, and/or moderate hedges, might be regarded as exempt?

8. High and Low Offer Caps and the Circuit-breaker

The second novel feature of the February experience was that the scarcity pricing mechanism turned out to be more complex than it first seemed. It provided for increases in wholesale price up to a system-wide offer cap of $9,000 per MWh; however, some modification was considered to be appropriate if the price level in the year to date had already adequately remunerated peak

[25] Ahmad Faruqui, posting to Electricity Brain Trust listserve, June 3, 2021.

generating capacity. At that point, a lower level of cap would be sufficient to incentivise generators to make existing capacity available.

The $9,000 per MWh was known as the High cap (HCAP), and a "circuit-breaker" was provided in the form of a Low system-wide offer cap (LCAP) of $2,000 per MWh that would be substituted for the HCAP when the peaker net margin (PNM) reached a threshold level of $315,000/MW-year on a natural gas peak generation unit. However, a further complication was that, to enable available generators to cover their current fuel costs, the circuit breaker was also geared to the level of natural gas price. More precisely, the LCAP was set equal to the maximum of $2,000 or 50 times a natural gas fuel index price.[26] This may have been an appropriate benchmark during the summer peak season, when gas prices are relatively low, but not during a winter freeze-up event.

On Friday February 12, the Texas state Governor issued a "disaster proclamation". On Monday February 15 ERCOT declared its highest state of emergency due to exceptionally high electric demand exceeding supply and directed transmission operators to shed over 10,000 MW of load. The situation was expected to continue. ERCOT informed the PUCT that energy prices were clearing at less than the offer cap of $9,000/MWh (and as low as $1,200 at times during the first day of the weather crisis).[27] It also noted that generator revenues were approaching the PNM threshold of $315,000, so that the HCAP would soon be superseded by the LCAP, but that due to exceptionally high natural gas prices, the LCAP could exceed the HCAP. (Indeed, two days later on February 17 the LCAP would have been $18,000 per MWh, twice the level of the HCAP.)

The PUCT considered that prices below $9,000 at that time were "inconsistent with the fundamental design of the ERCOT market. Energy prices should reflect scarcity of the supply. If customer load is being shed, scarcity is at its maximum, and the market price for the energy needed to serve that load should also be at its highest." So on that same Monday February 15 the PUCT directed ERCOT to adjust its calculation of the scarcity price, and to correct its past prices so as to achieve the $9,000 cap.[28] However, the PUCT considered a price above $9,000 contrary to the purpose of the rule, which was "to protect consumers from substantially high prices in years with substantial generator revenues". Accordingly, the PUCT also directed ERCOT to suspend use of the LCAP and instead to use the HCAP of $9,000 as the offer cap until the PUCT's next open meeting (on March 3). Unfortunately, the PUCT failed to appreciate that the circuit breaker was intended to mitigate extreme scarcity pricing once it had accomplished what its designers intended it to accomplish.

[26] S&P Global Platts, Electric Power, 3 March 2021.
[27] PUCT Project 51617, Second Order directing ERCOT to take action and granting exception to Commission rules, 16 February 2021, p 2.
[28] "Accordingly, the Commission directs ERCOT to ensure that firm load that is being shed in EEA3 is accounted for in ERCOT's scarcity pricing signals. The Commission further directs ERCOT to correct any past prices such that firm load that is being shed in EEA3 is accounted for in ERCOT's scarcity pricing signals."

ERCOT continued in emergency operations and the wholesale price stayed at $9,000/MWh from the evening of Monday 15 to the morning of Friday February 19, when ERCOT came out of emergency operations. Wholesale prices gradually reverted to normal.

Not everyone accepted the PUCT/ERCOT approach. TEAM, a retail trade organisation, requested that the PUCT order ERCOT to reinstate "normal" pricing for the preceding 32 hours. The PUCT declined to do so. Many retail providers were seriously affected: Exelon (see below) said that it suffered about $1 billion in pre-tax losses. On March 1 the oldest and largest power cooperative (Brazos) filed for bankruptcy, as did Just Energy ("a company specialising in bringing energy efficient solutions and renewable energy options to customers") on March 8 and Griddy on March 15. In contrast, several pipelines and traders each made over $1 billion profit. By March 2 the Peaker Net Margin had reached $717,500, twice the critical level of $315,000 achieved two weeks earlier, having far exceeded its $50,000 level in 2020 and the previous peak of almost $150,000 in 2019.

Political pressures continued. On March 1 the PUCT Chair resigned following criticism of her handling of the outages and of ERCOT. On March 3 the PUCT decided to "let the February 15 order expire as we expected".

On March 4 the Independent Market Monitor (IMM) wrote to the PUCT to say that "Unfortunately, ERCOT exceeded the mandate of the Commission by continuing to set process [sic, presumably prices] at VOLL long after it ceased the firm load shed."[29] It said that it had informed ERCOT of this on February 18th. It costed this error at $16bn and recommended that the PUCT ask ERCOT to correct these prices. The next day Senator Springer wrote to the PUCT reinforcing the IMM's recommendation.[30] Many other market participants urged similar action. On March 8 the Lieutenant Governor wrote following up Senator Springer's letter. That day a second PUCT member resigned. After revelations that the third PUCT member, now Chair, had assured investors that he would ensure that there would be no repricing of the electricity trades during the blackouts, the Governor asked for his resignation, which he gave on March 16.

Also on March 8 the PUCT opened a review of the ERCOT scarcity pricing mechanism. A dozen informed and constructive responses generally sought to facilitate a more reasonable and effective LCAP. Thus TIEC (Texas Industrial Energy Consumers) argued that "Many reliability events – including the recent winter event - are driven primarily by *operational issues*, rather than a shortage of *installed capacity*. In these situations, continuing to send price signals at $9,000/MWH may not elicit meaningful additional behavioral response, and may not

[29] PUCT Project 51812, number 61.

[30] "According to the Independent Market Monitor (IMM), they contacted ERCOT on Thursday, February 18th, to inform them that their pricing was incorrect, but ERCOT ignored their recommendation. The IMM also identified a second significant error that also must be corrected immediately. ERCOT failed to cap ancillary service prices at $9,000, which resulted in prices rising as high as $24,000 a megawatt hour at intervals during the storm. Pricing should never have exceeded the $9,000 cap at any time." PUCT Project 51812, number 122, letter dated March 8, filed March 10, 2021.

meaningfully encourage long-term investment." [31] TIEC proposed an event-specific circuit breaker, at a value of $2,000 per MWh, which would come into effect "when a substantial portion of the market is unable to respond to pricing incentives due to an identifiable event that is beyond market participants' control". It would also provide generators "an opportunity to prove up their verifiable costs" – that is, to get reimbursement for – any justifiable cost above that, such as a higher natural gas cost. Importantly, there was a consensus for reform by attuning the scarcity price provisions more closely with the reality of actual market conditions. PUCT Staff proposed a modification to this effect on April 29, 2021.

Unfortunately, at the time of the February outages, the natural gas price was exceptionally high, to the extent that the LCAP was above the HCAP. In effect, the "circuit-breaker" was broken. The PNM passed the critical level, it was open to the PUCT to have suspended the rule in order to charge a price below $9,000, but it did not do so. Indeed, it did the opposite, insisting that the price stay at $9,000 when the rule would have led to its reduction. A legal challenge ensued.[32]

These were difficult and unfamiliar conditions, so some tolerance of regulatory decision-making must be granted. However, the PUCT (and perhaps ERCOT) seem to have been under the impression that continued pricing at the maximum HCAP level was critical to keeping all available generators on the system. In fact, as TIEC and others pointed out, that maximum level was chosen to incentivise the construction of sufficient new generation, and a significantly lower price would have sufficed to incentivise existing generation to make itself available for running. Ironically, then, although concerns about regulatory implementation led to the scarcity pricing mechanism rather than "no cap" or a capacity mechanism, it was the problematic regulatory implementation of the scarcity pricing mechanism that greatly exacerbated the February problem in Texas.

9. Hayek on such mechanisms

This episode suggests that the scarcity pricing rule did not adjust finely enough to track changing market conditions. Hayek might question whether such fine-tuned adjustments are even feasible in a centralized administrative process. The complexity of the system and situation was such that the concept and detail of the mechanism eluded the PUCT decision-makers at this critical time. The circuit breaker did not adapt to the realized upstream problems in natural gas supply. For Hayek, this failure of the mechanism to reflect market participants' evolving and distributed knowledge of time and place would have been a serious defect.

The real-time regulatory implementation of these scarcity pricing provisions contrasts with ERCOT's technical operation of the physical system. While each set of circumstances is

[31] Texas Industrial Electricity Consumers' Initial Comments on the Low System-Wide Offer Cap, Evidence submitted to Review of the ERCOT Scarcity Pricing Mechanism, Public Utility Commission of Texas Project No. 51871, Number 12, at http://interchange.puc.texas.gov/Documents/51871_12_1117373.PDF

[32] On May 7 Exelon and Constellation, a major energy wholesaler and retailer, filed for judicial review, arguing that the then-Commissioners, "on their own motion and without any opportunity for notice and comment changed ERCOT's market pricing rules in response to the winter storm", with various seriously adverse consequences for customers and retail providers. PUCT Project 51812, number 202, 10 May 2021.

unique, ERCOT's system operators were familiar with this type of event. As the situation evolved, they knew what to do and when to do it, to keep as many lights on as possible while avoiding a system outage. No doubt they had practised similar events many times, just as the UK System Operator practices events in the control simulator and has wider system event rehearsals with industry.

Apparently not so with the scarcity pricing and circuit-breaker provisions. ERCOT and the PUCT were faced with the unknown. Not surprisingly, they seemed uncertain how best to proceed, or indeed what options were available to them. SB 3 requires the PUC and ERCOT "to conduct simulated or tabletop load shedding exercises with providers of electric generation service and transmission and distribution service", with at least one such exercise each summer and winter each year. These exercises should include the operation of the scarcity pricing and circuit-breaker provisions. This would familiarise ERCOT and the PUCT staff with the options available, with the pros and cons of each, and with the public communication of policy.[33]

10. A more Hayekian approach going forward?

Wood et al. (2021) refer to "$50 billion spent on power during the four-day-long outages—six times more than the cost of power in all of ERCOT in 2020". The IMM costed ERCOT's error at $16 bn. These figures dwarf any excess pricing that might characterise an energy-only market without an offer cap. Nonetheless, there is probably no public appetite for less regulation now. So, can anything more be done to alleviate concern about the non-Hayekian aspects of the scarcity price mechanism?

We suggest exploring various ways to make the mechanism more consistent with, and supportive of, a competitive market process. The aim would be to better discover the preferences and capabilities of the various market participants and to stimulate them to explore new ways of dealing with scarcity, making the operation of the scarcity pricing mechanism more responsive in real time to the ongoing market situation. Market rule modifications and perhaps other measures could enable these capabilities with a view to gradually reducing and even replacing the role of the scarcity pricing mechanism.

A considerable existing opportunity is in demand participation. Although VOLL is in principle a demand side calculation, and the aim is some sort of optimum position balancing the value of demand and supply, the focus to date seems to have been influenced by the cost of a particular natural gas peaking plant. More can be done to empower demand response and enable load flexibility. Market rules that take advantage of increasing digitisation and automation around the edge of the distribution network could access the decentralised flexibility in price-responsive demand. Innovation in distributed resources, including batteries, behind-the-meter generation, energy efficiency and demand response based on smart meters make increased demand participation in markets feasible. It should be easier now than it was when the scarcity pricing mechanism was designed a decade ago, to harness technological change to attenuate periods of supply shortage and reduce periods of reliance on administrative scarcity pricing as demand flexibility increases. Moving toward increased participation will be

[33] There could also be scope for using laboratory experiments (Kiesling 2005).

incremental, and a process of feedback and learning with these new capabilities. Market rules that reduce barriers to participation would enhance its development.

Financial practices can also improve scarcity situations, such as existing examples of customers and generating units making hedging arrangements and bilateral contracts to address potential outage or high price situations, in some cases involving ERCOT. These experiences and practices could be encouraged, shared and discussed, with a view to expanding the learning from experience, and drawing out common themes. Such information would show a more systematic pattern of evidence of a market process working, that could be drawn upon in setting the parameters of the scarcity pricing mechanism.

The time seems ripe for more local and individual experimentation, trying to discover what kinds and levels of security of supply each customer or customer group would prefer, what mixture of price and quantity limitations, what kinds and durations of advance warnings, what kinds of curtailment options, what mixture of automatic and voluntary response for what appliances and at what times of day, what kinds of rate design, and so on. Are the present obligations on transmission and distribution networks, and on ERCOT, best designed to encourage their participation in such explorations?

The parameters of the scarcity pricing mechanism seem to have been set in 2012. As noted, SB 3 initially proposed requiring that parameters be reconsidered every five years; others have suggested separate circuit breakers for winter and summer. Wood et al. (2021) suggest examining whether different market products (e.g. winter-focused ancillary services) or operational protocols (e.g. limits on maintenance scheduling) are appropriate to different seasons.

But competitive market processes require some participants to reconsider their plans every five minutes. There is of course a balance to be struck, given the advantage of providing a stable regulatory context against which market participants can make their plans. But is it inconceivable that the parameters of a scarcity pricing mechanism could and should evolve continually over time, rather than be adjusted once every few years?

The scarcity pricing mechanism implicitly assumes a single system-wide reliability adder (although the underlying energy LMP varies). In practice, as exemplified by the February events, different parts of the system were in different states of sufficiency. There were various distribution-level constraints, for example associated with technical ability to isolate parts of the system and the presence or otherwise of priority customers such as hospitals or airports. As others have suggested, the protected loads need to be better segregated such that more unprotected load is available to participate in rolling service interruptions. The severity of the event would have been greatly reduced by being able to access the very large amount of load on the same circuit as, for instance, a local hospital. Would it not be appropriate, then, to consider different scarcity prices for different parts of the system?

Indeed, under defined scarcity conditions, different arrangements could apply for different generators and different sets of customers. These arrangements and their method of implementation would be negotiated in advance and would evolve over time. There could be

different arrangements for different customers on the same distribution grid, as indeed there are now with priority customers. Transmission and distribution operators would need to be involved in the negotiations, as well as generators and retail providers, who in turn would be responsible for offering options to final customers. And local communities could be involved too, as indeed they increasingly are in several parts of the US.

11. More blackouts and brownouts?

The first author worked on privatisation and regulation of the UK electricity industry with Professor Michael Beesley, whose hero in economics was Joseph Schumpeter, an Austrian colleague of Hayek, with similar ideas about competition as "a perennial gale of creative destruction". Back in the 1980s, when asked what the main benefit of electricity privatisation and competition would be, Beesley replied "more blackouts and brownouts". He meant that government ownership had led to higher and more costly standards of reliability than customers themselves would choose, if better informed and faced with the actual costs at the margin of providing reliability.

For the first two decades after privatisation, the opposite was the case. Regulators (including the first author) retained responsibility for approving network investment plans, and were keen to demonstrate that privatisation worked, including by increasing reliability of supply. Customers themselves essentially had no say in such investment and reliability decisions.

But now, the availability of demand-side options means that the situation is changing. Increasingly, customers can say "At 9c/kWh we'll take grid supply, but at $9/kWh we'll skip that and reduce consumption, install energy saving devices, or use our own reserves to tide us over". Customers can increasingly choose to accept what would otherwise be inconvenient blackouts and brownouts, and manage them to their advantage, including by reducing costs.

It is now possible to develop and augment the scarcity pricing mechanism in Texas, using ideas inspired by the thinking of one of the most distinguished economists of our time. One of his central insights was that competition is a rivalrous discovery process taking place over time, with discovery enabled by informative price signals. That means discovery by customers as well as producers.

Present scarcity pricing arrangements have much to commend them compared to conventional capacity mechanisms, although their implementation in February 2021 was problematic and the legislative response in HB 16 was extremely unhelpful. But present arrangements have not yet focused on the scope for discovery of new and better ways of coping with unexpected fluctuations in demand and supply. That is what is needed – as well as the information that would emerge from better forecasting and scenario analysis – if the cost, pain and suffering of further blackouts like Texas are to be minimised, and if customers are to enjoy the full benefits of an efficient, robust and responsive electricity system.

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