Electricity retail competition:
From survival strategies to oligopolistic behaviors

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Abstract

The advent of retail competition in the electricity industry was concomitant with the explicit emergence of electricity suppliers. Introducing competition at the retail level with strict unbundling was thought to imply major development of "asset-light suppliers" who neither own generating nor distribution assets. This theoretical model was envisioned even in an oligopolistic market, where suppliers compete in price and retail prices should be subsequently aligned on wholesale prices. However, in sharp contrast to this theoretical premise, asset-light suppliers'entry has never eventuated as expected. Entrants bankrupted, left the market, were taken over, or evolved towards integration into generation for market hedging purposes. Because of capacity constraints, retail competition could not be a Bertand-like price competition. Generally in a setting of multimarket competition, retail markets become the field of parallel pricing behaviors. Departing from this unexpected result, the paper shows in a first stage the necessity of vertical integration through physical hedging by comparing the risk profiles of different portfolios of hedging. In a second stage, it studies the effects of market structures on retail pricing behaviors. For this purpose, we compare the British and Norwegian markets, both considered in the literature as benchmarks of competitive markets, but with different multimarket setting, to highlight the price parallelism of British suppliers.

1. Introduction

In most countries where electricity industries have been liberalized in the most radical way, the development of retail competition has not given the expected results, particularly for residential & commercial consumers. In the UK mass market retail competition does not work effectively for the benefits of customers, as shown by the UK regulator's inquiry in 2008 (Ofgem Supply probe) and its subsequent radical propositions to enhance retail market functioning (OFGEM, 2011). Several studies on the Nordic countries (Johnsen and Olsen, 2008; Olsen et al, 2006) are also pointing retail market difficulties particularly in Sweden and Finland, which result both from consumers information limitation and industrial structures by contrast to Norwegian retail market.

The reference paradigm of competitive decentralized electricity markets which promotes pure players in generation and retail requires the unbundling of network activities and retail on one side; and restrictions in vertical integration between generation and retail, on the other side (Hunt 2002; Hunt and Shuttleworth, 1997). Therefore, introducing competition at the retail level was thought to imply the emergence and development of asset-light suppliers who neither own distribution networks nor generating assets. By offering innovative retail contracts, asset-light suppliers were expected to generate a fierce price competition between entrants and regional or national incumbents, themselves vertically broken-up by the competitive reforms, in their respective former license areas.

In this reference model of competitive decentralized markets, all suppliers have an identical sourcing cost, aligned on the spot price. In such setting, retail profits are constrained because suppliers are strongly incentivized to reduce their retail mark ups prices when spot prices are in a falling trend in order to keep their market shares. The expected resulting competition either in the standard pure and perfect competition or in the oligopolistic price competition, was supposed to put pressure on both sourcing costs (including minimizing the hedging costs of electricity sourcing) and operational costs (billing, marketing, information systems). Under conditions of transparent information, no switching cost for consumers, and on small entry and exit costs, electricity retail competition should be on price in a setting of Bertrand-like competition. As is well known such competition should be fierce with cost-reflective prices (i.e. to retail prices aligned on wholesale prices) Subsequently, such competitive setting should result to low profits, even with a small number of competitors.

The reality of retail competition is in sharp contrast to these theoretical premises. Asset-light suppliers bankrupted, left the market, were taken over, or evolved towards vertical integration into production in every country. Even in Great Britain, presented as a successful liberalized market with regional incumbents restricted by regulation to acquire generation assets up to 1998 (Helm, 2003; Thomas, 2006), twenty new entrants left the retail market since 2000 despite a pro-competitive institutional environment (Oxera, 2008). The few remaining entrants are positioned on a niche market (such as supply of “green” electricity from exclusively renewable sources) with an insignificant total level of market shares (0.5% in 2010). In Norway, another benchmark in terms of electricity liberalization and in which retail business is very fragmented for historical reasons between hundred of municipalities, there were some temporary entries on the market, like suppliers having another core business (as Statoil), or two independent suppliers which succeeded in building up a quite large customers base, but eventually they gave up the business or have been bought by established retailing-distribution groups.

Departing from these observations, our paper analyses first the viability of the asset-light supplier model in liberalized electricity markets. We demonstrate that physical hedging (i.e. vertical integration into generation) is the only efficient risk management strategy in liberalized markets. It is confirmed by the fact that most of the markets which have been liberalized along the decentralized market model are characterized by a move towards oligopolistic competition between mainly vertically integrated suppliers (Henney, 2006). This phenomenon raises the issue of imperfect competition on electricity retail markets in a setting of both oligopoly between vertically integrated suppliers and multimarket competition, which we analyze in a second step. The purpose of the paper is to explain the progressive structuring of the retail markets and the type of imperfect competition which results from this by a move away from the Bertrand-like competition. We adopt an original perspective by analyzing electricity suppliers as intermediaries whose main function is to manage market risks on behalf of their customers. Indeed, the complexity of electricity markets and the hourly spot price variability justify the existence of electricity intermediaries who receive from customers a “mandate” of delegated risk managers. This function incites them to be vertically integrated to avoid bankruptcy, which then incite them to depart from a Bertrand-like price competition.

The literature on electricity market can be classified in two categories: an empirical literature on the social efficiency of retail competition and a theoretical one on models of imperfect competition. The empirical stream has studied the costs & benefits of extended retail competition (Green & Mc Daniel, 1998; Joskow, 2000; Littlechild, 2000, 2005, 2009), and more specifically retail competition benefits for consumers (Waddams Price, 2004 and 2008;

Waddams Price & Wilson, 2007), in particular the costs and gains from switching to a new supplier (Giulietti and al 2004). In the second stream of literature, models of imperfect competition on the different stages of the electricity industry analyzed the impact of extended competition on efficiency, in particular the combined effects on generation investments and wholesale prices (Green, 2004). The impact of vertical relations between producers and suppliers on the performance of wholesale markets, via the exercise of suppliers'oligopsonic market power (Bushnell and al, 2008) was also studied. The issues of market power and market performance were also studied empirically through the eventual lag between the respective moves of wholesale and retail prices (Johnsen and Olsen, 2008; von der Fehr and Hansen, 2010; Giulietti and al, 2010).

The paper is organized as follows. Section 2 analyses electricity supply as an intermediation function focused on risk management and compares numerically the risk profiles of different sourcing portfolios to show the comparative advantage of physical hedging. Section 3 studies the effects of the non fulfillment of a Bertrand competition's conditions on the dynamic of competition within a multimarket competition. We show how suppliers are prone to adopt parallel pricing behaviors to maximize their retail mark ups along a wholesale price cycle when they compete in a multimarket configuration. For that purpose, we compare the British and the Norwegian retail markets, given that the Norwegian competition is not structured as a multimarket competition and consequently resembles somewhat to a Bertrand price competition. Given the absence of data on retail prices to industrial clients, our paper focuses on retail competition on the residential and commercial segments as all papers in literature on retail competition do (Giulietti et al, 2010; Davies et al, 2007; Green, 2004).

2. Risk management as the core function of electricity suppliers

Through their sourcing for resale, electricity suppliers are market intermediaries. Pure suppliers buy electricity on the day ahead market, contractually from producers (forward and or futures contracts of several months), or through virtual power plant (VPP) for delivery to their residential and/or industrial customers through retail contracts of different durations. Given that most residential customers are deeply risk averse to short-run price volatility and equally reluctant to undertake the actions required to continually monitor and control usage,[1] they tend ideally to opt for fixed retail prices contracts (Chao and al, 2005). Therefore,

[1] In part because customers have limited options to alter usage patterns or to invest in alternative appliances and production technologies, and generally they can obtain financial hedges against fluctuating rates (Chao et al, 2005).

electricity is essentially sold through annual retail contracts at a uniform fixed price whatever the level of spot prices, or through variable price contracts in which the retail price is readjusted only at few regular steps. In these standard retail contracts, prices are fixed somewhat above the average cost of service while wholesale prices change every hour or half hour. By choosing such purchase contracts, customers delegate risk mitigation to suppliers. This service which consists in inter-temporal smoothing of prices is rewarded through a risk premium included in the contractual fixed price[2]. Therefore, by protecting consumers against intra-annual price variations and intra-week price volatility, fixed retail prices are implicit call options on quantity limited by the capacity of the connection.

2.1 The risks of electricity intermediation

Intermediaries‘classical functions, as identified by the literature, are informational (Freixas & Rochet, 1997 ; Allen & Gale, 1997) and transactional (Benston and Smith, 1976 ; Campbell and Kracaw, 1980 ; Fama, 1980) with two types of intermediaries: physical and financial. The former (e.g. a discount store) adds value to a product through transformation, conditioning, and differentiation whereas the latter (e.g. a bank) provide financial expertise and advisory services to protect savers against the complexity and risks of financial markets. However, electric intermediaries are neither purely physical nor purely financial intermediaries, but rather hybrid ones. Indeed, in contrast to classical physical intermediaries, not only electricity suppliers do not benefit from storage to smooth the consequences of offer and demand fluctuations on the market, but also they cannot ration the supply to their consumers for two reasons: they do not physically deliver electricity and the short term demand of electricity is price-inelastic. Besides, electricity cannot be physically transformed and differentiation of offers is very limited given electricity’s homogeneity. Differentiation can only be reached through enrichment of offers (dual fuel contract where electricity and gas supply is bundled, energy efficiency services, green labeled electricity). Some services (e.g. flexible billing, maintenance) and pricing innovations can also be offered. Last but not least in terms of intermediation specificity, electricity suppliers have been imposed by the regulator the contractual responsibility to settle financially and balance physically their upstream and downstream portfolios of electricity in order to facilitate the real time system balancing task

[2] This risk mitigation effect originates from the difference between low volatility of spot prices over the long term compared to the high volatility of fuel and power prices in the short term (Geman, 2005). Therefore, customers are exposed to trends and only gradually.

assumed by the TSO in liberalized electricity systems. This financial matching on very short term markets (almost on a real time basis without storage) is related to a virtually physical matching[3] between the electricity bought and sold. These specific features give rise to structural quantity risk and price risk.

An electricity supplier is exposed to a quantity risk on the demand side over a short term horizon (from a few days, a few hours, to real time exposure) due to unanticipated load variations, (e.g. related to the imperfect predictability of weather conditions)[4]. This risk is amplified for the supply to residential customers where the retail contract is designed in reference to a "load profile" which organizes an imperfect market segmentation that allows a collective mechanism of metering instead of metering the consumer real consumption. Since electricity is not economically storable, all imbalances will have to be instantaneously settled on the spot market at unforeseeable prices in particular during peak periods when supply is even more inelastic. This non storability accentuates the complexity inherent to the classical matching function between any intermediary's sourcing portfolio and selling portfolio as annalysed by Hackett (1992), Gehrig (1993), and Spulber (1999). Furthermore, the strong positive correlation between price and demand in electricity wholesale markets (Stoft, 2002; Chao et al. 2005), contributes to make any adjustment very costly[5]. This load/price positive correlation is an important rationale for hedging.

Another source of quantity risk is the eventual loss of market shares, given customers' right to switch suppliers. Market shares variations will generate vertical imbalances constraining suppliers to sell or buy any over or under-contracted quantity at uncertain spot prices. Financial losses will occur in the absence of hedging mechanisms capable to match hourly demand variability. Quantity risks systematically translate into price risks.

The price risk is generated by the discrepancies between the selling price of electricity on the retail market (generally a one year or more fixed price contract on the residential & commercial segment or a smoothed indexed price in some other cases) and the price of complementary spot transactions to offset the disequilibrium between a supplier's sourcing portfolio and selling portfolio.

[3] The physical matching is virtual since electricity intermediaries have no control on the physical exchange of electricity between producers and consumers.

[4] Weather uncertainty can be theoretically mitigated through weather derivatives which exploit the correlation of electricity consumption with temperature. However, due to their speculative feature, difficulty of pricing, and lack of liquidity, weather derivatives are very seldom used by electricity suppliers (Geman, 2005).

[5] Indeed, suppliers will need to buy electricity when demand and consequently spot prices are high. Conversely any contractual surplus of electricity will have to be sold when demand and spot prices are low. In both configurations, spot market's interventions happen at the worst periods.

To minimize quantity and price risks, suppliers will aim at investing in physical assets with different technologies and also contractually hedge a proportion of their aggregated load requirements through the purchase of hourly electricity blocks with a minimum physical capacity of 1 MW[6]. However, in the absence of mathematical models able to measure each individual stochastic electricity demand, suppliers will define their sourcing by relying on the imperfect market segmentation of "load profiling". Besides hedging risks through contractual sourcing, suppliers can also potentially rely on interruptible retail contracts to manage their uncertain delivery obligations. With an interruptible retail contract, a supplier virtually sells a forward contract to its customer and buys a call option from him. The seller of the forward (i.e. the electricity supplier) can exercise the call option if the electricity spot price exceeds the strike price, effectively cancelling the forward contract at the time of delivery. Interruptible contracts allow for interruptions of electricity supply in exchange for either an overall discount in the contractual price of electricity delivered or for financial compensation for each interruption (Baldick and al, 2006).

2.2 The need for physical hedging

We now demonstrate through numerical simulations on risk profiles of different hedging portfolios the necessity to manage risk through physical hedging[7]. We assume that financial contracts are efficient risk hedging instruments and perfect substitutes to vertical integration, as numbers of authors do (Chao et Huntington, 1998; Hunt et Shuttleworth, 1998; Hunt, 2002). We demonstrate in particular that this assumption does not hold since a supplier cannot reproduce the risk-reducing benefits of physical hedging by contractual hedging. For that purpose, we set the supplier's risk management problem in the most competitive retail market configuration with retail contractual prices aligned on the spot price. In this configuration, the risk management constraint originates from a quantity risk which is associated to a price risk on the spot market. The risk profiles of the considered portfolios of hedging are measured with the traditional Value at Risk (VaR) indicator (Danielsson, 2007). The Value at Risk (VaR) is an aggregated measure of the total risk of a portfolio of contracts and assets. The VaR summarizes the expected maximum loss (worst loss) of a portfolio over a target horizon (one year in this paper) within a given confidence interval (generally 95%). Thus, VaR is

[6] Electricity bloc with a capacity below 1 MW (called electricity "ribbon") cannot be bought in advance (Hunt, 2002).
[7] Our methodoly is more detailed in Boroumand, R.H & Zachmann, G., (2009).

measured in monetary units, Euros in our paper[8]. As the maximum loss of a portfolio, the VaR(95%) is a negative number. Therefore, maximizing the VaR is equivalent to minimizing the portfolio's loss. We rely on the Value-at-Risk because it is a relevant measure of the downside risk of a portfolio and is for example used as preferred criteria for market risk in the Basel II agreement. The Value-at-Risk for the 95% confidence interval that we use in the remainder of the paper is the one hundred fiftieth lowest of the 3000 payoffs.

Payoff of the assets and contracts within the portfolios

A supplier is assumed to have concluded a retail contract (the retail contract is given *ex ante* and is therefore not a portfolio's parameter of choice) with its customers that imply stochastic demand $\tilde{V}_t$ (for $t = 1{:}T$). The demand distribution is known to the supplier and the uncertainty about the actual demand $\tilde{V}_t$ is completely resolved in time t.

To fulfill its retail commitments the supplier can buy electricity on the spot market at the uncertain spot market price $\tilde{P}_t$.[9] The spot market price distribution is known by the supplier. To reduce its risk from buying an uncertain amount of electricity at an uncertain price, the supplier can conclude financial contracts and/or acquire physical generation assets All contracts (including the retail contract and the physical assets generation volumes) are settled on the spot market that is assumed to be perfectly liquid. Thus, the payoff streams depend on a given number of spot market realizations (one year, i.e., 8760 hours). For example, an annual baseload forward contract implies buying the agreed volume of electricity at the contractual price for 8760 hours.

In Table 1 five different contracts/assets – namely a retail contract, a forward contract, a semi baseload power plant, a call option[10] on the spot price and a put option on the spot price[11] given the spot price – are introduced with their payoff. If for example, the electricity spot price ($\tilde{P}_t$) is above the strike price of the options (X), there is a positive payoff of the call option, while the payoff of the put option is zero. The payoff of the power plant, depends on the installed capacity of the plant (V_{plant}) and its marginal cost (mc). The payoff of the retail contract is the only one which depends on the stochastic demand $\tilde{V}_t$. By subtracting the

[8] For further details please refer to Ph.Jorion. "Value at risk: The New Benchmark for Managing Financial Risk" Mc Graw Hill, second edition, 2000.

[9] We ignore balancing markets. This can be justified by the fact that most of the adjustments of retailers take place in the day ahead market.

[10] Many papers develop models with financial options (see for example Willems and Morbee, 2008; Deng and Oren, 2006)

[11] A put option on the spot price, gives the supplier the right to sell electricity on the spot market at a given price.

expected value ($E(\cdot)$) from the gross payoff all contracts/assets are assumed to have zero expected value. That is, we assume that in a perfect market (no market power, no transaction costs, full transparency, etc.) arbitrage would not allow for the existence of systematic profits. Without this postulate, the method for the evaluation of contracts and assets would drive our results. Indeed, the net loss calculated for each portfolio would be strongly determined by the valuation method of the assets or contracts within the portfolio. By assuming a zero expected value, the net loss of different portfolios can be compared without bias inherent to the types of contracts or assets composing the portfolio.

Table 1: Payoffs of different contracts/assets given the spot price ($\tilde{P}_t$)

Contract	Payoff
Retail Contract	$\pi_{retail,t} = -\tilde{P}_t \times \tilde{V}_t + E(\tilde{P}_t \times \tilde{V}_t)$
Forward	$\pi_{forward,t} = V_{forward} \times \tilde{P}_t - E(V_{forward} \times \tilde{P}_t)$
Power Plant	$\pi_{plant,t} = V_{plant} \times max(\tilde{P}_t - mc, 0) - E\left(V_{plant} \times max(\tilde{P}_t - mc, 0)\right)$
Call Option on Spot	$\pi_{call,t} = V_{call} \times max(\tilde{P}_t - X, 0) - E\left(V_{call} \times max(\tilde{P}_t - X, 0)\right)$
Put Option on Spot	$\pi_{put,t} = V_{put} \times max(X - \tilde{P}_t, 0) - E\left(V_{put} \times max(X - \tilde{P}_t, 0)\right)$

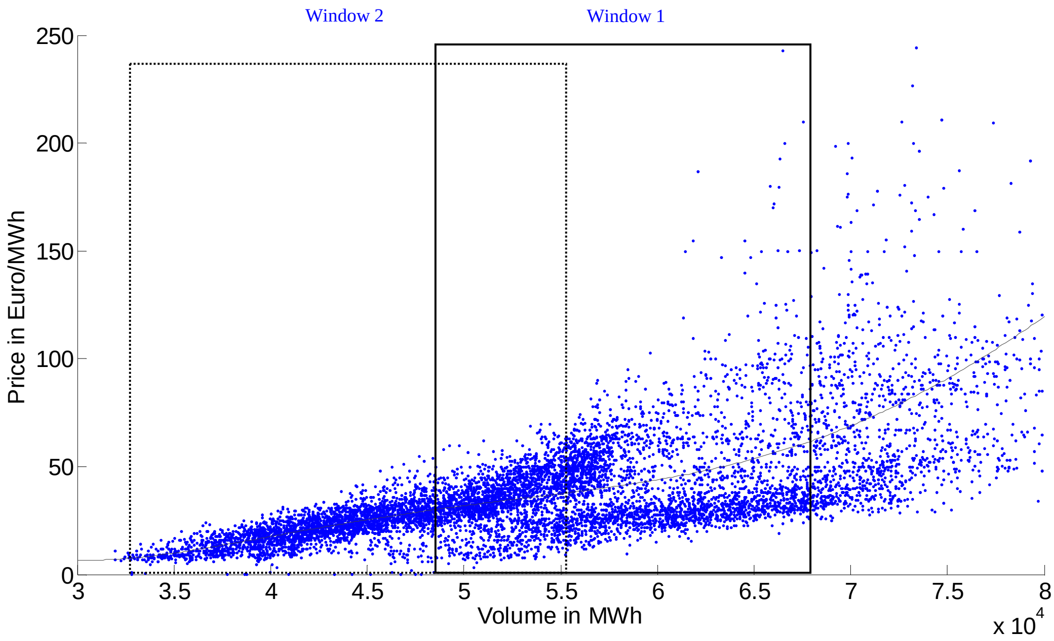
Methodology of numerical simulations

To simulate the payoffs some assumptions on the distribution of the electricity spot price and retail volume have to be made. We rely on real data of the French electricity market from 2006 and 2007. The hourly prices are obtained from the French electricity exchange Powernext and the corresponding loads are obtained from the network operator RTE. Electricity prices depend non-linearly on the total load (see Figure 1). Thus, load and prices are strongly (although not perfectly) correlated (46% in the sample period) and load increases have a stronger impact on prices than load decreases. To obtain realistic simulations we sort the observed price-load combinations by load. Then, the central points (medians) of 3000 windows of 8760 neighboring observations are drawn from a truncated normal distribution.[12] Note that, due to the normal distribution, windows with a median load closer to that of the

[12] The mean of this distribution is 8760, representing the central point of the 2 years data. The variance of the central points is 8760/4)^2. The distribution is truncated below 8760/2 and above 17520-8760/2 to fit the data sample.

observed sample are more likely than windows with a median very different from that of the real data. Finally, from each of the 3000 windows we draw randomly with replacement 8760 hourly price-load combinations. Consequently, in expectation the median of the observed data (load) is equal to that of the simulated data.[13]

Figure 1: French Prices and Volumes in 2007



The marginal generation cost of the power plant is set to the median of the simulated spot prices $mc = 39.0$ Euro/MWh, thus representing a peak load power plant. The strike price of the options is set to the expectation value of the spot price $X = E(P_t) = 43.0$ Euro/MWh. This is done to make call options and power plants distinguishable as they are equivalent according to Table 1 if $X = mc$. The intuition of setting the marginal cost to the median price is that thus, the power plant will run exactly 50% of the times. The intuition of setting the strike price to the mean price is that the option is “at the money” in this case.

[13] Due to the non-normal (joint) distribution of the observed data, the mean of the simulated load is slightly lower (54 instead of 55 GW) than that of the observed loads in 2006-2007. The mean price of the simulated data is slightly lower than that of the observed data (43 instead of 45 Euro/MWh) and the median of the simulated prices is higher than that of the observed data (39 instead of 38 Euro/MWh). The variance of the mean (median) price across the 3000 simulations is 29 (20).

The risk minimization

We can calculate the cumulated annual payoffs of the 8760 hourly price/volume combinations for all 3000 simulations given the portfolio ($V_{forward}, V_{plant}, V_{call}$ and V_{put}):

$$\pi^i = \sum_{t=1}^{8760} \left[\pi_{retail,t}\left(P_t^i, V_t^i\right)\right] + \left[V_{forward} \times \pi_{forward,t}\left(P_t^i\right)\right] + \left[V_{plant} \times \pi_{plant,t}\left(P_t^i, mc\right)\right] + \left[V_{call} \times \pi_{call,t}\left(P_t^i, X\right)\right] + \left[V_{put} \times \pi_{put,t}\left(P_t^i, X\right)\right]$$

Thus, π^i is the annual payoff of the i^{th} price and volume simulation given the portfolio defined by $V_{forward}, V_{plant}, V_{call}$ and V_{put}.

Using an optimization routine[14], the portfolio that produces the lowest VaR(95%) can be identified. The objective is to find the portfolio consisting of 1 MWh baseload retail contract and a linear combination of financial contracts as well as physical assets that reduces the supplier s' risk. Thus, the factors for the other contracts/assets are also measured in MWh. If the supplier, for example, sold two retail contracts of 1 MWh and if he would like to hedge this deal with only forward contracts (compare #4 in Table 2), he would have to buy (2 x 0,98 MWh) 1.96 MWh forwards. Any imbalance between the electricity sold and purchased (or produced) is settled in the spot market. The volume generated by the power plant is constrained to be positive, while call option, put option and forward contracts could be both bought and sold at the market (i.e., negative quantities are allowed). In five different scenarios we constrain the volume of certain contract types to zero. Thus, the cost to substitute one type of contract by another type for hedging a supplier' risk can be assessed.

[14] We use the „fmincon“ routine in Matlab. As the routine does not necessarily converges for this non-linear problem (especially for the three and four assets case), we rerun the optimization for each case with 100 different randomly drawn starting values. The result of the best run can be considered sufficiently close to the global optimum, as all results tend to be within a fairly narrow range.

Table 2: Portfolios containing one retail contract and hedging contracts that maximize the VaR(95%)

#	Used assets	Retail	$V_{forward}$	V_{plant}	V_{call}	V_{put}	VaR(95%)
1	All contracts	1	-0.04	0.26	1.24	-0.27	-2,088
2	without options	1	0.09	1.33	-	-	-2,131
3	only options	1	-	-	1.47	-0.28	-2,092
4	only forward	1	0.98	-	-	-	-12,942
5	only power plant	1	-	1.46	-	-	-2,201

The optimal portfolio if all assets are allowed (portfolio #1) has a VaR(95%) of -2,088 euros. Portfolio #1 consists in selling 0.04 MWh of forward, generating 0.26 MWh with the plant, buying 1.24 MWh on a call option, and selling 0.27 MWh with the put option. Portfolio #2 consists in buying 0.09 MWh forward and producing 1.33 MWh. Portfolio #3 consists in buying 1.47 MWh with a call option and selling 0.28 with the put option. Portfolio # 4 consists in buying 0.98 MWh forward. Portfolio #5 consists in generating 1.46 MWh.

Without plants or forwards a VaR(95%) very close to that of the unconstrained optimal portfolio (#1) can be attained if options are allowed (#3). If options cannot be chosen, the risk management characteristics of #3 can be reproduced without options if power plants and forward contracts are allowed (portfolio #2). With only forward contracts allowed (#4), the VaR(95%) is more than six times bigger than if both power plants and forward contracts are available portfolio choices (portfolio #2).

Through this analysis we provide evidence that a supplier can hedge the market risks originating from a standard retail contract by either a combination of forwards and options or by a combination of forwards and physical assets whose payoffs feature option-like characteristics. However, in all observed electricity markets, liquid derivatives (financial options) are absent (Geman, 2005; Hull, 2005). Thus, the only real choice for a supplier is to hedge its retail obligations through physical assets. In our example the VaR(95%) with physical assets (such as portfolio #5) decreases by more than five times compared to a situation where only forward contracts are used (portfolio #4). Consequently, as long as electricity options are not sufficiently liquid, suppliers will strive to vertically integrate to better hedge their risk exposure.

However, if the price risk can be hedged because part of electricity would be storable (hydraulic system) or could be partially transferred to customers (to some or to a majority of them), then the need for physical hedging would be less pregnant. In a hydraulic system, the variability of wholesale prices is seasonal rather than hourly, favoring real time pricing and the subsequent alignment of spot and retail prices. The wholesale price of electricity is aligned on the long term opportunity cost of hydraulic electricity. The hourly price is much less volatile than within a thermal system where the marginal cost of electricity would be based on the gas price (as is the case in Great Britain where gas is the marginal technology). With such setting of spot price variability, electricity could be sold through (smoothed) real time prices' contracts to a substantial number of consumers (for instance in Norway in 2008, 65% of Norwegian customers are on some types of variable price contracts[15]). With such retail contracts, suppliers sourcing power from the wholesale market face a lower price risk.

3. Vertical integration, multimarket competition and strategic behaviors

In an oligopolistic competition without vertical integration (i.e. by assuming that all suppliers can source electricity on indefinite quantities from the spot market), retail competition should be on price (i.e. with retail prices aligned on wholesale prices). Price competition should subsequently lead to low profits, even with a small number of competitors. Indeed, in absence of capacity constraints between firms with identical costs, competition for a homogeneous product looks like a Bertrand price competition respecting three main conditions[16] (Tirole, 1988). In presence of partially or completely vertically integrated suppliers, we must depart from this theoretical assumption. Indeed, suppliers with physical generation assets face capacity constraints[17]. The latter impedes any competitor to capture entirely the market. The hypothetical alternative would be a setting of quantity-competition where retail prices are misaligned with the marginal price of sourcing, which has to be to be the wholesale spot price. Indeed, the price of internal transactions between the generation and the supply arms of

[15] Standard-variable or spot-price contracts

[16] The process leading to such equilibrium is simple: if a firm's price is higher than those of its competitors, the later would capture all the market. Therefore, the firm has to offer a price slightly inferior but the competitors would react similarly until none of them is in a position to reduce its price, making losses otherwise. In this setting, the only possible equilibrium is the one where the price is aligned on the identical cost of any of the firms. However, there are conditions for such result: product homogeneity (which is the case for electricity), identical costs to reach an equilibrium with all the firms (which is almost the case), but with no capacity constraints (each firm can potentially take all the market).

[17] Kreps and Scheinkman (1983) show that the Bertrand equilibrium is analogous to a Cournot equilibrium when limits are imposed on productions by the original capacities of the players.

a vertically integrated company is aligned on the spot price in a logic of opportunity cost[18]. So we have a theoretical explanation of eventual misalignment of wholesale and retail prices.

In order to explain empirical observations of such misalignments between wholesale and retail prices on the markets studied (British and Norwegian), we consider another dimension of electricity retail competition within a country. This dimension, rooted in the institutional history of an electricity supply system, is the multimarket dimension of retail competition in the former historic areas of public utilities. Indeed, in each area competition is mainly between the incumbent and entrants who are themselves incumbent in another area. Competition can be enlarged to gas and electricity retail markets, given that gas incumbent in a geographic area (or in its national area when it used to be the national monopoly) compete with its dual fuel offers against electricity incumbents in their historical areas.

Multimarket competition theory identifies potential entrants as existing firms on adjacent markets. In such configuration, firms meet the same rivals in several markets, which stabilizes the competitive game nationally (Gimeno and Woo, 1999). Each supplier is conscious that any conquering strategy on different regional markets will generate down price alignments of all competitors in all regional markets and, subsequently a general erosion of profits. Thus, no supplier has interest in misaligning its pricing strategy from the implicit coordinated strategy, thus leading to a phenomenon of “mutual forbearance” (Jayachadran et al, 1999). This phenomenon rooted in the absence of competitive entries in each area explain the emergence of tacit collusion without need of explicit price agreements (Vives, 1999). Parallel pricing can emerge in a setting of multimarket competition, in particular when all incumbents are entrants in other markets. In electricity and gas retail markets, it is a fact that there are very few entrants in a geographical market which are not incumbents in other geographical markets.

To analyze pricing strategies, we observe asymmetrical time-lags in the pass-through of wholesale price changes to retail prices or even a misalignment between retail and wholesale prices alongside a wholesale price cycle. This approach for identifying oligopolistic behavior in retail competition on a commodity market is inspired by Borenstein et al. (1996 and 1997) who studied the retail market of two oil product prices (heating oil and gasoline). These authors showed asymmetry of responses to changes in crude oil price with faster responses to increases than to decreases for gasoline price, but not for heating fuel. The authors interpreted

[18] If the variable cost of the supplier’s marginal equipment electricity is inferior (versus superior) to the spot price, it will benefit respectively the supply (versus generation) arm of the company; the effect on the total mark up is neutral.

this as reflecting short-run market power exercised by retail gasoline companies. This short-run market power is explained by buyers' imperfect information, comparatively to the heating fuel market.

On electricity retail markets where competitive pressure is already restricted through product differentiation and innovation, the lag between retail and wholesale prices movements could be explained by several factors: the lack of competitive pressures from imperfectly informed customers, the passiveness of many customers sticked to their historic supplier, and the incentives of suppliers to adopt parallel pricing behaviors. These incentives are inherent to the setting of multimarket competition.

To bring to light the parallel retail pricing behaviors subsequent to the vertical integration of British suppliers, we compare the British retail market with the Norwegian retail market. In both markets, consumers are well informed and do not support high switching costs by difference to other retail markets (Henney, 2006, Ofgem, 2008; Olsen et al., 2006; VaasaETT, 2010). We select Norway and Great Britain, because given the price transparency and low switching cost in both markets, this allows to isolate the dimension "multimarket competition" as determinant of the competition. This comparison will show different pricing behaviors alongside a wholesale price cycle.

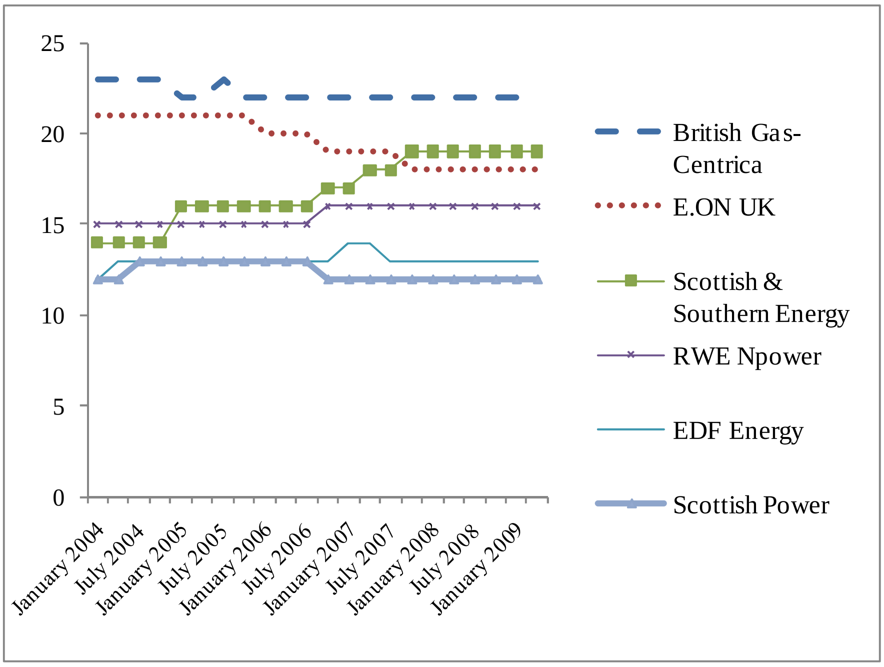
3. 1. The industrial structures of the British and Norwegian retail markets

We first characterize the industrial structures of the two retail markets.

- **The British market structure**

Before liberalization, the British retail activity was structured around twelve Regional Electricity Companies (REC) in England and Wales, two vertical electricity firms in Scotland, and one national gas distribution incumbent (British Gas-Centrica). The electricity regulation imposed the vertical separation between generation, transmission and supply, with restriction on vertical integration between generation and supply for historic suppliers up to 1998 and with clear unbundling between supply activity and grid. The completion of the liberalization process on the residential market segment (achieved in 1999) was followed by a strong market concentration (the twelve historical incumbent suppliers in England and Wales and the two Scottish suppliers were controlled by only six companies in 2005) while it gave rise to a multimarket competition on the former historical supply areas. Independent suppliers did not succeed in developing a sustainable business, as mentioned above. Any entrant in a region is an incumbent in at least one other region, with the notable exception of British Gas-Centrica which has a singular position by being simultaneously the national gas incumbent in the former national gas license area, and an electricity entrant in competition with the former electricity incumbents in all regions. This market structure explains that retail competition mainly developed by the dual fuel offer, in which consumers are being offered electricity and gas in a single contract. Selling electricity and gas separately or within a dual fuel offer, their market shares are stable (figure 3 on electricity market shares) after a first period of fierce competition consecutive to the opening up of the residential segment in 1998-1999 and Centrica's entry (Ofgem, 2004).

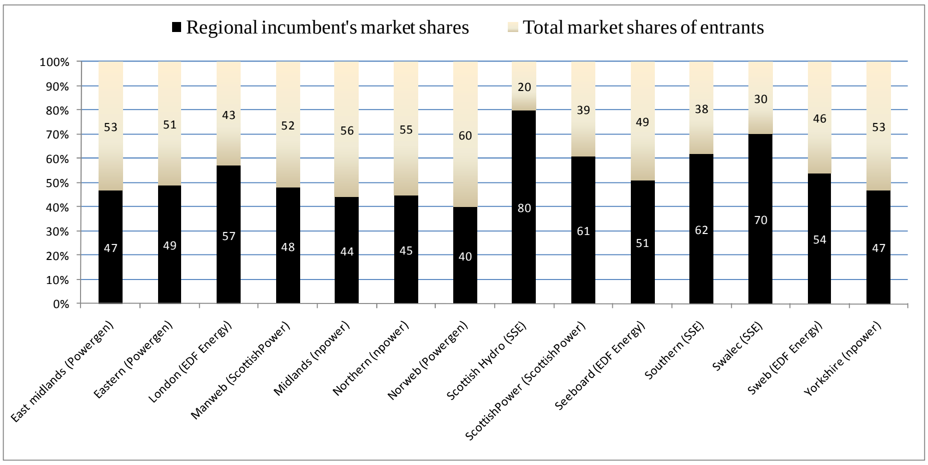
Figure 2 : Electricity residential market shares from 2004 to 2009



Source : Companies' annual reports 2004-2009

It is noticeable that in every region, the regional incumbent, who can rely on a core business of sticky consumers, remains the market leader (figure 4).

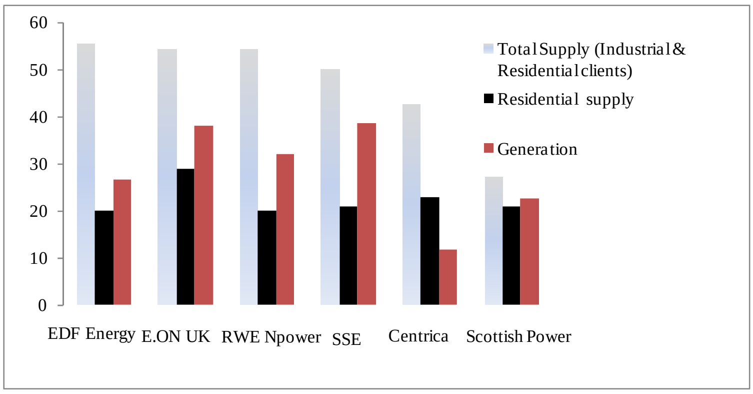
Figure 3: Respective share of incumbents and entrants in the 14 regional areas



Source : Ofgem, 2008

The six suppliers become quasi-vertically integrated and virtually able to cover physically, not only their residential sales, but also a large part of their industrial sales (figure 2).

Figure 2: Degree of vertical integration of the six suppliers on both their residential and industrial segments (TWh, 2008)



Source : Companies' annual reports 2004-2009

- **The Norwegian market structure**

In Norway, the retail sector is very fragmented with different types of companies in terms of both size and ownership. Since a certain move of concentration between 1995 and 2004, there are around 150 suppliers, but most of them are municipalities.

Table 3: Comparison of the retail market structures in Great Britain and in Norway

	Great Britain	Norway
Type of unbundling	Legal unbundling since 2000	Legal unbundling for business of more than 100,000 customers
Number of suppliers in 1994	14	224
Number of suppliers in 2004/2007	Total 10-15	Total 150-160

	With more than 50 000 customers : 6	With national coverage : 17
Market shares on the retail market Largest	22%	30-40%
Largest 3	59%	50-60%
Largest 6	99%	60-65%
Market shares on the residential market		
Largest	22%	20-25%
Largest 3	59%	35%
Largest 6	99%	45-50%

Source : Lewis et al. 2004 ; van der Fehr et Hansen , 2008

In Norway, there is no strategic move towards vertical integration. Indeed, ownership of generation plants or long term access to hydro plants generation by some suppliers is related to historical reasons. These municipal or regional ownerships of hydro plants were maintained throughout the liberalization process. Conversely there are no entities with generation as the core business, at the exception of the national hydro producer Statkraft which produces around 30% of the Norwegian electricity and sells 80% of its production (45 TWh on 58 TWh) to large industrial consumers and municipalities. Statkraft is weakly integrated in the retail supply (with only 400 000 customers).

The Norwegian market is much less concentrated and could be considered as more competitive than the British one. Besides, while 1% of the British consumers are not with the “big 6” suppliers, more than 50% of the Norwegian consumers are not supplied by the main 5 suppliers. As mentioned previously, there have been some temporary entries on the market, like suppliers having another core business (as Statoil), or independent suppliers with electricity retailing as their core business with notable examples as Norgesenergie and Frokbrukerkraft which both succeeded in building up a quite large customer base, but were eventually bought by established retailing-distribution groups (respectively Hasflund and Agder Energy). There has been also a market concentration mostly explained by larger suppliers taking over the business of their smaller neighbors (von der Fehr and Hansen, 2010). But, more importantly on the 158 suppliers in 2007, only 17 have a consistent business outside their historic area. The others, which are under municipal or district ownership, do not supply electricity outside their historical area.

On the 27 regions, the historic regional supplier keeps in average a dominant position of 73% (the market shares of the respective dominant suppliers varies from 29.8% to 95%) while the number two is in average at 10% (NVE, 2008, von der Fehr, 2008). Those who sell electricity outside their area have not an extended coverage: the Norwegian authority NVE shows that, 11 suppliers are in the top five in 2 to 5 areas, and only 4 suppliers are in 11 or more areas. Eleven suppliers represent the main competition to the incumbent suppliers and 4 suppliers seem to be the truly national and effective suppliers. This fragmented structure with no homogenous positions of respective incumbents in other areas than theirs, do not contribute at all to the development of a multimarket competition.

Another element influences the Norwegian competitive game. Suppliers who do not compete in other areas are not endowed with a market culture and do not look for profit maximization. They do not behave as private players with strategic behaviors. Indeed, local municipalities own concessions on hydraulic facilities that provide them with cheap power and make easy for them to strictly follow the Nordpool price to define their retail prices by applying a constant retail mark up (von der Fehr and Hansen, 2010). Statkraft, the main generator which is long in generation, sells part of its electricity at cheap prices to municipalities. They use their own hydro-electricity and the one bought from Stakraft to keep their retail prices at low levels for their local customers and their non core customers in other areas. Those who do not look for profit maximization represent a sort of competitive benchmark for the regulator who relies on them as a "shaming mechanism" against the more highly priced suppliers (Lewis et al, 2004).

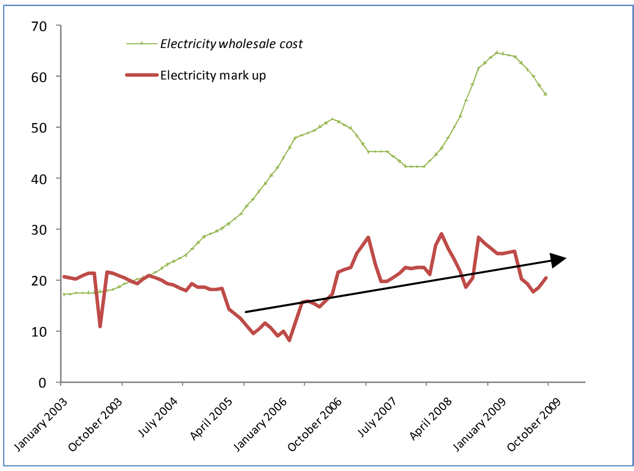
3.2. Wholesale costs and retail mark up: Great Britain *versus* Norway

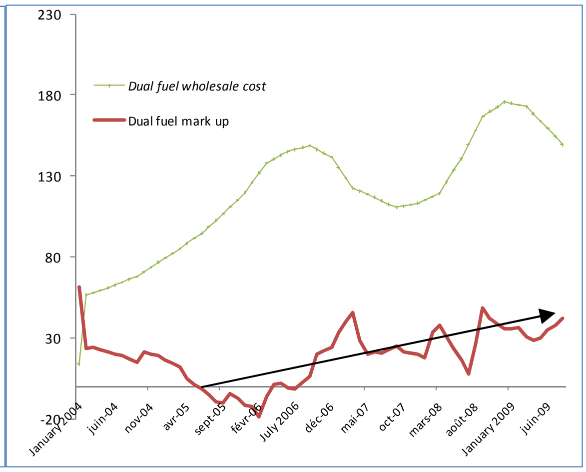
Comparing the evolutions of wholesale and retail prices in Great Britain and Norway shows contrasting results. Alongside the wholesale price cycle, there is not a strong alignment between spot and retail prices on the British market, as shown by the electricity retail mark up curve's evolution (figure 5 as shown by the linear trend curve), while there is a strong alignment in Norway between wholesale and retail prices leading to a constant mark up.

Figure 5 : Trends in year-ahead wholesale price and retail mark-up on electricity and dual fuel retail markets (£ per MWh)

Electricity mark up

Dual fuel mark up





Source : Ofgem 2008, and Spectron Data 2003-2010

For comparing the evolution of wholesale and retail prices, we refer as the British regulator to monthly averages of the one year forward electricity price (Ofgem, 2008). It makes sense for the British retail market since prices of annual retail contracts are based on the one year forward price. By using market-based prices to estimate wholesale costs even if suppliers rely on different sourcing mechanisms (generation, long term contracting,,,…), we price electricity at the price which suppliers are able to resell it on the wholesale market, following an “opportunity cost methodology”. The Average Revenue per User (ARPU) is the average annual bill paid by a residential consumer and weighted in relation to the share of each three payment method for a standard consumption of 3.3 MWh per year. ARPU is calculated from the real monthly prices charged by the “big 6” suppliers and here it is expressed in £ per MWh [19]. Then retail mark up is given by subtracting from the ARPU, the wholesale price, network & metering costs, and environmental charges per MWh. We proceed in the same way for the dual fuel retail market by mixing the sourcing costs of electricity and gas[20].

It can be seen (figure 5) that the retail mark-up follows an increasing trend despite the wholesale prices’ net rise alongside the wholesale price cycle and whatever the step of the price cycle which, by the way, has warned the regulator who requested an inquiry in 2008.

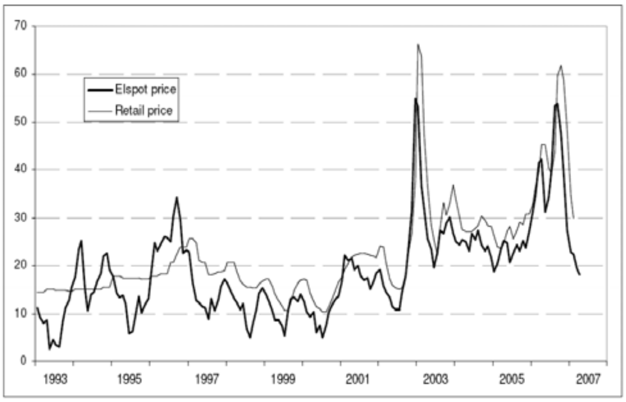
[19] In a first step, the three regional prices of each supplier (one price per payment method: “direct debit” price, “standard credit” price, and “prepayment” price) are weighted averaged to give a single national price per consumer and payment type. Then, in a second step, these national averages are weighted by proportion of customers on each payment method and by market share of each supplier.

[20] The ARPU and mark up of dual fuel are calculated following the same methodology as for electricity. The wholesale cost of dual fuel is resulting from adding the wholesale cost of sourcing electricity and gas for the corresponding quantities of a dual fuel contract.

Comparing the electricity retail mark up with the dual fuel retail mark up highlights the more competitive dynamic of the dual fuel segment where the mark up is more impacted by wholesale prices movements (with even a negative mark up between July 2005 and July 2006). From the beginning of liberalization of residential markets to 2005, the former electricity incumbents and British Gas-Centrica were using the dual fuel offer to price discriminate between their passive core customers and their new dual fuel customers to corner market shares in other geographical markets. (Nalebuff, 2004). Then, after stabilization of market shares, profits have been positive with no impact of price moves, but at a lesser extent than for the sole supply of electricity. For dual fuel submarket, profits remain lower than for electricity. This is explained notably by the fact that dual fuel customers are less sticky than electricity core customers since they have already switched at least once and are presumably more engaged in the competitive game.

In contrast, Norwegian wholesale and retail prices are strongly aligned given the dominance of variable retail price contracts (figure 7)[21]. Electricity retail prices incorporate spot prices' fluctuations with a smoothing effect, and only with a short lag (von der Fehr & Hansen, 2010; Johnsen and Olsen, 2008). This lag is explained by the regulatory delay of two weeks to change retail prices in Norway (Johnsen and Olsen, 2008). The average Norwegian mark up of the different suppliers is small and stable, between 7.2% and 13% (von der Fehr and Hansen, 2009), while the average mark up on the electricity retail price of the big 6 varies between 8.9% and 29.6% between 2003 and 2010.

Figure 6: The alignment of electricity retail price and spot price in Norway (øre/kWh) between 1993 and 2007



Source : Johnsen and Olsen, 2008

[21] Spot price is the Elspot Price and retail prices are weighted averages for all retailers and all different contract types ("standard variable", "spot price", and "fixed price"). There are no dual fuel offers in Norway.

The strong alignment of the retail and wholesale and retail prices (energy part of the retail price) with a constant and quite small mark up even during periods of large price variations shows that Norwegian suppliers use the wholesale price as an opportunity cost to their production. They do not seize the opportunity of having higher mark ups during periods of prices fall or very low spot prices. A comparison to the British market suggests that it does not result from differences in customers' informational and switching costs but is related to two features. The first one is the fragmented structure of the Norwegian retail market with a specificity: a number of municipalities which behave virtuously and serve as a benchmark for the regulator to hinder oligopolistic pricing of active competitors. The second one is the absence of multimarket competition.

Market institutions allowing customers to be informed and to easily switch are as much developed in Great Britain and Norway (table 4). The misalignment of retail prices on wholesale prices comes from the market structure which is not only more concentrated in the British case but also which corresponds to a multimarket competition.

Table 4. Comparative switching rates in Great Britain and Norway for 2009

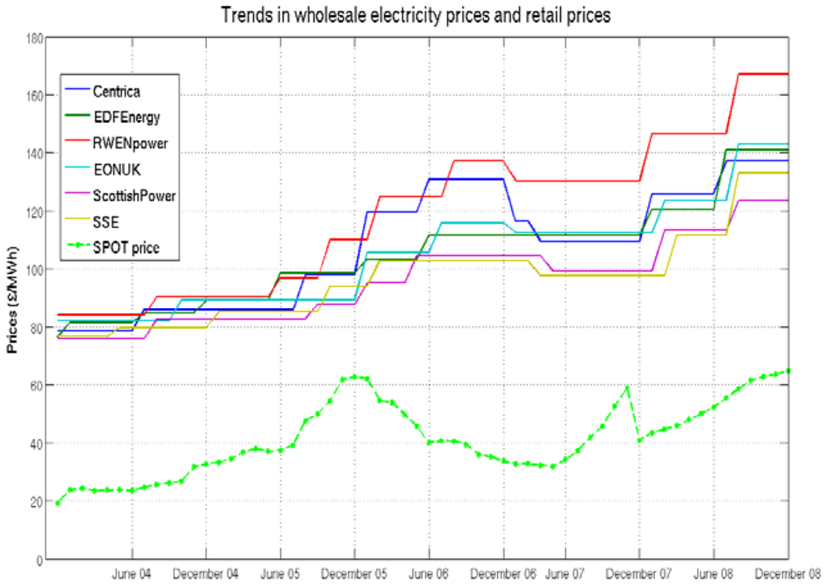
	Great Britain	Norway
Annual Switching	19%	8.1%
Cumulative switching	48%	44%

Source : Ofgem, 2010, "*Customer Engagement with the Energy Market – Tracking Survey*", March 2010 (Ipsos Mori) & VaasaETT 2010, *World Energy Retail Market Rankings Report 2010*

3.3. Individual pricing strategies along the wholesale price cycle in the British and Norwegian market

The British retail market. Its structure with six vertically integrated suppliers interacting repeatedly on 15 markets -the 14 historical regional areas and the national gas market area – without threat of entries leads to a lack of competitive pressure which is reflected in the parallelism of pricing behaviors (figure 8). In this setting of multimarket competition, suppliers' price behaviors show that they all follow one single strategy which consists in securing short term profits through higher prices than the wholesale market price instead of offering low prices to corner market shares on a longer run. This process which is continuously at work alongside the wholesale price cycle is amplified when wholesale prices decrease.

Figure 7: Trends in suppliers' revenues per MWh and wholesale prices between 2004 and 2008



Note: In the calculations, the retail prices are the averages national prices of each supplier for a standard annual consumption level of 3.3 MWh. The six average prices are calculated from the three prices (one for each payment method) of each supplier in each region (14 regions). Then we divide these resulting six national mean prices by 3.3 in order to compare their evolution to the curve of the smoothed (exponential smoothing) spot price per MWh.

Source: ConsumerFocus data, 2008, Heren and Ofgem data (2002-2008)

After a first period of fierce competition in the respective historical areas between 1998 and 2003, no supplier had interest in misaligning its pricing strategy from implicitly coordinated pricing between each another. Figure 8 highlights the parallelism in rapid increases of the retail standard contractual prices offered by the "big 6" suppliers when the wholesale price increases, while no systematic decreases are observed when the wholesale prices fell. We refer in this sub-section to the spot price instead to the 1-year forward price as done above since the suppliers themselves claim that their retail prices increases are consecutives to spot prices' raises while they even do not follow the spot price downwards move after the change of the wholesale price (Ofgem, 2008).

Analysis of individual annual contract prices shows clearly that suppliers increased their prices between January 2004 and December 2008 on different but very close periods in relation to spot price increases As shown by figure 8, wholesale price fell strongly between January 2006 and June 2007 and again from December 2007 with no significant effects on retail prices in 2007 and even 2008. Consequently, whatever the level of wholesale prices, not only mark-ups are maintained in periods of fall of wholesale prices, but in fact increased leading to an asymmetric pattern.

Suppliers justified these price increases by the raise of spot prices due conjointly to gas price increases and the introduction of a carbon price (Ofgem, 2008). However, when spot prices fell strongly from 2006 (figure 8), the fall was very partially transferred to retail prices arguing that their weighted average cost of sourcing was above the spot price. On average because of the retail prices' parallelism, net increase had no impact on market shares between 2004 and 2009 (figure 4), showing that a high level of switching (19 % in 2009 for instance) is not evidence of a lively competition. So with the help of this set of multimarket competition, suppliers prefer to adopt parallel pricing behaviors in order to benefit from a collective market power which enables profit maximization to the detriment of consumers' surplus. Suppliers rely on their basis of passive customers and market leadership position in their former historic regions to maintain high profits whatever the level of spot prices.

The Norwegian situation. In Norway, there are no parallel pricing behaviors despite the numerous points of contacts within a market structure which could be perceived *a priori* as a multimarket one. In fact as mentioned, there are only 4 suppliers coming from the larger municipalities or district utilities which have a national coverage and around 10 which are a bit diversified in no more than 4 areas. And this fragmented structure with no homogenous diversification of the respective incumbents in other areas than theirs, do not lead to a multimarket competition. With the geographical retail prices published by the Norwegian Competition Authority since mid-2003, von der Fehr and Hansen (2009) show that the average mark up of retail prices over wholesale prices is small.

Moreover, most suppliers kept their mark up constant, during the price cycles reflecting the scarcity or the abundance of hydrologic conditions, although there are very few exceptions of both upwards and downwards adjustments. These authors show that there is no systematic difference between the five larger suppliers' prices. Their mark ups have also tended to move downwards to a bit lower level, which is explained by the threat of new entrants coming in with lower mark ups than those of incumbents (von der Fehr and Hansen, 2009). The existence of a competitive pricing benchmark with the municipalities, helps also the Competition Authority to exert pressures to limit excessive pricing from larger suppliers in their historic area where they tend to display higher prices on their passive customers. To sum up on the Norwegian market, the retail prices follow quite strictly the wholesale prices with a markup that remains low. This contrasts with what is observed in an oligopolistic multimarket configuration with parallel pricing behaviors.

To sum up, while the multi-market competition setting naturally emanate from historical structured of electricity industry at the distribution stage by the liberalization process in numerous countries, this comparison shows that, even when the conditions of information transparency and absence of switching costs are realized, multi-market competition setting helps adoption of parallel behavior in pricing. Norwegian retail market structure which is not in this setting allows to a Bertrand like price competition to develop.

4. Conclusion

As intermediaries in the very specific trade of a non-storable commodity and with a short term price-inelastic demand which impedes any rationing of demand, electricity suppliers are strongly incentivized to rely on physical hedging to manage their quantity and price risks given the radical uncertainty of hourly electricity demand. This, on the other hand implies a vicious cycle. The more suppliers are vertically integrated, the less likely is the development of a liquid contract market, thus forcing asset-light suppliers to leave the market, be acquired by generators, or to move towards vertical integration. So it explains the move towards vertical integration in the countries which had been liberalized in the most radical way.

But vertical integration does not allow the development of Bertrand like competition. Retailers do not behave as asset-light suppliers of a homogeneous product in a competitive market. As they mutually compete within their respective historic areas while entrants cannot survive, they can adopt parallel pricing behaviors whatever their differences in levels of physical hedging and average wholesale costs. This setting enables them to transform spot price rises and falls into profits and to exercise a collective market power at the expense of consumers. This contrasts with the initial objectives of retail competition and questions about its potential benefits for residential customers.

This suggests one recommendation and one general statement. First, for improving retail competition, traditional remedies to limit the incumbent brand's advantage, to improve consumer' information and lower switching costs are obviously not sufficient. It will be necessary to break vertical integration in the retail in order to be close to the conditions of Bertrand-like competition. In this perspective, the British regulator proposed in March 2011 that the big 6 make available between 10% and 20% of their power generation into the market through a regular Mandatory Auction (Ofgem 2011). Even if it is a courageous measure going in the relevant direction, our analysis suggests that for reaching conditions in order that a Bertrand-like price competition develops which helps to compress retailers'margin at a reasonable level, there is a necessity of an almost complete de-verticalization between retail and generation. In any case, such a measure would make complex suppliers' hedging. However, a complementary solution for the de-verticalization of suppliers could lie in the development of a liquid market for financial options with different maturities, as suggested by our exercise on portfolios' risk profiles (section 2.2) and it could not be possible without an initiative from the regulator or the government to organize such a market for selling relevant options. After all and so the Brazilian market is partly designed in this manner on a basis of options contracts between generators and retailers (Bajay, 2006).

Second, we could doubt that there is a remedy to the lack of competitive pressure in any retail market which is in a setting of multimarket competition. This setting appears to be inherent to electricity and gas retail markets and rooted in the history of electricity and gas distribution, given that competition in this field could not be activated by intensive innovations which would breakdown the incumbents' advantage as it does in the telecom industry. The poor performances of retail markets invite to join the doubts expressed by skeptical economists as Richard Green (1998) and Paul Joskow (2000) who were favourable to electricity markets liberalization, when residential retail markets were opened to competition in Great Britain and North America.