Energy ≠ Coffee:

an assessment of blind spots on energy spotmarkets

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Preface

A key aspect of energy market liberalisation is to enhance competition on commodity markets. Such competition will clearly benefit from liquid, transparant and well-functioning spotmarkets. Although some liberalising markets show a gradual development of such spotmarkets, it yet remains to be seen how that development will proceed in the course of time. In other words, it is still uncertain whether, for instance in Europe, most of the natural gas trade will, in the near future, take place via a mature spotmarket.

In order to obtain a clearer picture of the future role of energy spotmarkets, it is extremely important to first analyse the energy market characteristics in detail, in terms of volumes and price formation, contracts, players, financing, *etc.* One aspect of that 'picture' is whether, and to what extent energy, spotmarkets fundamentally differ from other commodity spotmarkets, which requires a systematic spotmarket comparison.

This study is meant to be the first in a series of studies on energy spotmarkets and specifically focuses on the differences and similarities with a number of other spotmarkets. It specifically aims to frame the energy spotmarkets and their potential development into a broader perspective.

It is clear from the study that it would be unwise to simply lump spotmarkets together. First of all, contrary to markets where assets are traded (*e.g.*, FOREX or stocks), physical commodity markets are typically characterised by transport and other logistical issues, such as storage costs of buffers.

In addition, within the category of physical commodity markets, a distinction can be made between markets where the use of the commodity is strongly linked with accompanying restricted transport services, and those commodities where transport limits are practically absent. Natural gas, for instance, clearly belongs to the former category: natural gas that cannot be transported to the end user has little value; at the same time, the grid capacity, at least on the short term (and disregarding LNG), is fixed. Other distinguishing factors are: the presence of a regulator in the linked market, who can affect market predictability; the question whether the transport system only allows transport in one direction; the presence of vertically integrated firms, *etc.*

In short, energy spotmarkets differ in many respects from several other physical and non-physical spotmarkets. This implies that 'perfect' energy spotmarkets may inherently be (much) less perfect than other spotmarkets that have approximated the stage of theoretical perfection.

This study, therefore, tries to put the energy sector in a wider spotmarket perspective by using a number of market indicators and implementing these to a set of physical and non-physical commodity spotmarkets.

Finally, the research team would like to express its gratitude to Dr. Martien Visser of *Gasunie Trade and Supply*, who not only enabled this study, but has also turned out to be a very stimulating intellectual source of inspiration throughout the research process.

Catrinus Jepma

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1. Introduction

Due to the process of market liberalisation, the European energy sector is undergoing fundamental restructuring, which has strong implications for the market players and institutions. It is believed that energy market liberalisation will lower electricity and natural gas prices, as competition will reduce the market power of the traditionally vertically integrated natural monopolies to reduce their prices. Furthermore, liberalisation provides a larger scope for end users to take advantage of possibly existing price differences on the market. Finally, market liberalisation is believed to increase the security of supply as free market access and more competition will lead to extra supply in case shortages occur.

However, these possible benefits might be counterweighted by the impact of the larger complexity of liberalised energy markets. The process of unbundling supply and transport activities as well as the increased activities of traders reduce the predictability of the number of transactions and the (potential) number of players on the market due to a reduction in the amount of information that the 'traditional' market players used to dispose of. Moreover, financial instruments are traded which have been derived from physical energy volumes. For instance, in the USA the total traded value of natural gas-related financial instruments is on average 10 to 12 times greater than the value of the underlying physical volume of natural gas. On the Dutch Title Transfer Facility (TTF) for wholesale gas trade, this factor was 2.6 in 2004.[1]

An important aspect of the process of market liberalisation is the emergence of energy spotmarkets. On a spotmarket, a commodity is delivered and paid for immediately or shortly after closing an agreement. The period of time between agreement and delivery/payment generally depends on the nature of the commodity traded and could vary from instantly to at most a couple of days (on gas spotmarkets delivery usually takes plays within 30 days after the agreement; payment generally follows the delivery). Some commodities are therefore not or less suitable for spotmarket trading because of, *e.g.*, their long transportation periods.

According to economic literature, market development takes place through several stages. Initially, demand and supply are matched through bilateral contracts. In the next phases, which will take place in the process of liberalisation, the market can develop into a 'perfect' spotmarket, which is characterised by the following conditions:

- **Non-discrimination**: all players face the same tariffs, conditions and procedures for market entrance.
- **High transparency**: information on tariffs, conditions, procedures and energy transport capacity is publicly available.
- **Large competition**: a considerable number of players have access to the market and there are no or no strong levels of horizontal and vertical concentration of particular players.
- **Effective functioning of the market**: there is a high liquidity in terms of traded volumes and sufficient capacity in terms of physical availability of natural gas, transport, flexibility in terms of storage, linepack, production swing, quality conversion, interruptible customers, and imports.

[1] Frontier economics, 2005.

2. Objective and methodology

This study aims to explore whether the benefits from energy market liberalisation (including a well-functioning spotmarket), as suggested by economic theory and generally supported by empirical analysis of financial markets and some non-energy physical commodity markets, can reasonably be expected for energy markets in North-west Europe as well. For example, it is a well-established fact that commodity spotmarkets fundamentally differ from financial spotmarkets, due to commodity characteristics or limitations to commodity trade in terms of transport, storage, perishability, as well as inelastic market conditions (*e.g.*, for some commodities demand is extremely price-inelastic which creates a market that is fundamentally different from markets with price-elastic demand).

Therefore, the main objective of the proposed study is to explore the characteristics of eventual (*e.g.*, by the year 2015) energy spotmarkets by addressing the following questions:

1. What are requirements for well-functioning spotmarkets according to economic theory (Section 3)?
2. What do actually existing spotmarkets for other (non-energy market) physical commodities (*e.g.*, coffee, aluminium) and non-physical commodities (*e.g.*, currencies) look like and how well do they function (*i.e.* to what extent are they in line with a theoretically optimal spotmarket?) (Section 4)?
3. To what extent do energy spotmarkets fundamentally differ (in terms of the physical and socio-economic characteristics of the commodity/assets and the way these affect the functioning of the market) from commodity spotmarkets and financial asset spotmarkets (Section 5)?
4. What will be the implication of the answer to question 3 for energy market policy making (Section 6)?

As such, the study aims to describe an 'ideal' spotmarket for energy, which may not be similar to 'ideal' financial asset or other physical commodity spotmarkets. Such a description would provide useful insights for market stakeholders and policy makers with a view to their long-terms strategies and policy objectives. With respect to the latter, the study will explore what role governments could play in setting the institutional framework for energy spotmarkets. A clear commitment from governments to reform / liberalise the energy markets in combination with clear, systematic and predictable government policies (including incentives), reduces uncertainties for market players.

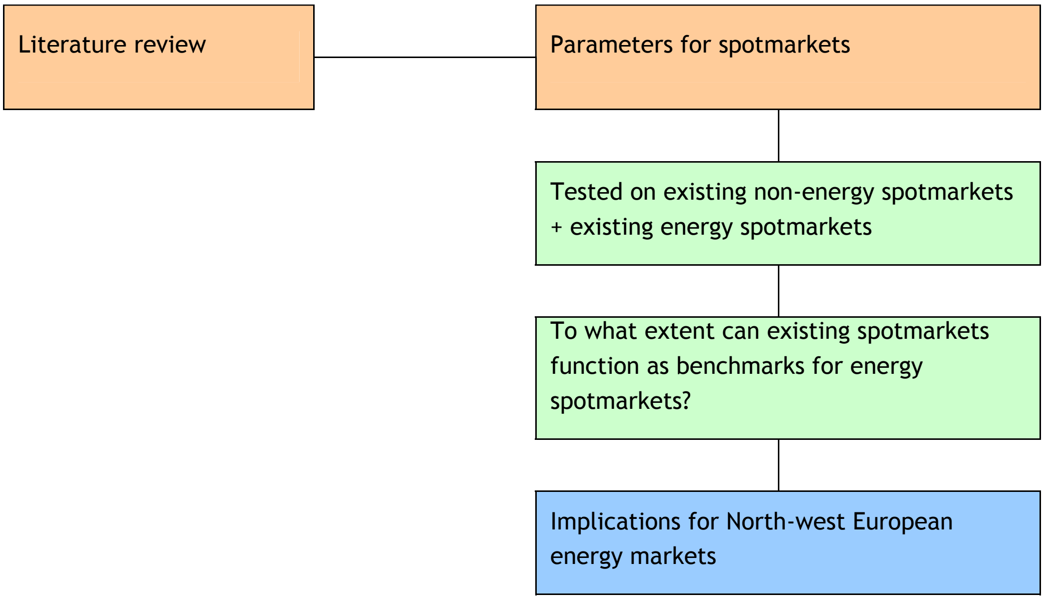
With a view to the above, it is emphasised here that the study does not specifically focus on the transition process towards fully functioning liberalised energy markets. Instead, the focus is what the market will look like when this process will be 'completed.'

Methodology

The methodology for the study is based on the following main elements:

1. The study carries out a literature review of economic theories on market liberalisation. From this review a number of parameters will be identified which are of key importance for well functioning, liberalised markets, including spotmarkets.
2. The extent to which each of these parameters plays a role in actual practice on other (physical, non-energy commodity, and financial asset) markets will be discussed by analysing a number of actually existing spotmarkets (aluminium, coffee, currencies).
3. Experiences with energy market liberalisation are described. In particular, it will be described to what extent the parameters identified in (1) and analysed for existing spotmarkets in (2) exist in or apply to energy markets in North-west Europe.
4. The theoretical insights thus combined with experience from actually existing markets in (2) and (3) provide insights into potential bottlenecks in liberalised energy markets and how to deal with these.

An important advantage of this methodology is that it enables an analysis of the extent to which the basic conditions for spotmarkets as described in the literature and/or the experience with other non-energy commodity spotmarkets can be used as benchmarks for future energy spotmarkets. The research steps are represented by the following scheme:



3. Spotmarkets in theory

3.1. Commodity market characteristics

Unlike long-term bilateral agreements on product delivery, spotmarkets are real-time commodity markets for sale and delivery of products instantly or within a few weeks. An important feature of spotmarkets is that they enable marketers to instantly find other market parties to match deficits in the markets (*i.e.* immediately required products) with elsewhere existing surpluses, without entering into long-term agreements. The prices for spotmarket transactions are thus largely determined through negotiations in an auction-like context, similar to, *e.g.*, stock market trading, based on supply and demand orders. However, short-term changes in supply and demand structures could easily lead to larger price volatilities than with long-term bilateral agreements.

Generally, gas spotmarkets are 'located' at a place with a large pipeline interconnection, which enables a larger number of market players to be active on the market. After all, a market player that wants to deliver a certain amount of gas to another party through a spotmarket deal is likely to transport this gas through the interconnection. Therefore, due to its infrastructure, the interconnection easily becomes a 'natural' trading place to conduct the transactions. Trading can also take place through virtual exchange points, such as the National Balancing Point (NBP) in the UK and the TTF in the Netherlands. Increasingly, energy spotmarket trading systems are Internet-based platforms.

Due to the liberalisation of energy markets and the emergence of spotmarkets, market parties have had to upgrade their trade functions in order to efficiently deal with short-term purchase and delivery transactions and manage the risks associated with spotmarket transactions.

Spotmarkets exists for several commodities, such as oil, gas, electricity, CO_2 allowances, coffee, steel, aluminium, *etc.*, although several of these commodities have a different nature. For instance, some commodities only exist on paper and have a high 'tradability', whereas other commodities are more difficult to trade on a spotmarket due to longer transportation times or other complexities concerning tradability (*i.e.* trade flexibility). In the next section, some of these spotmarkets will be analysed in more detail, but in order to enable a systematic analysis of spotmarkets first some parameters are introduced for comparison which have been derived from economic theory on industrial organisation and market liberalisation.

Competitive markets

According to economic theory, in a perfectly competitive market,[2] a firm has no influence on the market price and therefore takes the price as given. In addition, this 'ideal' market type assumes product homogeneity and free entry and exit for a firm in a particular industry. Product homogeneity means that the products of all the firms in a market are perfectly substitutable. Free entry and exit suggests that there are no specific costs that make it difficult for a firm to enter (or exit) a market. In perfectly competitive markets, a single market price prevails, which is also the prime goal for governments when they pursue a policy of market liberalisation.

[2] More background information on perfect competition can be found in the literature on microeconomics.

Since spotmarket deals basically resemble auction exchange, auction theory provides useful insights into the functioning of spotmarkets. An auction is a market in which products are traded through formal bidding processes. A spotmarket is, in fact, one of the possible formats in which an auction can take place.

In order to predict the behaviour of firms in a particular industry, economic theory uses the generally accepted assumption of profit maximisation.[3] In the long run, firms, in a perfectly competitive market, will earn zero economic profit. In the short run, however, events or behaviour that cause fluctuations in the parameters determining the price of a product, provide scope for firms to make positive (price rise) or negative (price drop) economic profits. For instance, short-term behaviour could be that a supplier offers a product at a price slightly above the marginal costs if there is reason to assume that the market will show a temporary increase in demand. In such a context, more information could lead to a supply above marginal costs (implicit supply). Due to the absence of entry and exit barriers market parties will immediately respond to the short-term profits or losses by entering or leaving the market, so that a zero (economic) profit market equilibrium is quickly restored.[4]

Although this picture of immediate entry and exit seems somewhat unrealistic for the energy commodity markets (see below), also in these markets firms appear to be maximising profits and thus respond to price fluctuations, albeit with sometimes considerable time lags. Generally, commodity (energy and non-energy) markets experience so-called 'boom and bust' cycles because firms have an incentive to under-invest in new production/transportation capacity when the market price is (temporarily) low. The capacity shortages that may thus arise lead to an increasing price of the commodity and an incentive for market parties to invest in new production capacity, as well as a larger scope for higher-cost producers and new entrants. The 'bust' in this cycle will come when a period of over-investment is followed by a substantial price decrease (oversupply or demand drop), which reduces the value of the new investments. Whether a producer will stay in the market depends, among others, on the extent to which the capital investment is sunk. A producer will leave the market when the costs of closing the production facility are lower than the losses incurred with production. Since the capital intensity of the energy markets is generally high, immediate entry and exit cannot take place and therefore this economically inefficient 'boom and bust' cycle can occur.

Market inefficiencies can be structural or incidental, mostly providing a particular (incumbent) firm(s) with a higher degree of market power (ability of a seller/buyer to affect the price of a good/service). For instance, the switching costs that end-users experience, either in searching costs or direct costs, when picking a new supplier is a potential source of market power. Economic theory and empirics are reasonably clear on this subject by arguing that the larger the degree of market power, the higher a price becomes that an incumbent firm can charge. In order to deter entry for new entrants, the incumbent or dominant firm sets its price just below the switching costs incurred/perceived by the end-user.

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[3] Standard neo-classical theory assumes that a business seeks to maximise profits from producing and selling an output in a market. However, any other objective, such as quantity maximisation, satisficing and limit pricing, has implications on prices, output and economic welfare.

[4] However, in actual practice, as will be discussed in later Sections, it may well be that for the purpose of social welfare, less competitive markets are preferred over perfectly competitive markets. For instance, "It may well be in the public interest (*i.e.* security of supply) to have a firm which is not forced to maximise profits in an oligopolistic industry. This is even beneficial if there are efficiency costs, provided they are not too large. Hence simply showing that a (previous) nationalised firm is less efficient than the private sector is not a sufficient argument for privitisation, as the net effect on welfare could still be positive" (Klemm, 2004).

Other potential sources of market power lie within demand/supply elasticities, the number of firms in the market, the extent to which products are differentiated and the interaction among firms (cartels or tacit collusion). Moreover, it is widely recognised in economic theory that firms have an incentive to engage actively in rent seeking, *i.e.* market players spend money on socially unproductive efforts (such as lobbying) to acquire, maintain or exercise market power. According to economic theory, market power can be reduced through auctions, where formal bidding processes are in place.

Liberalisation

Generally, liberalisation refers to the relaxation of government restrictions, which is usually found in social or economic policy. For instance, trade liberalisation concerns the removal of trade barriers in order to increase (international) competition and reduce market prices. The main rationale for liberalisation is to increase the overall societal welfare level beyond the level that corresponds with limited or no competition. However, this does not imply that these welfare gains are equally distributed amongst all market participants and consumers. In fact, they could in some cases even reduce the welfare of certain parties, either being a consumer, producer or government.

The role of the central authority in setting the 'rules of the game'[5] is crucial since it largely affects the direction of new investments, the degree of allocative efficiency and the development of competition. In the EU the role of national governments[6] is still prominent in the sense that they nationally decide on how to implement the liberalisation goals and competition policy set by the EU. For instance, in the EU electricity/gas market, the diversity of the chosen national regulatory regime, either NTPA or RTPA, for third parties access to the transmission grids is bound to have a re-allocative effect on investments; certainly within a well functioning single market.[7]

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[5] For instance, the main goals of EU competition policy are: (1) diffusion of private and economic power, the protection of individual freedom and individual rights (monopolies and cartels can be seen as a radical departure from such individualism), (2) protection of the economic freedom of market competitors (attention is directed to abusive practices, such as coercion, discrimination and cartels through which powerful firms might endanger the existence of weaker competitors), (3) competition policy is one of the main instruments to ensure consumer welfare through both allocative and productive efficiency.

[6] About the role of national governments the following should be noted. Acording to Tirole, 1989, the theoretical foundations provided by game-theory "led many economists to reject the simplistic 'Chicago view' of the world (based on perfect information) that price cuts are always natural responses to cost and demand shocks or to increased competitive pressure (p.380)". More generally, with the various types of non-price competition, consumer welfare becomes more multi-dimensional and includes aspects such as the quality of the product, the speed and security of supply and so on. Most of these aspects are not measurable and value judgements are necesarry. Jacquemin, 2000, argues that, on the whole, a definition of the 'efficiency' criterion most of the time requires a delicate appreciation of complex trade-offs.

[7] Competition policy is viewed as a key instrument for the European internal market. As stated by Jacquemin, 2000 (see also the European Commision's first report on Competition Policy in 1972): "Three principles seem to have inspired the European authorities: (1) Competition is the best stimulant of economic activity since it guarantees the widest possible freedom to all. An active competition policy makes it easier for the demand and supply structures to continually adjust to technological development. (2) The idea is not to strive for the realisation of perfect competition but to promote a "workable competition", which does not have the same theoretical foundations as perfect-competition theory and implies a value judgement from the political authorities; it simply describes market structures in which new technologies, organisational forms, preferences or products can arise and be developed without public or private restrictions. (3) Competition is not the exclusive means of achieving the Community's goals. Other instruments may have to be used in situations "when competition in itself is not enough to obtain the required results without too much delay and intolerable social tension". The choice between the alternative policies available, including industrial policy, must be based on their relative efficiency.

Tradability

The tradability of a commodity, and thus the liquidity in the market and arbitrage opportunities, depends on its transportability and the flexibility of its supply and demand structure (including storability). The ratios transportation costs/total production costs and/or transportation costs/end-price, each expressed per unit of commodity, are good indicators for tradability. The same holds for the ratios storage costs/total production costs and storage costs/end-price. In effect, these ratios give an indication of the costs of trading a particular product. Other costs, such as those related to search and risk of default, are generally negligible on a well-functioning exchange (spot) market (although these costs can be higher with bilateral trade).

The above two types of ratios (based on transportation and storage costs) enable a systematic comparison of the tradability of the commodities focussed on in this study and, consequently, the impact of the tradability on the functioning of spotmarkets. When transportation and storage costs are relatively high, the liquidity in the markets is likely to become lower which would affect the future development of the exchange (or spotmarket). Moreover, these costs more or less determine the geographical market[8] for the respective commodity. For energy exchanges, the geographical span to trade competitively could, for these reasons, just be a fraction of an envisaged single, liberalised European energy market.

In addition to tradability and transportability, it is also important to look at the current market conditions on the various commodity markets. For instance, electricity and natural gas markets, irrespective of their underlying market form, continuously need to be in equilibrium for technical reasons. These ‘constant’ equilibrium markets are by definition ‘tight’ because they always face the threat of supply disruptions. As will become clear elsewhere in this study, price volatility in tight markets is generally higher, due to speculative opportunities. Therefore, in the absence of sufficient storage/transport/flexibility capacity/capability near the exchange locations, the functioning of these markets will be structurally hampered. However, even when facilities to achieve this are present, still transport limitations reduce the scope for trade, which will have its effect on the level of inter-exchange arbitrage.

3.2. Spotmarket characteristics

A spotmarket is a commodity market where the sale and delivery takes place instantly (*i.e.* between a few seconds and a few weeks, depending on the commodity) and in real-time. As has been explained above, according to economic literature, spotmarkets resemble auctions where commodities are traded through formal bidding processes. Trading by means of an auction is generally considered to be quicker than one-on-one bargaining (bilateral trade) and to encourage competition. Auction markets (*e.g.*, financial commodities) are considered to be the world’s most important markets. During the past decade there has been an increasing interest in reforming energy markets from bilateral trading to auction-type trading.

According to auction theories, auctions fully absorp all relevant information and their market participants behave fully rational. With respect to this, auctions resemble the theory of perfect competition. However, an important difference between the theories of auctions and perfection competition is that the number of buyers and sellers on an auction market could be relatively small, whereas perfect competition requires many participants. Another distinguishing fact is that auction theory, with the help of game theory, allows for the analysis of the behaviour of individual market players, whereas perfect competition only assumes

[8] Transportation costs play an important role in the various models of the theory of ‘new economic geography’. It is reasonable to assume that relatively high transportation costs in relation to the total product price lead to an increasing restriction of the geographical market where the product can be traded.

profit-maximisation under the assumption that in equilibrium each participant's marginal costs equal marginal benefits. In practice, however, a supplier's marginal costs will generally be lower than the marginal revenues (unless some commodity producer engages in dumping).

Generally, when *evaluating* auctions, two main criteria are considered:

- **Efficiency**: the extent to which the auction assigns items to the bidders who value them the most; this criterion is generally considered most important by governments.
- **Revenue maximization**: the extent to which the auction maximises sellers' expected revenues; this is generally considered most important from the viewpoint of businesses.

Furthermore, for the *establishment* or *design* of an auction or auction-type market, the following criteria have been identified in the literature:[9]

- **Allocative efficiency**: the auction outcome must be optimal; for example, the total surplus generated should equal the available surplus in competitive equilibrium.
- **Budget balance**: no subsidies or supporting transfers are required for a deal to be reached.
- **Individual rationality**: the expected net benefit for each participant from using the auction should be no less than the net benefit of any alternative.
- **Strategy-proofness**: participants should not be able to benefit from offering inaccurate information.

According to Phelps *et al.* (2004), these criteria hold quite well for trade in high-value government and corporate assets. With respect to multiple-goods trading on a single exchange, the predictive power of auction theory of the behaviour of individual market participants reduces. This also implies that the extent to which products are homogeneous is important for the functioning of a spotmarket. Auction theoreticians generally recognise that the auction (spotmarket) design has to be addressed on a case-by-case basis with due consideration of specific market conditions.

Combining the conditions for a 'perfect commodity market' as explained in Section 1 with the above criteria for auctions or auction-type markets results in three categories of characteristics with which the functioning of a market can be systematically analysed:

1. **Market structure characteristics**, in terms of level of horizontal and/or vertical integration among marketers, supply and demand elasticities, entry/exit barriers, and product homogeneity.
2. **Trade characteristics**, which focus on trade flexibility, transportability of the commodity, storage capacity, dedication of the network to the commodity, technical tightness of the market.
3. **Price characteristics**, concerning price uniformity on a national or international scale, price formation, and price volatility on the market.

The identification of these characteristics enables a systematic analysis of a number of spotmarkets for physical (non-energy) and non-physical commodities (see next Section). For each spotmarket, it will be explored which characteristics are most important for the proper functioning of spotmarkets given the above criteria and conditions.

[9] Phelps, *et al.,* 2004.

4. What do existing (spot) markets look like and how well do they function?

In this section, the following (types of) spotmarkets will be analysed:

- Physical (non-energy) commodities: Coffee, Aluminium/steel market
- Financial assets: Currency market

4.1. Physical commodity market: Primary aluminium

Market characteristics

The aluminium industry consists out of four basic processes: bauxite mining, alumina refining, aluminium smelting, and fabrication. Of these, aluminium smelting is the most energy intensive process. The production of aluminium takes place through a fairly basic electrolytic process, in which bauxite (a rock containing a high concentration of aluminium hydroxide) is melted into pure aluminium. Since Charles Martin Hall (USA) and Paul Louis Toussaint Héroult (France) discovered the electrolytic smelting process in 1886, this technique has become the industry's standard. It is presently considered the only commercially viable production process for primary aluminium. Aluminium is the third most abundant chemical element found in the earth's crust and is quite evenly distributed across the continents.

Regarding global demand and supply conditions, Figure 1 shows the reported production figures of primary aluminium in the period 1996-2004 per region and total world production.

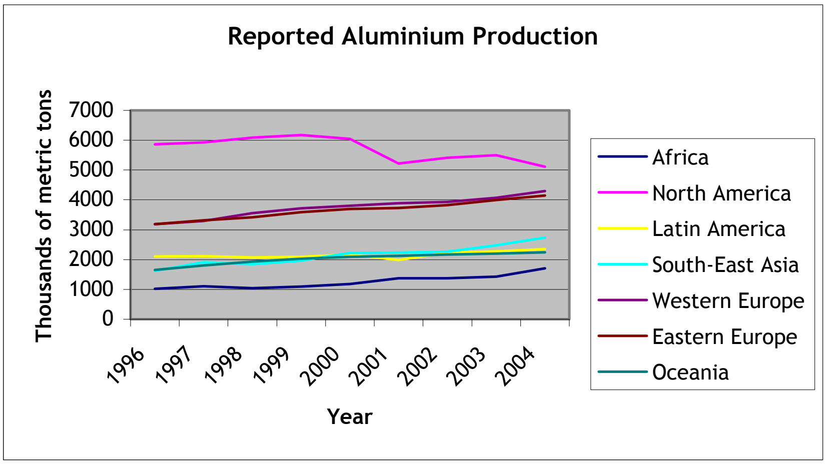

Figure 1. Reported aluminium production per region
Source: International aluminium institute (IAI), 2005.

The Figure shows that the USA and Canada have experienced a decline in aluminium production, whereas in the other regions the production has increased. Total world production has steadily risen, from 18.6 m tonnes in 1996 to 22.5 m tonnes in 2004. Especially the Chinese aluminium production capacity has strongly increased. In 2004, the degree of capacity utilisation in some global regions was as follows:

- North America: 0.76
- Africa: 0.84
- Asia: 0.98
- Western Europe: 0.99
- World: 0.92

These figures more or less show the underlying demand conditions in the selected regions, *i.e.* a relatively large demand leads to a higher capacity utilisation. Since global demand for aluminium is expected to grow in the future (*e.g.*, by 5% in 2005), new capacity will become available (4.5% increase in 2005), mainly in the Asian region, which will reduce the pressure on stocks (see also below). [10]

Primary aluminium is widely used as a basic material in a large number of industries, such as extrusion, construction, transportation, aviation, and automobile production, *etc.* While there are numerous buyers, aluminium supply is highly concentrated with the world's five largest primary aluminium producers who have a cumulative market share of 41.7% (see Table 1), which is relatively high, considering the fact that aluminium is the largest metal (non-ferrous) in terms of value and production. Table 2 shows the share of the five largest companies in the markets (the C5 ratio).

Table 1. Top 5 producers of LME metals, 2004.

Company	Cumulative market share in % (2004)
Alcan	11.6
Alcoa	23.1
Russian Aluminium	31.4
Hydro	37.2
BHP Billiton	41.7

Source: World Gold Council, 2005.

Table 2. C5 ratios of LME non-ferrous metal producers, 2004

LME Metals	C5 Ratio in % (2004)
Platinum	81.5
Tin	53.1
Nickel	52.2
Aluminium	41.7
Lead	33.5
Gold	33.2
Palladium	28.3
Silver	28.3
Copper	28.2
Zinc	27.8

Source: World Gold Council, 2005

[10] London Metals Exchange (LME), 2005.

Companies like Norsk Hydro ASA and Alcoa Inc. are to some extent vertically/'diagonally' integrated (see also Table 3). For instance, Hydro is also an energy utility and Alcoa is involved in the production of aluminium car bodies in the USA, which is beneficial for their strategic position in terms of market power. In addition, most of the large aluminium producers have their own bauxite mining branches. Over the last five years, the large 'metal' companies have rapidly grown, autonomously or through mergers and/or acquisitions. The degree of horizontal and vertical (up and downstream) integration is therefore substantial and is expected to rise further in the future.

However, the companies' possibilities to exert market power are reduced by the fact that aluminium supply is relatively low, which is a reflection of the high capital intensity (high fixed costs) of aluminium production. Consequently, new supply comes on stream with considerable time lags. Another limitation to market power is the relative strictness of the process of aluminium smelting and the difficulties associated with reducing or increasing production. Due to the high fixed and sunk costs, production is likely to continue until the variable costs are covered. The only way to reduce output is to switch the melting ovens to a slumber mode which keeps the aluminium liquid; entirely halting the production process is very costly, especially for producers who have long-term take-or-pay energy purchase agreements. However, those producers which posses their own bauxite mining branches have the opportunity to optimise their profit margins throughout the value chain. The advantage of being vertically integrated allows for cross-subsidisation and can be regarded as a potential source of market power.

Table 3. Sources of electrical power for aluminium production in 2003

Electricity sources	% share (2003)
Hydro	49.2
Coal	36.1
Oil	0.5
Natural gas	9.4
Nuclear	4.8

Source: IAI, 2004

With a view to the medium term, increasing concerns are voiced about the large increase in new capacity that will be commissioned after 2007.[11] As has been explained in Section 3, such an increase could lead to overcapacity in the market and lead to a 'bust'. However, companies cannot easily respond to a drop in demand by leaving the markets because of the high fixed costs. Consequently, a situation of oversupply is thus likely to occur, since, at least for the time being, production (including new production) at most sites will continue at prices which at least cover variable costs. Competition in this market is primarily based on costs, which is reflected by the industry's focus on reducing the energy intensity per tonne produced and moving production processes to low-cost countries (in terms of energy, mining and labour).

Trade characteristics

Primary aluminium has very favourable **storage** characteristics. As a non-ferrous metal, aluminium can be stored for long periods of time without losing quality/value. The costs related to the storage of aluminium

[11] Metal Bulletin Research, 2005.

are, when compared to the total value of the product, negligible, *i.e.* less than 1% of the spot price. As a result, the market was able to respond to the recent increase in aluminium demand through a decrease in stock levels (exchange and non-exchange). This is illustrated by Figure 2, which shows the development of primary aluminium stock levels at LME.

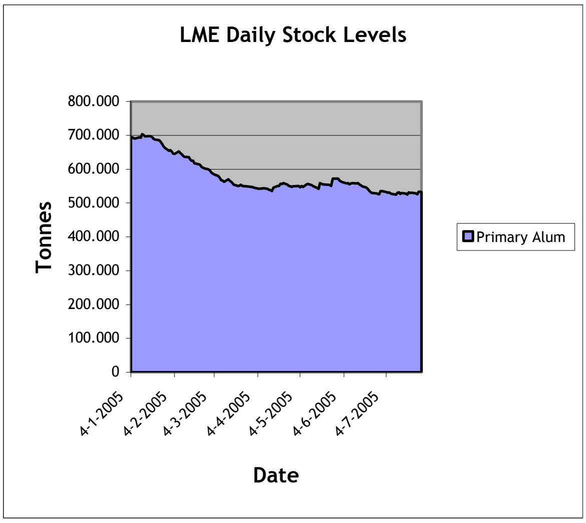

Figure 2. Daily stock levels (LME).
Source: London Metal Exchange, 2005.

Presently, the total reported stocks of aluminium, including the non-exchange stocks, could cover approximately five weeks of production/supply on the world market. This is a fairly normal proportion for any non-ferrous metal commodity; only gold and palladium have a significantly larger stock level equivalent to almost 700 and 52 weeks of production, respectively.[12] The gold metals market, due to its high stock levels is therefore more liquid and less volatile than the other metals markets. The LME metals exchange, on average, has a *churn* ratio of 25:1 (average financial turnover in relation to physical supply, see also Section 1).

The **transportability** of primary aluminium is high; one 'merely' needs a ship or truck to deliver the commodity at the required destination. However, there could be transport constraints in terms of availability of shipping capacity and shipping fees. Should such constraints occur, the global aluminium market would become less liquid and more regionally oriented, which is likely to be reflected by higher spotmarket prices. In practice, however, despite the recently increased freight rates[13] of primary aluminium, transportation costs are generally less than US$ 50 per tonne or less than 3% of the average price per tonne aluminium (US$ 1800 on average) at, for instance, the LME. The availability of shipping capacity also determines the extent to which arbitrage opportunities on the various metal exchanges can materialise.

An indication for the **tradability** of aluminium is the total volume of aluminium traded in relation to its total global production or trade. In 2004, the amount of aluminium traded on the various metal exchanges in relation to total trade in metals was 24.5%, which is fairly high for a metal commodity (only silver and platinum have a considerably higher rate: 45.3% and 35.6%, respectively).

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[12] From this perspective gold has more commonalities with the currency market than with other metal commodities, which is logical considering its monetary function.
[13] Data extracted from Baltic Exchange shipping indices (dry bulk and others).

Price characteristics

At least until 2007, the primary aluminium market is expected to become tighter due to an increasing demand and the expected reduction in production capacity in a number of industrialised countries. These developments are likely to lead to larger price volatilities, also because this market situation provides scope for speculation. Price developments at the various exchanges show similar trends, which is an indication that the global aluminium market functions reasonably well. In most bilateral contract negotiations, the LME price is used as a reference price, despite the fact that 'only' 25% of global aluminium is traded via exchanges (spot and forward markets). This implies that the aluminium exchanges have a relatively large impact on price setting on the entire market (exchange, non-exchange), which is an indication of the market's need for price signals and accurate/transparent and non-discriminatory information.

Nonetheless, despite their importance on price setting, aluminium exchange warehouses, similar to metals exchange warehouses in general, predominantly function as a 'last resort' outlet for producers to sell in an oversupplied market and for consumers to purchase metals in an undersupplied market. Therefore, when the market approaches its boundaries, *i.e.* becomes tighter, the exchanges become more important. Since exchange stocks tend to be more volatile than non-exchange stocks, any supply or demand fluctuation will result in a somewhat intensified price volatility, which in turn also affects the non-exchange market, which in some cases takes the exchange price as a reference point.

Figure 3. Price development primary aluminium
Source: LME (cash buyer) 2005

Conclusions

From the above it can be concluded that exchanges in a well-supplied market such as the metals market function properly. Expectations on how 'tight' a market will be in the future are crucial for the development of the exchanges. For instance, concerns about supply disruptions may hamper the development of a spotmarket. The 'last resort' function of the metals exchange markets could also apply to energy markets since bilateral trade covers the bulk of the energy transactions, whereas exchange trade is primarily used for peak-shaving purposes.

The main difference between the metals markets and the energy markets is the entirely different cost build-up per unit supplied. Transport and storage of aluminium is relatively cheap, whereas production makes up the bulk of the costs. The opposite is true for natural gas and electricity where the bulk of the costs are not related to production, but to transportation and storage (with storage for electricity being virtually impossible). Since western European demand for natural gas will increasingly have to be fulfilled by supply from remote countries/regions, transportation costs are not expected to decline and will pose an upper limit on the maximum amount of liquidity that can be attained (see also Section 5).

4.2. Physical commodity spotmarket: Coffee

Market characteristics

Coffee is the most heavily traded commodity in the world and up to 1992 the monetary value of global coffee trade was only surpassed by that of oil. Coffee is cultivated in countries of the tropical and subtropical belt with particular altitudes, temperature ranges and rainfall conditions. Two types of coffee can be distinguished, Arabica and Robusta. The former has a superior flavour and is consequently sold at higher prices. It comprises of Colombian-type or types of Mild Arabicas, Brazilian Arabicas, and other Arabicas. More than two-third of world production is of the Arabica type. Robusta (inferior flavour and sold at lower prices) is responsible for about 1/3 of world production. In 2004, about 80 % of world production was exported. Of this figure, 1/3 is re-exported.

The worldwide coffee market is an excellent example of a market 'ruled' by the worldwide interaction of supply and demand. Spanning some 55 producers, the possibility of national or even regional producers to influence prices is relatively limited despite the fact that the 5 biggest producers in volume terms are responsible for about 65 % of world production (see Table 4). Attempts in the early 1990s to limit the supply of coffee by means of an alliance failed, because competition from non-member 'free riders' posed an insurmountable task.[14]

Table 4. Main Producers

Country	2004 Production (000 bags)*	Share of total production (%)
Brazil	38,667	35
Colombia	11,500	10
Vietnam	9,900	9
Indonesia	6,488	6
India	4,850	4
Total	112,031	100

* 1 bag = 60 kg

Source: ICO, 2005a.

[14] FAO, 2004, p.32.

World coffee consumption for the year 2004 is estimated at 115 m bags, compared to 111.8 m in 2003 – a 2.9 % increase.[15] Of this production, about 85 m bags were exported and 30 m bags consumed domestically. The USA is the largest importer of coffee with more than 20 m bags (see Table 5).

Table 5. Main consumers

Country	2004 Consumption (000 bags)*	Share of total consumption (%)
USA	20,783	18
Brazil	15,490	13
Germany	10,168	9
Japan	7,117	6
Italy	5,405	5
Total	115,000	100

* 1 bag = 60 kg

Source: ICO, 2005b, p.6.

Until 1989, coffee prices were guaranteed under the 1983 International Coffee Agreement (ICA) export quota system. Indeed, during the operational periods of the ICA, coffee prices remained fairly stable between October 1980 (when they were introduced under the 1976 Agreement) and July 1989; the date of suspension of the quotas. After that, the ICO composite indicator price[16] collapsed from USDc105.6/lb in 1988/89 to USDc68.9/lb in 1989/90. Producing countries sought to compensate for a decline in prices by increasing export volumes, thereby further aggravating the situation. The lowest price level in real terms (USDc45.50/lb) was recorded in August 1992. Although switching costs[17] may be relatively low, entry costs are high as it will take four to six years for new coffee bushes to produce coffee (not to mention the time needed to re-establish a suitable tree canopy on denuded slopes). This makes farmers reluctant to switch to growing other crops instead. Moreover, according to Jeffrey (2003), 70% of the world's coffee is grown on farms smaller than 10 hectares. Generally speaking, small farmers have little access to sources of finance and training needed to shift to new crops and face obstacles in taking advantage of social and environmental certification as initial costs will be substantially higher. Thus, they are less flexible.

Therefore, especially with a view to the short term, coffee supply is rather inelastic. This means that relative variations in physical supply are substantially smaller than variations in price. When stocks are low and prices high, farmers can increase their planting, but they cannot compress the time it takes for crops

[15] ICO, 2005b, p.5.

[16] Physical prices for the most important growhts (Colombian milds, other milds, Brazilian naturals and Robustas) are collected by the International Coffee Organization and a weighted average is calculated.

[17] Apart from other costs such as degrading natural diversity as a consequence of cutting down trees to sow, for example, corn, beans and/or soja.

to ripen.[18] Calculations by the World Bank have shown that short term (*i.e.* less than two years) supply elasticity in coffee-producing countries is only 0.04. In the long run, elasticities rise to a calculated average of 0.35-0.40.

Income elasticity of coffee is estimated by the World Bank at about 0.60 worldwide (*i.e.* increase in coffee consumption when income increases). However, large differences have to be accounted for. For example, income elasticities tend to fall as per capita incomes (in importing countries) rise. Moreover, elasticities differ widely among countries considered.

Coffee, being a so-called perennial crop, is rather vulnerable to price volatility. When farmers eventually increase production, prices will fall without a significant increase in demand.

Finally, substitutes (*e.g.* fruit juice, (carbonated) soft drinks, milk, tea, cocoa) for coffee have become widely available and have become serious competitors. For example, in the 1970s, the average US consumer drank 136 liter of coffee and 87 liter of carbonated soft drinks. By the year 2000, the situation was almost the other way round.

At the same time, a so-called specialty market (specialty coffees) is rapidly growing, which differentiates supply. Such coffees are purchased through direct contracts between buyer and producer (often organised in co-operatives), as well as through Internet online auctions (E-trade), special events, and competitions. As its share in the overall market remains relatively low, only a few players actually benefit from higher prices being paid for specialty (premium) products. One example is provided by fair-trade coffee. It represents a mere 2 % of the global coffee market, but its share is rapidly increasing. Nevertheless, oversupply on this niche-market seems to damage this segment in an equal manner as in the overall market.

Trade characteristics

Intermediaries are involved in many aspects of the worldwide coffee supply chain. In fact, coffee passes from growers to traders/exporters or processors (often through brokers or governmental regulatory agencies, guaranteeing minimum prices). Then, exporters sell to dealers, who supply roasters like Nestlé, Sara Lee, Kraft, Procter & Gamble and Philip Morris in the end. On its way from farmer to consumer, nearly 40 % of the world's coffee is traded by just four companies and almost half of the coffee roasting business is controlled by three multinational enterprises (see Figure 4). In other words, the demand-side concentration of market power is substantial. Nevertheless, over 90 % of the coffee traded globally takes place at exchanges, such as those in London and New York.[19]

[18] FAO, 2004.
[19] Authors' estimate; only in some niche segments, like the specialties segment, bilateral trade takes place.

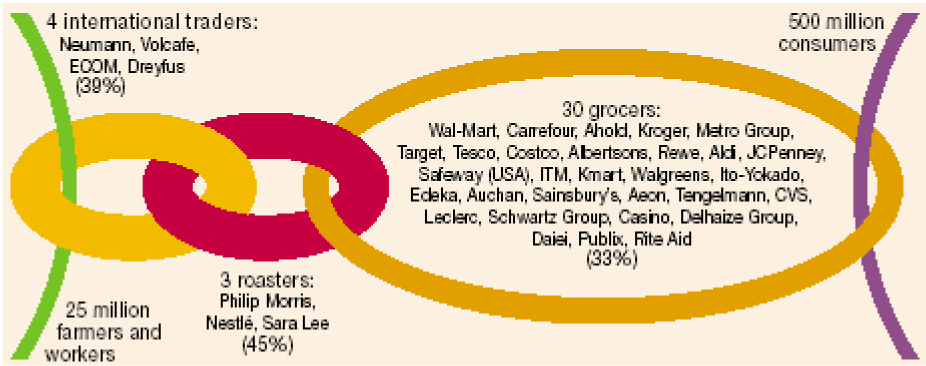

Figure 4. Concentration of market power in the global coffee chain
Source: UK Food Group in: FAO, 2004 (p.30).

Generally speaking, a mere 10 % of the retail price of coffee goes to the grower, with the remaining 75 % going to shippers, traders, processors and distributors in importing countries (See Table 6 and Figure 5). This can be explained by the high costs associated with processing, packaging, advertising, marketing and distribution, thus diminishing the share of coffee in the value of the final product.

Table 6. Price composition for non-specialty coffees

Part	Share in total (%)
FOB price (price received by producing countries, including price paid to the grower, processing costs, financing, transport and trade costs, the trade margin and export charges and taxes)	10
Freight, transport in the consuming country, storage, roasters' costs financing, roasters' and importers' margins and distribution margin	74
VAT	6

Source: Max Havelaar, 2005.

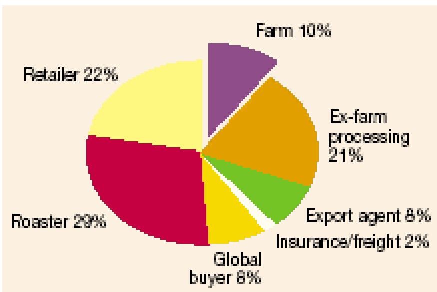

Figure 5. Coffee value chain: share of final sales value
Source: Africa Beverage Project in: FAO, 2004 (p.31).

Although coffee trade is truly international, trade barriers between both developing and developed countries, and even among developing countries, remain high. Tariff and non-tariff measures (*e.g.*, blend requirements) prevent a fully effective functioning of the market. Indeed, as Figure 6b shows, tariffs on fully processed food in many cases are more than double the tariffs applicable for the basic food commodities.[20] A FAO study concludes that tariff escalation is particularly pronounced in the commodity sectors (for a summarised overview of tariffs on coffee, see Figure 6a). As a result, primary food processing does often not take place where it would be economically most feasible. Between 1975-80 and 1998-2002, the share of the top ten coffee-producing developing countries in roasted (processed) coffee declined from 8.5 to 1.8 %.

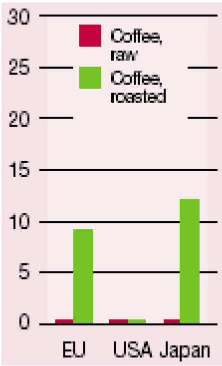

Figure 6a. Tariff escalation on coffee products in some developed countries (%)
Source: FAO, 2004 (p.23).

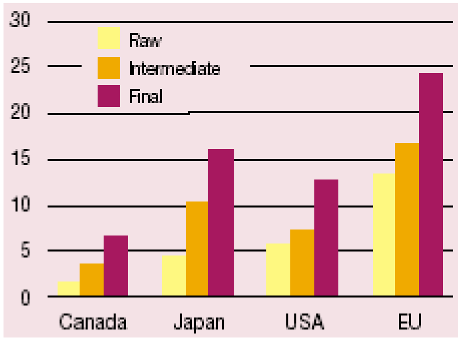

Figure 6b. Tariff escalation with level of processing in developed countries
Source: World Bank in: FAO, 2004 (p. 23).

Another characteristic of coffee trade is the uncertainty of the crop volume. Since coffee is a tree crop with a biennial yield cycle, production does not respond to prices in the short term (UNCTAD, 1995). Besides, despite low prices being prevalent during the first half of the 1990s, production levels remained unchanged. Moreover, climatic circumstances have to be accounted for. Frost, or merely the expectation hereof, can induce huge price increases as actually happened in 1994 in Brazil. Finally, parasites may cause shortfalls in production.

Concerning storage of coffee, present stock levels seem sufficiently high to provide flexibility to the market. Although coffee stocks in exporting countries have decreased in comparison to world production (from a high 64 m bags in the 1989/90 season), about 30 m bags were piled at the beginning of crop year 2004/05, which was about 25 % of world production in the same year (see Table 7). As a rule of thumb, for a well functioning coffee market, about 10 m bags in stock are required in consuming countries. At the end of 2004, the stocks in importing countries amounted to about 20 m bags.

[20] The exports by producing countries of processed coffee, mostly soluble, have never exceeded 5 % of total coffee exports, and that of roasted coffee 0.2 % (UNCTAD, 1995).

Table 7. Coffee inventories (exporting countries, 1000 bags)						
Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Stocks in exporting countries	41.66	40.5	41.79	35.96	40.27	28.71
World production	116,132	115,709	107,698	123,162	104,666	112,031
Share in world production	36%	35%	39%	29%	38%	26%

Source: ICO, 2005b.

Price characteristics

Most coffee is shipped on FOB (Free On Board) terms and their level is determined by distance and bargaining power of traders/processors. The difference between the FOB price and the unit value of imports (CIF price) is accounted for primarily by charges for shipping and, to a lesser extent, by customs entry, sampling, interest and brokerage costs. The average difference over the period from September 1988 to September 1993 amounted to USDc0.16/lb or 19% of the average CIF import price.[21]

Coffee prices are also influenced by market players' anticipation of the period of cold weather in Brazil (from April to August), which leads to a price increase already during January – June. On the other hand, the seasonality of world demand (*e.g.*, the growth in coffee consumption during the winter season) also influences prices, although to a lesser extent.

Prices at the international coffee market are realised through both spot and futures trading in London and New York. Premiums are being paid for futures contracts, as storage and insurance has to be accounted for. As time evolves, obviously, prices being paid at the spotmarket converge to those being paid at the futures market as storage and insurance need no longer be accounted for. Prices depend as well on the port of destination and quality of beans being traded (Five classes of coffee are being distinguished, from specialty coffee to so-called 'off-grade' coffee).

Finally, price formation is determined by the producing country. Costa Rica, El Salvador, Guatemala, Kenya, Mexico, New Guinea, Nicaragua, Panama, Tanzania, and Uganda deliver coffee at 'par', *i.e.* no discounts. Colombia has a differential of plus 200 points (USDc2/lb). Honduras and Venezuela have differentials of minus 100 points. Burundi, India and Rwanda deliver at discounts of 300 points, whereas the Dominican Republic, Ecuador, and Peru deliver at minus 400 points.

As Figure 7 shows, after reaching historically low prices in 2001, prices have been steadily increasing since then; during the past ten years, the price formation process has been rather volatile and erratic.

[21] UNCTAD, 1995.

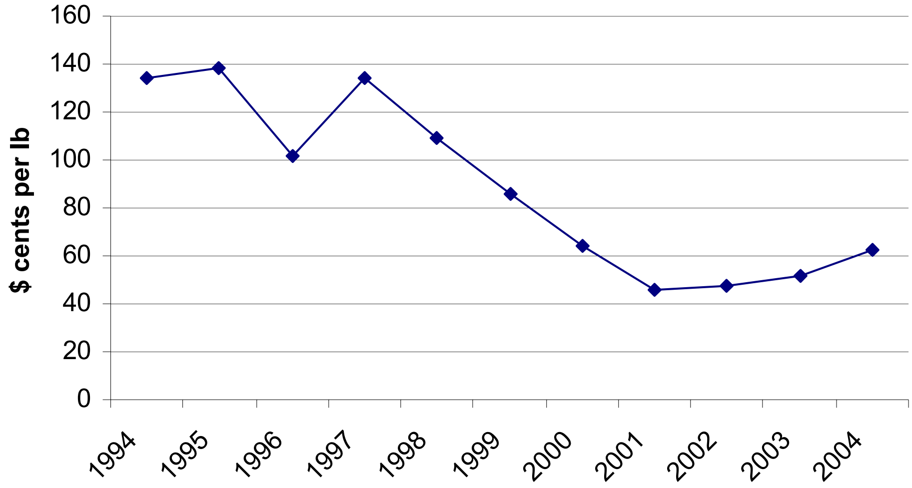

Figure 7. Composite Indicator Price, 1994-2004
Source: ICO, 2005b.

Long-term trends reflect the influence of changes in technology, consumer preferences, market structures, policies and institutions. As can be seen in Figure 8, the price of coffee plummeted with about 70 % between 1997 and 2001. Since then, recovery has taken place and further perseveres in 2005. An average indicator price of USDc 92.1 applies for 2005 (January-August).

Figure 8 and 9 show the realisation of prices on, respectively, a monthly and a daily basis.

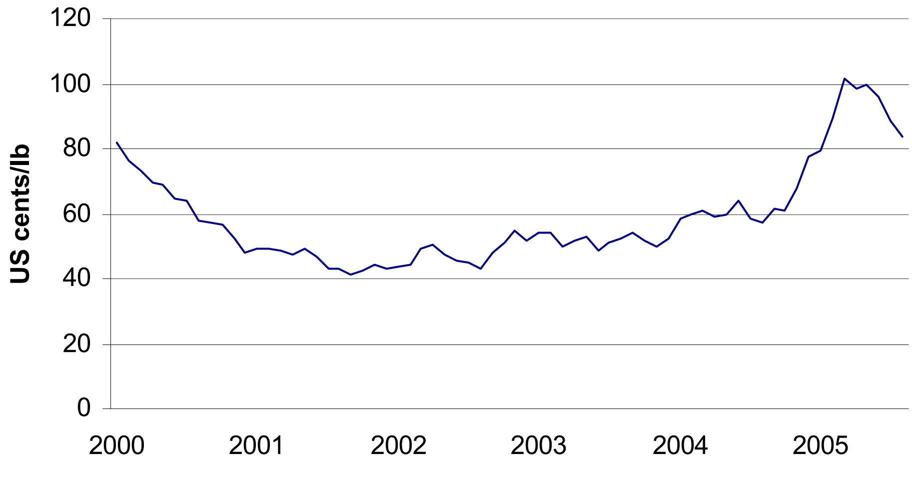

Figure 8. Monthly composite indicator price, January 2000 – August 2005
Source: ICO, 2005b.

Figure 9. Daily composite indicator price, 5 January 2004 – 5 August 2005
Source: ICO, 2005b.

Price volatility (as has been reflected in the Figures above) can be expressed by the coffee price instability index (annual average percentage deviation from trend). For coffee, this number was above 25 % during the 1986-99 period; the highest for tropical beverages.[22]

Conclusion

The section has identified the following market, trade and price characteristics as determinants of the prices on the world coffee market:[23]

- Uncertainty of crop volume;
- Seasonal weather conditions;
- Coffee inventories;
- Low supply and demand elasticity;
- Freight charges;
- Speculation; and
- Changes in consumption patterns.

Although truly international, one cannot speak of a 'perfect' coffee market. This is illustrated by the fact that oversupply seems structural without any significant adjustments being made. This situation is aggravated by high price volatility that can blur longer-term price trends that should lead to adjustments in supply and demand. Furthermore, farmers cannot quickly scale production up or down when prices change due to the perennial nature of coffee. Thus, production is maintained even in the face of falling prices, which even exacerbates the market imbalance problems.

On the demand side, lower prices generally do not stimulate consumers in developed countries to increase their purchases of commodity-based products as price elasticities are low. Although liquidity is high, non-discrimination, high levels of transparency, large competition and the effective functioning of the market – conditions characterising a fully liberalised market – are not in place. Substantial market power is exerted by traders and roasters alike, having a strong influence on prices being paid on the worldwide coffee

[22] FAO, 2004.
[23] UNCTAD, 1995, pp. 9-10.

market. However, retail prices are substantially higher as only a few roasters process coffee (based in developed countries - higher import tariffs apply in case of processed goods).

Given some typical characteristics, switching costs are relatively high as the majority of coffee production is grown by small farmers who are generally perceived to be rather inflexible when it comes to shifting to other crops or other means of subsistence. The emerging development of a market for specialty coffees (*e.g.*, certified Fair Trade coffee) seems to address some of the issues of the current state of development of the coffee market, although the same fundamentals seem to apply.

4.3. Non-physical commodity spotmarket: Foreign Exchange (currencies)

Market characteristics

The foreign exchange market is the trading platform that allows international transactions to take place in a safe and efficient manner. The spot price for a currency is the exchange rate, which is formed by fluctuations in the demand and supply of a particular currency relative to another currency (or a basket of other currencies). The degree to which national governments are able to modify their exchange rate is reflected by their monetary autonomy. For instance, most of the members of the EU–15 agreed to mutually fix their exchange rates in order to promote economic and monetary stability (Maastricht Treaty, 1991). On the other hand, the EU (through the European Monetary Union) applies a flexible exchange rate regime of the Euro vis-à-vis other currencies.

As in all physical and non-physical commodity markets, trade flows adjust according to changing demand and supply patterns. Any disruption in demand or supply has its effect on the exchange rate.

By setting the interest rate or by purchasing or selling government bonds (open-market operations) Central Banks can influence the quantity of money in the market, and with that the inflation rate and the exchange rate. Money demand is determined by the quantity of money people wish to hold when taking into consideration the price of the goods and services they want to buy (real money balances).

Trade characteristics

The supply and demand conditions for money are very beneficial for trading, since the product (money): is homogeneous, available in ample supply, and has low costs in terms of production, transportation and storage. Therefore, when demand for a currency on the spotmarket increases, delivery takes place almost immediately, through the ICT infrastructure; there are no underlying physical deliveries of the product (money) on the spotmarket. Therefore, capital flows and capital mobility are very important factors for international free trade of real and financial commodities.

In fact, the foreign exchange (spot) markets function so well, when considering trade volumes and integration, that even limitations on capital mobility through a tax on short-term capital movements have been proposed (*e.g.,* Tobin tax[24]). Such a tax would have to reduce the potentially destabilising effects of large capital movements. For instance, a sudden massive capital outflow, for whatever reason, from the USA would, taking into consideration the large US budget deficit, have dramatic consequences for both the USA and the world economy.

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[24] Haq *et al.*, 1996.

Price characteristics

The price of a currency (the exchange rate) in a system with flexible exchange rates is influenced by several economic factors, such as: balance of payment status of a country or currency area, and related to that the monetary and fiscal government policy of the country or region. Arbitrage can take place very effectively as information on exchange rates is quickly and cheaply available so that a difference between the values of one currency expressed by two or more exchange rates can be quickly taken into account. For instance, if currency A expressed in units of currency B cost 3 units, and if A expressed in terms of C costs 10 units, then the exchange rate of B in terms C must be 3.33. If the exchange rate B/C is higher or lower, then an arbitrage opportunity exists.

Of course, speculators are also active on these markets by taking a position in the foreign exchange market, *i.e.* speculate on an exchange rate depreciation/appreciation or devaluation/revaluation. Finally, numerous investors are active on foreign exchange markets in order to diversify their asset portfolio.

In addition, risks caused by uncertainties about future spotmarket exchange rates can be covered through forward market contracts or derivatives, which contain agreements on currency transactions somewhere in the future at a fixed price. It must be noted that this analysis only applies to flexible exchange rate regimes, since with fixed exchange rate regimes there is no price volatility on spotmarkets.

Conclusion

Due to characteristics of the product (tradability, transport and storage costs, and information availability), currency spotmarkets, despite the possible destabilising economic and social effects of large capital mobility, are very close to the theoretical model of perfect competition.

However, it must be noted that these characteristics do not rule out price volatilities in flexible exchange rate regimes. If the underlying economic factors are unstable or the economy of a country has an economic slow down, then this can have strong currency demand and supply consequences and hence impact the exchange rate, irrespective of the favourable market and trade characteristics for the currency spotmarket. The latter is an important reason why several currencies have fixed mutual exchange rates, or are pegged to a particular currency or basket of currencies (*e.g.*, GBP, USD, €).

4.4. Overall assessment non-energy spotmarkets

From the discussion of spotmarkets in this section, it can be concluded that the proper functioning of a spotmarket largely depends on the tradability of the commodity. For instance, if demand for a commodity cannot be met on the spotmarket by an accurate supply, *e.g.*, because of problems related to storage and transport, prices will increase. Moreover, next to flexibility in terms of 'physical' tradability, spotmarkets also need flexibility in terms of the time that market players need to respond to changing supply and demand conditions. Tradability is important provider of such flexibility, but also contract conditions, production flexibility, supply and/or demand elasticities determine how flexible market players can be.

In the following section, the conclusions regarding tradability and flexibility drawn from the case studies in this section will be projected on energy markets (natural gas and electricity). The market characteristics of energy commodities will be analysed and compared with those of the spotmarkets described. This will provide input into the research objective of exploring to what extent energy spotmarkets can function properly with a sufficient security of supply and limited volatility of prices.

5. Comparing non-energy spotmarkets with energy spotmarkets

5.1. The tradability of commodities

On commodity markets, trade takes place in the process of matching supply and demand. As Section 4 has shown, supply interruptions are possible and demand fluctuates in response to changes in consumer preferences, seasonal patterns, temperature, *etc*. Another general conclusion for commodity markets is that they all, albeit to different extents, experience 'boom and bust' cycles. According to this general description, natural gas and electricity markets do not fundamentally differ from other commodity markets. For each commodity, 'tradability' and market flexibility are crucial determinants for the development of competition on the market as these define the scale and scope for trade in the commodity.

Volume equilibrium

When comparing energy markets with non-energy commodity markets, it is important to distinguish between, on the one hand, commodity markets (the majority) which only reach volume equilibrium on paper, and, on the other hand, network industries or network commodity markets (such as electricity and natural gas) which have to remain in a physical volume equilibrium at all times.[25] With regard to network commodity markets, it should be acknowledged that flexibility for balancing purposes is different from flexibility for trade. 'Balancing flexibility' is more focussed on security of supply and system integrity, whereas 'trade flexibility' is clearly profit oriented. The utilisation level of balancing capacity in relation to total available balancing capacity is an indication of the scope for trade flexibility. Trade flexibility capacity, in turn, is required to facilitate trading on exchanges.

If ample capacity is present, then no technical barriers are in place for trade to develop effectively and efficiently. If, however, technical barriers/limitations exist, regulatory interventions to increase the flexibility of trade (*e.g.*, by reducing the market power of the dominant player) would reduce balancing flexibility and could potentially interfere with security of supply considerations. In case there is substantial 'room' for trade, *i.e.* sufficient flexibility capacity, it should be noted that a low flexibility capacity utilisation level makes it less attractive to invest in additional capacity. Seasonal demand patterns for total flexibility (balancing and trade) are informative for this purpose.

As traders are inclined to maximise their profits, they will sell when prices are high and buy at low prices. In the latter case, they store the product until prices have sufficiently increased again. For energy market commodities, prices and demand for flexibility are high during the winter (sell) season, with generally low storage levels, with the opposite being true for the summer (buy) season. Given this trade pattern, the next issue to address is the costs of such flexibility. The general assumption is that higher costs of flexibility (*e.g.*, transport, storage, linepack/JIT, production swing) lower the tradability of the commodity. This assumption implies that trade on exchanges is limited by geographic boundaries, which also limits the scope for arbitrage: the price differential between two exchanges will exist, *ceteris paribus*, as long as it is smaller than the additional costs of flexibility.

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[25] It should be noted though that on network commodity markets, trade does not necessarily result in a physical volume effect, because, as with most commodity markets, physically delivered volumes only make up a small part of the total value traded, the so-called *churn* factor or retrading ratio. Nevertheless, any physical trade must lead to an equilibrium.

Transport

Commodity transport generally occurs by means of shipping, which in most cases applies to water, road and air transportation. Trucks and ships can be used for several commodity types, although some products may need specific transport equipment due to security and safety concerns. Other commodities are transported through so-called dedicated networks[26], which have been specifically designed for the particular commodity. Examples of these commodities are the natural gas sector (natural gas grid), the electricity sector (high/low voltage electricity grid), the telecommunications sector (ICT network) and the financial sector (ICT network).

Concerning transport, all commodity markets face similar issues, such as availability of transport capacity and transportation costs. A particular characteristic of dedicated network sectors is that they all face some form of dedicated regulation and institutions to monitor them. The existence of a dedicated regulatory supervision alone is an acknowledgement that there are certain market-specific elements that require 'special' attention. Howevr, a distinction can be made between, on the one hand, dedicated network markets such as foreign exchange and telecommunications where transportability is not an issue, and, on the other hand, natural gas markets where transportation is relatively costly (see below). Based on the above, it is reasonable to assume that the tradability of the product reduces when transportation costs per unit of product increase (lower transport flexibility).

Below, particular attention is paid to transportation by ocean shipping and through dedicated networks. Air and road transportation do not play a substantial volume role in bulk transportation. Moreover, road transport is more regionally oriented and therefore less interesting for this analysis. Railroad transportation does have the similar characteristics as a dedicated network and transportable volumes are high. Nevertheless, this mode is used relatively limitedly in global bulk commodity transportation.

- **Ocean transport** is the primary mode for transportation of industrial bulk commodities. Ship brokers, ship owners and charterers, together with several other stakeholder groups, such as investors, financial institutions and maritime experts, are key players on this shipping market, which is essential for international trade. Key indicators that cause fluctuations in freight rates (unregulated prices) are fleet supply, commodity demand, seasonal patterns, bunker prices, 'choke' points and market sentiment. Just over 50% of the total global ocean transportation volume is energy related (oil, coal and gas). Container transportation makes up just about 10% of the total volume, but represents a far larger share in value terms. Various price indices are available for different cargo types, such as dry and wet cargo. The majority of the vessels can be used for transportation of different commodities.
- **Dedicated networks:** As mentioned above, 'network' commodities, such as telecommunication, foreign exchange, electricity and natural gas (excluding Liquefied Naturlal Gas, LNG) use a fixed infrastructure as the primary mode of bulk transportation. The fact that natural gas pipeline and electricity grids are bound (specified wobbe labels and there is no physical product differentiation possible in the electricity products) to a high degree of product homogeneity reduces their flexibility substantially. As mentioned above, tradability issues regarding flexibility and transport do not accrue to telecommunications and foreign exchange. Moreover, the ICT network for the latter commodity markets is, in fact, not truly dedicated, *e.g.* the telecommunication network could also be used for Internet purposes and several other services. Generally, a network is considered dedicated if the

[26] Williamson, 1975. Transaction cost economics (TCE), with the introduction of the concept of asset specificity, provide strong evidence for this argumentation. Transactions that involve assets that are only valuable (or are much more valuable) in the context of a specific transaction, the transaction costs will tend to be reduced by means of vertical integration.

alternative usage of the network requires a complete and immediate transition, with correspondingly high costs.

Transport of electricity and natural gas

The commodities traded by means of dedicated networks fulfil the theoretical perfect market condition of product homogeneity. In fact, it can be stated that natural gas and electricity are amongst the most homogeneous commodities in the world. Nonetheless, the functioning of these energy markets is hampered by the relatively high degree of sunk costs (asset specificity) of the investments made in dedicated network infrastructure. For instance, the majority of the ocean transportation vessels can be deployed in multiple commodity markets and are, therefore, less dedicated to the transportation of a particular commodity than a natural gas pipeline network. This reduces sunk costs and thus investment risk related to ocean transport. Consequently, potential investors need a higher rate of return (risk premium) on dedicated networks. This makes the marginal investment decision more difficult for dedicated network transportation than for ocean transportation.

Concerning the extent to which a (electricity or natural gas) network is dedicated it should be noted that the electricity network is truly dedicated, since no other product can pass through the high or low voltage lines (perhaps with the exception of the Internet through the electricity grid). The natural gas pipeline infrastructure is somewhat less dedicated, since different gas qualities can be transported through the network (using quality conversion techniques) or different products, such as hydrogen, biogas, and CO_2.

Nonetheless, the natural gas network still has a high degree of dedicacy. For instance, in the Netherlands, presently, over 97% of the gas traded via the TTF is high caloric (H).[27] When the market demands a different gas quality (*e.g.*, low caloric gas), the TSO (Gas Transport Services in the Netherlands) must be able to transport this gas by reserving pipeline and conversion capacity. In the cases of non-dedicated networks, the 'quality conversion', in fact, takes place before the actual transaction where product specifications are quoted (*e.g.*, Dutch or French tomatos) and reflected in the price. The fact that the TSO must reserve this capacity beforehand implies an additional market inefficiency, because with spotmarket trading the destination of the spotmarket gas is not known up until the moment of the transaction. Spotmarket gas trading therefore poses an extra burden on the available pipeline capacity. Once conversion of the gas has taken place, the opportunities to re-sell (or re-export for that matter, which can be seen in the coffee market) the gas are substantially reduced. In general, this reduces the tradability of natural gas.

5.2. Sources of (supply/demand) flexibility

From the assessment in Section 4, it has been concluded that a certain degree of demand for flexibility is essential for an effective functioning of a market. The extent to which markets offer such flexibility differs from case to case, and even if markets offer sufficient 'technical' flexibility, it remains to be seen whether this flexibility is commercially and economically available to the market for trading purposes. The most important question in this context is whether the demand for flexibility can technically and economically be met and what impact this would have on a product's tradability? As has been mentioned before, if a commodity's tradability is structurally lower than that of other commodities, it is reasonable to conclude that the benefits from competition are relatively low and that liberalised trade (spot/forward trading) is fundamentally restricted. This could imply that there is limit to the volume of trade.

[27] Frontier Economics, 2005.

In all commodity markets at least one of the below forms of flexibility is present:

- Storage,
- Linepack,
- Imported flexibility,
- Production flexibility,
- Interruptible contracts,
- Quality conversion capacity.

Storage

For most commodities, storage is the main source of flexibility in the market: warehouses, large tanks, gas fields, caverns and numerous other possibilities are available to store a bulk product. The most important indicators for the contribution of storage to flexibility are: response time and costs per unit stored. Note that storage can be used in situations of over and undersupply. For instance, aluminium can be relatively easily stored, since no large capital investments are needed for this. In this market, storage costs mostly depend on location, which incorporates the response time to compensate for supply/demand fluctuations.

When considering storage of electricity and natural gas, the picture is totally different. Technically and commercially speaking, storing electricity is not a realistic option and therefore can provide no flexibility whatsoever. Storage of natural gas, on the other hand, is a viable mode of providing flexibility to the market, via storage in caverns, depleted gas fields and aquifers, and underground tanks, each with their own specific volume, cost, price, functional, and operational characteristics.

Linepack

In network industries such as electricity and natural gas, linepack is the first source of flexibility used to alleviate demand and supply fluctuations. In ocean transport, linepack is probably better known as Just-In-Time (JIT) management, through which the shipping time is adjusted in order to meet demand just in time, and to reduce the costs of storage. Linepack in different markets could thus have different volumes, costs and price characteristics; the flexibility in volume provided by linepack in ocean transport can be a multitude of the linepack flexibility in the electricity or natural gas markets. Moreover, the use of JIT flexibility has a more financial/economical basis (reduce storage costs), whereas gas linepack has a more technical basis (security of supply, system integrity and volume equilibrium).

Imported flexibility

Imported flexibility can be achieved by booking foreign supply and (storage/production/transport) capacity that is close to the market in terms of distance and costs (price). The specific characteristics of imported flexibility depend on the type of flexibility that can be competitively offered in the market concerned. In some commodity industries, imported flexibility is negotiated in the supply contract, mostly based on operational and economic considerations. In other commodity markets, imported flexibility is usually called up to adjust the own production deficit by buying at spotmarkets or bilateral trade.

As imported flexibility can have many forms, it is wise to consider the relevant market for flexibility with respect to each individual commodity. Subsequently, the various types and volumes of flexibility that can be offered at competitive prices can be determined.

Production flexibility

Generally, it can be stated that in most commodity markets production flexibility is relatively low. For aluminium it is known that the possibilities of expanding production (capacity) in the short run is difficult to achieve, unless a substantial share of the installed production capacity operates below its usual capacity utilisation level. Downgrading production in the short run is possible (putting melting ovens in slumber mode or by taking ovens out of production) but is less attractive from a financial economic perspective. In this particular market maintaining production and storing surplusses is a more sound option. The coffee market case has also shown that short-term changes in production processes are rather difficult to achieve.

Each commodity market has its preferred mode of production flexibility, which is generally the option with the lowest costs. However, should this low-cost flexibility source provide a market participant with a substantial competitive advantage, additional measures may be needed to alleviate and compensate other market participants for not having access to this specific source of flexibility. In this context, a minimum price on the main flexibility source could be imposed, in order to provide other flexibility sources with fertile ground to develop.

From the above it can be concluded that for each market, flexibility sources can be ranked qualitatively/quantitatively. For instance, whereas flexibility in most commodity markets is primarily provided through storage (*e.g.*, coffee, aluminium), production flexibility is the main source of flexibility in most of the electricity and gas markets.

Interruptible contracts

Another feature of the electricity and gas sector is that when supply is not able to meet demand there are contracts in place to cut off the supply to some demand-side parties, mostly large industrial energy consumers. This instrument has some 'last resort' characteristics, since the economic damage to those interrupted parties could be substantial. For instance, in the aluminium industry an interrupted supply of electricity during more than two hours results in the loss of the total melting capacity. Although these parties are generously compensated for taking this risk, market parties generally consider execution of interruptible contract undesirable. Consequently, this flexibility option is not really suitable for trading purposes, especially in the electricity market and, to a somewhat lesser extent, the natural gas market.

In other commodity markets interruptible contracts have a somewhat different meaning: an interruptible contract could offer a contract holder the opportunity to re-sell its input at, for instance, higher prices and buying other supplies elsewhere. The scope for this additional trade opportunity reduces with the upcoming delivery date up to the point that alternative supplies can be secured, or as long as their own stocks allow it. In the case of, *e.g.*, supplier default the contract can be considered interrupted, but even in these cases operational consequences can still be avoided by securing alternative supplies, most of the time at higher costs. Those additional costs can be recovered from the responsible or default party.

Therefore, in conclusion, interruptible contracts in other commodity markets are not similar to the contracts in energy commodity markets and their financial and economic consequences are likely to be smaller than interruption of natural gas and electricity contracts. Note that interruption of a contract could just as well have a positive result for the buying party, since it can potentially gain from additional trading opportunities. Therefore, the decision power to interrupt a contract within non-network based commodity markets lies partially with the buyer, seller and unforeseen circumstances, which adds to the flexibility and tradability of the commodity in question.

Quality conversion capacity

Regarding conversion capacities, the natural gas market is a unique market since different gas qualities have a severe impact on the transportation through the network. Other commodities with differing qualities are numerous (different aluminium alloys, various coffee qualities and green or conventional electricity for example), but there is no other commodity market where the logistical consequences are compromising the mobility and tradability of the product. Only conversion of H-gas to L/G-gas is commercially possible, which could potentially alleviate H-gas oversupply or L/G-gas undersupply.

Although this could indicate some scope for arbitrage between H and L/G gas prices, conversion capacity is insufficiently available on the market. Only when the prices/costs of converting from H-gas to the L/G-gas market (H-gas storage and conversion capacity) equal the prices/costs of swing production of L/G-gas, sufficient room for competition and conversion capacity as a flexibility mechanism is present. It is assumed here that L/G-gas swing production capacity will not become available on the market, due to political considerations. Therefore, it can be stated that the L/G-gas and H-gas market substantially differ in terms of available flexibility sources and that for the L/G-gas market other considerations than purely economic ones potentially prevent the market from ever being competitive. On the other hand, by imposing a minimum production swing price it can be expected that the demand for converted H-gas (and attached flexibility demand by means of storage) increases. This secures domestic reserves and improves the infrastructure (conversion and transport), as well as improves the scope for more 'internationally' oriented trade in the H-gas market.

5.3. Conclusion

In Section 1, it has been argued that, according to economic literature, a 'perfect' spotmarket is characterised by the following conditions:

- **Non-discrimination**: all players face the same tariffs, conditions and procedures for market entrance.
- **High transparency**: information on tariffs, conditions, procedures and energy transport capacity is publicly available.
- **Large competition**: a considerable number of players have access to the market and there are no or no strong levels of horizontal and vertical concentration of particular players.
- **Effective functioning of the market**: there is a high liquidity in terms of traded volumes and sufficient capacity in terms of physical availability of natural gas, transport, flexibility in terms of storage, linepack, production swing, quality conversion, interruptible customers, and imports.

The extent to which these conditions contribute to the 'perfectness' of a market differs, however. Some conditions have a more fundamental or structural impact while other conditions are more facilitative and do not place serious obstacles to the functioning of a commodity spotmarket. Based on the analyses in Sections 2-5 the main differences between the selected spotmarkets (including those for natural gas and electricity) can be assessed. These results are presented in the tables below. It should be noted that this study only aims at producing qualitative results, which nonetheless can offer a clear and reasonable picture of the major differences between the selected commodity markets.

From the tables and the foregoing analysis, it can be concluded that actual spotmarkets for physical and non-physical commodities meet some of the above conditions, but not all of them. As will be explained below, of the markets analysed in this paper the foreign exchange market comes closest to the picture of a perfectly competitive spotmarket, with coffee and aluminium being second and third in our ranking.

Energy commodity markets, *i.e.* electricity and natural gas, remain relatively remote from this ideal picture on a distant fourth and fifth place.

Based on the analysis of actually existing spotmarkets, it seems reasonable to conclude that of the four conditions mentioned above, *effective functioning of the market* is the most important one for the successful development of a commodity spotmarket, since it is largely related to supply flexibility, product tradability, transportability, and market efficiency. The nature of the *non-discrimination* and *high transparency* conditions is more informational and less structural. They can be adjusted at will and the supervising authority, the regulator or policy maker can enforce compliance. Although the presence of large competition is indicative for a *perfectly* competitive market, this condition is certainly not a prerequisite for a *well functioning* spotmarket. After all, a large number of real life (well functioning) commodity spotmarkets are faced with horizontally and vertically integrated market players. This is also in line with auction theory, which has somewhat relaxed the *large competition* condition (see also Section 3).

Considering the above it can be stated that, in order to assess the future situation of the energy spotmarkets, the *effective functioning of the market* is a key condition, since it describes the physical and structural market characteristics determining the flexibility, tradability, transportability, and efficiency, and in essence determines the potential liquidity of the markets. From the analysis of the sources of flexibility in Section 4 it seems that the electricity and natural gas (spot)markets are structurally less well suitable for trade than other (spot)markets. From this observation, the question that follows is: *which structural factors are responsible for the low degree of tradability of gas and electricity and the high degree of market inefficiencies in the gas and electricity (spot)markets?*

Table 8. Qualitative assessment of transport network and costs

Transport	Prime mode of transport	Network type	Transport costs/price[28]
	Ship	Non-dedicated	<5%
Aluminium	Ship	Non-dedicated	<5%
Coffee	ICT-network	Non-dedicated	<1%
Currencies	Pipeline network	Dedicated	20-70%[29]
Gas	Hi/Lo voltage network	Dedicated	10-30%[30]
Electricity	ICT-network	Non-dedicated	<1%
Telecommunications (for illustration)			

Source: Various sources, Baltic Exchange indices for a.o. dry bulk, OME (2004) for long distance gas supplies, telecommunications and currencies own guesstimates.

The fact that the natural gas and electricity distribution networks are 'dedicated' (see Table 8) increases the relative costs for transportation, since no alternative products are expected to be transported through these networks within the near future. Moreover, the current ratio transportation costs/end-user price is significantly higher for natural gas and electricity, depending on distance (*e.g.*, natural gas imports from the Russian Federaton, electricity imports from France). This implies that capacity expansion of the two dedicated network commodities is relatively more expensive than for other commodities and thus requires a higher return on investment or larger profit margin. The transportability, hereby, is structurally hampered; the boom and bust inefficiencies are higher due to this structural incremental investment barrier. These inefficiencies could be reduced, however, when alternative applications of dedicated networks become technically feasible and commercially viable, *e.g.*, feeding hydrogen (or biogas) and natural gas in the network simultaneously. However, one needs to take account of the additional costs that are inherently related to creating a non-dedicated network.

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[28] Note that with price volatility this ratio can vary significantly, however the various ranges for electricity and gas on the one hand and the other commodities on the other hand, presented in the table, differ substantially. The main point to be made here is that the transportation costs per unit of product through dedicated networks are higher than for other commodities (non-dedicated).

[29] The range of transport costs/price for natural gas is caused by the geographical proximity of 'new' gas resources. For the upper boundary, based on the assumption that gas supplies to Europe will increasingly come from distant geographic regions, the OME in 2004 made some calculations based on the long term marginal cost approach. The lower boundary, however, is more divergent per country since some Western European countries lack significant domestic production and an extensive transportation network.

[30] The ratio range for electricity is a qualitative guesstimate and is also more geographically dependent of, for instance, the amount of imported electricity. With the prospected increase in cross-boarder electricity flows, the share of transportation costs relative to the price is likely to increase. Here again price fluctuations and geographical proximity play a significant role. The point made in footnote 25 still holds and is backed up by the fact that in Europe the gas and electricity TSO's are faced with the issue of regulated tarifs, which could be an indication that these tarifs are perceived to be relatively high.

Table 9. Qualitative assessment for usage of flexibility sources within various commodity markets.[31]							
Prime sources of flexibility	**Production flexibility**	**Line pack**	**Storage**	**Interruptible contracts**	**Imported flexibility**	**Conversion capacity**	**Total**
Aluminium	2	1	5	1	1	n.a.	10
Coffee	1	0	6	1	2	n.a.	10
Currencies	n.a.	n.a.	10	n.a.	n.a.	n.a.	10
Gas	6	1	2	1	1	-1	10
Electricity	6	1	n.a.	1	2	n.a.	10

Table 9 shows a qualitative assessment of flexibility sources within the commodity markets analysed. For most commodity markets the main source of flexibility is storage, whereas for natural gas and electricity most of the flexibility is provided by production. It should be noted that conversion capacity for natural gas, which must be kept in reserve by the TSO, reduces the flexibility of this market for trading purposes; this explains the negative value in Table 8. For currencies, flexibility from other sources than storage can be regarded non-relevant; production flexibility, for example, is essentially dependent on the availability of ink and paper. The foreign exchange reserve position of all entities that actively participate in the market (trade) can be considered unlimited.

In addition to the impact of usage/demand for flexibility mechanisms (Table 9) on the overall flexibility of the market, it is also important to assess the availability of such mechanisms. This is summarised in Table 10, which shows that the availability of flexibility mechanisms for electricity and natural gas trading is extremely low. This will inherently result in an underdeveloped spotmarket in comparison to other commodity spotmarkets: production flexibility for natural gas can be 'out' of the market for strategic reasons (*e.g.*, cap on the Groningen field); linepack for gas and electricity is 'out' of the market for reasons of system integrity, but depends heavily on the balancing regime (hourly, weekly or monthly). For electricity, storage is 'out' of the market for technical reasons and production flexibility is available to the extent that electricity generators are forced to auction generating capacity. Electricity production flexibility is out of the market because of the system integrity, governed by the national TSO.

[31] The reader should be aware of the qualitative, and thus subject nature of this assessment. The main point to be taken here is that the prime flexibility sources for electricity and gas differ substantially from the other commodity markets. Moreover, one should realise that the flexibility sources differ per country. For instance, a country like Belgium, with no domestic gas production flexibility whatsoever, obtains a large part of its flexibility from the Netherlands which offers a substantial production flexibility.

Table 10. Qualitative assessment for availability of flexibility sources for trading purposes[32]

In the market for trading purposes?	Production flexibility	Line pack	Storage	Interruptible contracts	Imported flexibility	Conversion capacity
Aluminium	Yes	Yes	Yes	Yes	Yes	n.a.
Coffee	Yes	Yes	Yes	Yes	Yes	n.a.
Currencies	n.a.	n.a.	Yes	n.a.	n.a.	n.a.
Gas	No	No	Yes	No	Yes	No
Electricity	No	No	No	No	Yes	n.a.

In order to address the future 'role' of electricity and gas spotmarkets it is needed to make a valued judgement of whether production flexibility and linepack will ever be 'in' the market for trading purposes. Moreover, it could be argued that production flexibility (in natural gas) will be priced in line with storage flexibility, thereby providing incentives to create more flexibility capacity, *i.e.* storage. For the electricity market, the flexibility issue seems somewhat more problematic since production flexibility is basically the only flexibility option.

In addition to the inefficiency and inflexibility of the electricity and natural gas market, there is the technical requirement to constantly maintain volume equilibrium. Although linepack can rapidly absorb short-term fluctuations, the system operator continuously has to ensure security of supply or system integrity by balancing input with output. As Table 11 shows, no other commodity markets have this volume equilibrium constraint, *i.e.* a balancing regime is unique for dedicated network (physical) commodities (including water). This fact undoubtedly reduces trade flexibility, resulting in higher market inefficiencies, which have to be weighed against the benefits of trade.

Table 11. Constant volume equilibrium constraint in selected commodity markets

Constant volume equilibrium constraint	Yes/No
Aluminium	No
Coffee	No
Currencies	No
Gas	Yes
Water (for illustration)	Yes
Electricity	Yes

Relaxing the balancing regime from a hourly/weekly basis to a monthly basis (as is the case at the US Henry Hub) would increase the market's flexibility for trade. However, a monthly balancing regime requires that transportation tariffs cover this additional 'storage' function.

From the above, it can be concluded that the low degree of tradability of natural gas and electricity are caused by: the constant volume equilibrium constraint, the dedicated network issue, and the different

[32] This qualitative assessment is entirely based on the authors' impressions during the research process.

usage/purposes of the various flexibility sources (storage capacity, function of linepack, position of production flexibility as prime source of flexibility). With these two markets being relatively inflexible, *i.e.* being unable to respond efficiently in case of a demand/supply fluctuation, additional costs are unavoidable and not necessarily attributable to the abuse of market power and/or a dominant market position. Therefore, a good case can be made to strive for a 'workable' form of competition as mentioned in the EC competition policy (see also Section 3).

Table 12. Assessment of the ratio spot trade to total trade for selected commodities.

Current function of spotmarket	Spot/total trade
Aluminium	25%
Coffee	90%
Currencies	99%
Gas	<10%
Electricity	<10%

Finally, Table 12 gives an indication of the importance of spotmarket trading in terms of total trade of a particular commodity. Considering the relatively young electricity and natural gas spotmarkets, it is not surprising that their ratio spot/total trade is rather low. However, in order to give a valued judgement about the future position of these two spotmarkets it is illustrative to consider the function of other 'older' spotmarkets. Coffee and currencies are primarily traded through the spotmarket, which is consistent with their relatively low capital intensity. Therefore, the characteristics of the aluminium market make this market more suitable as a benchmark for electricity and gas. Assuming that the aluminium market's ratio of 25% is the highest ratio achievable for electricity and gas, and realising that presently 5% of total Dutch trade of natural gas is traded through TTF, the likely ratio spot/total trade for natural gas would range between 5 and 25%.

Moreover, similar to the aluminium spotmarket it may well be that the electricity and gas spotmarkets will eventually function as a 'last resort' outlet for buyers and sellers. For the natural gas market, it can thus be concluded that, given the short-term gas transport inefficiencies and limited gas market flexibility, in combination with declining domestic production capacity, future flexibility on the gas market can mainly be offered by a drastic increase in storage capacity.

6. Implications for future research

This study has aimed to explore whether it is reasonable to assume that energy market liberalisation, including spotmarkets, can deliver the benefits in terms of efficiency improvement, price reduction, and overall welfare gains as suggested by economic theory. The applied methodology has primarily been of a top-down nature, *i.e.* starting from economic theory it has been analysed to what extent the characteristics of the natural gas and electricity markets are in line with the theoretical conditions for well-functioning, liberalised markets.

From this qualitative analysis it can be concluded that if the theoretical optimum for liberalised markets were taken as a benchmark, energy spotmarkets would not be able to meet this reference point. Several constraints have been identified which cause energy spotmarkets to deviate from theoretically optimal spotmarkets. Most importantly, it has been concluded that the condition of effective functioning of the market, which is considered most important for a successful development of commodity spotmarkets, is difficult to achieve on energy spotmarkets:

1. The tradability of natural gas and electricity is largely hampered by the relatively high costs of transporation.
2. Energy markets need to be in a continuous volume equilibrium, which implies that what is taken out of the grid, must be replaced with an equivalent amount of gas or electricity.
3. There are significant costs involved with storage of natural gas (storage of power is not a realistic option from a technical point of view), for instance, when compared with storage of coffee and aluminium, which storage does not need large capital investments.
4. Technical balancing options, such as linepack, can only limitedly offer market flexibility and must be carefully applied in order not to disturb technical balances in the systems.
5. The flexibility offered by interruptable contracts could be helpful at times when, due to *e.g.* weather circumstances, supply cannot meet energy demand, but the economic damage to the actors that face the interruption (mainly large-scale end users) can be considerable.
6. The flexibility provided by import of natural gas and electricity could be considerable but is also reduced by the dedicacy of the networks to gas and, to a somewhat lesser extent, electricity transport. This implies that investments in gas and power grids for transport can only be used for these homogeneous products, which implies relatively high sunk costs and asset specificity.
7. Finally, import flexibility can be reduced by larger competition at times of, *e.g.*, cold spells, when all countries in the same region face an increased demand.

These limitations to the effective functioning of energy spotmarkets imply that the theoretical benchmark for liberalised markets cannot be met by natural gas and electricity markets. As a next step the study has analysed to what extent meeting the theoretical benchmark is a necessary condition for well-functioning spotmarkets. In order to explore this, the study has analysed the functioning of a number of non-energy commodity markets and whether they meet this benchmark.

For coffee and aluminium it was concluded that production flexibility is limited as producers show a relatively low elasticity to changing market circumstances. On the other hand, storage flexibility, linepack flexibility, and network flexibility (non-dedicated transport, and no volume equilibrium) are considerably higher for coffee and aluminium. Of the markets analysed, only currency spotmarkets turn out to be quite close to the theoretical benchmark. Nonetheless, despite the deviation of aluminium and coffee spot trading from the theoretical benchmark, the share of aluminium and coffee spotmarkets in overall trade in these commodities is relatively large (see Table 12).

The question that remains is whether natural gas and electricity spotmarkets can eventually meet or approximate the 'coffee&aluminium benchmarks'. This study has qualitatively concluded that coffee&aluminium spotmarkets are more flexible in terms of international transport and storage than energy spotmarkets. Therefore, the functioning of, for instance, European natural gas spotmarkets could be strongly improved if storage capacity were enhanced, also within the context of a decreasing production flexibility in Europe (see Section 5.3).[33] For electricity, a reduction in production flexibility is not expected, but the functioning of liberalised electricity markets could be enhanced by increasing the overall flexibility on the market.

Finally, with a view to the above, it can be recommended that policy makers take into account specific structural market conditions that reduce market efficiency. In this context, it may be preferred that policy makers/regulators base their policy initiatives/interventions on a broader set of policy objectives, such as security of supply and limited price volatility, rather than more narrow objectives, such as profit maximisation or cost reduction. The European Competition Policy could serve as a benchmark in this respect as it also allows the inclusion in market liberalisation policies of other than economic objectives (see Section 3).

Based on this report it is recommended to extend the analysis in this study to a quantitative, bottom-up oriented analysis. Such an analysis would start with exploring the specific characteristics of the energy commodities markets and explore what market liberalisalition should look like in order to allow natural gas and electrictiy spotmarkets to develop into well-functioning exchanges. It would also involve a quantification of market inefficiencies and a calculation of costs related to removing inefficiencies and increasing flexibility/tradability of energy commodities via spotmarkets. While realising that future energy spotmarkets cannot meet the theoretical benchmark of a 'perfect' market, an extended study would have to explore (in a quantitative sense) which (policy) measures would need to be taken to enable liberalised natural gas and electricity markets to reach its own stage of 'perfection' and to approximate the 'coffee&aluminium benchmarks'.

[33] A similar conclusion has recently been presented by the Clingendael International Energy Programme (CIEP, 2005), which argued that enhancement of storage capacity would increase security of supply.

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