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Private Ownership and Pricing: Evidence from the Swedish District Heating Sector

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Abstract

I examine the pricing behavior of municipal and private firms in the unregulated Swedish district heating market, characterized by geographically bounded local monopoly networks. Conditional on exogenous cost factors, private firms charge on average seven percent higher prices compared to their municipal counterparts. Nearly all firms employ two-part pricing. Consistent with standard monopoly theory, the entire price difference can be explained by the fixed price component. Further, foreign-owned private firms charge an additional price premium relative to domestically owned private firms. A descriptive analysis of financial statements confirms that private firms achieve higher profit margins, despite municipal firms being legally required to operate in a business-like manner. These findings demonstrate that, in this market, private firms exercise more market power than public firms, and that the subsequent upward pressure on prices dominates any downward effects from the potential cost efficiencies associated with privatization.

Keywords: Privatization; two-part pricing; district heating; natural monopoly; market power; network industries

JEL: L12; L43; P18; L97; Q48

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1 Introduction

District heating plays a vital role in the Swedish energy system, accounting for more than half of the total heating demand. Moreover, the majority of the fuel is derived from renewable or recycled sources such as biofuels, waste, and excess heat. At the same time, the market is characterized by geographically bounded local monopolies without price regulation, and many networks are privately owned. The only competition is indirect, through electricity-based heating (gas heating is non-existent in Sweden). Since district heating is in most locations more cost-efficient, electricity based alternatives impose a weak competitive constraint, creating incentives for district heating firms to exercise market power. Several of the firms, especially the private ones, also openly employ strategies that calibrate prices so that consumers' heating costs become just below the cost of electricity based heating. This pricing strategy is commonly known as "alternative pricing" or "market based" pricing. By contrast, surveys show that a majority of municipalities instead employ cost based pricing schemes, aimed at earning a "fair" rate of return on invested capital.

In this study, I analyze the association between ownership and pricing using a unique dataset on prices and technical characteristics of all Swedish district heating networks, covering the years 2012–2023. The main data set has been collected by the Energy Markets Inspectorate (Ei), using units of observation that are more spatially granular than what could be captured using firm level data. Because most networks were privatized more than twenty years ago, during a period from which detailed pricing data is unavailable, I estimate the association using pooled cross-sectional regressions rather than a difference-in-differences (DID) estimator. The main identification challenge therefore stems from unobserved, time-invariant confounders that may be correlated with ownership. To mitigate this potential bias, my main specification includes spatial fixed effects by county, thereby controlling for any unobserved county-level heterogeneity. Since most counties include networks from both ownertypes, in main specification, identification still comes from 85 percent of all networks.

I show that, across consumer categories, the total heating cost for a representative consumer in privately owned networks is on average 7 percent (0.05 $/KWh) higher than in municipally owned networks. For a typical single-family household this corresponds to approximately $ 100 per year, or $ 100 million if multiplied by the aggregate turnover of all private firms. The price difference is precisely estimated across model specifications, and robustness tests using propensity score matching confirm the main findings. Additionally, there are indications that the price difference has increased over time, although the trend itself is imprecisely estimated.

Nearly all firms employ two-part tariffs, consisting of a fixed annual fee and a unit price per kWh. In a standard monopoly setting, a profit-maximizing firm will set the unit price equal to marginal cost and extract consumer surplus through the fixed fee [insert reference here]. In the present context, this implies calibrating the fee so that consumers become almost indifferent to switching to electricity-based heating. Consistent with monopoly theory, I find that the entire observed price difference can be explained by the fixed fee. Since fixed fees represent a smaller share of overall heating costs for most consumers, the mean price premium for the fixed fee only is 35 percent.

Analyzing heterogeneity across consumer types, I find that the relative price premium for single-family stand-alone houses is lower than that for multi-family dwellings and commercial customers. This pattern aligns with expectations, as electricity-based heating is typically more competitive for smaller houses, making them more price-sensitive and thereby less likely to choose electricity based heating. Moreover, I find that foreign ownership entails an additional price premium compared to Swedish-owned private firms. The magnitude is similar to the private-public differential, although less precisely estimated.

In terms of welfare, the main theoretical benefit of privatization is strengthened incentives to reduce costs, thus also lowering consumer prices (Shleifer, 1985). The main disadvantage is instead incentives to exercise market power, creating allocative distortions and having an upward effect on prices. In the current setup I can only observe the aggregate effect on prices, while a complete welfare analysis would require a more sophisticated analysis. However, given that firm behavior is in line with monopoly theory on two-part pricing and consumers are approximately homogenous within pricing categories, I can make conjectures related to both welfare effects: First, since unit prices are invariant to ownership, so should marginal costs, questioning the presence of cost savings resulting from privatization. Second, if firms are able to capture all consumer surplus using the fixed fee, allocative distortions are avoided. Hence, in the present context, the distribution of welfare between producers and consumers is likely a more prominent effect of privatization than any actual welfare effects.

As a complement to the econometric analysis I also examine firm-level financial statements. A majority of the firms, especially the private ones, own networks in different locations, which means that technical characteristics cannot be meaningfully aggregated at the firm level. Therefore, data from the financial statements should not be interpreted causally. However, consistent with the results from the econometric analysis, the accounted net profit margins of private firms exceed those of municipal firms by about 0.05 $/KWh (averaging 20 percent compared to 10 percent for municipality owned firms). Further, balance sheet data show no statistically significant association between ownership and debt ratios, suggesting that differences in pricing structures cannot be attributed to differences in capital structures.

Several prior studies have analyzed pricing in the Swedish district heating market, including the role of ownership. The only previous study to distinguish between fixed and unit price components is Egüez (2021), which uses data from 2012–2017. However, that study does not investigate temporal price trends, spatially correlated unobserved heterogeneity, or the role of foreign ownership. Nor does it examine financial statements. Another recent study of pricing in the Swedish district heating market is Hellström (2021), also finding that private firms charge higher prices than municipal firms, using data between between 2009-2019.

Other relevant studies include Åberg et al. (2016), who used a survey sent to 120 district heating firms (84 municipal and 17 private), of which 62 percent of the public firms but only 11 percent of the private firms reported using cost-based pricing models. The remaining firms used pricing models that generally incorporated consumers' alternative costs as a factor. Colnerud Granström (2011) analyzes data from 2009 and, although not focused on ownership structure, finds some evidence supporting higher prices in private firms.

A number of studies offer more nuanced econometric analyses of pricing strategies. Söderberg (2020) finds that firms with combined heat and power plants charge higher prices, as the extra investment costs are passed on to consumers. Bonev et al. (2022) investigate whether prices of nearby competitors affect pricing behavior. They find that the effect is present for private firms but not for municipal ones, suggesting that private firms may follow an informal norm of "price fairness" by benchmarking against neighbors. Biggar and Söderberg (2020) analyze price stability (rather than levels) and find that prices are more stable in left-leaning municipalities for both private and public firms. Finally, Bonev et al. (2020) study whether customer complaints to the District Heating Board, a mediation body under the Swedish Energy Agency, affect pricing behavior. Using an instrumental variables approach exploiting exogenous variation in complaints due to unexpected outages, they show that an additional complaint leads to a relative price decrease of 0.69 percent the following year.

2 The Swedish District Heating Sector

2.1 Technical Structure of District Heating Networks

District heating systems consist of a central facility for heat production. The most common heating technology is combustion. Some plants also have turbines installed adjacent to the combustion chamber to produce electrical power, i.e., combined heat and power. The use of industrial waste heat to complement existing heating plants is also common, and some facilities also employ electricity based heat pumps.

The heated water is then distributed through a network of pipes to end-users. District heating is primarily used for space heating and hot tap water in buildings. In buildings that rely on district heating for space heating, a heat exchanger is installed to transfer heat from the district heating water to the building's internal heating system. The cooled water is then returned to the production facility to be reheated (Ei, 2024).

In residential multi-family buildings, district heating accounts for 90 percent of total energy use for space heating, while the corresponding figure for commercial premises is about 80 percent. For single-family homes, electricity-based heating still remains the most common form of heating (Swedish Energy Agency, 2023).

The fuel mix primarily consists of biofuels, complemented by waste and fuel oils. Since nearly all district heating networks were initially developed under municipal ownership, municipal boundaries still often define the limits of the networks, although there is some trade across municipalities.

2.2 Ownership Structure

Until 1996, virtually all district heating operations in Sweden were municipally owned. Pricing was regulated by a cost-of-service principle, prohibiting the generation of profits. However, there was no regulatory authority overseeing the sector, nor was there any systematic collection of technical or financial data from the utilities. The deregulation of the electricity and district heating markets in 1996 introduced free pricing and also led to a gradual privatization process. The most active period occurred between 1996 and 2005, during which 56 municipal district heating networks were sold (Magnusson, 2015).

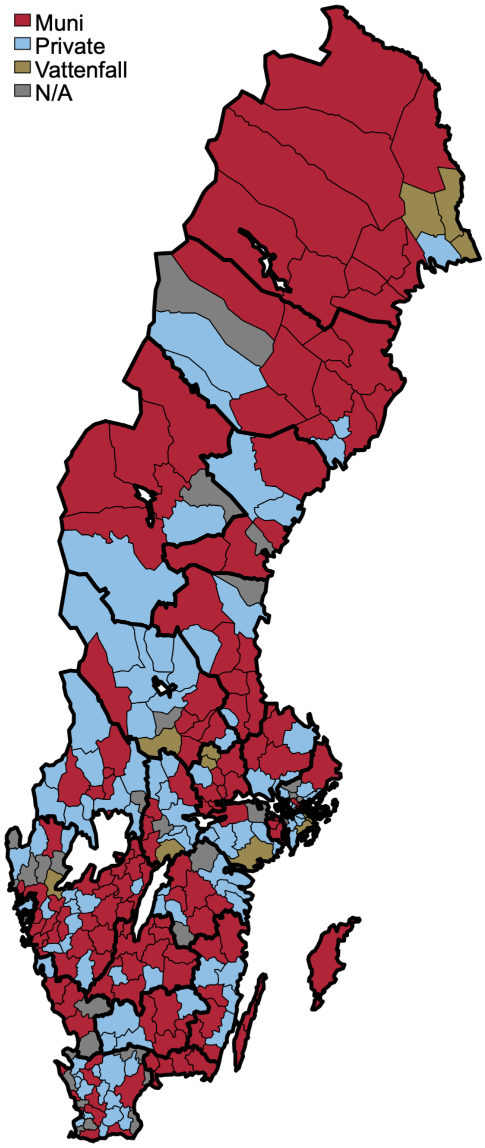
Today, all municipally owned district heating networks are organized as corporate entities. They are required to operate on a "commercial basis" and contribute with dividends to the municipal budget. However, they are not permitted to receive municipal funding other than equity, to ensure that municipal firms are not granted competitive advantages over private firms. For a more detailed discussion of what constitutes a "commercial basis," see Bürger et al. (2013).

Currently, 275 of Sweden's 290 municipalities have access to district heating, an increase of 15 municipalities over the past decade. As of 2023, there were just over 160 district heating firms, of which approximately 20 percent (33 firms) had a majority share of private ownership. When accounting for the fact that several of these firms share the same parent firm, the figure drops to 20. Privately owned firms represent about 35 percent of the total market turnover. Among these private firms, 15 have a majority of foreign ownership; this number declines to six when considering parent firms.

The largest foreign actors are Solör, Adven, and E.ON. Solör is 60 percent owned by Nordic Infrastructure AG, a Switzerland-based firm with primarily Norwegian owners. The remaining 40 percent is owned by Swedish national pension funds (AP-fonderna). Adven is owned by international institutional investors through J.P. Morgan Asset Management. E.ON, headquartered in Germany and publicly listed, is one of the world's largest energy firms.

Two percent of the firms are owned by economic associations, and in eight municipalities networks are owned by the state-owned utility Vattenfall. Since this study focuses on price differences between private and municipal firms, Vattenfall is excluded from the analysis. Figure 1 presents a map of the ownership structure in the market as of 2023 (economic associations are here

Figure 1: Geographic dispersion of ownership in 2023



Note: District heating ownership in 2023, by municipality. Thick black lines are county borders. If one municipality hosts several networks, the map displays ownership for the network with the largest production.

classified as private entities), by municipality. Thick black lines show county borders. No GIS-coded data exist on specific networks, other than information about the municipality a network is located in. If there are several networks in a municipality, the map displays ownership for the network with the largest production.

2.3 Legal framework

The main legal framework for the district heating sector is the District Heating Act. It was introduced in 2008, primarily aimed at improving transparency in pricing in the district heating market. This is achieved in part through mandatory reporting of standardized templates containing economic and technical information to Ei. The data reported under this framework form a basis for the analyses presented in this report. The law also grants customers the right to request mediation with their district heating provider, and to get information on the firms' pricing models. Mediation is handled by the District Heating Board (Fjärrvärmenämnden), a unit under the Swedish Energy Agency. The purpose of the mediation process is to facilitate agreement between the parties on contract terms and to provide customers with insight into the factors that influence these terms. However, the Board does not issue binding decisions, nor does it assess the reasonableness of the price itself.

The District Heating Act obliges district heating utilities to permit third-party access to their networks, provided that such access does not cause harm to the utility (Section 37 of the District Heating Act). This regulatory provision enables external actors to inject heat into existing systems, for example through the use of industrial excess heat. Compensation to third-party suppliers should reflect the value that their heat contributes to the utility.

In 2013, the Price Dialogue platform (www.prisdialogen.se) was launched as a joint initiative by a number of property owners and the Swedish District Heating Association, the umbrella organization for district heating firms. It was established as a private initiative to facilitate compliance with the price transparency stipulated by the District Heating Act. As of 2023, the Price Dialogue includes around 50 member firms, representing a combined market share of 70 percent. Member firms commit to notifying customers in advance about the following year's prices and providing a forecast for the subsequent two years. A majority of the pricing models listed are cost-based, aiming at gaining a reasonable return on equity. Some firms, particularly those privately owned, have shifted toward the so-called "alternative cost pricing" models discussed in the introduction. These models usually contain parameters than estimates of the cost of electricity-based heating, for example the price of long term electricity contracts. Additional parameters are usually also added to the model that do not explicitly relate to the cost of electricity based heating. Especially, price stability is often listed as a central component of the pricing model. Therefore, short term fluctuations in interest rates (reflecting the capital cost for installing heat pumps) or wholesale electricity prices only have minor impacts on the DH-price. It is also common that firms explicitly aim to set prices that do not diverge too much from prices in neighboring networks.

3 Descriptive statistics

Prices

Prices are collected for the fixed and unit price component respectively, for three main consumer types: single family houses, multi family houses, and commercial premises. Within each main type, prices are reported for four representative sub-types based on annual consumption profiles ranging from 15 to 40 MWh for single family houses, and from 80 to 1000 MWh for multi family houses and commercial premises. In total, this yields twelve representative consumer types.

Each price component is expressed in USD/MWh (assuming an exchange rate of 10 SEK/USD) for the consumption profile of a given sub-type. The main dependent variables are indices, computed as the arithmetic mean across all twelve sub-types. Indices are computed for both the fixed and the unit component, as well as for a combined total cost index that includes both components. Separate price indices for each main consumer type are also computed.

Descriptive statistics by owner type are presented in Table 1. Differences in means across owner types are assessed using t-tests. The first row present the total cost index. For private firms, the mean of the index is 74.9 USD/MWh, compared to 70.3 for municipalities, and the difference (4.5) is statistically significant. The following rows present the total cost by consumer type. Even if this figure is somewhat higher for single family houses compared to the other consumer types, differences are very small. Given that distribution costs in terms of infrastructure and heat losses should be significantly higher for single family houses than multi-family houses and commercial premises, this indicates that firms distribute costs relatively evenly across the entire customer base rather than differentiating prices in proportion to the cost of providing the service. Each of the total cost indices are statistically and economically higher for private firms. The next rows present the fixed fees, demonstrating that the entire difference in the total cost index is driven by this component. Subsequent rows present values for the unit price component, where all differences are economically and statistically insignificant.

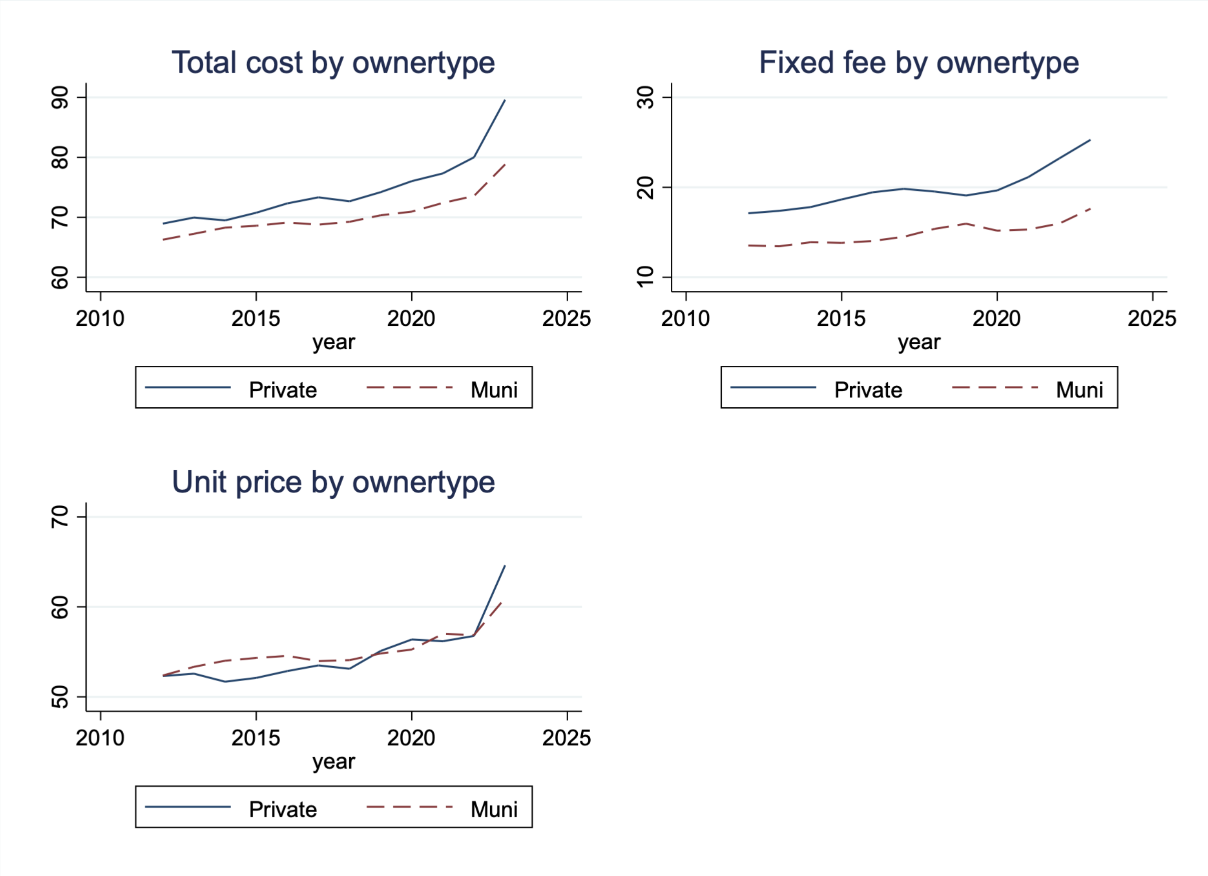
Table 1: Descriptive statistics of prices and technical characteristics

	Private		***Muni***		***Private-Muni***
	Medel	Sd	Medel	Sd	
Total cost					
Total (index)	74.9	8.5	70.3	8.3	4.5***
Total cost (single family)	75.5	7.7	71.9	8.2	3.6***
Total cost (multi family)	73.3	8.6	68.4	9.1	5.0***
Total cost (commercial)	74.7	8.7	70.7	9.3	4.0***
Fixed fee					
Fixed fee (index)	20.0	8.3	14.9	9.1	5.1***
Fixed fee (single family)	15.9	5.7	12.2	8.4	3.7***
Fixed fee (multi family)	21.0	10.3	15.1	10.6	5.8***
Fixed fee (commercial)	22.3	11.1	17.0	12.1	5.3***
Unit price					
Unit price (index)	55.0	9.0	55.2	10.5	-0.2
Unit price (single family)	59.7	7.8	59.1	11.2	0.6
Unit price (multi family)	52.6	11.0	52.9	11.9	-0.3
Unit price (commercial)	52.8	11.1	53.2	11.9	-0.4
Connection fee					
Revenue connection fee / MWh	0.6	1.3	0.6	1.1	-0.0
Customers					
Customers (single family)	289.7	751.8	566.9	1079.9	-277.2***
Customers (commercial)	31.3	58.8	47.6	91.9	-16.3***
Customers (multi family)	48.5	117.4	85.2	152.4	-36.7***
Technical characteristics					
Sold heat (GWh)	57.9	149.6	95.9	185.7	-38.1***
Network length	40.3	98.4	74.5	125.4	-34.2***
Heat (MWh) / network length	14.7	8.9	12.1	6.3	2.6***
Sold heat / customer (MWh)	28.0	29.8	18.4	19.8	9.6***
Electricity/heat unit	0.9	4.3	3.0	7.2	-2.1***
Network age (average)	23.9	8.1	22.9	5.7	1.0
Investments/MWh	8.8	31.3	6.5	19.1	2.3*
Fuel (shares)					
Bio fuel	82.8	31.0	75.3	36.1	7.4***
Oil (fossil)	3.9	12.0	5.5	17.2	-1.6**
Waste	2.6	11.9	5.4	18.5	-2.8***
Peat	0.1	1.0	0.4	1.9	-0.3***
Natural gas	0.0	0.6	0.1	0.6	-0.0
Electricity	0.4	1.9	0.7	2.8	-0.3***
Waste heat	8.5	24.4	10.2	27.0	-1.7
Observations	1281		2372		3653

* $p < .10$, ** $p < 0.05$, *** $p < 0.01$

Note: Descriptive statistics by ownership and network for the period 2012-2023. Price metrics and revenues from connection fees in USD/MWh. T-tests are used to test for differences across owner types.

Figure 2: Trends in prices by ownertype and region



Note: Trends in prices by ownertype 2012-2023 in USD/MWh. Region “North” comprises electricity price zones one and two, while region “South” comprises electricity price zones three and four.

As a complement to Table 1, Figure 2 presents three diagrams of price trends, by ownertype. The upper left diagram displays the total cost index by ownertype for all networks, revealing that this metric is higher for private firms during all sample years, and that the difference has increased over time. The greatest price increase for both private and municipal firms occurred during the last sample year (2023). The upper right diagram presents the index for the fixed price component, demonstrating that this figure has also been higher for private firms throughout the sample period. The difference was relatively stable throughout the sample period period, but increased somewhat in 2023, consistent with the trend in the total cost index. The lower diagram shows the unit price index, demonstrating that differences across ownertypes have been small throughout the sample period except for in 2023 when price increases for private firms exceeded those of municipal firms.

Several private firms employ pricing models that incorporate the cost of electricity, rendering regional electricity prices a potentially important source of exogenous variation in district heating prices. In the Swedish wholesale electricity market, the country is divided into four price zones arranged geographically from north to south. Electricity is typically exported from the northern to the southern regions, and in the presence of transmission constraints, prices tend to rise in the south. The principal transmission bottleneck lies between zones two and three, effectively segmenting Sweden into a northern region (zones one and two) and a southern region (zones three and four).

Up to 2021, electricity prices were largely uniform across these regions. However, during 2022 and 2023, prices rose markedly in both regions, with a more pronounced increase in the south. In 2024, prices declined somewhat across both regions, yet the north-south price differential persisted. While this regional disparity could, in theory, have induced a stronger increase in district heating prices in the southern zones, the nationwide surge in electricity prices was of such magnitude that a corresponding increase in district heating prices would likely have provoked substantial consumer backlash and regulatory interventions.

To visually assess the extent of regional heterogeneity in district heating prices, Figure A1 displays the total cost index disaggregated by ownership type and region. The figure demonstrates that price trends are highly similar across both ownertypes and regions, indicating that electricity price variation had limited impact on regional district heating pricing dynamics during the sample period.

Connection fees

Most district heating firms impose a one-time connection fee to grant consumers access to the network. These fees are typically determined on a case-by-case basis and reflect the cost of the specific incremental investment required to connect each new customer. However, the available data only report total annual revenues from connection fees at the network level, without any information on individual charges. As a result, it is not possible to recover the distribution or level of individual connection fees. To facilitate comparison with other price components, connection fee revenues are normalized by the total amount of heat delivered, yielding a per-MWh metric. On average, this metric amounts to 0.6 USD/MWh for both municipally and privately owned firms. The difference is neither economically nor statistically significant, and the contribution of connection fees constitutes less than 1 percent of the total cost index.

Customers

The next set of variables measures customer counts by consumer type. Municipal ownership is linked to higher values across all categories. Holding network density (customers per meter of pipeline) constant, a larger customer base should enhance economies of scale. However, this metric omits scale advantages from operating multiple, especially adjacent, networks, which is more common within private firms.

Technical Characteristics

The first two variables in this category, total volume of heat sold and network length, are also positively associated with economies of scale. Also for these variables, municipal networks exhibit higher values. The next two variables capture network "density", expressed as heat sold per meter of pipeline and heat per customer, respectively. In empirical studies of cost drivers in network industries, returns to density are often found to be even more important than economies of scale. See for example Boscan and Söderberg (2021) for an analysis of density-related cost advantages in the Danish district heating sector. By contrast to the scale-related metrics, both density measures are significantly higher in privately operated networks, suggesting a cost advantage. Unlike the scale-related variables, these measures are not directly affected by how networks are geographically delineated and should thus provide a more accurate reflection of firms' actual cost structures.

The next variable measures electricity output per unit of heat, i.e. MWh electricity / MWh heat. For municipal networks, the mean of this figure is three percent, compared to 0.9 percent for private firms. The difference is also statistically significant. A higher share of CHP production indicates both higher revenues from electricity, but also higher costs since CHP plants demand higher investments and maintenance compared to conventional heat-only plants.

The subsequent variable measures the average age of the network. These data are only available for the years 2021–2023, and is therefore excluded from the regression analysis. It is constructed from a weighted combination of several source variables indicating the share of the network built in different decades. It is not obvious how this variable should affect cost structures: newer networks tend to have higher capital costs, while older networks may have higher operating costs. For both ownership types, the average network age is around 23–24 years.

Fuel mix

The final set of variables captures the fuel mix, by expressing each fuel type as a share of the total fuel used per year. Although there are some differences across owner types, the overall mix is largely similar. Biomass is by far the dominant fuel type, accounting for 82.8 (75.3) percent in private (municipal) firms. This is followed by fossil fuel oil at 3.9 (5.5) percent, and waste at 2.6 (5.4) percent. All other fuel types constitute only a negligible share for both groups.

4 Econometric models

4.1 Main method: Regression analysis

In the regression analysis, the relationship between prices and ownership type is examined while also controlling for a set of cost-driving determinants, using a pooled cross-sectional analysis. While many relevant factors can be explicitly included as control variables, there are likely additional, unobserved variables that influence prices. To the extent that these unobserved factors are homogeneous within counties, their influence is mitigated by comparing only within-county variation through the inclusion of county fixed effects. This requires that both municipal and private networks are present within the same county in order to identify how price varies with ownership. Fortunately, about 90 percent of all networks are in counties where there is a mix of ownership, meaning that only ten percent of all observations are lost when including county fixed effects. Yearly fixed effects are also included to account for common temporal shocks. Consequently, the identifying variation in ownership type comes from within-county and within-year comparisons between municipal and private networks. Formally, the regression model is specified as:

$$P_{it} = \alpha + \beta_1 private_i + \Phi X_{it} + Z_l + M_t + \varepsilon_{it} \tag{1}$$

where P_{it} denotes the outcome variable in network i during year t. α is a constant, and β_1 is the coefficient of interest, It is associated with the indicator variable $private_i$, which equals one if the utility is privately owned and zero otherwise. X_{it} is a vector of network-specific control variables, with its corresponding coefficient vector Φ. Control variables are included in logarithmic form.

Each network i is nested within a county $l(i)$. County fixed effects are captured by Z_l, and M_t are year-specific fixed effects. The error term ε_{it} captures idiosyncratic variation not explained by the model and are assumed to be clustered within counties.

Some of the control variables exhibit strong correlations, and may in addition be affected by reverse causality. For instance, higher prices may, at least in the long run, reduce the quantity of heat sold, meaning that it is not appropriate to interpret this coefficient causally. However, this concern does not affect the interpretation of the *private*-coefficient.

4.2 Robustness: Propensity Score Matching

As a robustness check, I implement a propensity score matching (PSM) approach to assess the sensitivity of the estimated association between ownership and prices. The core idea behind PSM is to construct a matched sample in which the private and municipal networks are balanced with respect to the observed control variables. Specifically, I estimate the probability that a given network is served by a private firm, its propensity score, using a logistic regression model that includes the same network-specific control variables as in the main specification. Each private network is then matched to one municipal network based on propensity score similarity using nearest-neighbor matching with replacement (i.e., two private networks may be matched with the same municipality-owned network). By comparing prices across this matched sample, I reduce the influence of covariate imbalance and approximate a quasi-experimental setting. In the main specification I apply one-to-one matching. As a complement, I also test one-to-two matching, meaning that each private network is matched with the two municipal networks with the most similar propensity scores. I do not force private networks to be matched with municipality-owned networks within the same county, so the identifying source of variation does not necessarily come from within-county variation.

4.3 Results

4.4 Results from the regression analysis

Table 2 presents results from the main regression analysis. In columns (1)-(2) the dependent variable is the fixed fee index, and county fixed effects are added in the preferred specification (2). Columns (3)-(4) present the corresponding results for the unit price, and (5)-(6) for the total price index.

Table 2: Results from the main specification

	Fixed fee		Unit price		Total	
	(1)	(2)	(3)	(4)	(5)	(6)
Private	4.94***	4.58***	-1.09	-1.62	3.46***	2.49*
	(1.03)	(1.51)	(1.40)	(1.92)	(1.19)	(1.28)
Customers						
Customers (single family)	-0.43	-0.32	0.48	0.29	0.019	-0.041
	(0.29)	(0.26)	(0.30)	(0.27)	(0.22)	(0.25)
Customers (commercial)	0.41	0.085	-0.40	-0.47	0.093	-0.30
	(0.43)	(0.44)	(0.42)	(0.39)	(0.32)	(0.30)
Customers (multi family)	-0.45	-0.57	-0.11	0.11	-0.57	-0.46
	(0.47)	(0.46)	(0.49)	(0.51)	(0.33)	(0.32)
Technical characteristics						
Sold heat (GWh)	1.00*	1.07**	-0.51	-0.54	0.29	0.27
	(0.57)	(0.50)	(0.50)	(0.51)	(0.60)	(0.57)
Network length	-0.49	-0.15	-0.94	-1.05	-1.21**	-0.97*
	(0.73)	(0.62)	(0.67)	(0.74)	(0.54)	(0.52)
Heat (MWh) / network length	-0.16	-0.44	-1.10**	-0.71	-1.39*	-1.23*
	(0.63)	(0.58)	(0.48)	(0.47)	(0.67)	(0.65)
Sold heat / customer (MWh)	0.22	0.16	0.45	0.058	0.88*	0.53
	(0.48)	(0.46)	(0.39)	(0.44)	(0.44)	(0.44)
Electricity/heat unit	0.0044	0.0032	0.088	-0.063	-0.070	-0.15
	(0.60)	(0.60)	(0.53)	(0.49)	(0.47)	(0.49)
Fuel (shares)						
Bio fuel	-0.48	-0.53	0.68*	0.78*	0.054	0.12
	(0.30)	(0.33)	(0.37)	(0.40)	(0.18)	(0.17)
Oil (fossil)	0.59	0.24	-0.42	-0.28	0.16	-0.064
	(0.52)	(0.45)	(0.55)	(0.50)	(0.31)	(0.30)
Waste	0.77	0.50	-0.49	-0.14	0.20	0.24
	(0.45)	(0.40)	(0.36)	(0.34)	(0.36)	(0.34)
Peat	-0.52	-0.75	0.44	1.02	-0.095	0.24
	(1.16)	(0.92)	(1.08)	(1.06)	(0.49)	(0.48)
Natural gas	0.30	-0.15	-1.21	-0.42	-1.13	-0.91
	(0.91)	(0.75)	(1.17)	(0.82)	(0.73)	(0.71)
Electricity	1.39*	1.55**	-1.55*	-1.35*	0.20	0.46
	(0.76)	(0.61)	(0.74)	(0.73)	(0.56)	(0.50)
Waste heat	0.38	0.16	-0.60**	-0.53*	-0.38**	-0.54***
	(0.26)	(0.22)	(0.27)	(0.26)	(0.18)	(0.15)
N	3600	3600	3564	3564	3558	3558
County FE	No	Yes	No	Yes	No	Yes
Adj R^2	0.15	0.25	0.17	0.24	0.37	0.43

* $p < .10$, ** $p < 0.05$, *** $p < 0.01$
Note: Results from estimating eq (2). Control variables are included in logarithmic form. Outcome variables are in USD/MWh. Standard errors in parentheses, clustered by county.

When the dependent variable is the fixed fee, the coefficient on the private ownership indicator, β_1, is both economically and statistically significant at between 4.5 and 5 USD/MWh (or correspondingly about 30 percent of the fixed fee in the municipality owned networks), deviating only trivially from the raw mean difference at 5.1 USD/MWh reported in the summary statistics in Table 1.

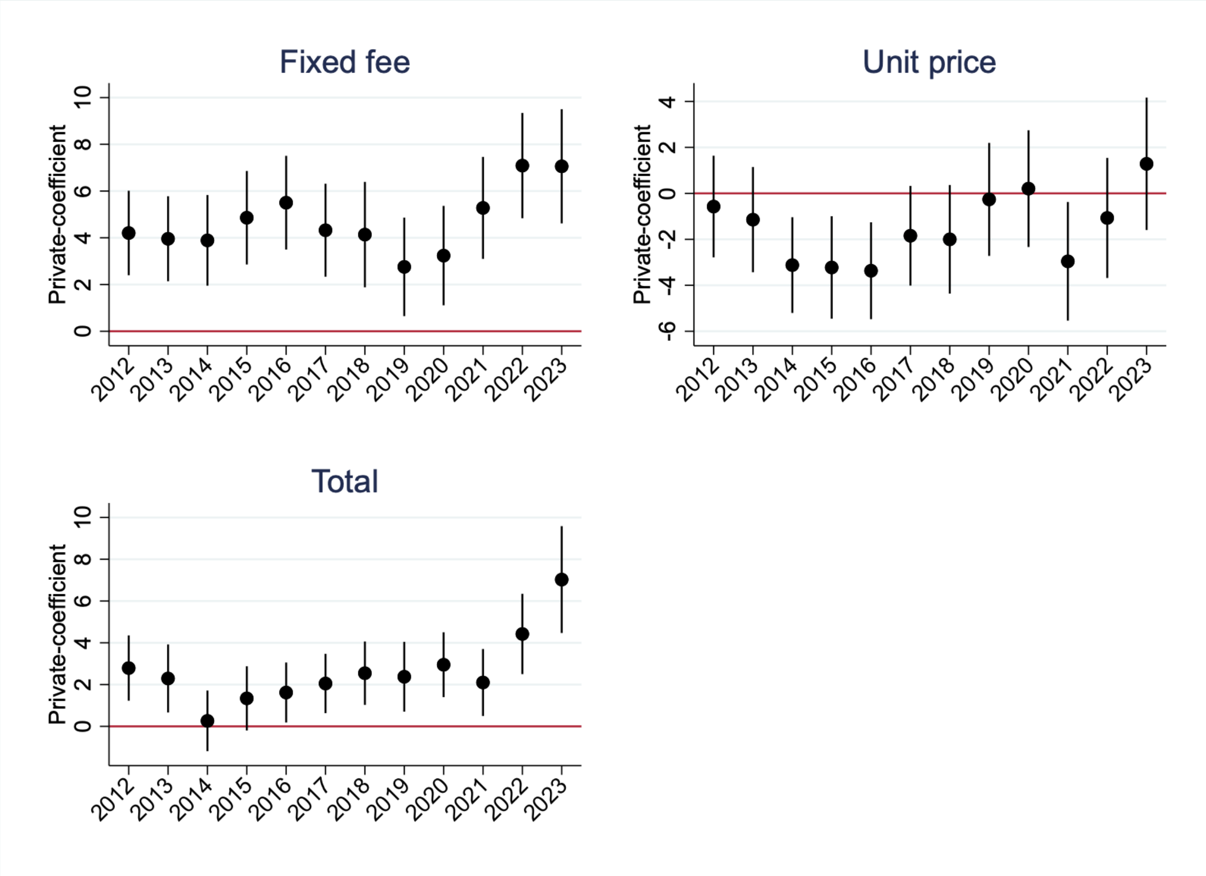
For the unit price in columns (3)–(4), the estimated coefficient is statistically insignificant, aligning with the patterns observed in the summary statistics. However, it is noteworthy that the point estimate is negative, suggesting that private firms may set lower unit prices. Assuming that firms set unit prices close to marginal costs, this may indicate that private firms also face somewhat lower marginal costs. That said, since the coefficients in both specifications lack statistical significance, they should be interpreted with great care. Further, given that the mean unit price is 55 USD/MWh, the estimated difference of –1.62 USD/MWh in column (4) represents only about 3 percent of the unit price average.

As expected, summing the estimated coefficients for the fixed and unit fees yields a total that closely approximates the private coefficients on the total price index in specifications (5) and (6). These coefficients are therefore naturally lower than those for the fixed fee alone. Nevertheless, since previous specifications demonstrate that the primary source of variation is driven by differences in the fixed fee, the coefficient associated with the fixed fee index should provide a more accurate account of the relationship between ownership type and pricing behavior than the corresponding total index coefficient.

Analysis of price developments over time

To examine how the association between ownership and prices has evolved over time, I estimate the preferred specifications (2); (4); and (6) separately for each sample year The estimated coefficients on the *private* indicator are presented graphically in Figure 3, together with 95% confidence intervals.

Figure 3: Results when estimating separate regressions for each year



Note: Results when estimating specifications (2); (4); and (6) from Table 2 separately for each sample year. Vertical lines represent 95 percent confidence intervals. Standard errors are clustered by county.

The top left figure presents results where the dependent variable is the fixed fee. The coefficient is precisely estimated for each year, and the magnitude ranges between 4 to 7 USD/MWh. Moreover, the coefficient has increased over time, with the greatest magnitude during the last two sample years. That said, this result should also be interpreted in the light of the increase in fuel prices that in fact caused profit margins to drop during the last sample years.

The top right figure presents the corresponding results for the unit price. Except during a few years, the coefficient is statistically insignificant. However, although imprecisely estimated, the coefficient is actually negative during all but two of the years, confirming the results from the pooled cross-sectional analysis.

Last, the bottom left figure presents results when the dependent variable is the total cost index. The coefficient is positive and statistically significant in all years except for 2014 and 2015, and approximately amounts to the sum of the coefficients for the unit and the fixed fee for every year.

Foreign ownership and pricing

Prior research indicates that privatizations involving foreign acquirers may induce more substantial operational changes than those involving domestic buyers. Although the precise mechanisms underlying this heterogeneity is only partially understood, several studies posit that foreign investors possess superior access to advanced technologies, broader market knowledge, external financing, and managerial expertise. These advantages may enhance their capacity to undertake significant organizational restructuring. For instance, Karpaty (2023) reports that Swedish firms acquired by foreign entities exhibit an average productivity increase of approximately 10 percent, where productivity is defined as the difference between revenues and costs. Under this definition, any price increase resulting from enhanced market power would manifest as a productivity gain.

Furthermore, analyzing Swedish privatizations of both state- and municipally owned enterprises during the period 1997–2017, Olsson and Tåg (2025) find that foreign ownership is associated with higher rates of worker displacement and larger productivity gains compared to domestic private ownership, at least conditional on the replacement of the CEO.

To examine whether pricing strategies differ systematically between foreign- and domestically-owned firms, I re-estimate the specifications reported in Table 2, incorporating an indicator variable for majority foreign ownership (defined as foreign control being at least 50 percent). Firms that underwent changes in ownership structure during the observation period are excluded from the analysis. Although only 12 percent of firms are foreign-owned, these firms are present in over 20 percent of the municipalities. Due to limited within-county variation between foreign and domestic private firms, I replace the county fixed effects with electricity price zone fixed effects. As previously noted, the four electricity price zones are approximately equal in terms of area.

Table 3: Foreign ownership and pricing

	Fixed fee		Unit price		Total	
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign owner	3.14*	2.66*	-0.76	-0.33	2.33*	2.27*
	(1.56)	(1.50)	(2.46)	(2.33)	(1.31)	(1.27)
Private	2.50	3.32*	-0.54	-1.58	1.64	1.48
	(1.49)	(1.73)	(2.42)	(2.46)	(1.51)	(1.55)
Customers						
Customers (single family)	-0.39	-0.39	0.48	0.44	0.065	0.038
	(0.31)	(0.27)	(0.30)	(0.28)	(0.21)	(0.21)
Customers (commercial)	0.33	0.25	-0.39	-0.38	0.039	-0.0085
	(0.42)	(0.40)	(0.43)	(0.38)	(0.32)	(0.32)
Customers (multi family)	-0.48	-0.49	-0.11	-0.19	-0.58	-0.66**
	(0.40)	(0.39)	(0.46)	(0.44)	(0.34)	(0.31)
Technical characteristics						
Sold heat (GWh)	0.87	0.80	-0.48	-0.31	0.18	0.23
	(0.52)	(0.47)	(0.50)	(0.51)	(0.58)	(0.53)
Network length	-0.31	0.074	-0.97	-1.29*	-1.07**	-1.00*
	(0.64)	(0.64)	(0.69)	(0.71)	(0.49)	(0.50)
Heat (MWh) / network length	-0.12	-0.33	-1.10**	-0.87	-1.35*	-1.30*
	(0.57)	(0.51)	(0.52)	(0.52)	(0.65)	(0.63)
Sold heat / customer (MWh)	0.24	0.052	0.47	0.45	0.91**	0.75*
	(0.46)	(0.43)	(0.40)	(0.42)	(0.43)	(0.42)
Electricity/heat unit	0.074	-0.024	0.067	0.19	-0.023	0.019
	(0.57)	(0.57)	(0.51)	(0.54)	(0.47)	(0.48)
Fuel type (shares)						
Bio fuel	-0.50	-0.48	0.67*	0.68*	0.038	0.062
	(0.30)	(0.29)	(0.37)	(0.36)	(0.19)	(0.19)
Oil (fossil)	0.59	0.41	-0.42	-0.24	0.16	0.13
	(0.50)	(0.47)	(0.54)	(0.51)	(0.31)	(0.29)
Waste	0.72	0.59	-0.48	-0.42	0.16	0.093
	(0.44)	(0.40)	(0.35)	(0.33)	(0.36)	(0.36)
Peat	-0.57	-0.38	0.45	0.71	-0.14	0.29
	(1.17)	(0.95)	(1.07)	(0.92)	(0.50)	(0.49)
Natural gas	0.22	-0.19	-1.17	-0.83	-1.17	-1.32*
	(0.90)	(0.84)	(1.16)	(1.04)	(0.72)	(0.74)
Electricity	1.45*	1.48**	-1.56*	-1.34*	0.25	0.42
	(0.79)	(0.70)	(0.74)	(0.76)	(0.57)	(0.50)
Waste heat	0.36	0.28	-0.61**	-0.53*	-0.41**	-0.41**
	(0.25)	(0.23)	(0.28)	(0.26)	(0.19)	(0.19)
N	3589	3589	3552	3552	3548	3548
FE El. price area	No	Yes	No	Yes	No	Yes
Adj R^2	0.15	0.19	0.17	0.19	0.37	0.38

* $p < .10$, ** $p < 0.05$, *** $p < 0.01$
Note: Results from estimating eq (2) and also including a private-foreign interaction indicator variable. Control variables are included in logarithmic form. Outcome variables are in USD/MWh. Standard error in parentheses, clustered by county.

Table 3 presents the estimation results. Columns (1) and (2) report regressions where the dependent variable is the fixed price index. The preferred specification is (2), which includes electricity price zone fixed effects. The results suggest that foreign-owned firms charge a fixed fee that is 2.66 USD/MWh higher than that of privately owned domestic firms. For comparison, the corresponding difference between municipally owned firms and the entire set of private firms is 3.32 USD (depicted in the following row). However, both coefficients are statistically significant only at the 10 percent level, and should therefore be interpreted with care.

Columns (3) and (4) examine the unit price as the dependent variable, with (4) being the preferred specification. Both coefficients are economically and statistically insignificant, suggesting that foreign ownership does not enhance any potential negative association with the unit price for privately owned networks.

In columns (5) and (6), the dependent variable is the total price index. As with the earlier specifications, coefficients approximately correspond to the sum of the coefficients for the fixed and unit prices.

Taken together, the findings indicate that foreign private ownership is associated with an additional price premium relative to domestic private ownership, which exclusively operates through higher fixed fees. However, the estimated effects are subject to greater statistical uncertainty than those reported in the main specifications, and should therefore be interpreted with care.

Heterogeneity across consumer types

While the price index employed in the main analysis reflects an average across all consumer types, it is also informative to examine how the relationship between ownership and pricing varies by consumer type. Specifically, single-family homes may exhibit greater sensitivity to elevated pricing relative to multi-family and commercial dwellings since electricity-based heating technologies such as ground source heat pumps tend to be more economically viable for single-family homes. These technologies are often infeasible in densely populated urban areas, where space constraints limit installation.

Hence, I estimate the main specification while decomposing the index into a single-family, multi-family, and commercial index respectively. Results are presented in Table 4. Since absolute price levels vary by consumer type, the dependent variables have been log transformed to enable comparisons across types.

Table 4: Heterogeneity across consumer types

	Single family		Multi family		Commercial	
	(1)	(2)	(3)	(4)	(5)	(6)
Private	0.13**	0.13**	0.48***	0.46**	0.45***	0.45**
	(0.058)	(0.059)	(0.13)	(0.16)	(0.13)	(0.17)
Customers						
Customers (single family)	-0.020	-0.0046	-0.035	-0.025*	-0.034	-0.020
	(0.013)	(0.010)	(0.023)	(0.013)	(0.025)	(0.015)
Customers (commercial)	0.025	0.00063	0.047	-0.021	0.050	-0.030
	(0.018)	(0.020)	(0.055)	(0.043)	(0.059)	(0.045)
Customers (multi family)	-0.043*	-0.029	-0.014	-0.056	-0.032	-0.071
	(0.023)	(0.020)	(0.057)	(0.052)	(0.054)	(0.049)
Technical characteristics						
Sold heat (GWh)	0.047**	0.042**	0.044	0.072*	0.055	0.083*
	(0.020)	(0.017)	(0.033)	(0.040)	(0.036)	(0.041)
Network length	-0.0024	0.0056	-0.0016	0.066	-0.0052	0.070
	(0.027)	(0.034)	(0.053)	(0.043)	(0.058)	(0.045)
Heat (MWh) / network length	0.0043	-0.028	-0.039	-0.045	-0.019	-0.039
	(0.025)	(0.027)	(0.028)	(0.041)	(0.032)	(0.044)
Sold heat / customer (MWh)	-0.0058	-0.022	0.023	0.025	0.028	0.038
	(0.017)	(0.020)	(0.050)	(0.051)	(0.054)	(0.052)
Electricity/heat unit	0.031	0.020	-0.0038	0.0036	0.0081	0.013
	(0.029)	(0.030)	(0.069)	(0.069)	(0.072)	(0.071)
Fuel (shares)						
Bio fuel	-0.00072	-0.0023	-0.044	-0.049	-0.051	-0.058
	(0.024)	(0.023)	(0.034)	(0.034)	(0.035)	(0.036)
Oil (fossil)	0.057**	0.027	0.100**	0.061	0.12**	0.067*
	(0.023)	(0.020)	(0.044)	(0.038)	(0.044)	(0.036)
Waste	0.040	0.035*	0.055	0.044*	0.049	0.044
	(0.024)	(0.019)	(0.036)	(0.025)	(0.039)	(0.026)
Peat	-0.033	-0.028	-0.15	-0.17	-0.12	-0.16
	(0.035)	(0.046)	(0.20)	(0.12)	(0.22)	(0.14)
Natural gas	-0.0055	-0.034	0.075	0.035	0.057	0.0040
	(0.10)	(0.097)	(0.14)	(0.10)	(0.14)	(0.090)
Electricity	0.022	0.020	0.076	0.076**	0.093	0.089***
	(0.040)	(0.033)	(0.059)	(0.031)	(0.063)	(0.031)
Waste heat	0.017	0.013	0.00097	-0.018	0.0037	-0.017
	(0.016)	(0.010)	(0.022)	(0.018)	(0.023)	(0.017)
N	3090	3090	3280	3280	3246	3246
County FE	No	Yes	No	Yes	No	Yes
Adj R^2	0.093	0.27	0.12	0.27	0.11	0.28

* $p < .10$, ** $p < 0.05$, *** $p < 0.01$
Note: Main estimation results from estimating eq (2) separately for each consumer type. The dependent variable is the fixed fee index. All regular variables are included in logarithmic form. Standard errors in parentheses are clustered by county.

For ease of exposition, the table only presents results for the fixed fee. Columns (1)-(2) presents results for single family houses, and the preferred specification is (2) where county fixed effects are included. Corresponding results for multi family houses and businesses are presented in columns (3)-(4) and (5)-(6). The *private*-coefficient in column (2) is precisely estimated and 0.13, indicating that, for single family houses, the fixed fee in privately owned networks is 13 percent higher compared to municipal networks. Corresponding figures for multi-family houses and commercial businesses are 46 and 45 percent respectively, consistent with the idea that these types are relatively less price sensitive. Table A1 presents a non-transformed version of the estimates, suggesting that differences are not quite as economically significant, at about 27, 35, and 30 percent respectively (these figures are obtained by dividing the coefficients with the mean value for the fixed index by consumer type).

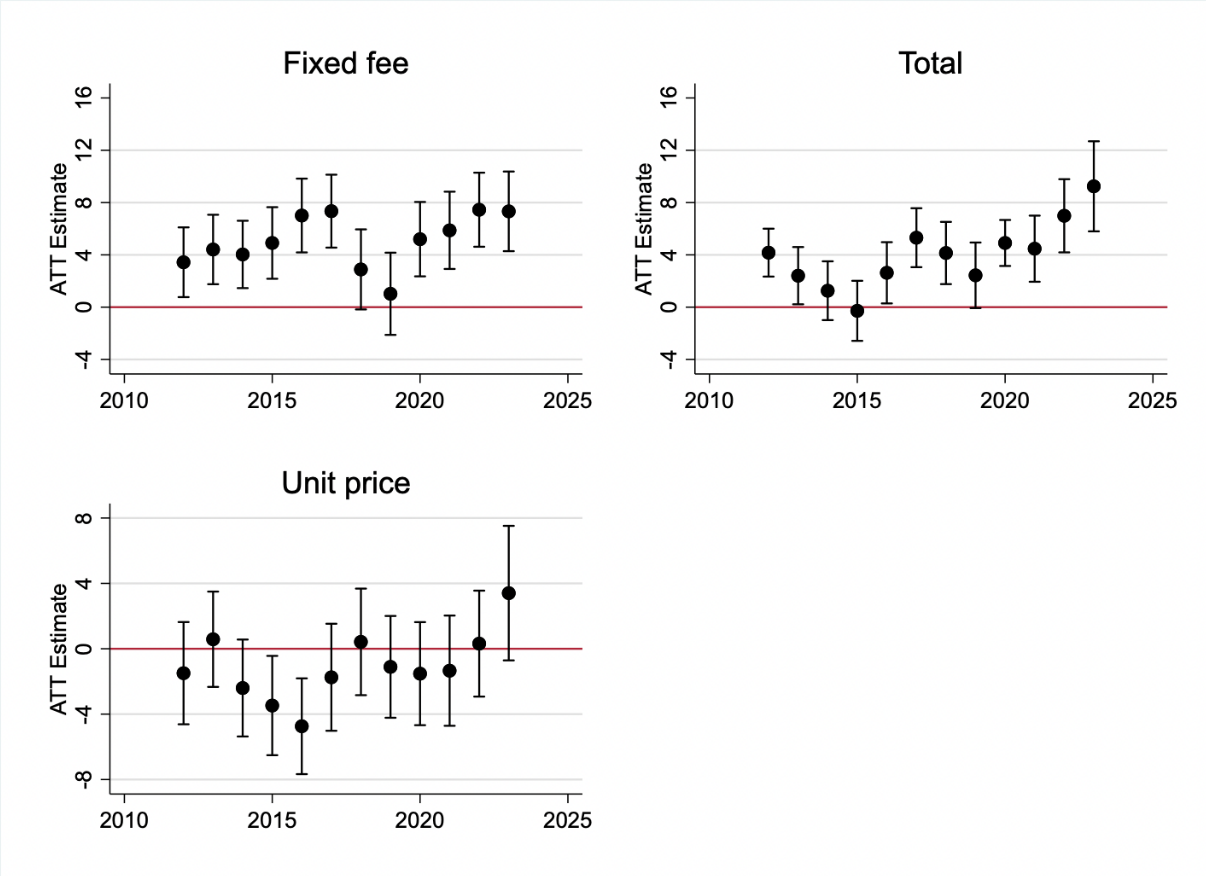
4.5 Robustness: Propensity score analysis

The propensity score analysis score analysis is conducted in two steps. First the ownership status of each network is regressed on the full set of observable network characteristics using logistic regression according to

$$private_i = \alpha + \Omega X_{it} + \varepsilon_{it}, \tag{2}$$

Thereby obtaining the probability (i.e. the propensity score) that a network is privately owned conditional on these characteristics. In the second step, each private network is matched to the municipally owned network with the closest propensity score using nearest-neighbor matching. Several privately owned networks may be matched with the same municipality-owned network. To ensure flexibility in matching, county fixed effects are not included, allowing matches across counties. Matching is performed separately for each year in the dataset. Ideally, the matched private-municipal network pairs should be as similar as possible based on observables. A common rule of thumb is that the standardized mean difference for any variable should be less than ten percent. Figure A2 presents this metric for each of the included variables, visually demonstrating that almost every variable falls within, or close to, this bound.

Figure 4: Propensity score matching results



Note: Results from propensity score matching estimates. Vertical lines represent 95 percent confidence intervals.

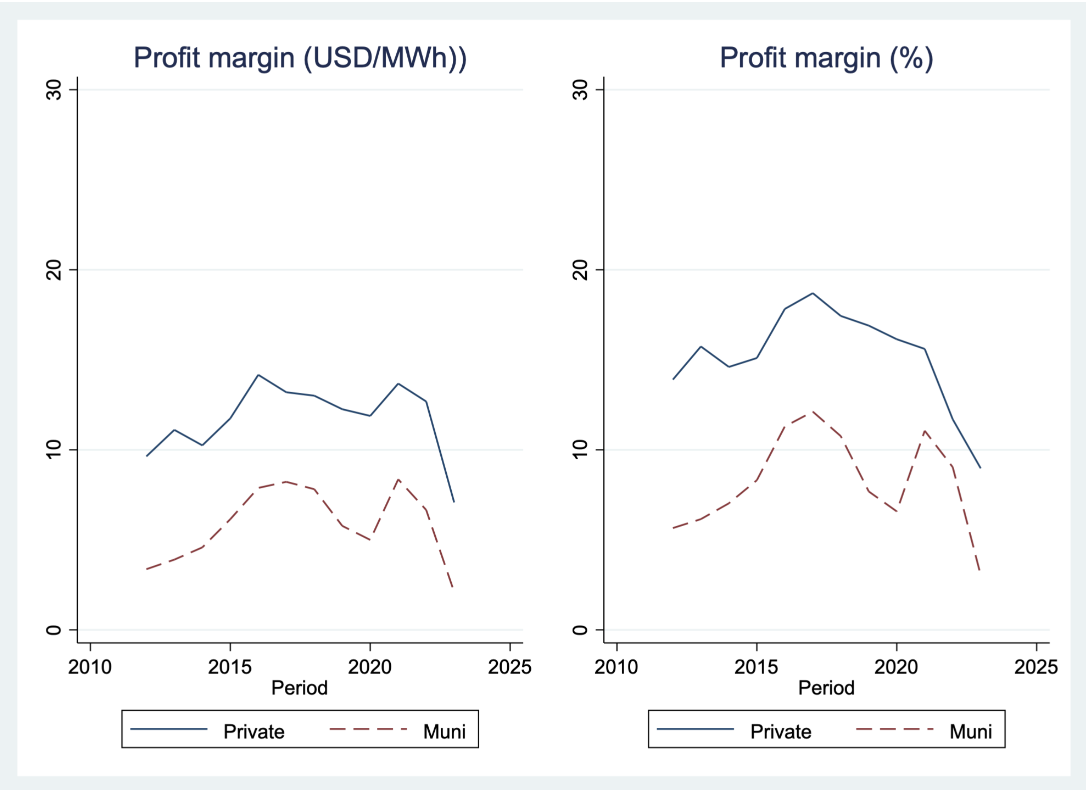
Results from the propensity score analysis are presented in Figure 4. The findings are broadly consistent with the regression results, both in terms of levels and the upward trend in differences observed over the sample period. One exception concerns the fixed fee, where the estimated difference is not statistically significant in 2017 and 2018. In terms of magnitude, the average difference over the full sample is 5.07 USD/MWh, which is comparable to the coefficient on the private ownership indicator in the preferred regression specification (2) in Table 2 at 4.58 USD/MWh. For both the total price index and the unit price, the propensity score estimates closely track those from the regression analysis across nearly all sample years.

As an additional robustness check, the analysis is repeated using a one-to-two matching strategy by matching each private network with two municipal networks. The results, displayed in Figure A3, indicate only minor deviations from the one-to-one matching results.

5 An examination of financial statements

Given that private firms set higher prices compared to municipal firms, private firms should also enjoy higher profit margins if they are at least as cost efficient as municipal firms. To test this I use financial statements to compute net profit margins before taxes, tax allocation reserves (i.e. shifting of taxable profits across years) and corporate group contributions (i.e. shifting of profits across firms within the same corporate group) by firm and year. These data are collected by the regulator and is publicly available in a standardized format, but are only reported by firm and not by network. Since firm level data is considerably less geographically granular, merging these data with data on technical characteristics is not appropriate. Hence, results cannot be interpreted in terms of causality, but should rather be seen as a complement to the main analysis. To enable comparisons across years, the analysis is restricted to the X (X) private (municipal) firms that have been active throughout the entire sample period. In total, X (X) firms were active at some point during the sample period.

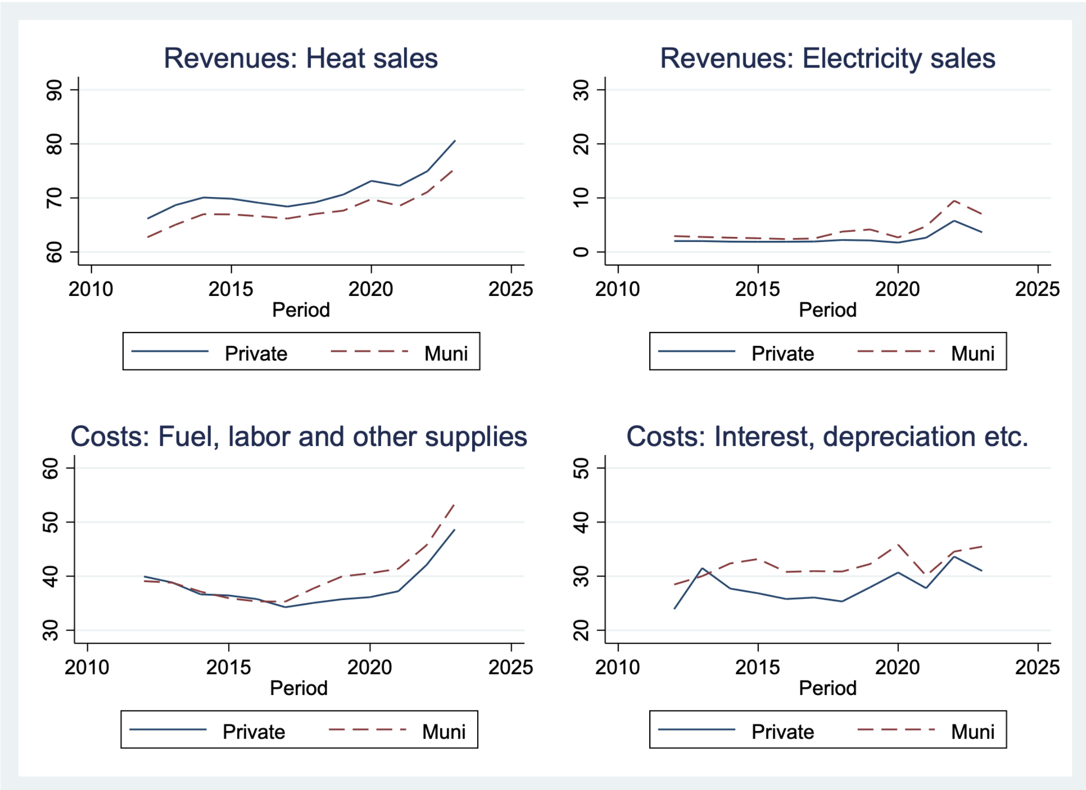
Figure 5: Profit margins by ownertype



Note: Trends in net profit margins by ownertype in USD/MWh (left) and percent (right). Taxes, tax allocation reserves (i.e. shifting of taxable profits across years), group contributions (i.e. shifting of profits across firms within the same corporate group) are excluded.

Figure 5 presents the mean profit margin by year and ownertype. Across the whole sample period, the mean profit margin for private (municipal) firms is 11.7 (5.7) USD/MWh, or correspondingly 15.8 (8.2) percent. The difference is statistically significant and amounts to $11.7 - 5.7 = 6$ USD/MWh, which is close to the estimated coefficient on the fixed fee in specification (2) of Table 2. As a complement to Figure 5, Figure A4 depicts kdensity plots over profit margins for the entire sample period by ownertype, demonstrating that both variables are approximately normally distributed.

Figure 6: Revenues and costs



Note: Mean revenues and costs by owner type and year, in USD/MWh.

Figure 6 decomposes profit margins into revenues and costs. The top left panel demonstrates that private firms consistently generate higher revenues from heat sales throughout the sample period.

The top right panel displays revenues from electricity sales for firms operating CHP plants. These were negligible prior to 2022 but rose sharply in 2022–2023 alongside electricity spot prices, particularly for municipal firms.

The bottom left panel shows fuel, labor, and supply costs, which spiked in 2022–2023 due to rising biofuel prices, which is also the primary cause of the recent drop in profit margins during 2022 and 2023.

The bottom right panel presents capital costs, split into interest and depreciation. While overall capital costs remained stable, municipal firms consistently report higher levels, driven mainly by higher depreciation. Interest costs, on the other hand, are similar across owner types. Had private firms instead faced higher interest expenses, e.g., due to greater leverage, this might have justified the use of elevated fixed fees to the extent that these fees are used to recover fixed costs.

6 Conclusion

This paper examines pricing behavior in the Swedish district heating market, a sector characterized by geographically bounded local monopolies and a lack of formal price regulation. Using detailed network-level data from 2012 to 2023, I show that privately owned firms charge significantly higher prices than municipal firms, and that this difference is entirely driven by the fixed component of the two-part tariff. Further, foreign-owned firms charge an additional price premium over Swedish privately owned firms. Unit prices do not differ significantly across owner types, consistent with the idea that firms set marginal prices close to marginal cost and extract economic rent through the fixed fee. Data from financial statements confirm that private firms also report higher profit margins per volume of energy sold than municipally owned firm, of approximately the same magnitude as the estimated difference in the fixed fee.

Both theory and empirical evidence suggest that the main advantage of privatization lies in improved cost efficiency, while the primary risk involves higher prices due to the exercise of market power. In the present context, any downward pressures on prices due to increased cost-efficiency are clearly outweighed by the increase in prices stemming from the exercise of market power. This is particularly concerning in the case of foreign ownership where profits, with the exception of corporate tax payments, are repatriated abroad. From a social welfare perspective, this makes foreign ownership especially concerning.

In standard monopoly models with two-part tariffs, short run allocative inefficiencies are minimal when the unit price equals marginal cost, fixed fees are used to extract surplus, and firms are able to price differentiate across consumer types. However, the absence of short run allocative inefficiencies does not imply that the long-run effects on consumer behavior are negligible. In particular, if consumers anticipate that private firms will fully exploit their market power over time, consumers may be less inclined to choose district heating as their main heating alternative. This is particularly relevant for new housing developments or property owners considering switching heating technology, thereby making technology-specific sunk investments. The prospect of facing a monopoly provider with strong incentives to maximize profits can erode trust and reduce the perceived long-term value of connecting to the network, even if the current price level is competitive in relation to electricity based alternatives.

A key policy implication concerns the decision facing municipalities that still own their networks. Selling a district heating network generates an immediate cash inflow which can be used to boost current public spending or reduce local taxes. However, this short-term fiscal benefit may come at the cost of higher prices and reduced consumer surplus in the future. Even though many sales include contractual price freezes for the first few years, such clauses do not constrain long-term pricing behavior. Moreover, once a network is sold, it is politically and practically difficult to reverse the decision.

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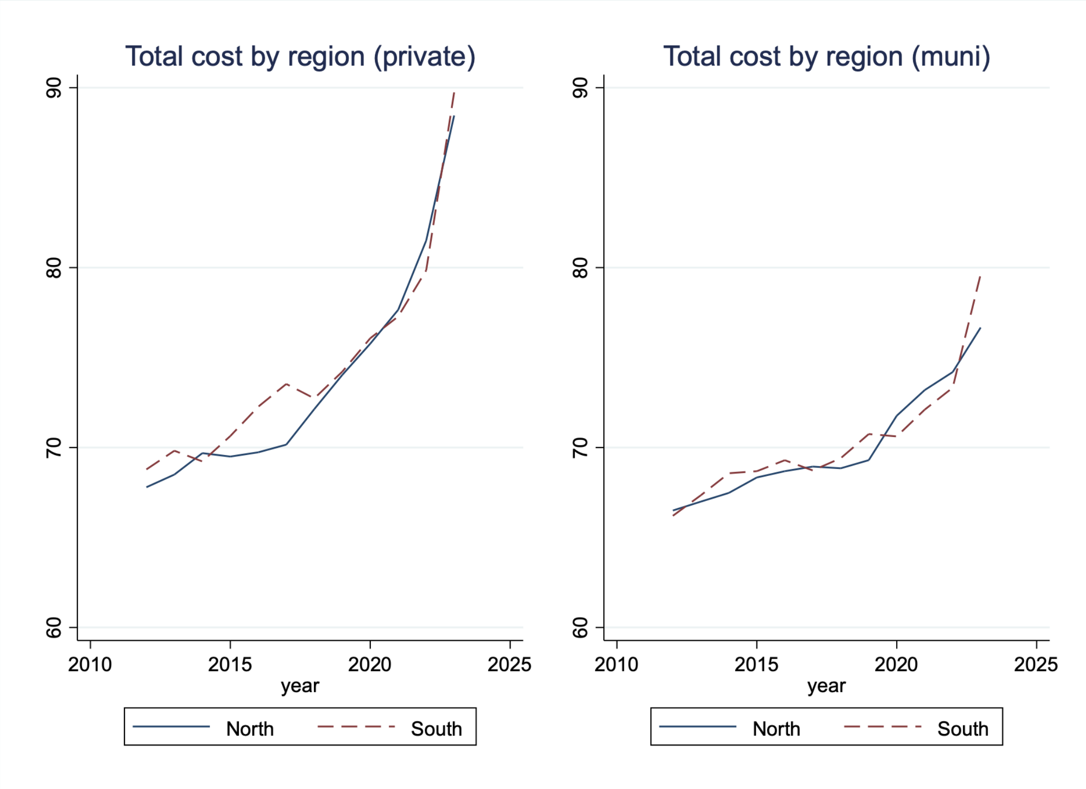
Appendix: Additional tables and figures

Figure A1: Trends in prices by ownertype and region



Note: Trends in prices by ownertype and region 2012-2023. Prices in USD/MWh. "North" is electricity price zones one and two, and "South" is electricity price zones three and four.

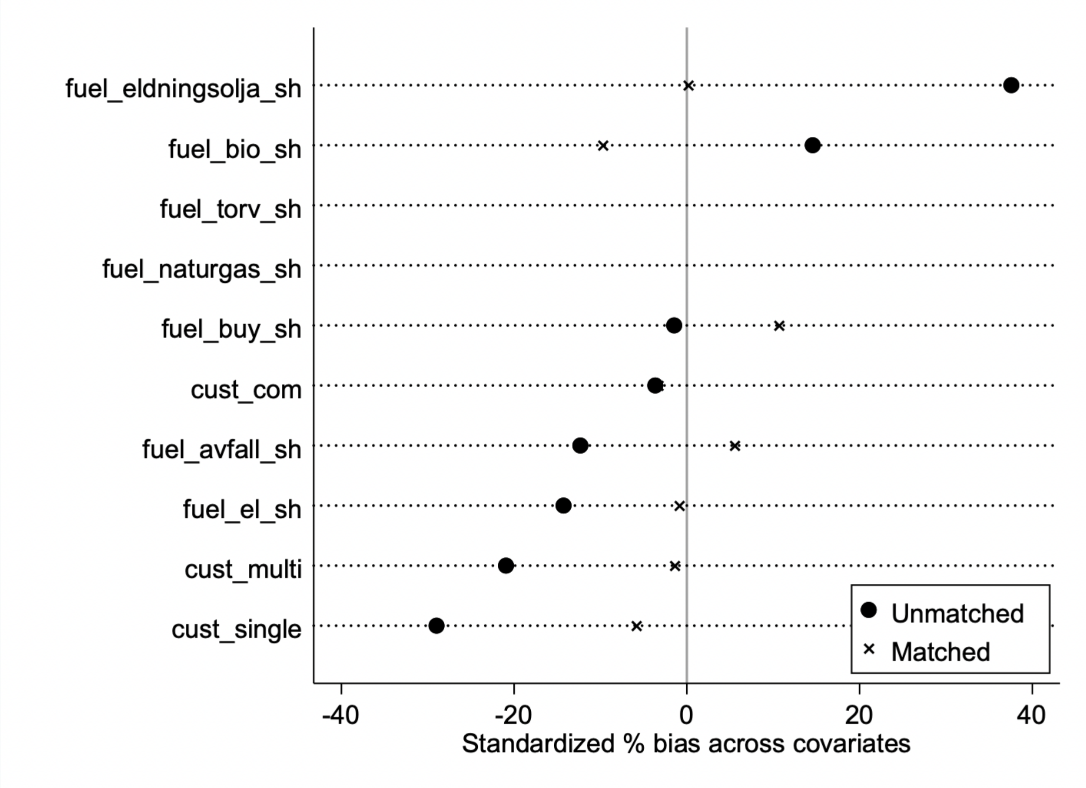
Table A1: Heterogeneity across consumer types

	Single family		Multi family		Commercial	
	(1)	(2)	(3)	(4)	(5)	(6)
Private	3.43***	3.28***	5.82***	5.31**	5.31***	5.01**
	(1.03)	(0.99)	(1.25)	(1.90)	(1.52)	(2.26)
Customers						
Customers (single family)	-0.26	-0.059	-0.44	-0.39	-0.41	-0.31
	(0.26)	(0.22)	(0.33)	(0.31)	(0.38)	(0.35)
Customers (commercial)	0.62	0.42	0.42	0.0039	0.51	-0.017
	(0.54)	(0.55)	(0.59)	(0.62)	(0.67)	(0.66)
Customers (multi family)	-0.57	-0.44	-0.38	-0.55	-0.68	-0.89
	(0.43)	(0.39)	(0.66)	(0.65)	(0.68)	(0.65)
Technical characteristics						
Sold heat (GWh)	0.71*	0.48*	0.84	1.06	1.08	1.36*
	(0.37)	(0.25)	(0.65)	(0.63)	(0.81)	(0.74)
Network length	-0.45	-0.31	-0.26	0.086	-0.41	0.048
	(0.64)	(0.56)	(0.79)	(0.69)	(1.00)	(0.83)
Heat (MWh) / network length	0.073	-0.64	-0.12	-0.22	0.067	-0.20
	(0.64)	(0.51)	(0.59)	(0.61)	(0.85)	(0.81)
Sold heat / customer (MWh)	-0.25	-0.29	0.38	0.25	0.56	0.55
	(0.45)	(0.33)	(0.68)	(0.70)	(0.75)	(0.75)
Electricity/heat unit	0.030	-0.024	-0.20	-0.16	0.12	0.12
	(0.49)	(0.50)	(0.72)	(0.72)	(0.81)	(0.82)
Fuel (shares)						
Bio fuel	-0.032	-0.088	-0.71	-0.72	-0.88*	-0.93
	(0.18)	(0.17)	(0.45)	(0.48)	(0.50)	(0.54)
Oil (fossil)	0.093	-0.064	0.56	0.19	0.96	0.40
	(0.42)	(0.35)	(0.57)	(0.50)	(0.67)	(0.55)
Waste	0.69	0.46	0.82	0.51	0.80	0.50
	(0.52)	(0.46)	(0.54)	(0.49)	(0.60)	(0.55)
Peat	0.26	0.73	-1.19	-1.48	-0.69	-1.31
	(0.52)	(0.62)	(1.56)	(1.15)	(1.96)	(1.45)
Natural gas	0.47	0.034	0.47	0.13	0.32	-0.22
	(1.31)	(1.10)	(1.15)	(1.04)	(1.15)	(0.88)
Electricity	-0.18	0.33	1.67	1.80**	1.98	2.11**
	(0.67)	(0.53)	(0.97)	(0.81)	(1.17)	(0.92)
Waste heat	0.35	0.29	0.31	0.042	0.34	0.047
	(0.23)	(0.18)	(0.33)	(0.30)	(0.38)	(0.31)
N	3501	3501	3604	3604	3570	3570
County FE	No	Yes	No	Yes	No	Yes
Adj R^2	0.092	0.28	0.13	0.22	0.11	0.22

* $p < .10$, ** $p < 0.05$, *** $p < 0.01$

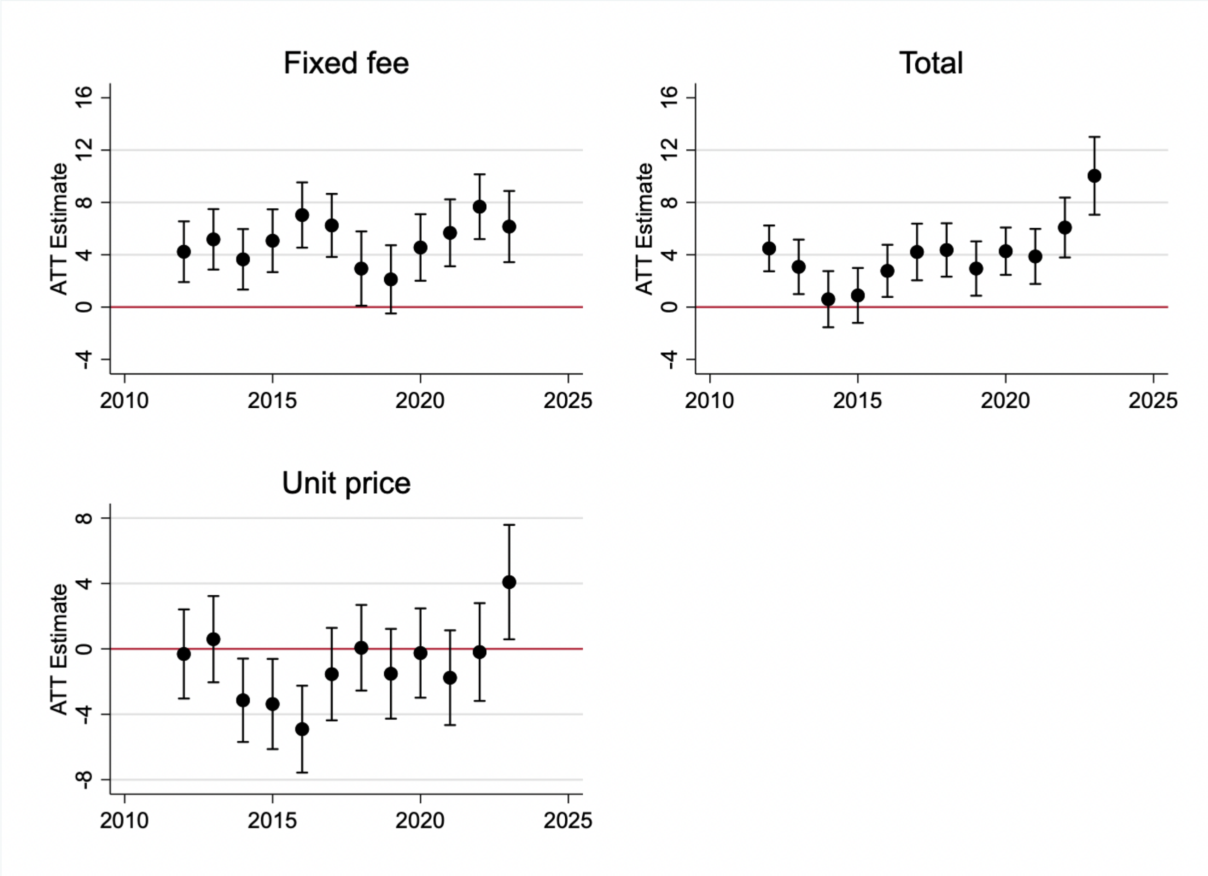
Note: Main estimation results from estimating eq (2) separately for each consumer type. The dependent variable is the fixed fee in all specifications. Control variables are included in logarithmic form. Standard errors are clustered by county.

Figure A2: Balancing test from propensity score analysis



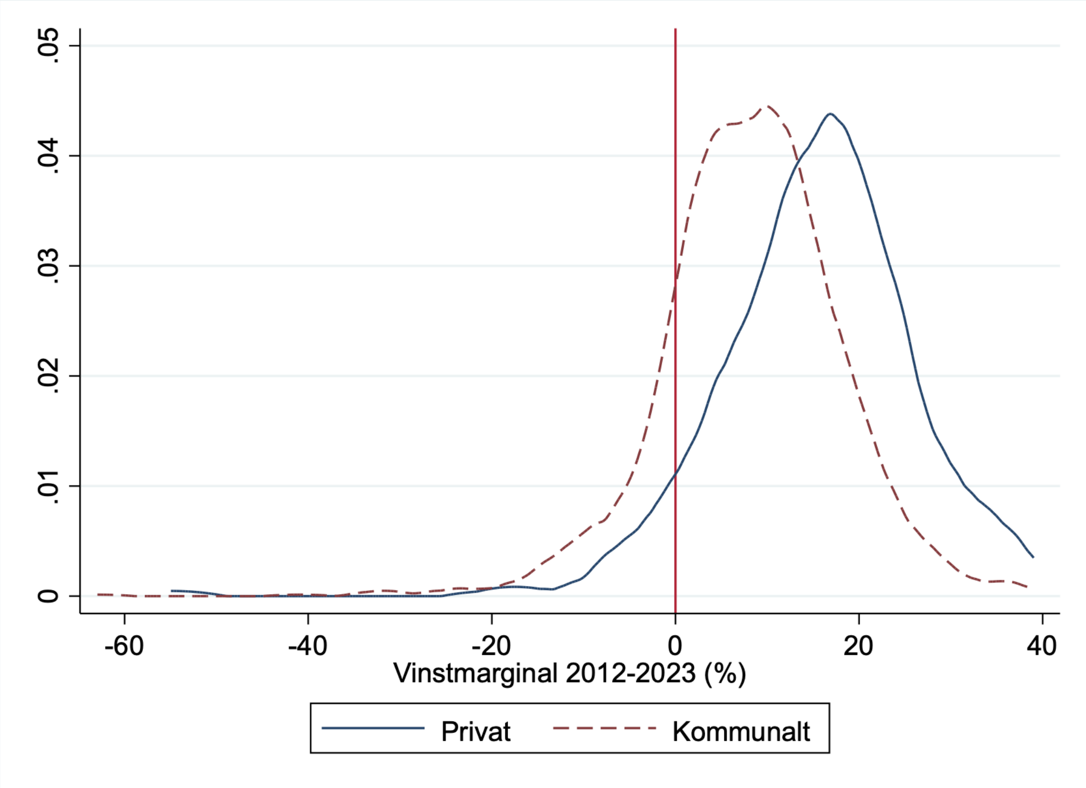
Note: Results from balancing tests in the propensity score analysis. Black circles indicate the mean standardized differences in covariates before matching, while x-marks represent the corresponding values after matching. [Note to reviewers: Variable labels will be added in the next version, these have to be manually inserted in the Stata module that has been used]

Figure A3: Propensity score matching results using two neighbors



Note: Results from propensity score matching estimates where each private network is matched with two municipality owned networks. Vertical lines represent 95 percent confidence intervals.

Figure A4: Distribution of profits



Note: Kdensity diagrams of profit margins in percentages during 2012-2023, by ownertype.