

# Dynamics of Evolution in the Global Fuel-Ethanol Industry

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The global bio-ethanol industry has expanded rapidly in the past decade, increasing at an average annual rate of 15%. About 80% of the production is supplied to the rapidly growing fuel-ethanol market and the rest is for the rather stable demand in the industrial and beverage sectors. Fuel-ethanol, as an additive/substitute for gasoline in Otto-cycle transport fuel market, is gaining substantial market share, especially in Europe, North and South America and reached about 6% of the global gasoline fuel market in 2009.

Bio-ethanol, or biofuels in a broader sense, has attracted substantial research. There is a growing body of literature related to biofuels, which has been primarily preoccupied with policy instruments, environmental impacts and greenhouse gas emission reductions, food and poverty interactions, and technology advances. Hitherto, there has been however no attempt to understand the evolution of the structure of this rapidly growing industry and the dynamics of industrial governance in a complex political economy landscape over time.

We analyse the forces behind the evolution of the bio-ethanol industry by examining the dynamics along the entire value chain, with a particular focus on the core stage of ethanol manufacturing. The global bio-ethanol value chain can be divided into three distinct groups - the upstream agro-commodity stages, the midstream ethanol manufacturing stages, and downstream transport fuel stages. Three forces that shape the evolution of the structure of industry will be discussed in a greater detail, namely: (i) permeable industry boundaries, (ii) security of supplies and (iii) access to the retail market. These forces encourage a trend towards vertical integration as observed in recent development in the industry.

The impact of permeability of industry boundaries has been observed by Fransman (2001) in the study of telecommunications industry. The permeability of boundaries can be seen in the ease of entry from neighbouring industries. There are many different types of industry players with different industry of origin and de novo firms entering the bio-ethanol industry at various stages along the value chain. These actors include engineering companies, major oil & gas firms, agro-food processors and agro-commodity traders.

We observed a trend of forward integration of commodity traders and farmer/cooperatives into manufacturing. Entrants with some pre-entry history in the value chain as (Klepper & Simons, 2000) are noted in countries such as the US, Brazil, China, France, Thailand and Vietnam. These de alio firms are more resilient in facing supply risks compared with de novo new start-ups. In addition, experience increased the value of entry and also encouraged entry into new markets (King & Tucci, 2002). De novo survival rate is expected to be lower than de alio (Geroski, 1995; Helfat & Lieberman, 2002).

In addition, backward integration of oil & gas firms into manufacturing of ethanol is increasing, but lagging, possibly due to inertia or mismatch between the set of organisational skills required (Teece et al., 1997) for conventional operations (in oil and gas, especially upstream activities) and those of the new venture (agriculture), including different in investment scale and expected returns, inexperience in agricultural commodity markets, agricultural management and social political aspects of agricultural activities. Nevertheless, we noticed a large-scale entry by Valero, the largest independence crude refiner in the US into the manufacturing stage. Other refiners do entry but in a smaller scale. There is a better overlap of skill sets between refiner and ethanol manufacturer compared with most of the upstream exploration orientated oil and gas companies.

These companies have their respective competitive advantages in terms of resources and experience. Klepper & Simons (2000) have also observed the heterogeneity among entrants in terms of pre-entry experience and background in television receiver industry.

Nevertheless, it must be much more than having 'leveragable' asset of dynamic competencies (Teece & Pisano, 1994) or a bundle of skills and technologies (Hamel & Prahalad, 1994). As downstream oil and gas firms are backward integrated and upstream commodity traders

are forward integrated, which are the keys capability for performance and survival?

This leads to the examination of critical success factors in the industry i.e. security of feedstock supply and the access to retail market that are the determinants of governance structure. Porter (1980) has also suggested that firms employed vertical strategy to assure supply of inputs and market for outputs. Moreover, it must mean more than simply acquiring inputs at low prices (much more than to avoid random fluctuations in the intermediate market) or selling outputs at high prices. In particular, the notion of "assuring supplies or market" entails the inability to obtain the quantity of inputs that the firms would wish to purchase at the prevailing input prices and the inability to sell the quantity of output that the firm would wish at the prevailing output prices due to some market imperfections (Perry, 1988:206).

The second driving force that shapes the industry structure is security of supply. There are two important supply points along the value chain - supply of feedstock for ethanol production and supply of ethanol for gasoline blending. The majority of ethanol manufacturers face substantial risks in feedstock supply and price volatility. In many countries, ethanol is neither the primary market nor large enough to have influence on pricing of major feedstock. This has created a propensity towards upstream integration in the industry, but the degree of integration from market to market has been strongly influenced by local and national political economy of feedstock production and supply markets. On the other hand, upstream integration to manufacturing stage in order to secure ethanol supply has been relatively easier and politically less sensitive. Therefore, a high instance of integration is observed in these stages. However, backward integration of manufacturers to farming/commodity trading is rare in both US and Brazil except a couple of cases. Barriers of entry could be too high including capital requirements, skills, and land acquisitions.

The third dynamic that shapes the industry structure is access to the retail market. As Perry (1988:206) has suggested that the one of the motivations for firm to employ vertical integration strategy is not only to secure the market for its product but also to gain the ability to sell the quantity of output the firm would wish. This factor appears to be significantly important in the instant of the market being controlled by incumbents that their very product is to be substituted. The size of the ethanol market is linked to the size of retail fuel market, in particularly its ethanol component. There are mainly three stages - low blend (E5 or E10), mid blend (E15 to E25) and high blend (E85 or E100). The low blend market is highly regulated in all markets. Governments have



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created markets for ethanol blending with a specific blending ratio and consequently have limited the expansion of these markets by putting a cap on blending ratio. In order to break through the cap set by the government and a market strangled by oil and gas industry, ethanol manufacturers integrate upstream to gain market access particularly in the high blend markets. It is a niche market where petroleum refiner has smaller market power and has not much interest to develop it.

This fast-growing ethanol industry with its special characteristics of crossover from agricultural value chain to energy value chain provides a different evolution patterns and dynamics in the formation of industrial structure. Working together with other political economy factors, these three fundamental forces have shaped the structure of bio-ethanol industry. We observe not only the creation of giant horizontally consolidated firms but also some evidence of increasing vertical integration.

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