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Incentives and coordination in vertically related energy markets

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Abstract

We present an agent-based model of a multi-tier energy market. We show how reward interdependence between strategic business units within a vertically integrated firm can increase its profits in oligopolistic energy markets. The effects are shown to be distinct from those of the raising rivals' costs model. In our case, higher prices relate to the nature of energy markets, which facilitate the emergence of financial netback effects.

JEL classification: C63; L22; L97

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1. Introduction

This paper studies the vertical relationships between gas and electricity markets. Vertical relationships are those that involve an exchange between sequential stages of the value chain. In the energy industry, gas is an important input for electricity generation, and therefore wholesale natural gas and electricity markets are vertically interrelated. The same is true for wholesale and retail electricity markets since retailers buy electricity from wholesalers (Stern, 1998).

Vertical interactions may involve separate firms or different strategic business units (SBUs) within the same firm (Gulati et al., 2005). Vertical integration is widespread among European energy firms. Gas producers often own gas-fired power plants, and many electricity firms consist of generation and retail SBUs (Finon and Midttun, 2004). Mergers between gas and electricity firms are relatively new in the United States, but they are occurring at a rapid pace (Hunger, 2003). Moreover, the merger activity appears to be accelerating as competition opportunities expand, incentive regulation diffuses more widely, and regulators have become less hostile to mergers (Joskow, 2000).

Several streams of literature have studied the advantages as well as the disadvantages of vertical integration. Industrial economists have extensively analysed whether vertically related firms could benefit from foreclosing non-integrated rivals (see Rey and Tirole, 2004 for a recent survey).[1] Ordover et al. (1990), for example, show that a vertically integrated

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[1] Management scholars have identified several other motives for firms to integrate vertically (Harrigan, 1984, 1986), including the reduction of transaction costs (Williamson, 1975; Mahoney, 1992), the reduction of corporate risk (Chatterjee et al., 1992) and the elimination of the double marginalisation inefficiency (see e.g. Gaudet and van Long, 1996).

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firm in a bilateral duopoly may benefit from disadvantaging its downstream rival.[2] The argument runs as follows. If the upstream unit ceases to sell in the input market, its upstream rival will face less competition and raise prices. Higher input prices increase the costs of the non-integrated downstream rival. This firm is forced to reduce production and increase prices. As a result, the vertically integrated firm can increase profits by raising both its end-user market share and price.[3]

Studies of vertical relationships in energy markets (e.g. Granitz and Klein, 1996; Bushnell et al., 2005) often explain their findings using this foreclosure argument. However, its logic depends crucially on the firm's ability either to internalise transactions or to set an internal transfer price that is different from the external (input) market price. In practice, wholesale energy markets are often compulsory, so trading internalisation is not feasible. Moreover, the standard energy market mechanism is the uniform price auction, which seems to make differences between internal and external prices impossible at the outset. Thus, two of the main resting points of the foreclosure or raising rivals' costs logic are often not present in energy markets.

This paper introduces an agent-based simulation model of natural gas and electricity markets. We show how corporate incentives linking the strategic business units within a vertically integrated firm can increase prices in energy markets. The effects are shown to be different from those arising in the standard models of vertical foreclosure. In our case, higher prices are related to the existence of financial netback effects in energy markets.

Wholesale natural gas is often priced against wholesale electricity prices, which, in turn, are usually set with reference to retail tariffs. Industry players refer to this financial process as netback or spark spread pricing. The use of netback pricing is well documented in the energy markets literature (for an early discussion, see Moxnes, 1987) and suggests a sequential relationship between energy markets in which gas and electricity markets are cleared in a down-to-upstream sequence. This is in contrast to the Ordover et al.'s "physical flow" formulation, widely adopted by the foreclosure literature, whereby upstream prices are determined before those downstream.

Trading is not a simple sequential procedure in most industry supply chains, as it is often iterative and tentative before deals are struck, so that modelling it either way is an abstraction. However, in the energy case, there are good reasons to support netback pricing rather than the physical flow formulation. First, retail prices are generally fixed for longer periods of time than upstream prices. For example, in the UK, retail consumers cannot change supplier during the first 28 days of signing a contract, but upstream prices vary every half hour. Therefore, retailers and generators take downstream prices as given when trading in the wholesale market.[4] Second, electricity is non-storable, consumption and generation have to be balanced at all times, but end-users are free to choose volume. As a consequence, information on retail consumption volumes has to flow upwards in the supply chain via prices.[5]

In this context, it seems plausible that widely used vertical incentives should play a role on the determination of energy prices. The general reward system of an organisation influences the behavioural choices of its members. Bonuses tied to overall profits create incentives for cooperative behaviour both between individuals (Zander and Wolfe, 1964; Wageman and Baker, 1997) and across departments within a firm (Petersen, 1992; Kretschmer and Puranam, in press). For individuals, the more interdependent the task, the more interdependent the reward system should be (Wageman and Baker) because it results in a positive relationship between effectiveness of the integrative devices and organisational performance (Lawrence and Lorsch, 1967). For firms, the importance of cooperation between SBUs grows with their interdependence (Gulati and Singh, 1998) and the higher the inter-unit synergies, the more useful the collaborative incentives are (Kretschmer and Puranam). Collaborative incentives, however, not only encourage

[2] Salinger (1988), on the other hand, analyses whether vertical integration leads to higher or lower prices in a successive oligopoly setting.

[3] Ordover et al. assumed that the vertically integrated firm can commit to limit its supplies to the downstream rivals and that the upstream competitor can charge only linear prices. Several authors have relaxed some of their assumptions. In particular, Choi and Yi (2000) and Ma (1997) dispense in different settings with the commitment assumption, although not with the linear pricing one. Allowing for a broader set of tariffs, Hart and Tirole (1990) show that vertical integration may also benefit the integrated firms if the upstream unit is more efficient than its competitors.

[4] In contrast, in other markets, one can argue that upstream producers fix their prices before downstream firms compete. In the typical example of a producer and a retailer, the retailer buys from the producer and then competes in the downstream market. As such, the downstream firm would take the upstream price as given (the item is already bought).

[5] In practice there are several cycles of this. Ahead of real-time, retailers will make forecasts of demand and seek to contract power to cover it. Generators will make forecasts of output and purchase fuels to cover it. In real-time, end-user demand is discretionary but at a preset fixed price. Retailers will have to cover imbalances between their contract and actual offtake at the spot electricity imbalance price, which is actually set slightly ex post depending upon what the system operator has to purchase in real-time to ensure system stability. Similarly, there will be real-time energy balancing in the gas network adapting to what the power stations have had to do.