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Impact of Ownership Type on Electricity Distribution Utility Performance: Evidence Using Value for Money Perceptions of Swedish Consumers

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Abstract

This paper examines which ownership arrangement is best for a natural monopoly network. Three broad classes of owners are considered: (i) investors; (ii) local governments (i.e. municipalities); and (iii) customers. Comparing the performance of differently-owned firms can be complicated by firms choosing different price-quality trade-offs, making direct comparisons impossible. To resolve this, we develop a model of quality provision under different ownership types when firms face a common regulated price, which can be treated as being the case for electricity distribution firms in Sweden. This enables us to predict "value for money" (defined as quality-price ratios) under different ownership types. We then use novel survey data on customers' perceived value for money to shed light on whether those perceptions differ by ownership type. Consistent with our theoretical predictions, we find that electricity distribution utilities owned directly by customers are perceived to deliver more value for money than those owned by municipalities or by investors. Our findings indicate that network monopolies owned by customers (or perhaps municipalities) may warrant different regulatory treatments to – or exemptions from – those applied to investor-owned monopolies.

Keywords: utility regulation, electricity distribution, ownership

JEL codes: D42, L33, L94

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1 Introduction

We investigate whether customer-ownership of a natural monopoly network utility delivers better performance, than either municipal or investor-ownership. We do so using a novel performance measure, namely customer reports of perceived value for money (VFM) for Swedish electricity distribution network service providers (DNSPs). How ownership affects performance is highly pertinent for utilities involved in distributing essential services such as electricity, gas and water. Due to scale economies and network effects, such utilities are typically monopolies, and hence they enjoy significant market power. This exposes consumers to under-provision and excessive pricing, as well as distortions in quality provision.[1]

In many jurisdictions, investor ownership of utilities has risen as a consequence of reforms such as market liberalization/deregulation. Regulation has commonly been introduced as part of such reforms to restrain excessive utility pricing, and to correct for other monopoly distortions.[2] While early utility regulation prioritized incentivizing utilities to reduce costs of supply, it was apparent that prioritizing just efficiency and profitability could cause undesired quality shading.[3] Later regulation has therefore incorporated features to also incentivize quality provision.[4] The presumption in such regulation has been that utilities are profit-focused, and hence that incentives affecting profitability are required to induce desired consumer outcomes. As detailed in Section 2, the reality is that there is significant diversity in utility ownership types, with state, municipality or customer ownership often featuring strongly, or even predominantly, alongside or instead of investor ownership. This raises the question as to whether regulation designed for investor-owned utilities provides the right mix of incentives for efficiency and quality in utilities featuring different ownership types.[5] These other types of owners are likely to prioritize the quality and accessibility of services over pure profit maximization. This is especially the case for customer-owned utilities, and may also be the case for municipality-owned utilities. In the former case, this is because the utilities are governed by representatives of customer-owners. In the latter, because they are accountable to elected representatives of local communities, who also tend to be utility customers. Customer- and municipality-owned firms may therefore need to be

[1] For early theoretical studies on quality provision under monopoly, see Spence (1975), and Tirole (1988).
[2] For a discussion of deregulation and associate regulation in multiple sectors, see Crew and Kleindorfer (2004).
[3] Joskow (2006) highlights the risk of quality being sacrificed when regulated firms are only incentivised to reduce costs.
[4] E.g. see Shestalova (2002), Mikkers and Shestalova (2003), Ajhodia and Hakvoort (2005), and Joskow (2006), for discussions of electricity distribution regulation incorporating quality. Sappington (2005) surveys quality regulation in utilities more generally.
[5] Doni and Mori (2014), and Meade (2014), are the only available theoretical studies analysing optimal utility regulation under customer ownership. The former study focuses on how profit-sharing rules affect pricing and regulation under customer ownership. The latter considers optimal regulation when either customer or investor owners set incentives for the monopoly's managers, when those managers can take hidden actions to achieve efficiency and quality under uncertainty. Herbst and Pruefer (2005) analyze quality choice under customer-, investor- and not-for-profit ownership, but not optimal regulation.

regulated differently to investor-owned utilities, since their different objectives affect how regulatory incentives translate into performance. It might even mean that they do not need to be regulated at all, if the owners' objectives are sufficiently aligned with those of customers, and hence also to those of customer-focused regulators.

In this paper we exploit a feature of the regulation of Swedish DNSPs to demonstrate both theoretically and empirically why "value for money" (VFM) should be, and is, higher for customer-owned utilities than for utilities owned by investors, with VFM for municipality-owned utilities intermediate to that of the other two ownership types. Specifically, the Swedish electricity distribution regulator, in English known as the Swedish Energy Markets Inspectorate (Ei), regulates all DNSPs without regard to their ownership type.[6] This means any two DNSPs that are identical except for how they are owned face the same regulation, and hence comparable implied regulated service prices.

Interpreting VFM as the ratio of service quality to service price, we present a simple theoretical framework showing that for a given service price, quality is expected to be highest for customer-owned utilities, followed by that for municipality-owned utilities, and then investor-owned utilities. Using novel survey data in which Swedish electricity distribution customers reported their perceived VFM for their DNSP, we present evidence consistent with these predicted VFM rankings. To control for possible selection effects, we also separately consider VFM reports of customers who relocated between areas with DNSPs having different ownership types, with the resulting change in ownership type acting as a proxy for a random allocation mechanism. Doing so replicates the VFM rankings by ownership type discussed above.

We also emphasize that "quality" in the context of electricity DNSPs – as in our survey data – is multi-dimensional, and in particular, encompasses dimension over and above commonly used measures such as service reliability. These include the visual amenity and public safety of distribution network assets,[7] speed at which new connections are completed, responsiveness to customer complaints, and ease with which customer information can be understood, among other dimensions. However, we show that service reliability correlates with such other quality dimensions.

Our contributions are therefore fourfold. Firstly, ours is the first study to assess the impact of ownership type on electricity network monopoly performance, using consumer reports of perceived VFM to measure performance instead of traditional indicators such as cost, price or reliability. Secondly, we exploit a feature of Swedish DNSP regulation to predict how VFM should rank under different ownership types, and show that the predicted rankings and survey results are aligned. Thirdly,

[6] Ei (2022) describes how DNSPs are regulated in Sweden, revealing that no distinction is made between utilities based on their ownership type. Further details are provided in Section 2.

[7] E.g. whether the networks involve overhead wires suspended on power poles – creating visual disturbances and safety hazards, as well as exposing consumers to weather-related outages – or are under-grounded.

we present evidence that DNSP reliability might in practice be treated as a sufficient statistic for broader measures of service quality.

Finally, we provide evidence that uniform regulation of electricity network monopolies featuring different ownership types results in divergent levels of firm performance as measured by consumers' perceived VFM. Hence, if the purpose of regulation is to achieve comparable levels of performance (in terms of customer satisfaction) across firms, our results indicate that regulation ought to be tailored to each ownership type, rather than applied uniformly across types.

Empirical studies similar to ours include those examining state versus investor ownership across a range of sectors (e.g. Megginson and Netter (2001)). Likewise, studies comparing the performance of publicly and privately owned Swedish electricity distribution utilities include Kumbhakar and Hjarlmarsson (1998), Jamasb and Söderberg (2010), and Söderberg (2011). These complement studies of public and private electricity distribution utility performance in the U.S. by Claggett Jr et al. (1995) and Kwoka (2005). Finally, Estache and Rossi (2005) compare the impact of ownership type on distribution utility performance in Latin America, while Meade and Söderberg (2020) focus on the performance of investor and customer owned electricity distribution firms in New Zealand. We complement these earlier studies through our use of a novel measure of firm performance.

Hansmann (1996) provides an extensive survey and analytical framework for explaining why different organizational forms dominate in a wide range of sectors in the U.S.. Later theoretical studies have analyzed how performance or regulation is affected by public versus private ownership (e.g. Hart et al., 1997), not-for-profit versus for-profit/investor ownership (Glaeser and Shleifer, 2001), and customer versus investor ownership (Doni and Mori, 2014; Meade, 2014). Our empirical findings provide an indication of the direction in which theoretical refinements to utility regulation ought to operate.

The balance of this paper is structured as follows. Section 2 provides details of the extent of customer ownership in electricity and other utilities around the world, as well as the diversity of regulatory treatments applied to customer-owned utilities. Rationales for different ownership forms for electricity distribution networks are also discussed, as are details of the ownership and regulation of Swedish electricity distributors. Section 3 presents our theory model predicting how VFM should rank for customer, municipal, and investor ownership. Section 4 describes the data, with findings and analysis in Section 5. Section 6 concludes.

2 Background

2.1 Incidence of Customer Ownership in Network Monopolies

Customer-owned cooperatives in infrastructure sectors first emerged in the 19th century in power and water sectors, but flourished after WWI (Heilman, 1925; Bruner, 1925). In the U.S., they spearheaded

rural electrification from the 1930s, but grew in prominence following the end of WWII.[8]

As a consequence, customer-owned "rural electric cooperatives" now dominate the provision of rural electricity distribution services in the U.S., with networks covering 56% of the country's landmass and supplying 42 million people (NRECA, 2023). Customer-owned cooperatives also feature prominently in the delivery of telephone and water services in rural areas (Deller et al., 2009).

Customer-owned electricity distribution networks and related electricity concerns also feature in many other countries. They are prominent in all Scandinavian countries, alongside investor and public/municipality ownership (Qasim et al., 2024).[9] They also feature prominently in Spain (NRECA International (2010)) and Italy (Doni and Mori (2014)). In Latin America, they feature in Argentina, Bolivia, Brazil, and Chile (NRECA International (2010)). In the Asia-Pacific region, customer-owned electricity distribution dominates in New Zealand (Meade and Söderberg (2020)), and also feature in India, the Philippines, and Bangladesh (NRECA International (2010)). They are particularly prominent in bringing electrification to rural areas in many developing countries (Barnes and Foley (2004), Kirubi et al. (2009), NRECA International (2010)).

Customer-owned telecommunications cooperatives also feature in countries outside of the U.S. (Mori (2013)). Customer ownership also features strongly in rural water supply, such as in the U.S. (Deller et al. (2009)), Australia (ACIL Tasman (2005)), New Zealand (Le Prou (2007)) and Finland.[10] Such ownership also features in natural gas supply and community heating (Mori (2013)), as well as community energy projects such as community solar electricity generation or battery storage (Löbbe et al. (2022), Biggar and Hesamzadeh (2022)).

Importantly, such customer-owned electricity network utilities face a diversity of regulatory treatments. As in other Scandinavian countries, they are regulated like investor- or municipality-owned utilities in Sweden (Ei, 2021).[11] Conversely, in the U.S., investor-owned electricity distribution utilities are all price regulated, but customer-owned utilities are regulated in just 16 of the 47 states that they serve (NRECA International (2010)). Electricity distribution cooperatives are often exempted from price regulation because they are regarded as supplying service at cost, and through customer ownership and control are "self-regulating" (Deller et al. (2009)).[12]

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[8] https://www.electric.coop/our-organization/history, accessed 10 May 2024.

[9] Many Finnish electricity concerns are privately owned but operate on a non-profit basis to supply their shareholders at production cost instead of making profit and paying dividends, thus operating as customer-owned cooperatives. See Finnish cooperative association Pellervo (2024a).

[10] In Finland, such cooperatives are not confined to rural areas (Pellervo, 2024b).

[11] Ei (2022) does not directly refer to different ownership types in its discussion of DNSP regulation, with the implication being that all ownership types are regulated uniformly. This treatment has been confirmed by personal communication with Ei by this study's corresponding author (Söderberg).

[12] For other discussions of why customer-owned utilities might warrant exemption from regulation, see Birchall

A similar pattern of regulatory exemption emerges for U.S. telecommunications cooperatives), while all water cooperatives in the U.S. are unregulated (Deller et al. (2009)). In New Zealand, 18 of 29 electricity distribution utilities are customer-owned, and of those 18, 12 are sufficiently customer-controlled that they can opt out of price-quality regulation that would otherwise apply (Meade and Söderberg, (2020)).

The above studies emphasize the widespread incidence of customer-ownership in electricity distribution network utilities, and their frequent exemption from price (or price-quality) regulation. These details underscore the importance of considering how customer ownership might affect utility performance, and hence what sort of regulation – if at all – they might warrant.

2.2 Rationales for Different Electricity Network Utility Ownership Forms

Hansmann (1996) presents a framework for explaining why certain ownership forms tend to dominate in certain sectors – e.g. supplier or customer cooperatives in agriculture. Under his approach, the costs of different possible firm owners ("patrons") undertaking trade through markets must be weighed against the costs of coordinating and governing collective action. The ownership form that dominates in a given sector can be explained in terms of that form providing the most compelling balance of these two types of costs.

Customer ownership, for example, can be considered to be the best (or least undesirable) mix of market contracting and coordination/collective decision-making costs where investor ownership of a certain activity (e.g. network services provision) exposes customers to a high risk of monopoly pricing and/or quality distortion, but customers are sufficiently organized and homogeneous in interests that they enjoy relatively low costs of forming and governing the network activity themselves. Alternatively, certain customers might be insufficiently profitable to attract investor-owned providers. This is often the case in rural networks, where low customer densities and relatively high network costs make investor-ownership unprofitable (though still generating sufficient consumer surplus to warrant customer ownership). Either way, customer ownership is a way to ensure network services of a certain quality and cost (e.g. prices sufficient only to cover costs) which reflect their preferences and would not otherwise be available.

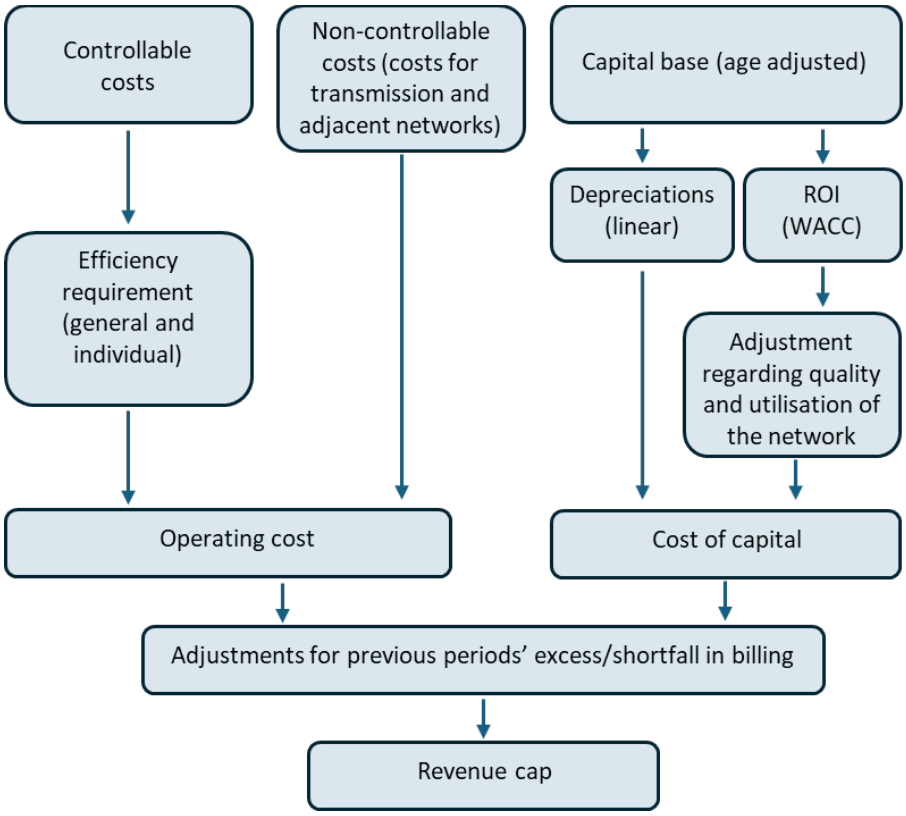
Municipal ownership of network monopolies, by contrast, can be explained in terms of customers facing the same risk of market power abuse (or non-provision) by an investor-owned provider, but being sufficiently heterogeneous in interests (e.g. due to being more transient, or simply more diverse) that it is prohibitively costly for such customer groups to act collectively. Municipal ownership is likely to

(2002), and Meade (2005). Conversely, Meade (2014) presents conditions under which customer-owned utilities warrant tighter price regulation than investor-owned firms, and Doni and Mori (2014) also find that customer-owned utilities may need to be regulated.

reflect customer preferences less directly than customer ownership, but it enjoys economies of scale and scope in making decisions for wider communities. It can also be used to limit excessive pricing, and/or reduces the harm of such pricing by using utility profits for community purposes (thereby benefitting customers, albeit not in proportion to their patronage of the utility).

Finally, investor ownership of network monopolies can be expected to dominate where capital constraints or other (e.g. collective decision-making) limitations of customer or municipal ownership mean those alternatives are untenable, and when service provision is sufficiently profitable to warrant investor provision. This is particularly so if network regulation provides adequate consumer protection while imposing more favorable costs than these other ownership types. Regulation, in this case, substitutes for direct customer control provided by customer ownership, or indirect customer control via municipal ownership.[13]

Figure 1: Elements of Revenue Cap Setting for Swedish Electricity Distribution Utilities



Source: Adapted from Ei (2022), Figure 3.

[13] Meade (2005) provides an assessment of the relative efficiency of each of these forms of organization in electricity distribution networks.

2.3 Ownership and Regulation of Swedish Electricity Distribution Utilities

Figure 1 depicts how four-yearly revenue caps are determined by the Swedish energy regulator, Ei, for DNSPs (Ei (2021)). As can be seen, those caps incorporate features intended to induce cost efficiencies, but also to induce (or maintain) certain levels of quality.

A notable feature of this regime is the absence of any allowance for how DNSPs are owned. In effect, Sweden's regulatory regime for DNSPs is silent regarding ownership, meaning we can treat the regulated revenue cap for any two firms that are identical save for ownership as being the same. We further discuss how we interpret this regulatory approach, and exploit it to enable performance rankings across ownership types, in Section 3.

3 Model

In this section we present a simple model of quality choice under different ownership types, adapting and extending the seminal work of Spence (1975), and similar treatment in Tirole (1988). In doing so, we abstract from governance and incentive issues that might either be shared between ownership types, or are particular to certain such types.[14]

We represent VFM as the ratio of service quality to (regulated) price. Service quality is interpreted broadly to include traditional measures such as reliability, but also other measures. These include visual amenity and public safety of distribution network assets, speed at which new connections are completed, responsiveness to customer complaints, and ease with which customer information can be understood, among other dimensions.

For standard goods and services, quantity would also be an important attribute of VFM. However, for electricity distribution customers are typically ignorant of their electricity consumption quantity, which is revealed ex post when periodic bills are received. Furthermore, since both electric energy and electricity transportation services are derived demands, consumption quantity is largely determined by long-term consumer decisions, such as choice of housing and heating types, and portfolio of energy-consuming appliances, as much as it is on explicit consumption choices (e.g. due to usage changes in response to varying temperatures). As such, the most salient attributes for perceived VFM are expected to be price, and service quality (which would tend to be more noticeable – e.g. outages, or helpful call center staff when changing residence, etc).

As discussed in Section 2.3, DNSPs in Sweden are subject to regulated revenue caps, irrespective of their ownership type. Without loss of generality, we represent revenue caps in terms of a corresponding average price of supply. This means firm-level revenue caps can be understood in terms

[14] Meade (2014) incorporates aspects of both governance and incentives in his study of optimal regulation of investor- and customer-owned monopolies. Herbst and Pruefer (2005) include governance costs in their analysis of quality provision under different ownership types.

of customer-level average distribution prices, which would be more salient to consumers when they form their VFM perceptions.[15]

Formally, average price is denoted by p, while product/service quality is denoted by q. Demand is represented as $x(p, q)$, and denoting derivatives by subscripts, has partial derivatives $x_p < 0$ and $x_q > 0$. The cost of producing a given output at quality q is represented by $c(x(p, q), q)$, with partial derivatives c_x, c_q, c_{xx} and c_{qq} all assumed positive. With these specifications, profits write as:

$$\pi(p,q) = x(p,q)p - c(x(p,q),q) \tag{1}$$

while consumer surplus is written as:

$$CS(p.q) = \int_p^{\infty} x(v,q)dv \tag{2}$$

A general objective function, encompassing a range of utility ownership types, is given by:

$$W(p,q;\alpha) = \pi(p,q) + \alpha CS(p.q) \tag{3}$$

The weight α attaching to consumer surplus is assumed to range between zero, representing profit maximization (i.e. investor ownership), and one, representing customer ownership (since consumers will value consumer surplus as well as profit). Intermediate values of α are taken to represent municipal ownership. This is because municipal firms are assumed to at least partially internalize consumer surplus, given they exist to serve their local communities, while also needing to also be financially viable (and hence being concerned about profitability).

For regulated utilities, output price p is given from the standpoint of the regulated firm, so is taken to be exogenous and denoted $\hat{p}$. More particularly, under Sweden's regulatory regime, the regulated revenue cap set for electricity distribution utilities does not differentiate between ownership types, so any two utilities that are comparable except for ownership type are assumed to face the same regulated price $\hat{p}$. This requires that the output quantity of two firms identical except for ownership type is itself not affected by service quality (which is expected to vary by DNSP ownership type).[16] Formally, we

[15] We assume that most customers will be unaware of their DNSP's revenue cap, but will be more aware of how much of their average power bill is comprised of total (i.e. fixed and per-kWh variable) distribution charges. In Sweden, customers receive two separate electricity invoices: one for their energy consumption, and another for distribution services.

[16] It further requires that average prices are determined by the revenue cap (i.e. that the cap is binding), which we assume to be the case.

have assumed $x_p > 0$, so this requires that quantity is only weakly increasing in quality. In practice, this is expected to be the case, since quality dimensions like service reliability only minimally affect quantity,[17] while others (e.g. visual amenity or public safety of distribution assets, service staff friendliness) are unlikely to materially affect quantity for the reasons set out above.

As a consequence, taking its $\hat{p}$ as given, each regulated utility chooses its output quality q to maximize $W(\hat{p}, q; \alpha)$. Taking the first order condition with respect to q (denoting partial derivatives by subscripts as above):

$$W_q(\hat{p}, q; \alpha) = \pi_q(\hat{p}, q) + \alpha \int_{\hat{p}}^{\infty} x_q(v, q) dv \tag{4}$$

The integral in (4) is positive, given the assumed sign of x_q, meaning that $CS(\hat{p}.q)$ is increasing in q. Since $0 \leq \alpha \leq 1$ by assumption, we further have that:

$$W_q(\hat{p}, q; \alpha = 0) < W_q(\hat{p}, q; 0 < \alpha < 1) < W_q(\hat{p}, q; \alpha = 1) \tag{5}$$

In particular, since the profit-maximizing firm chooses q such that $W_q(\hat{p}, q; \alpha = 0) \equiv \pi_q(\hat{p}, q) = 0$, we have:

$$0 < W_q(\hat{p}, q; 0 < \alpha < 1) < W_q(\hat{p}, q; \alpha = 1) \tag{6}$$

Assuming $\pi(\hat{p}, q)$ and $W(\hat{p}, q; \alpha)$ are each concave in q,[18] this implies that a profit-maximizing, investor-owned utility will choose a lower quality than that chosen by a municipal firm, which in turn chooses a lower quality than that chosen by a customer-owned utility, as the objective functions of the latter two ownership types are increasing in quality at the point where the investor-owned firms profits are stationary with respect to quality. This is illustrated in Figure 2.

Denoting $W(\hat{p}, q; \alpha = 0)$ as W_{IO}, an investor-owned utility chooses q_{IO} to maximize profits W_{IO}, as represented by the red curve in the figure. Conversely, since $CS(\hat{p}, q)$ is positive and increasing in q, and denoting $W(\hat{p}, q; \alpha = 1)$ as W_{CO}, a customer-owned utility chooses q_{CO} to maximize W_{CO}, represented by the green curve in the figure. A municipality-owned utility is an intermediate case, with

[17] Data are provided in Section 4 on the hours per year of outages, which range from less than one hour to less than three hours per year on average across different DNSP ownership types. Hence increasing quality by reducing outages will minimally increase quantity consumer over a year, while it could materially reduce the perceived inconvenience of outages.

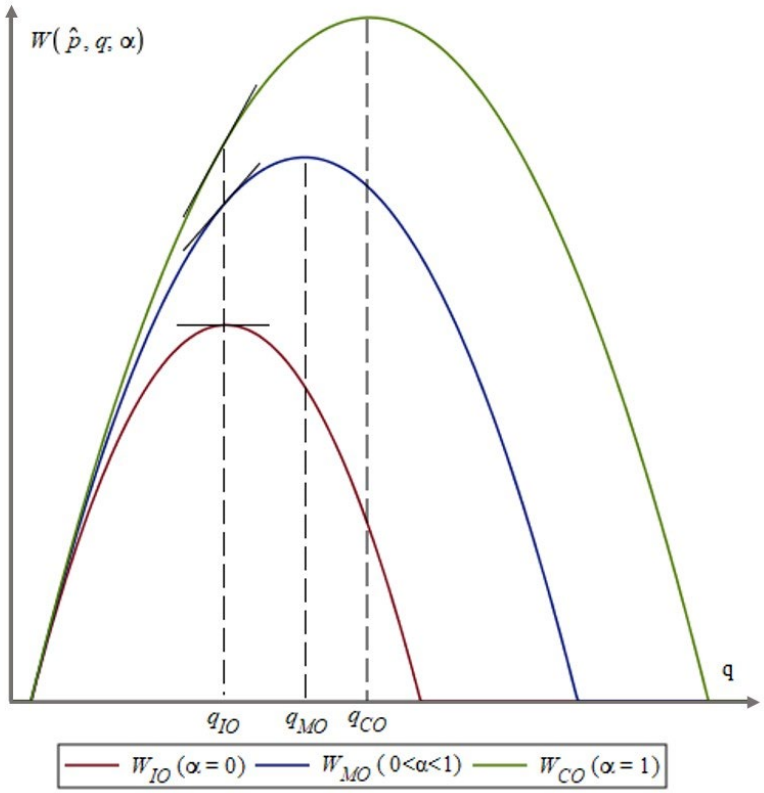
[18] The latter requires that $CS(\hat{p}, q)$ is not so strongly increasing in q that it dominates the assumed concavity of $\pi(\hat{p}, q)$.

$W(\hat{p}, q; 0 < \alpha < 1)$ denoted W_{MO} lying between W_{IO} and W_{CO}, thus optimally choosing quality level q_{MO}, with $q_{IO} < q_{MO} < q_{CO}$ as illustrated.

Since this result applies for a given regulated price $\hat{p}$ applying across all firm ownership types for otherwise comparable firms, this means that:

$$\frac{q_{IO}}{\hat{p}} < \frac{q_{MO}}{\hat{p}} < \frac{q_{CO}}{\hat{p}} \tag{7}$$

Figure 2: Optimal Quality Choices of Investor-, Municipal-, and Customer-Owned Utilities Facing Common Regulated Price $\hat{p}$



Taking these quality-price ratios to represent value for money, this implies that customer-owned firms should be expected to provide their customers with the greatest value for money, with value for money lowest for otherwise comparable investor-owned firms, and intermediate for municipal firms.

While Spence (1975) does not formally analyze quality provision under different ownership types, the analysis above shows how Spence's setup can be re-framed to encompass the three ownership types of interest. Conversely, Meade (2014) specifically models the quality – and efficiency – choices made by regulated monopolies under both investor and customer ownership, making similar predictions as here.

In that setup, the monopoly utility faces a price set by a regulator that cares about both efficiency

and quality. The firm has a risk-averse manager who can make non-contractible choices over cost-reducing and quality- enhancing efforts under uncertainty. Confronted with such a multi-tasking moral hazard problem, the firm's owners choose the manager's incentive power (i.e. profit share) to induce their desired mix of efficiency (which enhances profits) and quality (which is costly to achieve).

Meade derives conditions under which customer owners optimally choose a lower incentive power for the manager than that chosen by investor owners. This is because customer owners are assumed to inherently value quality, whereas investor owners are assumed to only care about profits. As such, customer owners choose a lower incentive power to avoid inducing the manager to unduly pursue profits at the expense of quality.

Under these conditions, Corollary 1 of Meade (2014) shows that for a given regulated price, expected quality is higher for a customer-owned firm than in an otherwise identical investor-owned firm. As in Spence (1975) and its extension above, this implies a higher quality-price ratio for a customer-owned firm than for an otherwise identical investor-owned one. Once again, interpreting the quality-price ratio as value for money, this implies higher value for money under customer ownership, but in a richer setting.

4 Data

We performed a large-scale interview study in which network customers were asked to assess how much VFM they perceived that they obtained from their DNSP. VFM can be thought of as the relationship between the total economic value received by a consumer, and the cost of obtaining that value, which we defined above in terms of the ratio of quality to (average) regulated price. Total value is a function of all relevant quality attributes, which in practice could be difficult to define and measure. Instead, we use VFM as a composite measure of the utility or welfare received by the customers. If customers of one DNSP report a higher VFM than those of another we can conclude that the former customers enjoy higher utility, without going into detail as to how that is achieved.

A total of 604 interviews were conducted and distributed across the ownership categories according to Table 1. The approximately 150 individuals who responded within each category have been selected at random using a national telephone directory as a base. The group with municipally owned networks is more heterogeneous than other groups of owners, so we also separately examine 'small municipal networks' and 'large municipal networks'. In addition, we compile and analyze customers qualitative feedback to better understand the underlying drivers behind value for money.

The phone register contains mobile phone numbers only. When the person being called answered, the interviewer asked if he/she was of legal age (above 18 years old) and is the person who has signed the contract with the electricity DNSP and/or if s/he regularly contributes to paying the electricity network cost. If the person answered 'yes' to those questions, the rest of the questions are asked, otherwise the interview was ended.

Table 1: Number of respondents per ownership category

Ownership category	Number of respondents
Municipal	153
Customer	150
Investor	151
State	150

Interviews were conducted over 18 January to 17 February 2023. During that period, the wholesale electricity price was approximately twice as high as it was during 2018-2020, but at the same level as it was during 2021-2022 (except for a few short price peaks). The electricity spot market was subjected to relatively intensive media coverage before and during the data collection period, so we assume that respondents were better informed during this period than prior to 2021. At the same time, the period is short enough for the production and distribution conditions, and the respondents' perceptions of electricity as a service, not to have changed in a material way within the period.

Since VFM is a function of the price customers pay for their connection and the quality attributes for which they have a willingness to pay, we begin by looking at how the actual price and a broad set of quality perceptions vary across ownership categories. Prices were collected from Ei, using the prices charged by each DNSP on 1 January 2023. Quality perceptions were collected in our survey. All quality attributes were measured on a 5-point scale where '5' represents the highest perceived quality. Results are summarized in Table 2.

The first column shows the average annual price in SEK for a customer with a 20A connection who consumes 20,000 kWh electricity per year. As indicated, there are large differences across categories. DNSPs owned by the state or by investors set prices that are relatively similar – the state's price is only 2 percent lower. The customer-owned DNSPs set a price 7 percent lower than the investor-owned firms. Finally, the DNSPs owned by the municipalities set a price that is more than 20 percent lower.

On the quality attributes, customer- and municipality-owned DNSPs have the highest scores, with the customer-owned firms rating highest in every attribute except one. The attribute that stands out the most is how the firms resolve customer complaints, where the municipal and customer-owned DNSPs

score substantially higher. The investor- and state-owned DNSPs are almost identical, with their customers' ability to understand the invoices being the only attribute that is noticeably different, which may potentially set them apart.

Table 2: Price and quality attributes

Ownership category	Annual price (SEK)	Satisfaction with staff	Service reliability	Invoice easy to understand	Complaint resolution
Municipal	7,684	4.42	4.77	4.17	4.00
Customer	8,981	4.51	4.73	4.26	4.20
Investor	9,649	3.92	4.57	4.12	2.11
State	9,424	3.93	4.52	3.91	2.14

Notes: Price data comes from the Swedish Energy Markets Inspectorate. Prices represent what a customer with a 20A connection who consumes 20,000 kWh per year is charged. Quality attributes are measured on a 5-point scale where '5' is the highest. 'Satisfaction with staff' is a composite measure that is calculated as the average of (i) Staff Accessibility (answer phone quickly, punctual), (ii) Attitude (kindness, empathy). (iii) Competence, (iv) Give clear response, and (v) Inform/help when outages and other problems occur (willingness to repair, response time). All quality perceptions are collected as part of this study.

Since the regulator records both actual outage frequency and average outage time at the firm level, the results about service reliability reported in Table 2 can be used to assess how well customers' perceptions reflect actual quality outcomes. Using the regulator's outage data from 2022, the association between actual and perceived reliability turns out to be strong. State owned DNSPs have the highest outage frequency and outage time, while those owned by investors have the second highest values. The municipality owned DNSPs have the fewest and shortest outages, but the differences compared to those owned by customers are small.[19]

The attribute that measures customers' level of satisfaction with the DNSP's staff members in Table 2 is a composite variable that potentially hides further heterogeneity. Hence, in Table 3 we show customers' perception of each of those attributes, which comprise:

- Accessibility (how quickly they answer the phone, how punctual they are to appointments etc.);
- Attitude (degree of kindness, empathy, etc.);

[19] Actual outage frequency in 2022: Municipal (0.79); Customer (0.88); Investor (1.32); State (1.88). Actual outage time in 2022: Municipal (46 min); Customer (54 min); Investor (117 min); State (148 min).

- Competence (how well they do their job);
- Understanding (to what extent they give clear responses to questions); and
- Inform/help when outages and other problems occur (willingness to repair and the speed with which they respond).

The results show that there are differences across these attributes. For example, when comparing investor- and state-owned DNSPs, it is not clear which of the two is better in the eyes of the customers, since state-owned DNSPs have higher scores for three of the five attributes. However, the customer-owned DNSPs have higher scores than the municipality-owned DNSPs on every attribute, except on 'Competence', where they have the same score. The average, absolute correlation across the quality attributes in Tables 2 and 3 is 0.36.

Table 3: Staff characteristics

Ownership category	Accessibility	Attitude	Competence	Clear response	Info/help when problem occur
Municipal	4.27	4.58	4.55	4.51	4.20
Customer	4.56	4.60	4.55	4.57	4.29
Investor	3.66	3.90	4.00	3.94	4.10
State	3.43	4.10	4.11	4.11	3.91

Notes. All quality attributes are measured on a 5-point scale where '5' is the highest.

5 Analysis

5.1 Value for money

One of the questions asked in the interview was 'How much value for money do you think you get from your DNSP?'. Respondents indicated an answer on an ordinal scale from 'very low value' to 'very high value'. They could also answer 'don't know', or choose not to answer at all. Those who gave a response that could not be placed on the five-point scale were excluded from the subsequent analysis. The respondents' answers were recoded into numbers where 1 corresponds to 'very low value' and 5 to 'very high value'. This information allowed us to calculate the average VFM for each ownership category. The results of these calculations are presented in Table 4.

Table 4 shows that networks owned by municipalities and customers deliver higher VFM than networks owned by the state or investors. For investor- vs. municipality/customer-owned, it is almost a one-unit difference on the 5-point scale, while for state- vs municipality/customer-owned, the difference is slightly less. It is notable that respondents on either large or small municipal networks had identical values.

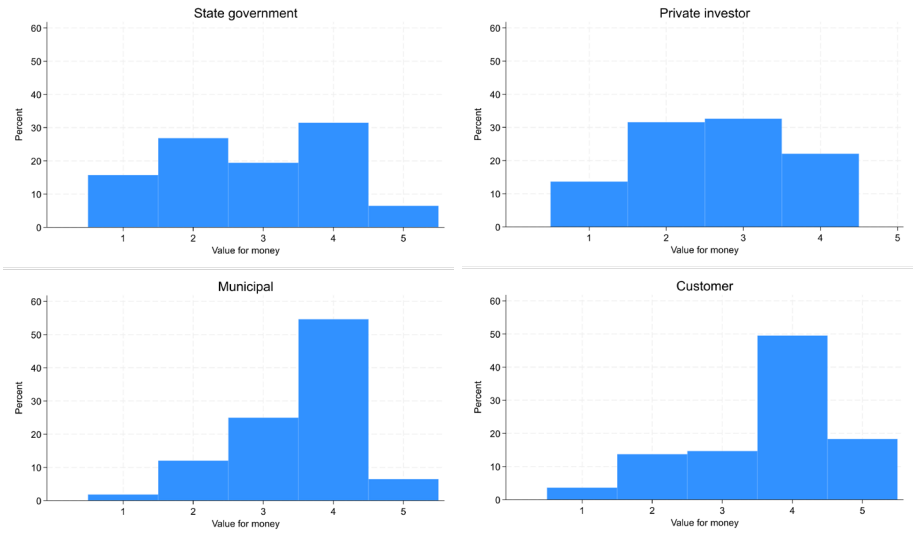
Table 4: Value for money

Ownership category	Value for money
Municipal	3.52
Municipal, large (>20,500 customers)	3.52
Municipal, small (< 20,500 customers)	3.52
Customer	3.65
Investor	2.63
State	2.86

No. of respondents 420. Of the 604 interviews, 420 gave a response that generated a value on the 5-point scale. The threshold between a small and large municipal network is 20,500 customers. This makes the two groups as equal in size as possible (76 and 77, respectively).

We now turn to the distribution of the responses for each ownership category. Figure 3 shows that the values are relatively uniformly distributed when customers have networks owned by the state or investors. Incidentally, it is noteworthy that no respondents on investor-owned networks the rating '5' (Figure 3, upper right). Respondents on networks owned by municipalities or customers were more positive overall, with approximately 50 percent of respondents giving the rating '4', and for the customer-owned networks almost 20 percent gave the rating '5'. Fewer than 5 percent of the respondents from these two ownership categories gave the rating '1'.

Figure 3: Distribution of value-for-money responses by ownership type



5.2 Isolating potential differences in the customers

The analysis above indicates that networks owned by municipalities and customers deliver higher VFM. However, a key possible objection is that the sample is not random. Municipal and customer-owned networks, which dominate in more rural areas, tend to have customers with different preferences and socio-economic characteristics – perhaps these customers tend to give higher VFM ratings?

To reduce this selection problem, we focus on those individuals who have recently moved and who previously had a DNSP with a different owner than their current DNSP. Since the customer who moved likely did not do that to obtain a DNSP with a different/particular owner, the resulting change in ownership acts as a proxy for a random allocation mechanism. Thus, this approach eliminates two types of respondents:

- Those who had the same DNSP throughout their life (e.g. those who have always lived at the same address, and those who have moved within a DNSP's concession area); and
- Those who moved and contracted with a new DNSP, but the new DNSP was owned by the same type of owner as their previous one (e.g. those who moved from a location with a DNSP owned by a municipal to a location with DNSP owned by a different municipal).

The results from eliminating these respondents are presented in Table 5. All the values in Table 5 are lower than the corresponding values in Table 4 – the value for private investors only marginally though. There is now a distinctive difference between small and large DNSPs owned by municipalities, suggesting that small DNSPs owned by municipalities and DNSPs owned by customers are very similar. However, the overall conclusion remains unchanged, namely that DNSPs owned by municipalities and customers deliver higher VFM than DNSPs owned by investors of those owned by the state.

However, for ownership to be considered random, two more criteria must be met. First, respondents must have access to all relevant information about distribution quality and price, and this can be assumed to take at least a year as price change cycles and weather variations vary by calendar year. Thus, it is relevant to restrict the respondents to those who have been with their current DNSP for at least one year.

Table 5: Value for money when respondents have had two networks with different types of owners

Ownership category	Value for money
Municipal	3.26
Municipal, large (>20,500 customers)	3.04
Municipal, small (< 20,500 customers)	3.42
Customer	3.44
Investor	2.57
State	2.63

Number of respondents 112.

The second criterion is that the respondents are not influenced by factors other than actual conditions. After a long time as a customer of a specific DNSP, it may be that a customer recalls historical events, and those events influence the customer's perception today (even if conditions have changed). A closely-related phenomenon is that customers develop habits and sluggish perceptions that do not adequately reflect current conditions. It is also possible that customers are exposed to rumors (i.e. shared purported negative experiences of their peer groups), and the likelihood of being affected by other people's perceptions of the DNSP will increases the longer the customer lives in a given location. Thus, it is also relevant to exclude those respondents who have been with the current DNSP for a long period of time.

The time the respondents have been with their current DNSP varies – here we set the minimum time to two years.[20] We then extend the time period by one year at a time to see if more experience with a specific owner changes perceived VFM. These results are displayed in Table 6.

The results in Table 6 are based on only a limited number of respondents, so should be treated as indicative. They suggest that respondents with customer-owned networks consistently report greater VFM than respondents in the other categories. Conversely, DNSPs owned by municipalities have high values for the first three years, but drop sharply after that. Customers with a DNSP owned by a municipality have the lowest values of all categories when they have been with their DNSP for four to five years. Restricting the time to three years, however, the value is higher than when the owners are either investors, or the state.

We note that the perceived VFM drops during the initial years for all owner types – for some types it drops during the first three years and for others during the first five years. A possible explanation for this increasing dissatisfaction is that several of the distribution service's broad set of quality attributes are not immediately observable and that the value customers receive declines as more attributes are 'discovered'.

[20] Our small sample size prevents us from investigating shorter times.

Table 6. Value for money when respondents have had two DNSPs with different types of owners

Ownership category	Time with new owner			
	< 2 yrs	< 3 yrs	< 4 yrs	< 5 yrs
Municipal	2.72	2.02	1.97	
Customer	3.81	3.21	2.83	2.99
Investors	2.47	2.11	2.26	2.02
State	2.65	2.03	2.37	2.72
# of respondents	7	11	16	19

5.3 Qualitative feedback about value for money

A compilation of respondents' qualitative responses shows, firstly, that about a third of the respondents in each ownership category have left one or several qualitative comments in addition to their 'value for money' assessment. Thus, there are no differences in how engaging the respondents are as a function of who owns their network. The following differences in their responses are particularly relevant to note:

- 13 percent of those with a customer-owned DNSP explicitly emphasized the value, or value for money, they received, while only 6-8 percent of customers of DNSPs with the other types of owners mentioned that. By far the most common comment was how the respondents' own DNSP was performing compared to other DNSPs. One third of customers highlighted such comparisons, except those who had a state-owned DNSP, for which only 25 percent mentioned such comparisons. If it is the case that the comparative competition that customers engage in is reduced when the state is the owner, then that has implications for economic outcomes.[21]
- A quarter of the customers with a municipality-owned DNSP excused or explained their low VFM report with reference to temporarily high electricity prices.[22] This suggests that customers with municipality-owned DNSPs are more alert to short-term price movements, while customers on DNSPs with different ownership types take a more long-term perspective and (partially) ignore the fact that electricity prices are temporarily high and contribute to higher network prices.

[21] Bonev et al. (2022) show that the price charged by Swedish district heating firms are affected by the price charged by their neighbors.

[22] Network charges partly depend on wholesale electricity prices due to DNSPs needing to pay for network losses.

- There is a difference in how much respondents think their DNSPs contribute to the local economy and community. Just over 15 percent of customers with customer-owned DNSPs highlighted the local contribution in positive terms, while none of the customers of DNSPs with other ownership types mentioned that aspect. It was unexpected that customers of DNSPs with (small) municipal owners did not bring this up.

In summary, customers' comments varied based on ownership. The customer-owned DNSPs distinguished themselves by emphasizing the quality of the distribution service, and the network's contribution to the local community. Both these claims are economically relevant and it is therefore not surprising that the VFM reported by respondents who have customer-owned DNSPs is higher than for those with other owners. The relatively low VFM for large municipal networks stands out. It may be worth investigating whether the municipal DNSPs have used temporarily high electricity prices as an excuse to raise their network price, and whether it has happened there to a greater extent than with other networks. That state-owned networks are not clearly providing more VFM than those owned by private investors is also unexpected.

6 Conclusions

In many jurisdictions customer (or municipality) ownership is considered to be an alternative solution to the problems posed by local monopoly network utilities. Provided customers can be effectively represented in the governance of the utility, and provided the costs of collective decision-making are not too severe, a customer-owned entity can in principle protect customers from the threat of market power, while ensuring that the regulated firm delivers the service quantity and quality that customers desire.

While this is accepted in many countries, with customer-owned utilities exempt from price(-quality) regulation, in others like Sweden, as in other Scandinavian countries, the regulatory framework is 'blind' to ownership. This may make sense in a context in which firms are required (by law, or by convention) to operate in a similar manner to investor-owned firms. But it is not clear that this is necessary or appropriate in the context of customer-owned firms which are responsive to the preferences of their customers.

This paper reports the results of a telephone survey of customers of DNSPs in Sweden, which firms vary by ownership type. Consistent with our theoretical predictions, our survey-based analysis shows that DNSPs owned directly by customers are perceived by those customers to provide higher VFM than DNSPs owned by the local municipality, state-owned DNSPs, or investor-owned DNSPs. Importantly, this potentially challenges the efficacy of Sweden's (and other Scandinavian countries') uniform DNSP regulation, which in principle might be expected to result in more comparable VFM perceptions across DNSPs of different ownership types (controlling for DNSP and customer characteristics, and over time).

More generally, these observations raise the question whether the regulatory framework could be relaxed or eliminated in the case of customer-owned firms. One way to do that, as New Zealand did in 2009, is to largely exempt customer-owned networks from the regulatory framework (Meade and Söderberg (2020)). The results in this study indicate that such a policy might be warranted for networks owned directly by customers (and possibly also those owned by small municipalities). We leave it to future work to demonstrate that such an approach is appropriate, or what alternative form of regulation might instead be warranted.

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