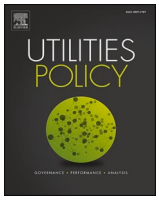
Utilities Policy 78 (2022) 101405

Contents lists available at ScienceDirect

Utilities Policy

journal homepage: www.elsevier.com/locate/jup



Is more competition better? Retail electricity prices and switching rates in the European Union

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ARTICLE INFO

Keywords:
Retail electricity markets
Liberalization
Regulation

ABSTRACT

The European Union (EU) promotes the liberalization of retail electricity markets to achieve lower prices, diversified offers, greater customer participation, and sustainable consumption behaviours. While retail competition has been a reality in most EU member states, most studies find that retail competition is suitable for large customers, but the evidence on small customers is inconclusive. We analyze data on electricity prices and switching rates in 27 EU member states and the UK from 2000 to 2019. We find that retail competition is associated with lower prices and that the effect of full liberalization is greater than that of partial liberalization.

1. Introduction

The European Union has consistently promoted retail competition in electricity and natural gas markets as a tool to achieve lower prices, higher environmental quality, and further integration of national markets (EC, 2015). This goal has gained momentum as technological progress, distributed generation, smart grids, smart meters, and the increasing diffusion of smart appliances empowered the consumers. Directive 944/2019, which regulates electricity market design in the EU, calls member states to "take appropriate actions to ensure effective competition between suppliers" and remove the remaining, non-transitional forms of price control. These provisions rely on the claims that: i) "Healthy competition in retail markets is essential to ensuring the market-driven deployment of innovative new services that address consumers' changing needs and abilities while increasing system flexibility"; and ii) "A fully liberalized, well-functioning retail electricity market would stimulate price and non-price competition among existing suppliers and provide incentives to new market entrants, thereby improving consumer choice and satisfaction" (recitals #10 and #22 of the Directive).

The EU Member States have had an obligation to allow all customers, including large businesses, small and medium enterprises, and households, to switch energy suppliers since 2007. Most have complied, at least partially, with this requirement, following the pioneering examples of Great Britain and, to a lesser extent, Norway (Von der Fehr and Hansen, 2010). As the European Union pushes toward full liberalization, the UK has partly re-regulated its retail electricity market by introducing a transitional price-cap mechanism covering about 15 million customers under a Standard Variable Tariff. The British re-regulation follows an inquiry from the Competition and Markets Authority, the country's antitrust body, on alleged abuses by the most prominent suppliers (CMA, 2016).

Although retail competition in electricity markets has been a reality, both inside and outside Europe, for about 20 years or more, the literature about its outcomes is still inconclusive, and there is a need for more evidence on the impact of these policies on relevant market performance indicators such as electricity prices. By trying to shed light on the liberalization's effects on price levels, this paper answers the following research question: What has been the effect of retail electricity market liberalization in Europe on prices and consumer behaviour as can be inferred from switching rates? The paper contributes to the existing literature by assessing the impact on electricity prices of different degrees of market liberalization observed in European countries.

The paper is structured as follows: the next section reviews the relevant literature, while Section 3 presents our data and model. In section 4, we comment on the results of empirical estimations, while in section 5, we highlight the limits of the papers and draw some conclusions.

2. Literature review

In assessing the first wave of electricity market liberalization of the

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https://doi.org/10.1016/j.jup.2022.101405
Received 25 October 2021; Received in revised form 15 June 2022; Accepted 16 July 2022
Available online 19 August 2022

1990s and early 2000s, Joskow (2008) argued that competition is likely to result in lower prices and better quality for large customers, but the results are much less clear for small customers. In fact, "The promised benefits of retail competition for residential and small industrial customers have been slow to emerge in many countries" (p.15). Several years after, Littlechild (2022) reviewed the experiences of retail competition, finding that large electricity customers are "unequivocally" better off because of liberalization whereas "some [residential customers] are, some are not". Notwithstanding, "today's customers and retailers are more experienced and active than those of ten and 20 years ago" (pp.143-144).

Analysing the trade deficit, Navarro (1989) showed that an intervention on regulatory burden and inefficiencies in the U.S. could have reduced electricity prices by 30%. Vickers et al. (1991) showed the importance of analyzing the effect of electricity market reforms on the market structure in the British experiment. Several earlier studies confirmed that, while the retail competition was likely to lower prices for large customers, the evidence was mixed (but not necessarily negative) for small customers (Newbery and Pollitt, 1997; ECME Consortium, 2010). Other studies explored the conditions under which competition may be expected to benefit small customers and the whole electricity system (Joskow and Tirole, 2004). Such conditions may include time-of-use tariffs, real-time pricing, or other tools that may make retail prices more cost-reflective (Borenstein, 2002, 2005; Allcott, 2011) and sound mechanisms for price formation (Puller and West, 2013). Still, the literature remains inconclusive (Borenstein and Bushnell, 2015).

Small, residential customers are the focus of our paper, and we will review the literature concerning this specific group of consumers. More recent studies have found more nuanced evidence, depending on whether they focused on prices or other features of competitive electricity markets. In the US, Su (2015) found little effect of retail competition, while others found a modest pressure toward lower prices (Ros, 2017) or smaller markups of retail prices over wholesale costs (Swadley and Yücel, 2011). In the same country, Dormady et al. (2018) found that the favourable effects of electricity restructuring in Ohio were offset by cross-subsidization activities of energy retailers, ultimately leading to higher prices. Rose et al. (2020) found that the price of electricity in restructured states grew relative to non-restructured states, but that likely depended on the increase of natural gas prices in the same period and the greater extent to which higher prices were passed through to small customers.

In Spain, Batalla-Bajerano et al. (2016) found some evidence of price increases following liberalization. Similar effects have been found by Karahan and Toptas. (2013) regarding wholesale and consumer electricity prices when liberalization was followed by privatization in Turkey. In Portugal, Fotouhi Ghazvini et al. (2019) found that high switching rates followed the phase-out of price regulation in 2013–15, but concentration rates remained high, nor did the pattern of prices change significantly. Fontana et al. (2019) explored the determinants of switching in Italy's electricity market. By applying a Bayesian mixed Logit model to the switching behaviour of a relatively large sample of individuals and households, they found that heterogeneity in the geographic and social context of choice and the household composition has a significant impact on the significance and the identification of switching determinants.

Nagayama (2009) suggests that higher electricity prices are one of the driving forces for governments to adopt liberalization models, but the development of liberalization models in the power sector does not necessarily reduce electricity prices. By analyzing panel data from 78 countries in four regions (developed countries, Asian developing countries, the former Soviet Union and Eastern Europe, and Latin America) from 1985 to 2003, the author finds a tendency for the price to rise in every market modelled. Somehow contrarily, in Italy, Stagnaro (2017) showed that offers in the free market fell systematically below the regulated price unless they were bundled with other services. In the UK, Ferreira et al. (2005) found a long-run relationship between the energy prices before and after the liberalization. Retail competition has been found beneficial to small customers in China (Chen and He, 2013) and in India (Singh, 2010). In Japan, Shin and Managi (2017) found a positive impact of retail electricity competition on consumer satisfaction, while Itaoka et al. (2022) found that the potential for lower prices is the main determinant of switching and emphasized the need to promote market participation in order to reap the potential economic and environmental benefits of retail competition. Nogata (2022) found similar results, whereas Matsukawa (2019) highlighted the high risks of, and potential negative welfare effects from, collusion among the incumbents.

Regulation and market design in liberalization processes are essential to ensure that liberalization processes increase consumers' welfare, as Bağhe and Taymaz (2008) show for Turkey. Szöke et al. (2021) show that a Universal Service Provider (USP) in a liberalized market can impact prices. They analyze the relationship between USP and free trader margins in different regulatory periods in Hungary. The results suggest that the public intervention focused on universal service and residential consumers and did not have an indirect horizontal profit reallocation effect.

This latter point leads to a further issue relevant as far as the retail competition outcome is concerned. Since the first experiences with liberalization, it became clear that product differentiation and bundling with higher value-added goods and services would be a potential driver for developing electricity markets (Littlechild, 2002; Eakin and Faruqui, 2000). This phenomenon is magnified by technological progress and digitalization (Chen and Liu 2016; Lavrijssen and Parra 2017), as well as potential value gains from managing behind-the-meter assets such as interconnected devices, rooftop solar, and home storage systems (Mountain, 2020). The commercial offer's non-price dimension is a significant determinant of switching (Ndebele et al., 2019). Vihalemm and Keller (2016) analyze the role of media in increasing consumers' consciousness toward the new purchasing system after liberalization in Estonia, thus highlighting the importance of a supportive communicative environment for efficiency improvement. Chapman and Itaoka (2018) confirm the importance of consumers' perception of liberalization reform for Japan's electricity market. They show that "economic factors are considered the most important, [although] environmental benefits and attractiveness of the product to stimulate the curiosity of consumers [are] also considered important" (p.108), thus highlighting the importance of effective communication policies. Consistently, Deller et al. (2021) show that, while the prospect of saving is the single most important determinant in switching, various non-financial factors also enter into play. These include uncertainty, non-monetary characteristics of the offers, and concerns about the switching process. Indeed, some customers consciously choose more expensive offers, suggesting that at least some do not regard electricity as a homogeneous product. Moving them forcibly to the cheapest offer might reduce their utility insofar as it prevents them from benefitting from non-monetary features of the service.

The heterogeneity in retail competition outcomes suggests that setting the incentives right – and preventing market power – is critical. Many studies have tried to identify why small customers do not always seem as ready to grab the benefits from the competition as they are in other instances (CEER, 2016; Deller et al., 2014). Other proposed regulations or roadmaps ensure that liberalization would benefit small customers (Crampes and Waddams, 2017; Grubb, 2015; Polo and Airoldi, 2017; Stagnaro et al., 2020; Hortacsu et al., 2015). Not surprisingly, information is crucial for well-functioning competition (Ilieva and Gabriel, 2020; Hortacsu et al., 2017).

The degree of market openness has also been measured to assess to what extent regulation, particularly price-setting mechanisms or price controls, promotes or hinders competition (IPA, 2015; ACER 2019a, 2019b; CEER 2019, 2020; EC, 2021). Recent experiences with price controls and similar measures have been disappointing or susceptible to harming more active customers without protecting the disengaged ones (Ioannidou and Mantzari, 2019; Brown and Eckert, 2018).

In the following analysis, we take advantage of EU member states' common framework and differences in liberalization and retail market design. Some have removed price controls altogether, while others retained standard tariffs set by the regulators while recognizing the customers' right to choose alternative suppliers or offers.

In light of the cited literature and we want to test the following research hypotheses:

H1. Liberalization policies are negatively correlated with retail electricity prices (net of taxes and levies);

H2. Full liberalization has a more significant effect on price variation than partial liberalization.

By full liberalization, we mean the complete removal of any form of price control or other administered price-setting mechanisms, including regulated default tariffs. By partial liberalization, we mean that some form of administered or regulated tariff coexists with the consumer's freedom to choose her electricity supplier.

The paper's main contribution is to add empirical evidence to the relationship between liberalization and prices. The choice of the European market as a case study can also be relevant for the role of the European Union in promoting liberalization in member countries and contribute to the literature on regulatory mechanisms in electricity markets.

3. Data and empirical strategy

This article aims to estimate the effects of liberalization on electricity prices. To address this concern, we build an original panel dataset including data on electricity prices, switching rates, and information on the economic and social background of 28 European countries (including 27 members of the European Union and the UK).[1]

In defining liberalization, we define "formal liberalization" as the empowerment of small customers with the right to switch suppliers. Furthermore, we call "partial liberalization" the coexistence of market prices with regulated (default) tariffs, while we call "full liberalization" the removal of any administered or regulated price, including regulated default tariffs. Consequently, "no liberalization" coincides with the absence of retail choice.

In most EU member states, retail choice of electricity has been introduced after the transposition in the national legislation of EU Directive 2003/54, which required all customers to be allowed to switch offers or suppliers by 2007. Many governments maintained forms of price regulation together with this opportunity, although they were presumed to be transitional. States that became members of the EU after 2007 were required to comply with Directive 2003/54 (and, later, Directive, 2009/72, which updated and substituted the previous one) by opening retail markets to competition. More recently, the European Union adopted Directive 2019/944, which is being transposed into the national legislation of member states as this paper is being written. Directive 2019/944 urges member states to open up retail markets for electricity and remove any remaining form of price regulation unless limited in scope (for example, applying to vulnerable customers alone) and proportional to the alleged market failures.

Moreover, price regulation should be transitional, and the relevant national legislation should set an end date. Regulated prices shall be set by governments or independent regulators and made available to all small customers or a subset thereof (for example, vulnerable customers). However, suppliers shall still be able to make offers in the free market. In other words, under the EU law, price regulation entails the possibility of maintaining a regulated offer as an alternative to the offers from various competitors. The latter will still be free to offer alternative tariffs that customers may or may not choose.

As of 2020, 15 EU member states and the UK maintained some form of end-price regulation for electricity, and 14 did the same for natural gas (ACER/CEER, 2021) (Fig. 1).

In 2020, to which Fig. 1 refers, the UK was implementing its withdrawal from the European Union, effective at the end of the year. The UK had been the first country in Europe to deregulate its electricity sector, but – following an inquiry by its antitrust body (CMA, 2016) in 2016 – it re-introduced a wide-ranging price cap to protect the customers of the so-called Big Six, i.e., the largest electricity suppliers. The re-regulation of British electricity retail markets has been much disputed, and the CMA's analysis attracted much criticism (Gammons et al., 2014; Littlechild, 2020). The price cap implementation has been criticized (Ioannidou and Mantzari, 2019; Hardy et al., 2019).

The above-described legal changes provide the institutional background against which we have collected data on the degree and depth of electricity retail markets regulation and several other market performance and control variables. Despite the heterogeneity among EU member states, they share a broadly consistent legal framework for electricity concerning wholesale and retail markets and network regulation due to the EU directives and regulations.

Data are retrieved from various sources (e.g., Eurostat, CEER/ACER, International Energy Agency),[2] covering 2000 to 2019 and resulting in a balanced panel consisting of 560 observations. The complete list of variables and their summary statistics are reported in Tables 1 and 2, respectively. We did not include 2020 in the analysis because of the swift variations in electricity prices and demand as well as the wide-ranging policy intervention due to the Covid-19 outbreak.

The model has household retail prices and switching rates as dependent variables. Prices are intended net of taxes and levies. Florio (2014) uses household electricity prices as the dependent variable in a similar econometric setting and explains that focusing on this category can be relevant to social and economic motives. We then employ an array of controls to account for the institutional heterogeneity, the macroeconomic conditions, exogenous determinants of electricity prices, and other potential confounding factors. The prices of electricity are retrieved from the Eurostat database. They refer to the most common consumption band (called DC) as between 2500 and 5000 kWh/year. These data, collected by national statistical institutes and validated by Eurostat, represent weighted average prices, using the market shares of electricity supply undertakings surveyed as weighting factors (in the case of monopolies, data are reported by single electricity companies). They are representative of the entire country. Table 1 provides further details.

Switching rates represent the percentage of all customers that have changed either tariff or supplier in a given year. Data are retrieved from the reports about retail electricity markets provided by ACER (the EU Agency for the Cooperation of Energy Regulators) and CEER (the Council of European Energy Regulators). Switching data are missing for the countries and years where switching is not allowed.

In order to account for institutional heterogeneity, three dummies are introduced, i.e., formal liberalization (set to 1 if consumers have a right to choose their supplier, 0 elsewhere), full liberalization (set to 1 if all price regulations have been phased out, 0 otherwise) and liberalization degree (0 if retail competition is not allowed, 1 if customers have a right to choose but some form of price intervention is still in place, and 2 if all price regulations have been removed). The information regarding the degree of liberalization is based on the annual reports by ACER and CEER. We employ dummy variables because we define liberalization as a *formal* feature of the market design. In other words, these variables merely tell whether or not retail choice is allowed and whether or not a standard (regulated) offer is available. The choice of a

[1] The countries are Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and United Kingdom.

[2] See Table 1 for the Correspondence between variables and sources.

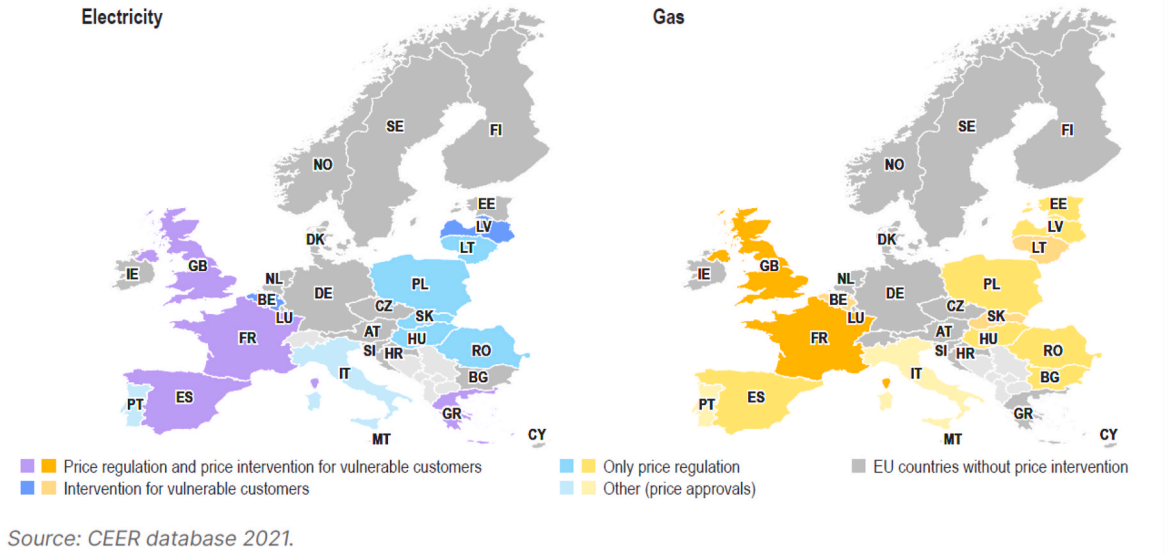

Fig. 1. Existence of price intervention in electricity and gas in 2018. Source: ACER/CEER.

binary definition is consistent with the research question that is entirely concerned with exploring whether and how this impacts the market *outcomes* (which are non-binary). This approach to measuring the effect of liberalization through dummy variables has been used several times in the literature (Pereira da Silva and Cerquiera, 2017; Steiner 2000). We did not explicitly include indicators used to measure regulatory quality as in Hattori and Tsutsui (2004), Steiner (2000) and Nagayama (2007) because the market design in the EU and the UK is relatively homogenous, and there is insufficient variance to explain differences in the action of the regulatory bodies beyond the recognition and extension of the customers' right to choose. Also, the Heritage Foundation/Wall Street Journal's Index of Economic Freedom is used to capture the country's broader social and political attitude toward competition and free markets. This variable reflects the intuition that competition in a given industry is more likely to deliver in jurisdictions where customers are also culturally oriented to choose their suppliers in other industries. Zhang et al. (2002) use measures of economic freedom to assess the impact on the performance of the electricity supply industry. The homogeneity of the broader market design, with particular reference to the design of wholesale markets and restructuring processes, is granted by the obligation of EU member states to comply with European directives and regulations that pose wholesale liberalization both as a mandate to member states and as a pre-condition to retail liberalization.

Other, more complex indicators have been developed occasionally. For example, IPA (2015) developed an indicator of competition in Europe's retail electricity market on behalf of ACER. This index considers market structure, performance, and conduct variables. It aims to measure the degree of *actual* competition in the market, encompassing ex-post information, such as switching rates, the number of suppliers and offers, as well as the supplier markups and customer satisfaction. Relying on such a complex indicator, which is only available for one year, would not allow us to answer our research questions. We are concerned with the outcomes of a formal feature of market design (i.e., whether and to what extent retail choice is allowed to small consumers). These questions cannot be answered by relying on indicators built on market outcomes in the first place. Still, other liberalization indexes, such as the OECD's Product Market Regulation report (Koske et al., 2015), while considering variables concerning market design at the wholesale as well as the retail levels, ultimately rely on a binary choice in order to assess whether or not retail competition is allowed.[3] Still another index, developed by IBL (2021), considers both formal features of the market design and market outcomes. The former includes a binary choice (whether or not retail choice is allowed and whether or not some form of price regulation is still in place) along with indicators such as switching rates.

Occasionally, and for limited periods, some member states may have introduced price freezes or other forms of price controls, and rarely they have set regulated prices below costs, but these policies were fortuitous and broadly inconsistent with EU regulations, so they have little (if any) statistical significance given the broad geographical coverage and the relatively long period being considered in the paper.

We reviewed ACER's retail market monitoring reports for 2010 to 2020 and found no mention of price caps or freezes. Regulated prices are generally set close to where wholesale prices would imply; the spread between regulated and non-regulated prices is generally low. In some cases, there is a significant difference, but that goes the opposite way, i.e., regulated prices are set at a relatively high level to encourage switching, as happened in Portugal (see, for example, ACER, 2015). There is no comprehensive report covering all today's EU member states before 2010, but we could find no evidence of any protracted policy to keep retail prices below costs after liberalization. Indeed, the opposite occasionally happened: in some Eastern EU countries (e.g., Latvia, Hungary, Bulgaria and Lithuania), regulated prices were kept below costs before liberalization and, to a lower extent, for a few years after that, resulting in lower switching rates (ACER, 2015), but in the following editions of the report this problem was no longer mentioned, suggesting that these practices were phased out. At any rate, they were not allowed by EU law that requires retail price regulation to be

[3] Questions Q.1.3.2. "Are electricity retail tariffs regulated or approved by the government, ministry, regulator or other public body for any of these categories of consumers?" and Q.1.3.3. "If electricty retail tariffs are regulated, are there measures in place which require that the regulated retail tariffs are based on the tariffs or costs of the most efficient supplier?".

Table 1
List of Variables and sources.

Variables	Definition	Source	Hypothesized relationships
Dependent Variables:			
Electricity Prices	Annual electricity prices for household consumers expressed in EUR per kWh. Consumption Band Dc with annual consumption 3500 kWh of which night 1 300, until 2007. Consumption Band Dc with annual consumption between 2500 and 5000 kWh, from 2007.	Eurostat	
Switching rates	Electricity switching rates from 2011 to 2018.	CENTRE/ACER	
Explanatory Variables:			
Formal Liberalization	Dummy variable equals 1 when formal liberalization occurs and 0 otherwise.		–
Liberalization Degree	Categorical variable assuming values 0 if there is no formal liberalization; 1 if liberalization and regulated prices coexist (Liberalization degree-1); 2 if the liberalization is complete (i.e., there is no regulated tariff) (Liberalization degree-2).		–
Full liberalization	Dummy variable equals 1 if the country experiences a complete liberalization and 0 otherwise.		–
Real GDP per Capita at market price	Ratio of real GDP to the average population of a specific year. Unit of measure: Euro per capita.	Eurostat	+
Median Age	The age that divides a population into two numerically equal groups, meaning half the people are younger than the median age and half are older.	Eurostat	–
Tertiary Education	The indicator measures the share of the population aged 30–34 who have completed tertiary studies (e.g., university, higher technical institution).	Eurostat	–
Index of Economic Freedom	Annual index and ranking that measures the degree of economic freedom in 186 countries using 12 qualitative and quantitative factors (e.g., property rights, tax burdens).	Heritage Foundation	–
Share of Nuclear In Electricity Production	Share of electricity production derived from nuclear sources	International Energy Agency annual Electricity Information data service	–
Share of Renewable in Electricity Production	Share of electricity production derived from renewable sources	Until 2003: International Energy Agency annual Electricity Information data service From 2004: Eurostat	–
Electricity Consumption per capita	Electricity consumption per capita (MWh per capita)	International Energy Agency annual Electricity Information data service	+
Unemployment rate	Number of unemployed persons (aged 15 to 74) as a percentage of the labor force (i.e., the total number of employed and unemployed).	Eurostat	–
Regulatory quality estimates	Estimates of governance performance (ranges from approximately −2.5 (weak) to 2.5 (strong) governance performance). It reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	Worldwide Governance Indicators (WGI)	–
Oil Prices	Europe Brent Spot Price FOB (Dollars per Barrel).	US Energy Information Administration (EIA).	+
Gas Prices	Annual average of Global monthly price of Natural gas (U.S. Dollars per Million Metric British Thermal Unit, Monthly, Not Seasonally Adjusted).	Federal Reserve Economic Data	+

Table 2
Summary statistics.

Variables	Obs.	%	*Mean*	*Std. Dev.*	*Min*	*Max*
Electricity Prices	518	/	0.09	0.05	0.013	0.39
Switching rates	193	/	5.97	6.38	0	31.1
Formal Liberalization	560	69%	0.68	0.46	0	1
Liberalization Degree	560					
0	175	31%	/	/	/	/
1	138	25%	/	/	/	/
2	247	44%	/	/	/	/
Full liberalization	560	44%	0.4410	0.4969	0	1
Real GDP per Capita at market price	557	/	24,398.62	15,885.21	3010	84,420
Median Age	558	/	39.99	2.60	32.4	46.7
Tertiary Education	553	/	33.47	11.79	7.4	58.8
Index of Economic Freedom	559	/	68.20	6.65	47.3	82.6
Share of Nuclear In Electricity Production	531	/	20.11	24.02	0	82
Share of Renewable in Electricity Production	523	/	21.87	18.30	0	73.05
Electricity Consumption per capita	531	/	6.494	3.39	2	17.2
Unemployment rate	556	/	8.67	4.38	2	27.5
Regulatory quality estimates	559	/	1.19	0.44	−0.11	2.098
Oil Prices	559	/	64.57	28.45	24.46	111.63
Gas Prices	560	/	7.19	3.11	2.66	13.14

proportionate and transitory and result in cost-reflective prices.[4]

The limited extent of these policies is further confirmed by the retail competition index developed by consultancy IPA on behalf of ACER (IPA, 2015). While not considering price levels as an indicator of competition, the study considers the supplier's markup, i.e., the difference between wholesale and retail prices, which is a function of where retail prices are set. Nor does it mention any relevant issue concerning regulated prices being set below costs. It explicitly mentions price levels as a potential alternative for measuring the outcomes from competition, the focus of this paper.

Moreover, quite often, the governments' interventions to keep prices low intervene on the non-contestable component of prices (i.e., network costs, taxes, and other levies) rather than on the contestable component thereof (i.e., energy costs) (Sgaravatti et al., 2021). As IPA (2015, p.35) argues, "Where data are available, excluding taxes and network costs (the non-contestable components) from price reduces this problem somewhat, although [the extent] relies on the data reported being accurate. Notwithstanding, the wholesale component of energy price can still be reasonably expected to vary across countries based on generating technologies and renewables subsidies (although greater interconnection could reduce these differences).". In the following analysis, we consider retail electricity prices net of taxes and levies, and we control for the price of commodities and the generation mix to capture the price variations that are dependent on market behaviours rather than on technological or fiscal drivers.

Other controls account for the macroeconomic conditions and human capital and reflect the heterogeneity both cross-country and over time: real GPD per capita at market prices and unemployment rate. GDP per capita has been used by Pereira da Silva and Cerquiera (2017), that found it also significant in influencing electricity prices. GDP per capita has also been used by Hattori and Tutsui (2014), Steiner (2000), Nagayama (2007) and Zhang et al. (2002) in similar econometric settings. Median age and the share of the population with tertiary education are employed to account for the social capital and other individual features that may affect the ability or propensity of customers to take advantage of competition. Zhang et al. (2002) use the urban population ratio to measure similar factors. There is some evidence that older and less educated people are less likely to switch. Electricity consumption per capita is a proxy for the extent of electrification within a country.

Finally, we consider several exogenous factors that may affect retail prices via the channel of wholesale markets, with particular reference to the generation mix or the cost of commodities: the share of nuclear power and renewable sources in the generation mix are often the consequence of public policies rather than competition in the wholesale market, and they hardly resent from signals from the retail competition. Oil prices are taken as a proxy for the broader dynamics of commodity markets. This variable has also been included as an explanatory variable by Pereira da Silva and Cerquiera (2017) and showed a significant impact on electricity prices. We also explicitly include gas prices as explanatory variables to address this technical role in electricity production. We have also included the World Governance Index to consider the quality of the regulatory framework. The taxes and levies added to retail electricity prices are also considered, as higher taxes and levies may reduce the perception of price variations among different offers (for any given price difference or level), thereby reducing the perceived gains from switching.

To understand the effects of liberalization on electricity prices (if any), we run first a panel error correction model specified as follows[5]:

$$Electricity\ Prices_{it} = \beta formal\_liberalization_{it} + \boldsymbol{X}_{it} + \mu_t + \nu_i + \varepsilon_{it} \quad (1)$$

We study the determinants of electricity (retail) prices (net of taxes and levies) in country i and year t, depending on various controls (X_{it}). Moreover, we include both time fixed-effects (μ_t) to control for the number of years since liberalization, time-variant unobservable factors affecting the electricity markets, and standard time shocks, and country fixed-effects (ν_i) to control for time-invariant factors.[6]

The primary variable of interest is formal liberalization, a dummy variable assuming a value equal to 1 when liberalization occurs and 0 otherwise. In this first estimation step, we do not distinguish between different forms of liberalization. We expect liberalization, either partial

[4] As confirmed by the European Court of Justice decisions concerning price regulation in the gas sector in Italy in 2010 (Federutility case, Case C-265/08) and in France in 2016 (ANODE case, Case C-121/15). Interestingly, the two cases are based upon different directives, as the EU law was updated in the meantime, namely the 2003 gas liberalization directive and the 2009 directive, respectively.

[5] All the models are estimated using STATA and, specifically, commands *xtpcse* for the model in Eqs. (1) and (2), *sureg* for Eq. 3 and *teffects* for Eq. (4). The estimation of the panel error correction model (*xtpcse*) allows correcting for serial correlation in the idiosyncratic error terms, which has been investigated running a specific test on residuals through the STATA command *xtserial*. These results are available upon request.

[6] We try several robustness checks including oil and gas prices variable one at the time and including time and country fixed effects. The main results of interest are not altered using these alternative specifications.The same robustness checks have been applied for the other models in the manuscript.

or full, to lower electricity prices. The vector of controls (X_{it}) captures the countries' economic, institutional and cultural contexts. It includes, for example, per capita GDP levels, tertiary education, and the median age of the population, together with some characteristics of the electricity generation mix, e.g., the share of nuclear and renewables in electricity production.

Furthermore, we proceed with modifying the above model. In particular, we replace formal liberalization with a categorical variable – Liberalization Degree - assuming values 0 when there is no liberalization; 1 in the case of *partial* liberalization, i.e., regulated (standard) tariffs still exist while retail choice is allowed; 2 in the case of *full* liberalization, i.e., regulated tariffs are eliminated.

$$Electricity\ Prices_{it} = \beta Lib - Degree_{it} + \boldsymbol{X}_{it} + \mu_t + v_i + \varepsilon_{it} \quad (2)$$

This variable's inclusion allows us to disentangle the effects of different liberalization modes on prices, separating those countries where the adoption of default prices are still in place from those that undertook a complete energy market liberalization. We expect the negative effect to be higher in the case of *full* liberalization.

Since prices are not the only relevant factor impacting consumers' demand and the nature of liberalization policies can change other relevant determinants of consumers' behaviour correlated with prices, we also make a further step by considering another regression model with switching rates as dependent variables. Switching rates are the percentage of consumers who have changed electricity providers following liberalization. Since the trend in prices can also influence this decision, and there can be a correlation between electricity prices and switching rates, we run a Seemingly Unrelated Regression model (SURE), where the primary independent variable of interest is the one indicating liberalization degree. The SURE, specified as follows, estimates the two equations considering the correlation among the error terms.

$$\begin{cases} Electricity\ Prices_{it} = \beta Lib - Degree_{it} + \boldsymbol{X}_{it} + \mu_t + v_i + u_{it} \\ Switching\ Rates_{it} = \beta Lib - Degree_{it} + \boldsymbol{X}_{it} + \mu_t + v_i + \gamma_{it} \end{cases} \quad (3)$$

Finally, to add robustness, we also estimate an Average Treatment Effect (ATE) model for electricity prices to measure the difference in average outcomes between units assigned to the treatment $y_1(i)$ and units assigned to the control $y_0(i)$.

$$ATE = \frac{1}{N}\sum_i (y_1(i) - y_0(i)) \quad (4)$$

Specifically, we run this model using two alternative treatments: formal and full liberalization. This last variable is a dummy assuming value equals 1 in full liberalization and 0 otherwise.

4. Results

The results of the panel error correction models are described in Table 3.

Liberalization policies seem to be correlated to lower prices after controlling for potential confounding factors, thus confirming hypothesis H1. In this model, there is a statistically significant effect on prices when we consider different policies like partial liberalization, while there is no statistically significant effect in the case of full liberalization. Thus, hypothesis H2 is partially confirmed. Regulatory quality estimates show a positive relationship, thus indicating a possible cost effect on utility performance connected to the effective implementation of retail competition. The population's median age has a positive relationship and might signal that the older the population, the more the inertia regarding switching and associated efficiencies.

We obtain different results when considering the effect of prices, including switching rates as a dependent variable to account for the correlation between the latter and electricity prices and using the SURE model (see Table 4).

Table 3
Estimation of panel error correction models with Electricity prices as a dependent variable. Standard errors are in parenthesis. Statistically significant levels are: *** p<0.01, ** p<0.05, * p<0.1. Year and country fixed effects have been included in the regression.

	Electricity prices	Electricity prices
VARIABLES	(1)	(2)
Formal Liberalization	−0.0167*	
	(0.00932)	
Liberalization Degree-1		−0.00873
		(0.0111)
Liberalization Degree-2		−0.0289***
		(0.00853)
Real GDP	0.00000191	0.00000209
	(0.00000349)	(0.0000035)
Real GDP$_{t-1}$	−0.000000166	0.0000000499
	(0.00000473)	(0.00000469)
Real GDP$_{t-2}$	−0.000000276	−0.000000022
	(0.0000035)	(0.00000346)
Unemployment rates	0.00201	0.00236
	(0.00177)	(0.00179)
Unemployment rates$_{t-1}$	0.0000514	0.0000375
	(0.00272)	(0.00272)
Unemployment rates$_{t-2}$	0.00197	0.00207
	(0.00172)	(0.00172)
Median Age of Pop	0.0119***	0.0114***
	(0.00211)	(0.00223)
Tertiary Education	−0.000703	−0.000596
	(0.000599)	(0.000569)
Index of Econ Freed	−0.000442	−0.000339
	(0.000822)	(0.000809)
Share of Nuclear	−0.000343	−0.000140
	(0.000485)	(0.000478)
Share of renewable	−0.00111***	−0.00121***
	(0.000302)	(0.000311)
Electricity Consumption	−0.000201	0.000312
	(0.00361)	(0.00363)
Regulatory Quality Estimates	0.0354**	0.0437***
	(0.0151)	(0.0151)
Oil prices $_{t-1}$	0.000180	0.000196
	(0.000167)	(0.000165)
Oil prices $_{t-2}$	−0.000225	−0.000232
	(0.000191)	(0.000187)
Gas prices $_{t-1}$	0.000549	0.000417
	(0.00220)	(0.00218)
Gas prices $_{t-2}$	0.00199	0.00214
	(0.00142)	(0.00139)
Constant	−0.406***	−0.417***
	(0.102)	(0.103)
Observations	438	438
R-squared	0.683	0.686
Number of id	28	28

This regression confirms hypothesis H2 since full liberalization decreases prices compared with partial liberalization. The inclusion of switching rates as a mediating factor between prices and consumers' demand confirms that full liberalization has a more sizeable impact on price reduction. Greater freedom to choose increases competition between providers, and when the market is fully liberalized, providers compete on prices as well as on non-price components of their offers. The statistically significant coefficient of Liberalization-degree-1 cannot be commented on since, before partial liberalization, there is no possibility of switching for most countries in the database. The only country that went for partial liberalization after the full one was the UK, and only in the last two years of our sample. The sample is thus substantially reduced, and we have only 190 observations generated by the year and country combination in which switching is allowed. This limitation could be relevant to the validity of the results, but our primary interest is in the overall effect of liberalization on prices when considering switching rates, a relevant aspect of consumer behaviour. The SURE model estimation thus adds robustness to our main result even if the sample selection has to be considered for the validity of the results.

Table 4
Estimation of a SURE model with Electricity prices and Switching Rates as dependent variables. Robust standard errors are in parenthesis. Statistical significance levels are: *** p<0.01, ** p<0.05, * p<0.1. Year fixed effects have been included in the regression.

	Electricity prices	Switching rates
VARIABLES	(1)	(2)
Liberalization Degree-1	−0.0646***	3.788**
	(0.0198)	(1.932)
Liberalization Degree-2	−0.103***	−0.997
	(0.0199)	(1.945)
Real GDP	0.00000491	0.000505
	(0.00000502)	(0.000490)
Real GDP_{t-1}	−0.000000249	−0.000311
	(0.00000773)	(0.000754)
Real GDP_{t-2}	−0.0000034	−0.000141
	(0.00000511)	(0.000498)
Unemployment rates	0.00477	0.245
	(0.00428)	(0.418)
Unemployment $rates_{t-1}$	−0.00421	0.198
	(0.00665)	(0.649)
Unemployment $rates_{t-2}$	0.00635	−0.205
	(0.00389)	(0.380)
Median Age of Pop	−0.00783***	−0.214
	(0.00233)	(0.228)
Tertiary Education	−0.00334***	−0.238***
	(0.000675)	(0.0659)
Index of Econ Freed	−0.00199	−0.0914
	(0.00149)	(0.146)
Share of Nuclear	−0.000131	0.0163
	(0.000189)	(0.0185)
Share of renewable	−0.000818***	0.133***
	(0.000286)	(0.0279)
Electricity Consumption	−0.00423**	−0.233
	(0.00196)	(0.191)
Regulatory Quality Estimates	0.111***	10.99***
	(0.0203)	(1.979)
Oil prices $_{t-1}$	0.000653	0.0807
	(0.000926)	(0.0904)
Oil prices $_{t-2}$	0.00163**	0.0986
	(0.000753)	(0.0735)
Gas prices $_{t-1}$	−0.0176	−1.500
	(0.0131)	(1.283)
Gas prices $_{t-2}$	−0.0104**	−0.639
	(0.00530)	(0.517)
Constant	0.660***	14.68
	(0.155)	(15.13)
Observations	190	190
R-squared	0.442	0.379

After two years, the coefficient on the lag of the unemployment rate shows a positive sign, which is quite puzzling. Maybe the variables also capture some form of inefficiency or stickiness in the countries shown by prices in the electricity sector. This effect may be the quintessential case of correlation-not-causation.

The older and the more educated potential customers are, the more prices decrease. This relationship could be attributed to more experienced and informed customers that can be harder to convince since the market's information asymmetry could be lower. Some evidence at the micro level suggests that more educated and more informed (and wealthier) consumers tend to be more able to capture the gains from switching (Six et al., 2017; Loi and Ng, 2018; He and Reiner, 2017). The correlation we found might reflect the corresponding consequence at a macro level, whereby societies, on average, are more aged and educated and may be more responsive to competing offers.

The more economically free the country, the more the prices increase. This relationship could be considered counterintuitive, and it comes at odds with the results we found in the previous setting. It may reflect more mature markets where competition is also on quality and complementary services. There may also be an issue of collinearity given the strong correlation between the Index of Economic Freedom and GDP per capita. The share of renewables is expected to lower wholesale prices and indicates that substitutability between different energy sources can increase market efficiency.

In Table 5, we also present the result from the average treatment effect (ATE) estimation in which we consider the effect of formal liberalization and full liberalization. However, in this context, we are not in a standard 2 × 2 framework (treatment and control groups and two periods), as common in DID models, since countries in our sample experience liberalization at different points in time. Failing to account for this time-varying treatment may bias the results. Thus, we estimate the ATE following a recent and growing strand of the literature on the difference-in-difference models (see, among the others, Goodman-Bacon, 2021; Callaway and Sant'Anna, 2021) considering a time-varying treatment. Specifically, we use the Stata command *tvdiff,* which implements ATE when the treatment variable is binary and varying over time and tests for parallel trends assumption as common in DID models (Cerulli and Ventura, 2019). Fig. 2 reports the graphical representations and the test results for the parallel trend assumption for both formal and full liberalization. Our findings show that the assumption has been confirmed with formal (panel a) and full (panel b) liberalization.

The results show that the average treatment effect on all observations is negative and significant for formal liberalization, while negative but insignificant for full liberalization, confirming that H1 adds robustness to previous findings.

5. Conclusion and policy implication

The effect of liberalization policies on market efficiency in the electric sector presents empirical evidence that is not conclusive. This paper contributes to the existing literature by presenting an empirical analysis of European countries from 2000 to 2019. We test two different research hypotheses concerning the effect of liberalization policies in whatever form they take and differentiate between different forms or degrees of liberalization. We consider prices for the residential consumer as a proxy for the market efficiency based on the evidence from the previous literature that showed more frictions in this market than in large customers. Our results show that liberalization policies are negatively correlated with prices even when adopted in a partial form or coexist with regulated tariffs for some categories. The effect of full liberalization is also relevant regarding switching rates by small consumers, thus suggesting that liberalization policies that change consumers' behaviour and increase freedom to choose can improve market efficiency in the long run.

There are some limitations to the generalization of our results. We have relied on a database of European countries as a unit of observation, but we are aware that a micro-based study on the consumer can be more effective in analyzing the effect of liberalization processes. We are also aware that prices are not the only factor affecting consumer welfare since the quality of the service and some complementary services can increase it, and the consumers could show a willingness to pay higher prices to enjoy a higher added value. Customers may also be willing to pay a loyalty premium to their traditional suppliers, although this effect and its welfare implications are unclear. Microdata on consumers could allow the analysis of both price and non-price dimensions. Several EU

Table 5
Estimation of the average treatment effects of formal and full liberalization on electricity prices. The other regressors are the same as used in Eq. (1). The estimation has been done using the Stata © routine tvdiff . Statistical significance levels are: *** p<0.01, ** p<0.05, * p<0.1.

VARIABLES	Formal Liberalization	Full liberalization
	(1)	(2)
ATE (1 vs 0)	−0.0129**	−0.0116
	(0.00625)	(0.00687)
Observations	479	479

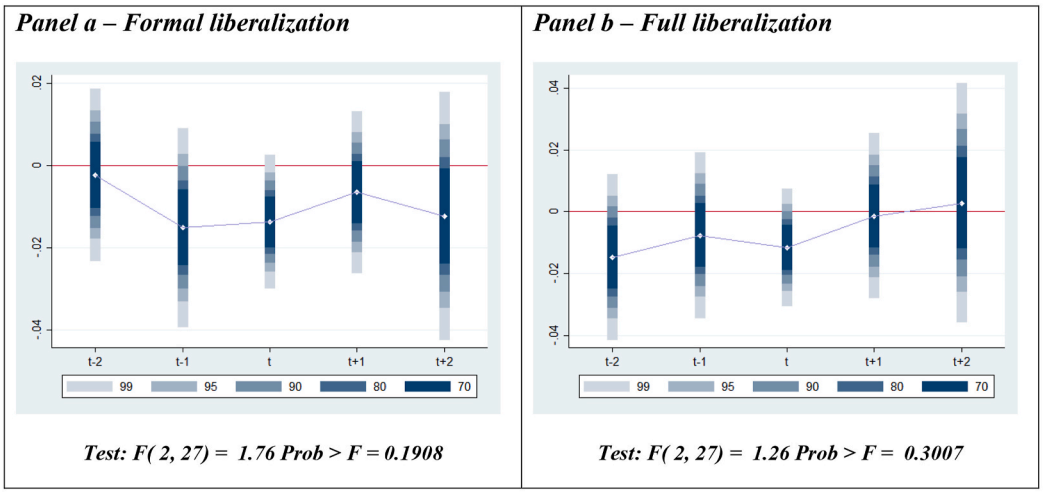

Fig. 2. Tests for Parallel trends assumption.

member states have introduced or are introducing centralized data hubs for switching and accessing the DSOs (distribution system operators) information (EC, 2021).

A second limitation is related to using a dummy variable to assess liberalization policies. Dummy variables are useful to indicate a change in the policies. However, they fail to account for differences in relevant aspects of policies in different countries, and they cannot account for the gradual response by market participants to the incentives provided by the policy changes. Some indexes have been proposed that assess the scope of retail competition in the electricity markets (IPA, 2015; EC, 2021), but panel data are not available as they cover only one year each. Other indexes (IBL, 2021; OECD, 2020) are available for a more extended period, but they cover the entire electricity market (including wholesale markets, network regulations, and retail markets) rather than retail markets alone. This approach is unsatisfactory and fails to provide more detailed information than a mere dummy variable does. A third relevant limitation is sample bias because not all the countries allowed switching in every year considered.

This paper confirms that the European Union's claim is proper, that liberalization may improve prices, quality, and consumer participation in the market. However, not all regulatory frameworks are equally effective in pursuing the desired objectives. While retail competition is likely associated with lower prices and higher switching rates, providing adequate information to the customers, contrasting market power, easing the switching and billing processes, and promoting customer engagement are necessary steps to make the promises of liberalization effective.

Even in light of the above-described limitations, the empirical results presented in the paper should be adequately considered in countries where the full liberalization of the electricity market is delayed and still upended by politicians who claim they want to ensure consumers' protection and welfare.

This paper contributes to a better understanding of retail competition in the electricity markets by providing evidence that the European approach to competition is well-designed and consistent with its stated goals. However, more precise and granular data are needed to improve understanding of the consumer behaviour and switching determinants and whether retail competition contributes to the achievement of other goals, such as the decarbonization of the European economy and the promotion of energy efficiency. Further research is needed to understand better each of these aspects and how the retail market's regulatory design may improve or hinder market functioning, consumer protection, innovation, sustainability, and active demand.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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