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Defining geographic coal markets using price data and shipments data ☆

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Abstract

Given the importance of coal in world energy supply an analysis of the relevant geographic market is essential for consumers, producers, as well as for competition policy. The purpose of this paper is to define the relevant economic market for steam and coking coal, and to test the hypothesis of single world markets for these coal products. Methodologically the paper relies on two different tests for defining markets, using both shipments data and price data. The results from both methods point in the same direction. In the case of coking coal the results indicate that the market is essentially global in scope, and also that the market has become more integrated over time. The results for steam coal show that the market is more regional in scope, and there exist no clear tendencies of increased integration over time. One policy implication of the finding that the steam coal market is more regional in scope, and thus that the market boundary is smaller than if the market would have been international, is that a merger and acquisition in this market likely would have been of a more concern for antitrust authorities than the same activity on the coking coal market.

Keywords: Coal; Market definition; Price test; Quantity test

1. Introduction

Coal represents a major energy source in a world where electricity consumption is increasing at a rapid pace. During the last decade electricity demand in developing Asia increased by more than 75%, in North America the increase was almost 30%, and in Europe the equivalent was about 20% (Keay, 2003). This development does not show signs of deceleration. Coal's share in generating electricity is about 34% (2000) globally, a number which has been relatively constant during the last decade (IEA, 2001). Developments in the coal industry, mainly the large increase in traded coal during the last decades, have led many analysts to describe the market for internationally traded coal as an integrated international coal market (e.g., Ellerman, 1995; IEA, 1997; Humphreys and Welham, 2000).

Lately the coal industry has experienced a number of mergers and acquisitions, which have led to a more consolidated market (Regibeau, 2000). This development has raised the concern for whether the new and larger companies can exert market power, and thus raise consumer prices. In order to determine whether this is a plausible scenario it is important to define the relevant market boundaries for coal. Defining market boundaries is an important part (of several steps) when determining whether a market is anti-competitive or not. At first, the market shares of leading firms are evaluated and compared to critical threshold values.[1] It is in this initial

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[1]Markets are in antitrust analysis defined both over product space and geographic space. Given the aim of this research, only the relevant geographic market boundary will be analyzed. A further reason for this is given by the relatively homogeneity of the two main coal products, as compared to differentiated product markets, such as the market for automobiles.

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Table 1
Market shares for internationally traded coal, 2000 (%)

Coking coal				Steam coal			
Countries	Imports	Countries	Exports	Countries	Imports	Countries	Exports
Japan	33.6	Australia	51.5	Japan	21.1	Australia	23.0
Korea	9.8	US	14.8	Korea	11.2	South Africa	17.7
India	8.0	Canada	14.1	Ch. Taipei	10.3	China	12.6
Brazil	5.8	Indonesia	4.5	Germany	4.8	Indonesia	12.6
UK	4.4	Former SU	3.8	Netherlands	4.6	Colombia	8.9
Total	61.6	Total	88.7	Total	52.0	Total	74.8

Source: IEA (2001).

phase that market boundaries are defined and assessed. Given the relevant market boundary, in this case either regional or international, the concentration ratios will have different effects, i.e., if the market is regional it is more likely that, e.g., a merger, will have anti-competitive effects than if the market is international. After this initial step, an antitrust analysis need also to establish if there are barriers to entry, and if the existing firms conduct any anti-competitive behaviour, such as price discrimination, collusion, or have mark-ups that indicate abnormal profits. It is important to note that this paper will only consider the definition of market boundaries and will therefore not be able to answer questions regarding anti-competitive behavior.

The aim of this paper is to define the relevant economic market for steam and coking coal with the use of shipments data and price series data to test the hypothesis of a single world market for coal. Methodologically the paper relies on two distinctly different methods; the Elzinga–Hogarty test and the cointegration test. Given two different approaches to define market boundaries, a second aim of the paper is to evaluate and compare these methods. The analysis will be conducted for the time period 1978–2000 in order to distinguish any changes in market integration over time.

The paper proceeds as follows. First, an overview of the coal sector, with a focus on the market structure and trade patterns, is presented. Next, the chosen methodologies and criticism towards them are discussed. In the following, the main results from the two approaches are presented, permitting an evaluation of the different methodologies for defining a relevant market. Next, some critique towards the different methods is discussed, and finally, the overall conclusions and policy implications of the paper are outlined.

2. Coal markets and trade flows

Coal is as a consequence of different quality contents and end uses commonly divided into two different coal products; steam coal (or thermal coal) which is mainly used as an input in the energy sector to produce electricity, and coking coal (or metallurgical coal) which is primarily used as an input into blast furnace iron and steel production (IEA, 1997). The different end-uses and developments of steam and coking coal imply that these products should be treated separately in the ensuing analysis. The coal market is dominated by steam coal, which in 2000 represented 84% of world coal production, compared to 16% for coking coal (IEA, 2001).

Large coal deposits are located in specified geographic regions, but demand for coal is global. This implies that international trade is important both for consumers and producers. World hard coal consumption has grown considerably during the last three decades, an increase of over 60% since 1970. However, this increase is not as remarkable as that for world hard coal trade, which has grown by 230% during the same time period (IEA, 2001). Regarding the market structure for traded coal it is evident that there are few countries that dominate the industry. The five main actors on both the demand (import) side and supply (export) side for steam and coking coal are presented in Table 1. We can see that both markets are concentrated, especially on the supply side. The coking coal market appears to be more concentrated, given that the five largest countries on the supply side have almost 90% of the total market.

Trade flows of both coking and steam coal have not been stable since the 1970s. In the first part of the 1980s growth in export of coal came mainly from the US and Poland, but since then new exporters, such as Australia, South Africa and Indonesia, have entered the market and outplayed the previous market leaders. Australia is the largest exporter of coal in 2000, with a market share of almost 52% of coking coal exports and 23% of world steam coal exports (Mélanie et al., 2002). In 2000, 90% of all traded coal was directed to the two dominating regions, the Asia–Pacific[2] market and

[2]The Asia-Pacific market includes Australia, China, Chinese Taipei, Hong Kong, India, Indonesia, Japan, Korea, New Zealand, Vietnam, and other Asia and Oceania.

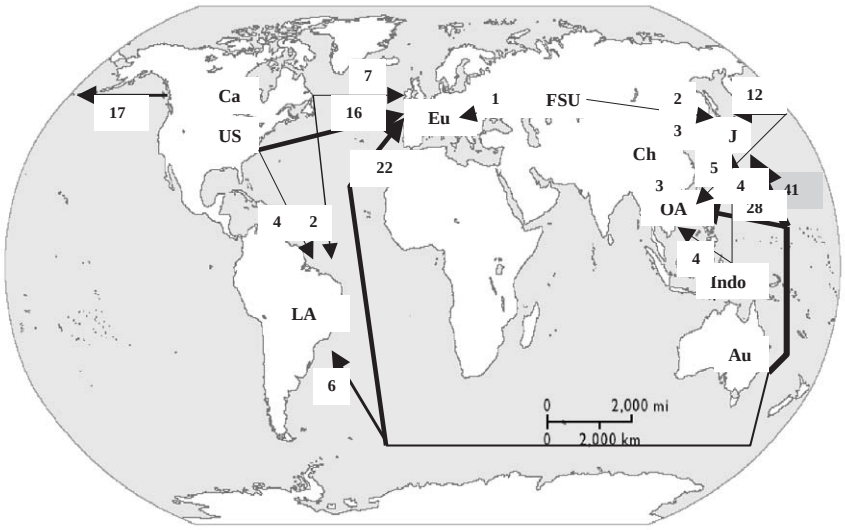

Fig. 1. World coking coal trade routes 2000 (Mt). *Source*: Own construction based on IEA (2001).

the Europe–Mediterranean[3] market, 52% and 38%, respectively (IEA, 2001). This illustrates the situation of relatively regional market tendencies for internationally traded hard coal.

2.1. The development of coking coal trade and prices

Coking coal represents coal with a quality that allows the production of coke suitable to support a blast furnace charge, and is thus primarily used as a chemical reductant in iron and steel production. Growth in the coking coal market was most evident during the 1960s, something which can be ascribed to higher demand for coking coal primarily in Europe where production could not sustain the newly created demand. This produced significant trade of seaborne coal, where previously there had been almost none. During the 1970s the demand for coking coal increased substantially in the newly industrializing countries, mainly in Asia and Latin America, something which reinforced the development in the 1960s. During the 1980s, though, growth in the coking coal market slowed down due to the slow growth in industry use for coking coal (mainly in Europe), and a new technical process that decreased the use of coke in the steel making process (IEA, 1997). Of specific interest for this paper is an analysis of the major trade routes, i.e., the import and export patterns, of the international market for traded coal. Fig. 1 shows the trade flow patterns in 2000 for coking coal, which amounted to 192 million tons this year (IEA, 2001).

This figure illustrates that Australia, who is the world's largest exporter of coking coal, is the dominant supplier to both Japan and Europe. It is interesting to note that coking coal in Europe imported from Australia is, despite the distance, as competitive as import from geographically closer markets. When analyzing the coking coal market over time, world consumption of coking coal has been relatively constant since the 1980s. Japan alone accounts for about 33% of world imports, which makes them the largest importer of coking coal during the last 30 years. Regarding the growth pattern, coking coal imports to Japan and Western Europe have been relatively stable since the 1980s. Increases in imports have thus mainly been to India, Brazil, Chinese Taipei, and Korea (Mélanie et al., 2002).

The quarterly price levels for import of coking coal in the two dominant regions, Europe and Japan, were in 2000 US$ 47.9/ton and US$ 39.5/ton, respectively, measured in average customs unit values (IEA, 2001). Fig. 2 presents coking coal price levels for Europe and Japan from 1980 until 2000. It is evident from this figure that the prices in the two markets tend to be closely correlated. The prices for coking coal are generally settled in long-term contracts (more than 5 years) through bilateral negotiations between suppliers and consumers. During the last 5–6 years spot markets for coal have developed, but these are still limited in scope since the demand for coking coal is to a large extent fixed in the short run. There is though evidence that the prices paid in spot markets have an effect on the contract prices settlements, especially in the European market (IEA, 1997).

[3]The European-Mediterranean market includes EU(15), Bulgaria, Czech Republic, Egypt, Former USSR, Hungary, Iceland, Israel, Morocco, Norway, Poland, Romania, Russia, Slovak Republic, South Africa, Switzerland, Turkey, Ukraine, Zimbabwe, other Africa, Eastern Europe and Middle East.

Despite the existence of long-term contracts, the prices for coking coal are considered to be relatively flexible. Annual renegotiations, allowing the prices to change, are the norm. The timing of the negotiations has a great impact on the prices, and for the coking coal market the price settlements with the Japanese Steel Mills are the most influential. These settlements are made before the negotiations involving European and South African steel makers. In Japan it has also been common to conclude negotiations for coking coal before steam coal, mainly due to the fact that the Japanese Steel Mills have a longer tradition of coal import than have the Japanese Power utilities (IEA, 1997).

2.2. The Development of steam coal trade and prices

International trade of steam coal was insignificant until the 1970s when the oil price shocks increased demand for steam coal as an electricity input. The high oil prices enforced by the OPEC cartel spurred the development towards an international market for steam coal (IEA, 1997). Since 1980, steam coal's share of the electricity generation market has been relatively constant. However, the world-wide increase in electricity demand has led to a significant increase in steam coal consumption over the same time period. Still, in some regions steam coal consumption has during recent years decreased compared to other fuels. This trend has been most significant in Europe where, due to environmental concerns and technical progress, many countries have shifted from coal to natural gas in electricity generation. Despite this, coal remains an important part of the energy sector in Europe. Steam coal is the dominant source of energy for some of the countries, e.g., Germany, Denmark, and Greece. Coal is also the back-up fuel for many countries, and due to security of supply issues coal dependency has increased for many countries during the last years (IEA, 2001).

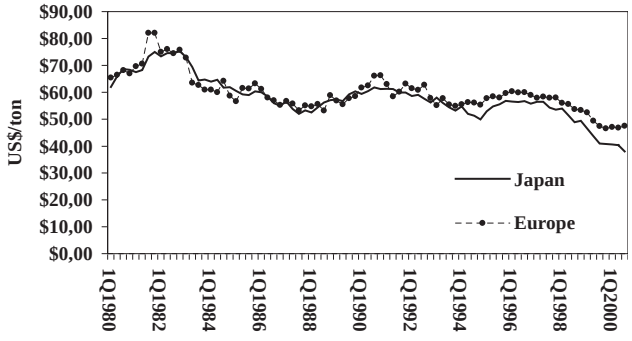

Fig. 2. Import prices for coking coal. *Source*: IEA (quarterly).

Fig. 3 illustrates the world steam coal trade routes in 2000; total trade in this year amounted to a total of 381 million tons. The figure illustrates that Australia, who is the world's largest exporter, is the dominant supplier to the Asia–Pacific market, but also exports to the more distant European market. The largest exporter to the European market is South Africa, which is geographically closer to Europe. It is evident from Fig. 3 that the main imports and exports are directed to the countries that are geographically closer to each other. However, noticeable is that some exports, e.g., from Australia to Europe, from Indonesia to Europe, and from South Africa to Asia–Pacific, defy the far distances. A brief examination of the import patterns over time shows that imports of steam coal in the Asian countries have increased more than the imports of coal to the European countries. In 2000, Japan, Chinese Taipei, and Korea alone accounted for about 40% of world steam coal

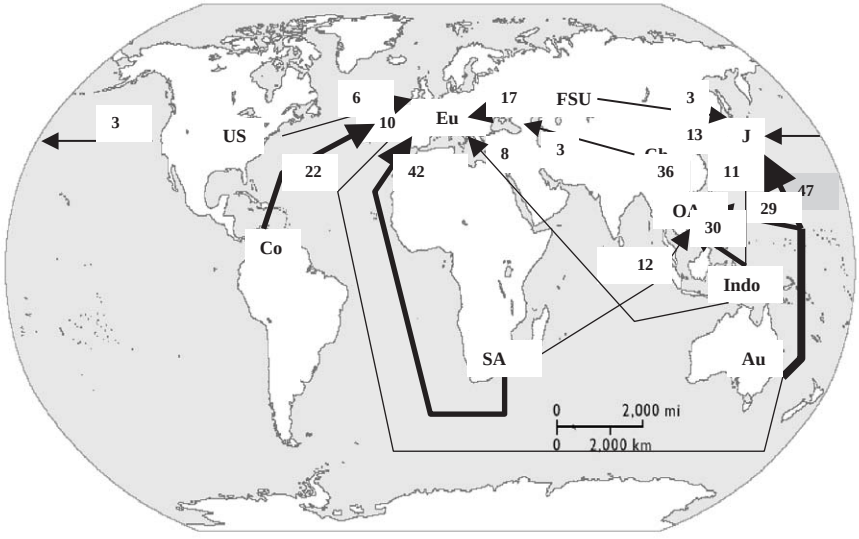

Fig. 3. World steam coal trade routes 2000 (Mt). *Source*: Own construction based on IEA (2001).

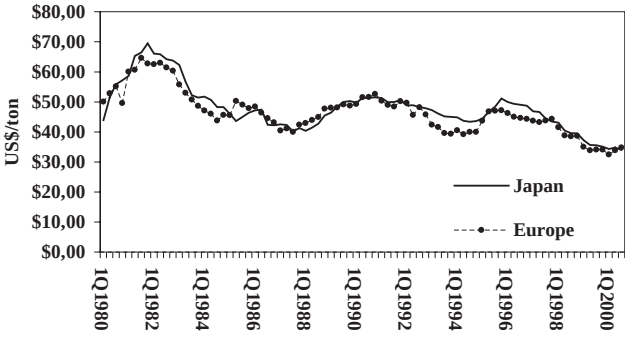

Fig. 4. Import prices for steam coal. *Source*: IEA (quarterly).

imports. Consumption of steam coal in electricity generation has differed between different world regions. In the European region, where many electricity markets have been deregulated during recent years, steam coal has reduced its share in the electricity market (IEA, 2001).

The price levels for imported steam coal in the two dominating regions, Europe and Japan, were in 2000 US$ 34.9/ton and US$ 34.6/ton, respectively, measured in average customs unit values (IEA, 2001). Fig. 4 presents the quarterly steam coal prices for Europe and Japan from 1980 until 2000. The prices in these geographically separated markets seem highly correlated. It is worth noting that the trend for steam coal prices is opposite to the one for coking coal prices, in that the prices for steam coal have been converging significantly, especially since 1997. The contractual arrangements for steam coal are by and large the same as those for coking coal. So far long-term contracts are dominating the market, but spot markets are becoming increasingly common in the price formation process. The spot purchasing practice is more developed for steam coal than that for coking coal, something which is mainly due to the greater number of supply alternatives in the steam coal market, as well as reduced concern among major electric utility companies over secure supply alternatives. Spot markets are most frequent and developed in the Asian market, where spot sales are functioning as indicators for the long-term contract negotiations. The prices in the Asian market are also influenced by the prices set in the European market, since prices in the European market are mostly set one quarter ahead of the contract prices in Asia (IEA, 1997).

2.3. Structural trends

Since the 1980s coal prices have experienced a downward trend caused mainly by increases in the export capacity for many exporting countries, as well as significant productivity improvements in the uses and the production of coal products. Recent consolidations in the coal industry, which have led to a higher concentration in the market, may, though, put an upward pressure on prices. Today the largest 10 coal companies' market share is 23% of all produced coal. However, analysts often claim that competition is relatively strong, at least for steam coal (Keay, 2003).

An important link between the two dominating geographic markets, the European and the Asian–Pacific, is Australia who exports to both. This is primarily explained by the excess supply from the Australian producers. Australia can therefore be seen as a marginal supplier. Another link between the markets is the possibility for the US producers to enter the international coal market when price levels are favorable, something which makes the US a swing supplier with the excess capacity to move in and out of the market depending on the current market situation (IEA, 1997).[4] The above facts, and the relatively strong relationship between coal prices as illustrated in Figs. 2 and 4, tend to support the notion of a unified market for internationally traded coal (see also Ellerman, 1995).

Still, even if the prices tend to follow the same path in the long run, the responses to price deviations in the short run can provide useful information on the degree of market integration. In addition, the recent development of more consolidated coal suppliers may be an issue of concern, since the prospect of these companies exercising market power increases substantially when there are fewer, more dominant, players operating in the market (IEA, 2000). Changes in contractual arrangements and the wave of mergers that have characterized the international coal market over the last 5 years therefore provide further motivations for a detailed investigation of market integration in the coal industry.

3. Methodology and data

To define the relevant market for internationally traded coal two different methods for market delineation will be used and compared. The *first* method is based on shipments data, and it builds on the notion that regions that trade significantly with each other belong to the same economic market. The underlying assumption is that the product flows (in quantities) will capture all of the fundamental demand and supply shifts that affect prices. The *second* method is based on price series data where a long run cointegrating relationship indicates whether or not the regions belong to the same market. By using two different methodological

[4]According to Ellerman (1995) the US can be seen as a swing supplier on the steam coal market, and therefore it is likely to believe that market integration between the US and Europe is strong. It is therefore reasonable to believe that any regional tendencies (i.e., lack of market integration) are more likely to be detected between Europe and Japan. Worth noting is also that the US is not a big importer of coal, given their large domestic production volumes.

traditions an evaluation and comparison of these methods will also be made.[5]

3.1. Defining markets through shipments data: the Elzinga–Hogarty test

This method is based on two related tests suggested by Elzinga and Hogarty (1973). They calculate the inter-regional shipments in order to decide whether different regions belong to the same geographic market. The tests proposed are; the little in from the outside (LIFO) test, and the little out from the inside (LOFI) test. The LIFO test concerns the demand side of the market, and asks whether total purchases in an identified region is also produced within the area. The LOFI test concerns the supply side of the market, and identifies the smallest geographic region that is required to include almost all shipments from the defined market area. This implies that a relevant geographic market area will include all regions that either exports or imports significant amounts of the product under investigation. The tests are only based on quantity data, and it is assumed that all necessary information about the product, such as prices and elasticities, is reflected in the demand and supply behavior. It is though important to know where the shipment comes from (origin), and to where the product is delivered (destination). When the necessary data have been collected, Elzinga and Hogarty (1973) propose the following procedure.

Start with a market region, in the case of coal it could be the European market.[6] Estimate whether 90% (or 75%) of the total sales within the hypothetical area comes from countries located within the area.[7] If this is the case, the little in from the outside (LIFO)[8] test is met, and the analyst can move on to the next step. This step is the so called little out from the inside (LOFI)[9] test, which states that if at least 90% (or 75%) of the shipments within the hypothetical market area are to consumers within the area, it is fair to conclude that this constitutes an economic market area. When both the LIFO an LOFI tests are met total consumption (from all shipping points) is calculated to obtain an estimate of the market size of the hypothetical market (Elzinga and Hogarty, 1973). If the LIFO and LOFI tests are not met for the defined market area the procedure is repeated until 90% of all the shipments is within the specified market area.

According to Elzinga and Hogarty (1973) it is of vital importance that both the LOFI and the LIFO tests are met since a sole dependence on, for instance, the supply side would likely define a market too narrowly. Fundamental economic theory, as first presented by Alfred Marshall, asserts that sales in one region will affect the prices in all regions where the product is sold, and therefore it is vital that all affected regions are a part of the geographic market. The Elzinga–Hogarty method has since its development been widely used by competition authorities in merger analysis, especially in the United States. Primary motives are the importance of geographic market definition in merger analyses for products where areas of production and consumption are separated. The Elzinga–Hogarty method makes economic sense and is simple to apply, and has thus become important in practice.

3.1.1. Criticism towards the Elzinga–Hogarty method

Research conducted by Capps et al. (2001) discusses what is termed the silent majority fallacy of the Elzinga–Hogarty criteria. The silent majority fallacy concerns the potential error in relying on shipments data when there are significant differences in demand behavior within and outside the defined market area. Capps et al. (2001) argue that markets sometimes are defined too broadly when some exports are directed out of the country, even if this export does not follow the same demand pattern as that within the defined area. The authors use hospital mergers as an example to show that even if some patients travel for hospital care, most patients do not, and thus the relevant market is not as broad as is often stressed.[10]

Werden (1981) has also directed some critique towards the method proposed by Elzinga and Hogarty. Werden identifies two situations where the method will lead to fundamental errors regarding what constitutes a relevant market. *First*, in a situation where there are no shipments between two regions, the Elzinga–Hogarty test would conclude that the regions belong to distinct markets. However, if the cross-elasticity of demand is

[5]Both tests that are analyzed in this paper are based on the principles of an economic market, where it is assumed that prices and quantities, respectively, reveal the demand and supply characteristics that are important when defining the relevant market area.

[6]The procedure of selecting a starting point (which in this article is a region or a country) is somewhat arbitrary. However, the authors propose using informed judgment such as either starting in a large producing area, or a large consuming area.

[7]The percentages are also arbitrarily chosen. Elzinga and Hogarty (1973) suggest that a strong market implies that 90% of the shipments are within the market, and that a weak market suggests that at least 75% of the shipments are within the specified market.

[8]The LIFO test states that "if only a small proportion of the product consumed in the hypothetical geographic market is "imported" into the area from the outside, this is an indicator of a unique geographic market area" (Elzinga and Hogarty, 1973: 54).

[9]The LOFI test states that "If the firms in a hypothetical geographic market area receive little of their business from customers outside of the geographic market area, this is an indicator of the propriety of defining that area as a market" (Elzinga and Hogarty, 1973: 57).

[10]Capps et al. (2001) do however acknowledge that the silent majority fallacy is of more concern when the products under investigation are highly differentiated, regarding both location and other dimensions.

high, it is not likely that the firms in the different regions would be able to set prices independently. In other words, the Elzinga–Hogarty test does not account for *potential* competition from other regions. When this is the case, the regions do in fact belong to the same economic market. The *second* situation concerns the issue that a shipment test could neglect to detect a relevant market that exists within the defined area. The test does never answer the question of whether firms could profitably raise the price level after a merger has taken place. Given that the test only considers shipments data at one point in time, it fails to analyze post-merger shipment patterns. This line of criticism therefore concludes that the test could in some instances define the market too broadly, and thus not be able to detect anti-competitive behavior within the region. Once again Werden notes that this problem would be avoided if the cross-elasticity of demand was known by the analyst.

Nevertheless, Werden concludes that regardless of the shortcomings of shipments tests they may be very helpful in defining markets, if used properly. Shipment tests are valuable since they provide an understanding of the product flow patterns, something which is an important part of the process of delineating the relevant market. Werden emphasizes, though, that shipments data need to be supplemented with some notion of cross-elasticity of demand in order to correctly delineate the relevant market.

3.1.2. Data use and choice of starting points

In this paper separate shipment tests will be conducted for the steam coal and the coking coal markets. This permits an analysis of whether there exist significant differences in market integration between the two products. Data for production, consumption, import and export, between the years 1978 and 2000, are collected from *Coal Information*, published annually by the International Energy Agency (IEA). The test will be performed for a number of selected years, something which permits an analysis of whether important changes in market integration have occurred over time.

In the case of both coking coal and steam coal it seems applicable to start with the dominant regions the—Europe–Atlantic and the Asia–Pacific—when estimating the hypothetical market areas. If the above explained procedure cannot be met without the inclusion of, e.g., Australia, South Africa, and Japan, in the hypothetical market area Europe, it would be fair to conclude that the market for internationally traded coal can be seen as a world market. However, if the above procedure can be conducted without the inclusion of exporters/importers that belong to other world regions, it is likely that the markets are more regional in scope. The tests have also been performed using different starting points, Europe,[11] North America,[12] Australia,[13] and Japan. These regions are chosen because they are either significant coal producers (Australia, North America) or large coal importers (Japan, Europe). The reason for conducting the analysis using different starting regions is that it will illustrate if similar patterns of market integration appear regardless of the choice of starting point.

3.2. Defining markets through price series data: the cointegration test

In the late 1970s and 1980s a substantial economics literature that relied on price tests for delineating relevant antitrust markets was published (e.g., Shrieves, 1978; Stigler and Sherwin, 1985; Engle and Granger, 1987). The price tests empirically implemented the classical definition of an economic market as a tool by using different econometric methods. The logic behind these tests is that two geographically separated areas constitute a single market when the prices at the different areas are cointegrated, i.e., over time follow the same price trend. This implies that if the prices in two different markets over time stay persistently out of line with each other, then the markets are not integrated into one market.

The method for determining market integration in this paper is an error correction model introduced by Engle and Granger (1987). The error correction model incorporates a long run cointegrating relationship, which implies that two cointegrated price series will not drift apart without limit, as well as speed of adjustment parameter which measures how fast the prices will converge towards the long run equilibrium level in case of a price shock in one of the markets. Error correction models have gained increased support for empirical estimations of market integration in energy industries during the last 10 years (e.g., deVany and Walls, 1993; Sauer, 1994; Asche et al., 2001). The technique thus examines movements in prices for goods located in different regions in order to test the hypothesis of a single international market for coal.

3.2.1. Cointegration and error correction models

Consider two price series, p_i and p_j, that by themselves are non-stationary and must be differenced once to generate stationarity. A linear transformation of the two original series can though result in a series ε_t that is

[11] "Europe" includes the following countries: EU (15), Iceland, Norway, Switzerland, Turkey, Poland, Czech Republic, Slovak Republic, Hungary, Romania, Bulgaria, Albania, and Former Yugoslavia.

[12] "North America" includes the following countries: Canada, Mecixo, and the USA.

[13] "Australia" includes the following countries: Australia and New Zeeland.

stationary, $I(1)$:[14]

$$p_{j,t} - \alpha - \beta p_{i,t} = \varepsilon_t \quad (1)$$

If this linear transformation exists between p_i and p_j, the time series are considered cointegrated since the regression indicates that the difference between the time series, $p_{j,t} - \beta p_{i,t}$, is varying at random around a fixed level (Engle and Granger, 1987). When this is the case, it is possible to distinguish between a long run and a short run relationship between p_i and p_j. The long run relationship captures the cointegration relation, in which the series move together around a fixed level. The short run relationship describes deviations of p_i and p_j from their long run trends. The vector $[1,-\beta]$ in Eq. (1) captures the cointegration relationship between the two price series. When cointegration between time series is evident there is an indication of a single market.

The model that differentiates between a long run and a short run relationship for time series analysis has been widely known as the error correction mechanism (ECM) model (Engle and Granger, 1987). When non-stationary variables in a model are verified as cointegrated, the following ECM model can be derived:

$$\Delta p_{j,t} = \beta_j \Delta p_{j,t-k} + \beta_i \Delta p_{i,t-k} + \delta EC_{t-1} + \varepsilon_t, \quad (2)$$

where k represents the lag length and the error-correction term is represented by EC_{t-1}, which adopts the following form:

$$EC_{t-1} = p_{j,t-1} - \alpha - \beta p_{i,t-1} \quad (3)$$

and this term captures the deviation from long-run equilibrium, and the coefficient δ in Eq. (2) measures the speed of adjustment, which indicates how long it takes for the time series to move back to the equilibrium level in case of a price shock in one region. The coefficients β_i and β_j represent the short run counterparts to the long run solution in Eq. (3).

The Engle and Granger test for cointegration uses a standard OLS estimation for the long run relationship between the two price series. In order to conclude that the price series are cointegrated, the residuals from the OLS estimation have to obey stationarity. When this is the case, the residuals from the cointegrating relationship are incorporated in the ECM model and the equation then only consists of stationary variables, so standard estimation procedures can be applied (Dolado et al., 1990).

3.2.2. Criticism towards using price series data

The use of price series data is however connected with a number of drawbacks and therefore also criticized. According to Werden and Froeb (1993) and Elzinga and Hogarty (1973) the use of price data is not always applicable when defining relevant market boundaries. There are primarily two reasons for this. *First*, it is often difficult to identify the correct price, as well as transportation cost, when the geographically separated markets include a variety of products with different prices, and conclusions based on poor data may be misleading. *Second*, even if it is possible that when prices for products sold in geographically separated markets tend to unity or follow the same trend they belong to the same economic market area, it does not necessary have to be the case. For example, the prices in two distinct markets could exhibit the same movements even if it is coincidental, or caused by the price change of a common input factor, i.e., so-called spurious correlation. Given this situation, an assessment of price data would induce the wrong assumption of an integrated geographic market area, when in fact this is not the case.

3.2.3. Data and time interval

The data used in this paper represent quarterly import average CIF (cost, insurance, and freight) prices in US dollars/ton, separated for coking coal and steam coal, for the two dominant importers of coal, Europe and Japan. Weekly or daily price data is preferable in time series analysis, but since the coal market is dominated by long-term contracts, quarterly data will be sufficient in providing the relevant information. The time period examined stretches from 1980 until 2000, which includes coal prices 'all time high' in the beginning of the 1980s, when the security of supply issue dominated most political agendas. At the end of the time period the coal market structure has changed; the contract standard is under development, moving towards spot markets, and multinational corporations specializing in mining are the dominant suppliers. This suggests that it is also useful to test whether significant changes in the degree of market integration have occurred over time.

4. Empirical results

4.1. Results for coking coal

4.1.1. Elzinga–Hogarty test results

The results from both the LIFO and LOFI tests for the four starting regions are presented in Table 2. The LOFI ratios are calculated by extracting export from production, and divide through by production, in order to evaluate whether or not the region export significant amounts (here the critical level is 10%). Regarding *Europe* we can see that the LOFI test is over the 90% threshold level for all years under investigation, which thus implies that the exports out of Europe are insignificant. The LIFO ratios are calculated in a similar fashion, but now divide through by consumption instead of production, in order to detect whether

[14]This is only true if p_i and p_j are integrated of the same order, in this case integrated of order one (Greene, 1993).

Table 2
LIFO and LOFI test results for coking coal

Year	Europe		North America		Australia		Japan	
	LIFO	LOFI	LIFO	LOFI	LIFO	LOFI	LIFOa	LOFI
1978	0.7891	0.9901	0.9286	0.6787	0.9200	0.1648	0.1467	0.9948
1980	0.7004	0.9971	0.9526	0.5135	0.9497	0.1562	0.5347	0.9952
1985	0.6235	0.9981	0.9949	0.4025	0.9954	0.0970	0.4569	0.9997
1990	0.5440	0.9985	1.0235	0.3570	1.1616	0.1082	0.4282	1.0
1995	0.6307	0.9874	1.0188	0.3436	1.030	0.0746	0.4788	1.0
1997	0.5709	0.9906	1.0577	0.3285	1.9518	0.1245	0.5289	1.0
1998	0.5050	0.9858	1.0075	0.3246	0.7466	0.0470	0.5210	1.0
1999	0.52314	0.9756	0.9845	0.3677	2.167	0.1176	0.5477	1.0
2000	0.4687	0.9850	0.9472	0.3920	−1.7613	−0.0864	0.6208	1.0

consumption in the chosen region comes mainly from domestic production or from producers outside the region. In the case of *Europe* the LIFO test is not fulfilled for any of the years, which indicates that a significant amount of the consumption in Europe is imported from outside the defined area. This suggests that more countries, or regions, need to be included in the analysis in order to define the relevant market area for *Europe*.

Regarding *North America* we can see that the results show that the LIFO test is fulfilled, but not the LOFI test. This implies that the region does export but not import significant amounts of coal to and from the region. For *Australia*, the conclusion is similar, i.e., a significant amount of the production in the region is exported and therefore the test indicates that the region cannot be seen as a relevant geographic market. For *Japan*, the results show that a significant amount of the consumption within the area is imported.[15] The above results imply that more countries, or regions, need to be included in the relevant market areas for all the regions investigated. The region, or country, chosen to be included in the market areas is the region that in the case of LIFO most of import comes from, and in the case of LOFI where most of export goes to. After including a new region, the same calculations as above are repeated but now for the new market areas.[16] This procedure is repeated until both the LIFO and LOFI tests are fulfilled for the chosen market areas. The results for including more countries, or regions, into the analysis are presented in Table 3. The table shows all the regions, or countries, that had to be included in the four starting regions in order to define these as relevant economic markets.

[15]The years for which LIFO is above one are years in which some production is neither exported nor consumed.

[16]When including more regions the market boundary becomes larger, and what was previously defined as shipments between, e.g., Europe and North America, need now to be defined as shipments within the new and broader market area.

Table 3 shows that the same regions, or countries, are included regardless of which region that is defined as the hypothetical market area. It is only in 1 year, 1978, that Europe and North America alone can be seen as a relevant economic market. The results also indicate that the market is integrated from 1978 and onwards given that all the four regions under investigation have to be included in defining the relevant market for coking coal. When analyzing the development over time the results indicate that more and more countries, or regions, need to be included in order to define the relevant market for coking coal. This indicates that the market have become more integrated over time.

4.1.2. Cointegration and error correction test results[17]

A standard OLS estimation for the long run relationship between the two price series is performed. The cointegrating regression of prices in Japan (P_J) on prices in Europe (P_E) and a constant was run. The result, normalized on Europe, has the following representation:

$$P_E = 1.04 + 0.75P_J \quad (-7.66) \quad (-22.5). \tag{4}$$

Eq. (4) indicates that when the price in Japan rises by 1%, the corresponding long run increase in the European price level is 0.75%. The values in the parentheses represent the t-statistics. The sign indicates that the price level in Japan is lower than the price level in Europe, as is also evident when looking at Fig. 2. To test for cointegration the residuals from Eq. (4) have to obey stationarity. This implies that the residuals have to reject the null hypothesis of "no-cointegration" according to the test statistics given by the Dickey Fuller test. Regressing the change in the residuals on past levels presents a test statistic of −4.52, which is statistically significant. This implies that the price series in Japan

[17]For a more complete presentation of the results presented in this section, see Wårell (2003).

Table 3
Relevant economic markets for coking coal

Year	Europe	North America	Australia	Japan
1978	North America	Japan, Australia, Europe	Japan, North America, Europe	Australia, North America, Europe
1980	North America, Japan, Australia	Japan, Australia, Europe	Japan, North America, Europe	North America, Australia, Europe
1985	North America, Japan, Australia	Japan, Australia, Europe	Japan, North America, Europe	North America, Australia, Europe
1990	North America, Japan, Australia, Korea	Europe, Japan, Australia, Korea	Japan, North America, Europe, Korea	Australia, North America, Europe, Korea
1995	North America, Japan, Australia, Korea, Latin America	Europe, Japan, Australia, Korea, Latin America	Japan, North America, Europe, Korea, Latin America	Australia, North America, Europe, Korea, Latin America
1997	North America, Japan, Australia, Korea, Latin America	Europe, Japan, Australia, Korea, Latin America	Japan, North America, Europe, Korea, Latin America	Australia, North America, Europe, Korea, Latin America
1998	North America, Japan, Australia, Korea, Latin America	Europe, Japan, Australia, Korea, Latin America	Japan, North America, Europe, Korea, Latin America	Australia, North America, Europe, Korea, Latin America
1999	North America, Japan, Australia, Korea, Latin America	Europe, Japan, Australia, Korea, Latin America	Japan, North America, Europe, Korea, Latin America	Australia, North America, Europe, Korea, Latin America
2000	North America, Japan, Australia, Korea, Latin America, USSR	Europe, Japan, Australia, Korea, Latin America, USSR	Japan, North America, Europe, Korea, Latin America, USSR	Australia, North America, Europe, Korea, Latin America, USSR

Table 4
Error correction estimates (coking coal)

Coefficients	Europe			Japan		
	b_E	b_J	δ_E	b_J	b_E	δ_J
Estimate	0.03	**0.41***	**−0.38***	**0.20*****	0.09	−0.03
t-values	(0.28)	(2.58)	(−3.20)	(1.69)	(0.97)	(−0.47)

Bold numbers indicate statistical significance at *1% level,**5% level, and ***10% level.

and Europe are cointegrated, and thus the error correcting dynamics can be tested for.

The error correction model used is given in Eq. (5). Regressions with up to four lags have been performed, but presented in the tables are only models where the lag length is one since these were the models that were statistically significant. Note that the model already includes one lag given the regression of changes in prices. The dependent variable is Europe in Eq. (5), but an estimation using Japan as the dependent variable has also been performed. We thus have:

$$\Delta p_{E,t} = \sum_{k=1}^{1} b_E \Delta p_{E,t-1} + \sum_{k=1}^{1} b_J \Delta p_{J,t-1} + \delta EC_{t-1}, \qquad (5)$$

where b_J and b_E is the estimated short run counterparts to the long run solution in Eq. (4), and δ represents the speed of adjustment parameter, which indicates how fast the prices moves back towards long run equilibrium in case of a deviation in the previous time period. Table 4 presents the estimated values of these parameters, using both prices in Europe and Japan as the dependent variable.

The results using prices in Europe as the dependent variable indicate that a 1% increase of prices in Japan the preceding period yields a 0.41% increase of the price level in Europe the present time period. This result is statistically significant, and suggests that the prices in Europe are reacting to price changes in Japan the previous time period. The speed of adjustment parameter implies that a deviation from the long run equilibrium in Japan the preceding time period, is adjusted for by 38% in Europe the following quarter. Turning the attention to the results when using Japanese prices as the dependent variable we can see that none of the short-term response parameters are statistically significant.

In order to investigate increased market integration over time the price series have been divided into two time periods, representing the 1980s and the 1990s.[18] The long run results for the 1980s indicate that the long run price change is almost perfect, but decreases in the 1990s. Both time periods are cointegrated, which indicates that the markets are integrated. Regarding

[18]For a more thorough discussion see Wårell (2003).

Table 5
LIFO and LOFI test results for steam coal

Year	Europe		North America		Australia		Japan	
	LIFO	LOFI	LIFO	LOFI	LIFO	LOFI	LIFO	LOFI
1978	0.9755	0.9999	0.9799	0.9966	1.0137	0.8419	0.9002	0.9989
1980	0.9311	0.9999	1.0374	0.9718	0.8036	0.7455	0.6319	0.9975
1985	0.8670	0.9989	0.9598	0.9613	0.7143	0.4082	0.3467	1.0
1990	0.8004	0.9986	1.0401	0.9602	1.1095	0.5255	0.1810	1.0
1995	0.7020	0.9998	0.9987	0.9533	1.0683	0.4518	0.0981	1.0
1997	0.7192	0.9995	0.9674	0.9740	0.8414	0.3803	0.0615	1.0
1998	0.6441	0.9999	0.9848	0.9798	0.9191	0.3802	0.0524	1.0
1999	0.6361	0.9955	0.9807	0.9864	0.8569	0.3821	0.0526	1.0
2000	0.5723	0.9998	0.9835	0.9856	0.8066	0.3594	0.0378	1.0

the short run responses, the results for the 1990s indicate a stronger relationship between the price series in Europe and Japan than for the 1980s. The speed of adjustment parameter shows that the prices move back to the long run equilibrium by 60% in the first quarter after the price shock in the 1990s. When summarizing the results for coking coal, it is evident that the prices in Europe and Japan are cointegrated, and therefore follow a long run relationship. Regarding the short run responses these are relatively high, and we can also see that the short run results indicate stronger market integration over time. This result supports the hypothesis of an integrated world market for coking coal. Thus, the results from both the Elzinga–Hogarty test and the error correction model define the relevant market for coking coal as an integrated international market.

4.2. Results for steam coal

4.2.1. Elzinga–Hogarty test results

The results from both the LIFO and the LOFI tests, applied on the steam coal market, are presented in Table 5. The same procedure as for the coking coal market is applied in order to achieve these results. Compared to the results for the coking coal market, where none of the chosen market areas represented a relevant geographic market, the results show that for a number of years the starting point region itself could be considered a relevant market area.

Europe fulfills the requirements for a relevant geographic market in 1978 and 1980. After this year, the LIFO test is not fulfilled, which implies that a significant part of the consumption was imported into the region from then on. The results for *North America* show that it can be seen as a relevant market area for all years that are investigated, implying that most production of steam coal in North America is consumed within the region. Thus, there are no significant shipments of steam coal neither to nor from North America. This contradicts the notion of a unified Atlantic market for steam coal (e.g., Ellerman, 1995). In the case of *Australia* the LOFI test is not fulfilled for any of the years, and neither is the LIFO test for five of the years investigated. For *Japan* the results show that in 1978 the country could be considered a relevant market area in itself, but after that year the LIFO test is not fulfilled implying that Japan imported a significant amount of the countries consumption from that year onwards. The above results indicate that, except for North America, more regions, or countries, need to be included in the analysis in order for the regions to be considered a relevant geographic market. The results from this procedure are presented in Table 6.

Table 6 shows that South Africa is the dominant supplier to fulfil consumption in *Europe* from 1985 and onwards. In 1995 this import is complemented with imports from North America, and in 1998 and 1999 the imports from South Africa are complemented also with imports from Colombia. We can thus see that, even if North America is classified as a relevant market area according to the Elzinga-Hogarty test, in two occasions (1985 in Australia and 1995 in Europe) it is included in the defined market areas for other starting regions. In 2000 the Asia–Pacific region must be included in the market in order to accomplish the 90 percent shipments level. Concerning *Australia* and *Japan* the results indicate that these regions belong to the same market, the Asia–Pacific. From 1995 and onwards Japan, Australia, Korea, and China can be considered a relevant market area. Korea is the second largest importer in the Asia–Pacific market, and China is the second largest exporter in the market. Thus, the results concerning steam coal indicate that the market is more regional than is the case for coking coal.

4.2.2. Cointegration and error correction test results[19]

The tests for cointegration and error correction for the steam coal market follow the same general procedure as for coking coal. The cointegrating

[19]As for coking coal, a more complete presentation of the results is presented in Wårell (2003).

Table 6
Relevant economic markets for steam coal

Year	Europe	North America	Australia	Japan
1978			Europe	
1980			Japan, China	Australia, China
1985	South Africa		Japan, Europe North America	Australia, South Africa
1990	South Africa		Japan, Europe, South Africa	Australia, Europe, South Africa
1995	South Africa, North America		Japan, Korea, China	Australia, Korea, China
1997	South Africa		Japan, Korea, China	Australia, Korea, China
1998	South Africa, Colombia		Japan, Korea, China	Australia, Korea, China
1999	South Africa, Colombia		Japan, Korea, China	Australia, Korea, China
2000	South Africa, Colombia, Russia, Australia, Japan, Korea, China		Japan, Korea, China	Australia, Korea, China

Table 7
Error correction estimates (steam coal)

	Europe			Japan		
Coefficients	b_E	b_J	δ_E	b_J	b_E	δ_J
Estimate	0.003	**0.25*****	−0.16	**0.25***	**0.21***	**−0.17***
t-values	(0.20)	(1.78)	(−1.38)	(2.76)	(2.33)	(−2.41)

Bold numbers indicate statistical significance at *1% level, **5% level, and ***10% level.

regression of prices in Japan (P_J) on prices in Europe (P_E) and a constant was run. The result, normalized on Europe, have the following representation:

$$P_E = 0.30 + 0.91P_J$$
$$(2.00)\quad (23.39). \qquad (6)$$

Eq. (6) indicates that when the price in Japan increases by 1%, the corresponding long run increase in the European price level is 91%. Compared to the coking coal market, it is evident that this price change is higher. To test for cointegration the residuals from Eq. (6) have to obey stationarity. When regressing the change in the residuals on past levels the test statistic is −4.82 which implies that the price series in Japan and Europe are cointegrated, and thus the error correcting dynamics can be tested for.

The error correction model is once again performed as outlined in Eq. (5). Table 7 presents the estimated values of these parameters, using both Europe and Japan as the dependent variable. The results when using Europe as the dependent variable show that none of the short run response parameters are statistically significant. The result using Japan as the dependent variable indicates that a one percent increase of prices in Europe the preceding period yields a 0.21% increase of the price level in Japan the present time period. This result suggests that the prices in Japan are reacting to price changes in Europe the preceding time period. The speed of adjustment parameter is 0.17 when using Japan as the dependent variable. This means that a deviation from the long run equilibrium level in Europe the preceding time period, is adjusted for by 17% in Japan the following time period. The results considering steam coal indicate that the European and the Japanese markets are integrated into one market given the presence of cointegration. The corresponding long run price change in one region due to a change in the other region is higher for steam coal than coking coal. When examining the short run response, responses to price changes are lower for steam coal than for coking coal given a speed of adjustment of 17%, compared to 38% in the case of coking coal. The overall conclusion on which of the two markets that appears to be more integrated than the other is indecisive given that the long run price change and the short run responses do not point in the same direction.

In order to investigate increased market integration over time the price series have once again been divided into two time periods. The results indicate that the long run price change in one region, due to a 1% increase in the other region, has increased in the 1990s compared to the 1980s. However, when analyzing the cointegration relationship the results show that steam coal prices for the 1990s are not cointegrated. This result does not support the conclusion of an integrated world market for traded steam coal. When summarizing the price test results we see that over the whole time period, the prices in Europe and Japan are cointegrated. However, the short run responses to price changes are not as high as for coking coal, and when analyzing market integration over time there are no evidence of increased integration

over time. Thus, both the results from the Elzinga–Hogarty test and the error correction test indicate that the defined relevant market for steam coal have more regional tendencies than the coking coal market.

5. Comparison and analysis

By using two different methods an evaluation and comparison of these are applicable. The overall conclusions when using both tests point in the same direction, i.e., the conclusion regarding market boundaries are similar for both tests. This is of course positive given that these methods often are not used as complements, but rather as substitutes when defining a relevant market. However, it is still relevant to discuss some of the pros and cons with each method. Regarding the Elzinga–Hogarty method, the pros are foremost that it is simple to use, in that it only requires quantity data, and also that the results from the test is easily interpreted. It also gives a good picture of the trade flow patterns and their development in a more formalized way than studying flow chart diagrams. On the other hand, given the simplicity and crudeness of the method it is easy to criticize. Some of the critique discussed in Section 3 will be addressed here.

5.1. Evaluation of the Elzinga–Hogarty method

The main critique directed towards the Elzinga–Hogarty method is that, *first,* when there are "insignificant" shipments between the areas these are concluded to be distinct markets. The results regarding steam coal show that shipments to or from North America are insignificant, i.e., less than 10%, and thus to be seen as a distinct market area for steam coal. However, according to Ellerman (1995) the United States is a swing supplier in the steam coal market, i.e., American producers enter the world market for steam coal only when the price levels are beneficial. This implies that it might be the lower price level in the steam coal market that leads to the conclusion that North America is a distinct market. A shipment based test is not able to detect any potential market participation; for this the analyst has to have some notion of the cross elasticity of demand at the market. This is the same conclusion as that made by Werden (1981).

The *second* critique concerns the difficulty for the Elzinga–Hogarty method to detect whether there exists a submarket within the defined market area. This critique deals with the level of analysis. Thus, starting from a regional market, e.g., *Europe*, the method does not reveal whether a submarket could be found within Europe. In order to adjust for this Wårell (2003) conducts the same analysis when starting on a country level. The findings from this exercise are similar as when conducting the analysis on a regional level. This indicates that the defined market areas would not change significantly and thus that there were no tendencies of submarkets within the regions (e.g., the European countries, e.g., France, still imported significant amounts of coal from countries outside the region). However, in order to detect anti-competitive behavior within a specified market area it is most likely necessary to bring the analysis down to a firm level, instead of a country level and to analyze cross elasticity of demand.

An additional problem of the Elzinga–Hogarty method is that it might come to an erroneous conclusion regarding the size of the relevant market when there are large differences in the size of the markets that are part of the analysis. This problem is related to the use of ratios when calculating the LIFO and LOFI. For example, if a large producer and consumer of coal, that independently is a separate market, are included in the relevant market area for a relatively small consumer, the criteria for the LIFO and LOFI tests will instantly be met. Moreover, a region can be defined as a separate relevant economic market even if its export is relatively large on the world market, but not compared to domestic production and consumption. An example of this situation is given by North America where even though the region is defined as a relevant market area for all years investigated regarding steam coal, it is included in the relevant market area for Australia in 1985 and Europe in 1995. This implies thus that North America still exports significant amounts of steam coal during those years. Thus, a formalized test for product flows does not always portray the situation correctly. The overall conclusion is that the Elzinga–Hogarty method is not well equipped to detect potential market participation or potential anti-competitive behavior within a defined market area (especially when there are large differences in the size of the participants). However, as a method of defining relevant economic markets it is still useful as a first step in antitrust analysis since it contributes to a good understanding of the product flow patterns.

5.2. Evaluation of the cointegration and error correction approach

The main critique directed towards the use of prices in defining relevant markets concerns mainly the accuracy of the underlying data (the prices) and spurious correlation. When using prices in order to define a relevant geographic market the analyst relies on the underlying assumption that the prices are determined by the balance of supply and demand in the market. According to Chang (1995) there are many reasons to believe that, at least the coking coal industry is not a competitive market. The main reasons for this are that coking coal is not a homogenous product, and the

market primarily uses long-term contractual arrangements which are renegotiated once a year. Chang also stresses that steel mills are risk averse in that they tend to secure supply of a certain coal quality. Coking coal prices may therefore be formed based on quality differences, as well as the need of different suppliers, which would imply that prices for this market is not formed competitively.

Chang (1995) also discusses the difference in using FOB (free on board) coal prices and CIF (cost, insurance, and freight) prices in evaluating price differences for coking coal. CIF prices are often derived by adding an estimated transport cost component to the FOB contract prices, and thus the quality of the CIF price depends on the accuracy of the estimated transport costs. However, for the analysis conducted in this paper it is important to include the transport prices, and given that specified prices of origin with respective transportation costs data is not available, CIF prices are considered to be the best proxy available for a spatial analysis. Another caveat regards that the CIF prices are based on customs unit values. Customs unit values are average values derived from customs' administrations total volume and total value data. These data indicate broad price movements given that they reflect the contract terms and conditions under which the trade occurs. Preferable is therefore to use spot and tender prices that is reported in the trade press, given that these pertain to one time transactions, and thus reflect more short-term market conditions. This provides a more accurate estimation of the price formation process.[20]

An additional caveat concerning the error correction model is that it is sensitive to the different econometric specifications that are necessary for estimating the relevant coefficients, i.e. how many lags to include, should an intercept and trend be included in the model and so on. Because of this all results should be treated cautiously, and reliant upon the specified levels and orders. We therefore conclude that the results produced in this paper needs to be reinforced by the use of other methods in order to provide a more comprehensive analysis of market integration in the international coal market.

6. Conclusions and policy implications

This paper has defined the relevant economic market for steam coal and coking coal using shipments data and price data in order to test the hypothesis of a single world market for coal. Regarding coking coal the overall results point towards an integrated world market, both when analyzing the shipments data and the price data. When analyzing the development over time, the results from the Elzinga–Hogarty test show that more and more regions need to be included in order to define the relevant market for coking coal. This indicates that the industry has become more integrated over time. The results regarding market integration over time are similar when applying the error correction model. Both time periods are cointegrated in the long run, and the short run responses indicate more integration over time given a larger price adjustment to price changes in the other region in the 1990s.

In the case of steam coal the results from the Elzinga–Hogarty test show that the markets are more regional in scope, and there are no clear tendencies of more integration over time. The results when using the price data indicate that the European and the Japanese markets are integrated into one market for the entire time period. The corresponding long run price change is actually higher for steam coal than coking coal, but when examining the short run response it is evident that they are lower. Regarding market integration over time, the results does not point towards increased market integration given that cointegration between the price series cannot be confirmed in the 1990s.

The finding that the steam coal market has not become more integrated over time does not support the notion of a unified world market for coal. Economic theory predicts that the substantial increase in steam coal trade would lead to a more integrated market. One would also expect that the steam coal market would be more integrated than the coking coal market, given the rapid development of steam coal demand during this time period. However, the evidence in this study points towards the coking coal market as being more integrated globally. This is also surprising given other evidence that prices in the coking coal market are not competitive (Chang, 1995).

One policy implication of the finding that the steam coal market is more regional in scope, and thus that the market boundary is smaller than if the market would have been international, is that a merger and acquisition in this market likely would have been of a more concern for antitrust authorities than the same activity on the coking coal market. The findings that the steam coal market is regional in scope and that North America is considered a single economic market, do though not have to imply that anti-competitive conduct is performed. The methods applied are not applicable to answer questions regarding whether the market is anti-competitive or not. Monopoly power depends on the price elasticity of demand, and if producers outside North America try to raise prices, the price elasticity of demand would increase for these producers since

[20]Spot and tender prices are not available for the entire time period evaluated. However, steam coal spot prices for the 1990s are available and used in Wårell (2003) in order to find cointegration between prices in Europe and Japan. The results from this regression shows that steam coal prices are not cointegrated in the 1990s, which supports the results conducted using average prices.

American producers would enter the market. Thus, the methods applied in this study would not detect potential market power from producers that choose to not enter the world market.

Finally, the methods applied are limited when analyzing antitrust issues, at least when used alone. However, they still provide useful information and guidance for the antitrust practitioner. The shipment test provides a good understanding of the product flow patterns, which is useful to estimate the size of the market, and the price test provides valuable information about, for instance, the short-term adjustment processes in the case when the price deviates from its long run equilibrium level. When used in combination with other tests, which preferably provide some notion of the price elasticity of demand, the antitrust practitioner should be provided with a good understanding of the competitive situation in the market. Future research on market delineation methods would however be necessary in order to provide better guidance on which method to apply given different market situations.

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