Pellervon taloudellisen tutkimuslaitoksen raportteja 208

Pellervo Economic Research Institute Reports 208

THE EFFECTS OF A REVISION OF THE EMISSIONS TRADING DIRECTIVE FOR THE PERIOD STARTING IN 2013 ON THE EUROPEAN NITROGEN FERTILIZER INDUSTRY

Helsinki 2008

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ISBN 978-952-5594-95-9 (NID)
ISSN 1456-3215 (NID)
ISBN 978-952-5594-96-6 (PDF)
ISSN 1796-4776 (PDF)
Helsinki 2008

THE EFFECTS OF A REVISION OF THE EMISSIONS TRADING DIRECTIVE FOR THE PERIOD STARTING IN 2013 ON THE EUROPEAN NITROGEN FERTILIZER INDUSTRY. Pellervo Economic Research Institute Research Reports 208. p. 50. ISBN 978-952-5594-95-9 (NID), ISBN 978-952-5594-96-6 (PDF), ISSN 1456-3215, ISSN 1796-4776.

Abstract: The European Commission is now preparing a revision of the Emissions Trading Directive (ETS Directive) for the period starting in 2013. The cost pressure on the fertilizer industry due to the ETS Directive is greatest among nitrogen fertilizer manufactures, which will face increasing costs from several directions. Direct costs come from the effects of the ETS Directive on ammonia and nitric acid production. According to our calculations the probable extra cost due to the Emissions Trading Directive, even in the mildest scenario, would be so high that there would be no possibilities to cover the losses by increasing productivity. In addition, given the global market situation, fertilizer manufacturers in the EU are not able to pass increasing costs further to final consumers.

Keywords: *Emission Trading Directive, European nitrogen fertilizer industry*

VUONNA 2013 VOIMAAN TULEVAN PÄÄSTÖKAUPPADIREKTIIVI-EHDOTUKSEN VAIKUTUKSET EUROOPAN LANNOITETEOLLISUUTEEN. Pellervon taloudellisen tutkimuslaitoksen Raportteja 208. 50 s. ISBN 978-952-5594-95-9 (NID), ISBN 978-952-5594-96-6 (PDF), ISSN 1456-3215, ISSN 1796-4776.

Tiivistelmä: Euroopan komissio on valmistelemassa muutoksia päästökauppadirektiiviin vuonna 2013 alkavalle ajanjaksolle. Lannoiteteollisuudessa päästökauppadirektiivistä aiheutuvat suorat ja epäsuorat kustannuspaineet kohdistuvat erityisesti typpilannoitteiden tuotantoon. Päästökauppadirektiivin suorat kustannusvaikutukset tulevat ammoniakin ja typpihapon valmistukseen kohdistuvien kustannusten kautta. Analyysin tulosten mukaan päästökauppadirektiivin seurauksena typpilannoiteteollisuuden kustannukset kohoavat jo lievimmän skenaarion mukaan niin merkittävästi, että tuottavuuden kasvulla ei pystytä kompensoimaan kohonneita kustannuksia. Eurooppalaiset lannoitevalmistajat eivät nykyisessä maailmanmarkkinatilanteessa myöskään pysty siirtämään kohonneita kustannuksia eteenpäin kuluttajien maksettavaksi.

Asiasanat: *Päästökauppadirektiivi, Euroopan lannoiteteollisuus*

FOREWORDS

The European Union has been the leading actor in the global context to reduce carbon dioxide (CO2) emissions. In 1997 the European Union signed the Kyoto Protocol and thereby committed to reducing its CO2 emissions by 8 percent compared to the level in 1990. To achieve the CO2 target the European Union created a trading mechanism for emission–allowances that started on 1.1.2005.

In the period from 2008-2012 the European Union is committed to reducing CO2 emissions by 8 percent compared to the level in 1990 according to the Kyoto Protocol. To achieve this target, the total amount of the emission allowances has been reduced by about 13 percent from the level of 1990.

The European Commission is now preparing a revision of the Emissions Trading Directive (ETS Directive) for the period starting in 2013. The cost pressure on the fertilizer industry due to the ETS Directive is greatest among nitrogen fertilizer manufactures. This paper examines the effects of a revision of the Emissions Trading Directive on European nitrogen fertilizer manufacturers in the case where they are not be exempted from the auctioning mechanism and where other fertilizer manufacturing countries have neither binding Kyoto targets nor emission trading systems. In addition, we evaluate the strength of international competition in fertilizer markets and the pricing power of fertilizer manufacturers by estimating price elasticities in the export markets and by testing whether fertilizer prices are globally co-integrated.

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THE EFFECTS OF A REVISION OF THE EMISSIONS TRADING DIRECTIVE FOR THE PERIOD STARTING IN 2013 ON THE EUROPEAN NITROGEN FERTILIZER INDUSTRY

Chapters and writers:

“Summary”, “Introduction” and “Conclusions”
Kyösti Arovuori, Pasi Holm and Perttu Pyykkönen

“A revision of the Emissions Trading Directive and the European nitrogen fertilizer industry”
Kyösti Arovuori, Pasi Holm and Hanna Karikallio

“Global markets in the fertilizer industry” and “Competition in the fertilizer market”
Kyösti Arovuori and Hanna Karikallio

“Price elasticities in the world fertilizer market”
Petri Mäki-Fränti

“The law of one price in the fertilizer market”
Niko Suhonen

CONTENTS

RESEARCH GROUP

CHAPTERS AND WRITERS

SUMMARY 1

1. INTRODUCTION 4

2. A REVISION OF THE EMISSION TRADING DIRECTIVE AND THE EUROPEAN NITROGEN FERTILIZER INDUSTRY 6

   2.1 Nitrogen fertilizer production and capacity development 6

   2.2 Effects of the ETS directive on the European nitrogen fertilizer industry 9

3. GLOBAL MARKETS IN THE FERTILIZER INDUSTRY 15

   3.1 Development and trends in the nitrogen fertilizer market. 15

   3.2. World trade in the urea market 18

4. COMPETITION IN THE FERTILIZER MARKET 20

   4.1 Overview of the market structure and market shares 20

   4.2 Intense global competition 28

5. PRICE ELASTICITIES IN THE WORLD FERTILIZER MARKET 33

   5.1 Model 33

   5.2 Data and methods 34

   5.3 Results 35

6. THE LAW OF ONE PRICE IN THE FERTILIZER MARKET 37

   6.1 Introduction 37

   6.2 Data 38

   6.3 Results 40

7. CONCLUSIONS 42

REFERENCES 44

DATA SOURCES 44

APPENDIX 45

SUMMARY

The European Union has been the leading actor in the global context to reduce carbon dioxide (CO2) emissions. In 1997 the European Union signed the Kyoto Protocol whereby it committed to reducing its CO2 emissions by 8% compared to the level in 1990. To achieve the CO2 target the European Union created a trading mechanism for emissions allowances that started on 1.1.2005.

The European Commission is now preparing a revision of the Emissions Trading Directive (ETS Directive) for the period starting in 2013. The Commission has called for the auctioning of emission allowances to be given a larger role. This implies that more firms in the future than now with CO2 emissions will face the direct cost depending on the amount of emissions. This will considerably affect market competitiveness especially for highly energy intensive industries. Thus, it is important to consider the cost effects of the ETS Directive in the global context. This study will focus on the European fertilizer industry.

Due to the ETS Directive the cost pressure on the fertilizer industry is greatest among nitrogen fertilizer manufactures, which will face increasing costs from several directions. Direct costs come from the effects of the ETS Directive on ammonia and nitric acid production, both of which are essential intermediates in the nitrogen fertilizer manufacturing process. Production costs are also highly affected by natural gas prices. Additional costs come from higher electricity prices due to emissions trading.

Nitrogen is the most important nutrient in plant production. Carbon dioxide is an unavoidable by-product in the production of nitrogen fertilizers, and thus the ETS Directive would impose significant pressures on the fertilizer industry. However, if the fertilizer industry in the EU experienced some significant market power, increasing costs from the emissions trading directive could be passed through to retailers and final consumers. This depends, however, on the global market situation, competition and the market power of individual firms. In our analysis we have focused on the cost effects of the ETS Directive on ammonia and nitric acid production and thus, on the overall manufacture of nitrogen fertilizers within the EU.

Firstly, we analysed the effects of a revision of the Emissions Trading Directive on European nitrogen fertilizer manufacturers in the case where

they are not exempted from the auctioning mechanism and where other fertilizer manufacturing countries have neither binding Kyoto targets nor emission trading systems. Based on our calculations of the cost effects of the ETS Directive, producer prices of the European nitrogen fertilizer industry should increase by about 21 to 34 percent of the turnover to compensate for the increase of about 30 to 48 percent in the cash manufacturing costs due to the ETS Directive with full auctioning of emission allowances.

Secondly, we evaluated the strength of international competition in fertilizer markets and the pricing power of fertilizer manufacturers by estimating price elasticities in the export markets and by testing whether fertilizer prices are globally co-integrated. The estimations confirmed the hypothesis that the export demand for fertilizers is price elastic. The point estimates for the price elasticities obtained values greater than one measured as absolute values. Thus, a one per cent increase in the price of the fertilizers reduces the value of the exports. The other estimation results clearly validated the law of one price of the fertilizer markets examined. Our results supported the view of competitive European fertilizer markets, where companies cannot set their prices without taking into account the global competition originating from the USA, Africa, the Black Sea and Asia.

Given the global market situation, fertilizer manufacturers in the EU are not able to pass these costs further. This clearly indicates that if an industry somewhere (e.g. in Europe) were burdened with an extra cost compared to its competitors elsewhere, the industry could not pass through the extra cost to the selling prices of the products.

In order to be able to continue production one should be able to compensate for increasing costs through higher productivity. However, according to our calculations the probable extra cost due to the Emissions Trading Directive, even in the mildest scenario, would be so high that there would be no possibilities to cover the losses by increasing productivity.

The biggest impact from the ETS Directive would be on ammonia and nitric acid production. The urea fertilizers are manufactured directly from ammonia, whereas typical European nitrogen compound fertilizers are manufactured from ammonia via nitric acid. Although nitric acid's cost share of the total nitrogen fertilizer manufacturing costs is relatively small, the combined cost effects are still significantly higher for nitrate-based nitrogen fertilizer than urea. Increasing demand for urea combined with declining production within the EU would probably increase imports from low-cost natural gas regions, and thus increase carbon leakages.

The European fertilizer market is relatively mature and capacities have been already declining within the EU, mainly because of decreasing demand, the lack of natural gas and the high price of natural gas within the EU. The most recent forecast of the European fertilizer manufacturers association (EFMA) shows, however, slightly increasing production figures. If we add the possible extra cost due to the ETS Directive the carbon leakage would lead the long term declining trend to continue in the future. Numerous small ammonia and nitrogen plants in Europe are under threat of being unable to continue.

The European nitrogen fertilizer capacity could easily be compensated by nearby competitors directly behind the eastern border of the EU. If EU fertilizer production were not allowed an exemption from the ETS Directive, the EU would become highly dependent on the production of Eastern European and Central Asian countries and their policy and pricing.

1. INTRODUCTION

The European Union has been the leading actor in the global context to reduce carbon dioxide (CO2) emissions. In 1997 the European Union signed the Kyoto Protocol whereby it committed to reducing its CO2 emissions by 8% compared to the level in 1990. To achieve the CO2 target the European Union created a trading mechanism for emissions allowances which started in 1.1.2005. The first trading period was 2005-2007. At the beginning of the period the price of the tradable emissions allowances was even more than 30 euros per tons, but at the end of the first round the price was close to zero.

In the period of 2008-2012 the European Union is committed to reducing CO2 emissions by 8% compared to the level in 1990 according to the Kyoto Protocol. To achieve this, the total amount of the emissions allowances has been reduced by about 13% from the level of 1990. The price of tradable emissions allowances has risen to about 20 to 25 euros per ton at the beginning of 2008.

So far the emissions allowances have been allocated free of charge to those firms operating in sectors included in the emissions trading system. This means that if a firm’s total amount of emissions has been less than its emissions allowances given in the initial allocation the firm has been able to sell its additional emissions allowances to achieve extra earnings. If, in turn, a firm’s total amount of emissions has been more than its emissions allowances the firm has had to buy additional allowances at the market price of the emissions allowances.

The European Commission is now preparing a revision of the Emissions Trading Directive (ETS Directive) for the period starting in 2013. The Commission has called for the auctioning of emission allowances to be given a larger role. This implies that more firms in the future than now with CO2 emissions will face the direct cost depending on the amount of emissions.

The European Council emphasised in its conclusions in March 2007 the great importance of the energy intensive sector and that cost-efficient measures are needed to improve its competitiveness. In practise, some sectors could be exempted from the auctioning of allowances. This kind of reasoning calls for exact criteria for exemptions. At least four points can be identified: energy intensity, global competition, profitability and degree of pass through of costs.

This study focuses on the European fertilizer industry. Firstly, we analyse the effects of a revision of the Emissions Trading Directive on European nitrogen fertilizer manufacturers in the case where they are not be exempted from the auctioning mechanism and where other fertilizer manufacturing countries have neither binding Kyoto targets nor emission trading systems. Secondly, we evaluate the strength of international competition in fertilizer markets and the pricing power of fertilizer manufacturers by estimating price elasticities in the export markets and by testing whether fertilizer prices are globally co-integrated. Finally, we will conclude on our main findings.

2. A REVISION OF THE EMISSION TRADING DIRECTIVE AND THE EUROPEAN NITROGEN FERTILIZER INDUSTRY

2.1 Nitrogen fertilizer production and capacity development

The fertilizer market is composed of three primary nutrients, which all have essential and complementary roles in the ecological processes of plants. Nitrogen is the most important nutrient in the world, accounting for 60 % of total nutrient consumption. The other two main nutrients are phosphorus and potassium. While nitrogen fertilizers are manufactured directly via chemical processes, the production of phosphate and potash fertilizers involves digesting and mining activities. Two key raw materials for nitrogen fertilizers are natural gas, which is widely available in many parts of the world, and air. The availability of raw materials makes the manufacture of nitrogen fertilizer possible in a variety of locations. However, phosphate rock, the raw material for phosphate fertilizers, and potash mineral deposits are only available in certain regions of the world, especially in Canada, Russia and some European countries.

Fertilizers are utilized as straight fertilizers or as complex fertilizers. Straight fertilizers contain one single primary nutrient, while complex fertilizers are manual or chemical blends of the main nutrients. Urea is the most important straight fertilizer and globally the most important source of nitrogen. NPK, a fertilizer that contains varying proportions of the three main nutrients, is the most important complex fertilizer. Complex fertilizers, especially NPK, have been more widely used in Europe. However, the use of complex fertilizers is declining in favour of straight fertilizers and blends. This trend means increasing challenges for the fertilizer industry in Europe, which has primarily focussed on nitrates and compound NPKs.

Despite the fact that primary nutrients might be provided as complex fertilizers, it is important to distinguish nitrogen fertilizers from phosphate and potash fertilizers. The production processes and market conditions of nitrogen fertilizers are significantly different from those of phosphate and potash fertilizers. Due to the differences in production processes and the major role of nitrogen fertilizer production and consumption in the EU, we will focus our analysis on the nitrogen fertilizer industry. In addition, while carbon dioxide is an unavoidable by-product from the ammonia production process and ammonia is the basis for producing nitrogen fertilizers, the emissions trading directive will have a direct effect on their production costs.

Ammonia, a derivative of natural gas, is used as a straight raw material in different mineral fertilizers and solutions. In addition, ammonia is also a raw material for nitric acid, which is used in the production of ammonium nitrate and other nitrogen fertilizers. While natural gas accounts for approximately 80 % of the production costs of ammonia, ammonia accounts for approximately 80 % of the costs of producing nitrates and urea. Ammonia is produced by combining nitrogen in the air with hydrogen in natural gas, using a catalyst under high temperature and high pressure in a process called the Haber Bosch (Figure 2.1).

Because of the central role of ammonia, the production of nitrogen fertilizers is closely associated with the production of natural gas. The EU is highly dependent on natural gas from regions such as Russia and North Africa. Moreover, since natural gas is difficult and expensive to transport, nitrogen fertilizer plants are typically located close to gas reserves. In other words, the transportation of manufactured fertilizers is possible with fewer costs than the transportation of natural gas. Because of the high nitrogen content (46%), the transportation of nitrogen fertilizer in the form of urea is relatively cheap.

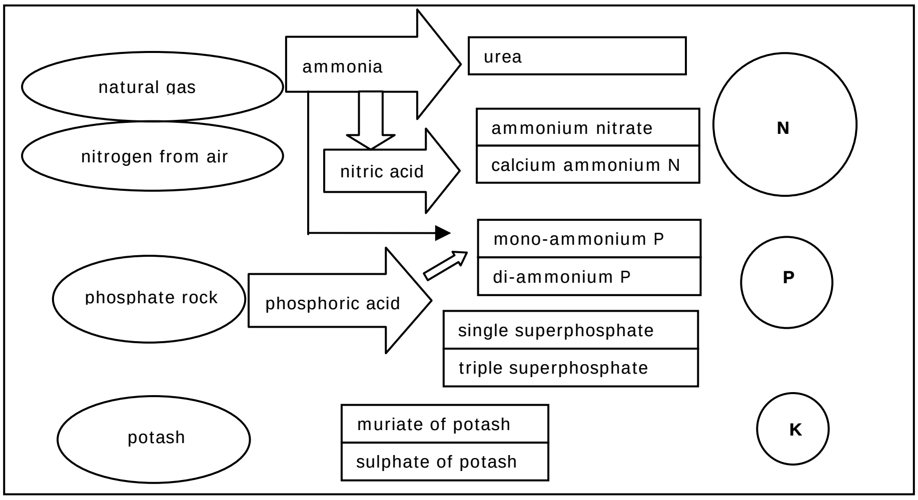


Figure 2.1. *Sources, intermediates and primary processes in the fertilizer manufacturing industry according to the main nutrient*

The nitrogen fertilizer production capacity in regions with low cost gas reserves is being significantly expanded, while the higher cost areas, such as the EU, have faced disinvestments. Rapidly increasing natural gas prices have led to plant closures in Europe and thus to increasing imports of ammonia from the world markets. The existing ammonia and fertilizer capacity in Europe has been in decline over the last two decades. Similarly, in the US, the production has decreased dramatically during recent years and thus, the dependency on imports has significantly increased. Figure 2.2 presents ammonia capacities in 1999 and in 2008 according to region. Western Europe has lost 2.5 million tonnes and North America over 6 million tons of its ammonia capacity in the past ten years. At the same time, the nitrogen fertilizer production capacity in regions with low-cost gas reserves is being expanded significantly. Much of the new capacity in Latin America and the Near East exceeds by far the local consumption of fertilizers in these regions, and thus will make it possible to export increasing amounts of nitrogen fertilizer in the near future. In addition, Russia and Algeria are also seeing some large investments in ammonia capacities.

Recent development in the worldwide manufacture of fertilizers demonstrates that European manufactures are facing increasing competition, especially from those regions with lower cost natural gas. Moreover, major players in these regions are mainly direct neighbours of the EU, such as Russia, Ukraine and Algeria. Changing consumption patterns in the EU, where complex NPK fertilizers are being replaced by straight fertilizers, especially urea, will make the European fertilizer markets even more competitive. The direct costs of the emissions trading directive for fertilizer manufacturers will mainly come from ammonia, and thus the greatest effects will be on the production costs of urea and other nitrogen fertilizers.

Different consumption patterns in the EU and elsewhere will also affect the implementation of the emissions trading directive. Total carbon dioxide emissions in the fertilizer industry also include those from soil due to fertilizer use. These emissions are mainly from urea, while nitrated nitrogen fertilizers cause emissions mainly in the production processes. If emissions from soil were to be excluded from the total emissions, urea would become relatively less expensive compared to NPK and nitrate based nitrogen fertilizers. Urea is the most important fertilizer in world, but less significant in the EU. However, its share is also increasing within the EU. If urea was relatively cheaper than other nitrogen fertilizers within the EU, the CO2 emissions from soil would probably increase because of the increasing use of urea.

In the next section, we will estimate the effects of the Emissions Trading Directive on the production costs of ammonia and nitric acid, and thus the overall costs of the Directive on the nitrogen fertilizers manufacturers in the EU.

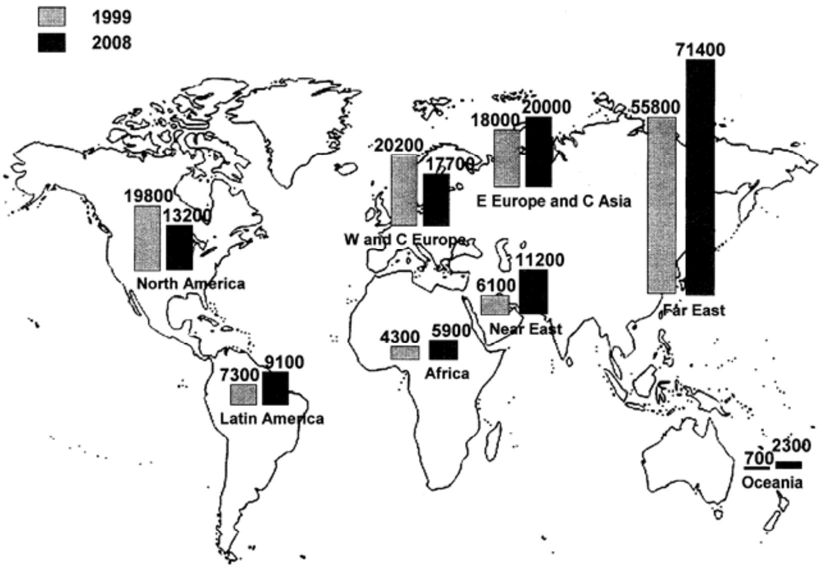


Figure 2.2. *Ammonia capacities in 1999 and in 2008 according to regions (1000 tons), (Source: IFA).*

2.2 Effects of the ETS directive on the European nitrogen fertilizer industry

In this section we evaluate the cost push effects of a revision of the Emissions Trading Directive (ETS Directive) on the European nitrogen fertilizer industry. We apply a kind of first-round benchmark analysis by assuming that all relevant quantities remain constant. After collecting the appropriate data we calculate changes in terms of values due to changes in terms of prices. A revision of the ETS Directive will affect to the European nitrogen fertilizer industry by increasing the direct emission costs and by increasing the price of electricity.

In the first trading period of 2005-2007 the emission allowances for firms operating in sectors included in the EU's emissions trading system were allocated free of charge. Yet, the fertilizer industry has been only partly included on ETS. At the beginning of the first trading period (2005-2007) the price of tradable emission allowances even exceeded 30 euros per ton. However, at the end of the first period the price was close to zero. At the beginning of the second trading period (2008-2012) the price of tradable emission allowances has been about 20 to 25 euros per ton. In July 2008, the price of tradable emission allowances was about 25 euros per ton.

What will happen to the price of emission allowances in the third trading period starting in 2013? According to the study of Russ and Criqui (2006), the prices of CO2 emissions allowances may vary between 16.5 and 45.2 euros per ton in 2010 and between 53.5 and 99.8 euros per ton in 2020. Based on this, three scenarios are specified in this study. The price of emission allowances is assumed to be 30 euros per ton, 40 euros per ton and 50 euros per ton in the three alternative scenarios and the emission allowances are assumed to be allocated by an auctioning mechanism.

There is a straightforward impact of the price of emission allowances on the price of electricity. According to Finnish business analysts specialised in the electricity markets, a one euro increase in the price of emission allowances will increase the price of electricity per MWh by about 75 cents. An increase in the price of emission allowances from 20 euros (the price at the beginning of 2008) to 30 euros per ton will thus increase the price of electricity by 7.5 euros per MWh, i.e. from 50 euros (the price at the beginning of 2008 in Finland) to 57.5 euros per MWh. In the same way, when the price of emission allowances is 40 or 50 euros per ton the respective price of electricity is 65 or 72.5 euros per MWh. The different scenarios are summarized in Table 2.1.

Table 2.1. *Three scenarios for the effects of the Emissions Trading Directive on the prices of emission allowances and electricity.*

	Scenario 1	Scenario 2	Scenario 3
Price of emission allowances, euros per ton	30.0 *(20%)*	40.0 *(60%)*	50.0 *(100%)*
Price of electricity, euros per MWh	57.5 *(15%)*	65.0 *(30%)*	72.5 *(45%)*

The percentage price increases are provided in parentheses.

Table 2.2. *The effects of a revision of the Emission Trading Directive on the European nitrogen fertilizer industry (EU-27 countries) in the case where the European nitrogen fertilizer industry is not even partially exempted from the auctioning mechanism and where other large nitrogen fertilizer producing countries do not participate in the Kyoto Protocol*

Base year 2005	Ammonia	Nitric Acid
Total production, million tons	16,8	21,5
CO2 emissions, million tons	28.7*	48.1**
Purchased electricity, million euros	345	60,1
"Cash manufacturing cost", million euros	2 895	1462
Scenario I		
- emission cost, million euros	861	1443
- additional cost of electricity, million euros	133	69
- total cost of a revision of ETS Directive, million euros	994	1512
- total cost increase, % of the cash manufacturing cost	34.3	103
Scenario II		
- emission cost, million euros	1148	1924
- additional cost of electricity, million euros	150	78
- total cost of a revision of ETS Directive, million euros	1299	2002
- total cost increase, % of the cash manufacturing cost	44.9	137
Scenario III		
- emission cost, million euros	1436	2405
- additional cost of electricity, million euros	167	87
- total cost of a revision of ETS Directive, million euros	1603	2492
- total cost increase, % of the cash manufacturing cost	55.4	171

** Year 2007; ** Year 2006*
Sources: EFMA and the authors' calculations.

To calculate the effects of the scenarios we collected data from 2007 on the total amount of CO2 emissions and the purchased electricity in the European nitrogen fertilizer industry (see Table 2.2). As explained above we have considered the ammonia and nitric acid production separately. The total production in the European (EU-27 countries) ammonia industry was 16.8 million tons in 2005, which implies 28.7 million tons of CO2 emissions. The production of ammonia consumed about 345 million euros of electricity. The cash manufacturing cost was about 2.9 billion euros.

The total production in the European (EU-27 countries) nitric acid industry was 21.5 million tons in 2005, which implies 48.1 million ton of CO2 emissions. The production of nitric acid consumed about 60.1 million euros of electricity. The cash manufacturing cost was about 1.5 billion euros.

By assuming that all quantities are constant, the effects of the scenarios on the costs of the European nitrogen fertilizer industry can be calculated as shown in Table 2.2. If the European nitrogen fertilizer industry is subject to full auctioning of emission allowances in line with the Commission proposal on the Emissions Trading Directive for the period starting in 2013, this will cause about 0.9 to 1.4 billion euros of additional costs to the European ammonia industry and about 1.5 to 2.5 billion euros of additional costs to the European nitric acid industry. The total cost increase as percentage of the manufacturing cost in the ammonia industry varies from 34.3 to 55.4 % and in the nitric acid industry varies from 103 to 171 % depending on the scenario.

By relating the total costs of emission trading to the total turnover of the European nitrogen fertilizer industry one can estimate the upward pressure in producer prices (see Table 2.3). To do this, one should take into account the additional purchased electricity in this part of the production process. When analysing the numbers in the table one should take into account that the Eurostat database includes statistics from the total European fertilizer industry as a whole. To obtain statistics considering the European nitrogen fertilizer industry we use the assumption that the nitrogen fertilizer industry accounts for about 80 % of the total fertilizer industry. We have used this 80 % share in all statistics requiring a split.

Table 2.3. *The upward pressure on the producers prices of the European nitrogen fertilizer industry caused by a revision of the Emission Trading Directive in the case where the European nitrogen fertilizer industry is not even partially exempted from the auctioning mechanism and where other large nitrogen fertilizer countries do not participate in the Kyoto Protocol (base year 2005)*

Total production, million tons	74.9		
Total turnover, million euros	13 088		
Purchased electricity, million euros	256		
Cash manufacturing cost, million euros	9 268		
Gross operating surplus	1 118		
Profits, % of the total turnover	8.5		
	Scenario 1	*Scenario 2*	*Scenario 3*
- total cost of the new ETS Directive, million euros	2800	3600	4500
- total cost increase, % of the cash manufacturing cost	30	39	48
- total cost increase, % of the total turnover	21	28	34
- only electricity cost in the case of exemption, million euros	500	560	630
- electricity cost, % of the total turnover	3.8	4.3	4.8

Sources: EuroStat, EFMA and the authors' calculations.

To compensate for the increase of about 30 to 48 percent in the cash manufacturing costs due to a revision of the ETS Directive with full auctioning of emission allowances, the producer prices of the European nitrogen fertilizer industry should increase by about 21 to 34 percent of the turnover.

If the European nitrogen fertilizer industry is totally exempted from the auctioning mechanism, a revision of the ETS Directive will cause about 500 to 630 million euros of additional costs to the European nitrogen fertilizer industry. To keep profits constant, the European nitrogen fertilizer industry should increase the final output price by about 3.8-4.8 percent.

If the European nitrogen fertilizer industry is not able to almost fully pass through the cost increase due to a revision of the ETS Directive with full auctioning of emission allowances to their final customers, the industry is in serious trouble, since the gross operating surplus from the total turnover in the European nitrogen fertilizer industry was 8.5 percent in 2005. Even if the European nitrogen fertilizer industry is totally exempted from the auctioning mechanism, the industry will lose half of its profits due to the increasing price of electricity.

In next sections we consider whether the European nitrogen fertilizer industry will be able to pass through the cost increase to the final customers.

3. GLOBAL MARKETS IN THE FERTILIZER INDUSTRY

3.1. Development and trends in the nitrogen fertilizer market

Generally speaking, population growth and economic growth are the main drivers for increased fertilizer consumption. The Asian share of global fertilizer consumption is about 65%, and growing rapidly. Developments in Asia will continue to play a major role in how the global fertilizer market will develop. Demand in Latin America has been rapidly increasing due to the strong development in the agricultural sector. It is anticipated that 89% of the increase in world fertilizer consumption will come from East Asia, South Asia, and Latin America together. Consumption in the mature markets of North America and Europe is stable, and forecast to remain stable.

Due to the historical structure of mainly nationally owned fertilizer industries in the EU-27, nitrogen fertilizers are still manufactured in relatively small plants. With the exception of Norwegian-based Yara International, European nitrogen fertilizer manufacturers operate mainly within the European Union. Rising gas prices in Europe have caused European ammonia producers to close a number of ammonia plants and instead purchase ammonia on the world market. During the last 20 years more than half of the fertilizer plants in the EU-15 area have disappeared.

The nitrogen fertilizer production capacity in regions with low-cost gas reserves is being significantly expanded. On-going investments in Russia, Egypt and Algeria will multiply the ammonia production capacity just outside the EU-27 borders. Higher production volumes combined with the lower cost of available natural gas will pose a significant challenge to nitrogen fertilizer industry in the European Union. In addition, pipeline routes from the Black Sea region will put increasing pressure on production plants in the EU.

In Figures 3.1 and 3.2 are presented the changes in ammonia production and consumption during the period 1999-2006 according to regions. Even in a short period, one can see quite large changes in production: Asia, Eastern Europe and Latin America have increased their ammonia production sharply, while in Western Europe and North America, production has decreased. The changes in regional consumption are similar to the changes in regional production: Consumption has increased mostly in Asia and Eastern Europe. The consumption of ammonia has decreased in Western Europe and North America. If we combine the information from Figures 3.1 and 3.2, we get the changes in net exports during 1999-2006 according to regions. Latin America, Eastern Europe, and Western and Central Asia have increased ammonia export while North America and South Asia have been the largest ammonia importers.

Europe's role as a fertilizer production region has been declining over time, while other world regions are growing in importance. Europe has transformed from being a region in which more nitrogen fertilizers were produced than consumed to one that consumes more nitrogen fertilizers than are produced.

The forecast[1] is for world nitrogen fertilizer demand to increase at an annual rate of about 1.4% until 2011/2012, which is an overall increase of 7.3 million tonnes. About 69%t of this growth will take place in Asia. In 2007, world ammonia production increased by 3.8%, reaching 153.6 Mt of ammonia. China contributed half of the net increase. World ammonia trade in 2007 grew by 1% over 2006, to 19.6 Mt of NH3. The main increases in exports came from Saudi Arabia, Australia and Iran. The main import growth destinations were the United States and northeast Asia.

1 FAO (2008): Current world fertilizer trends and outlook to 2011/12.

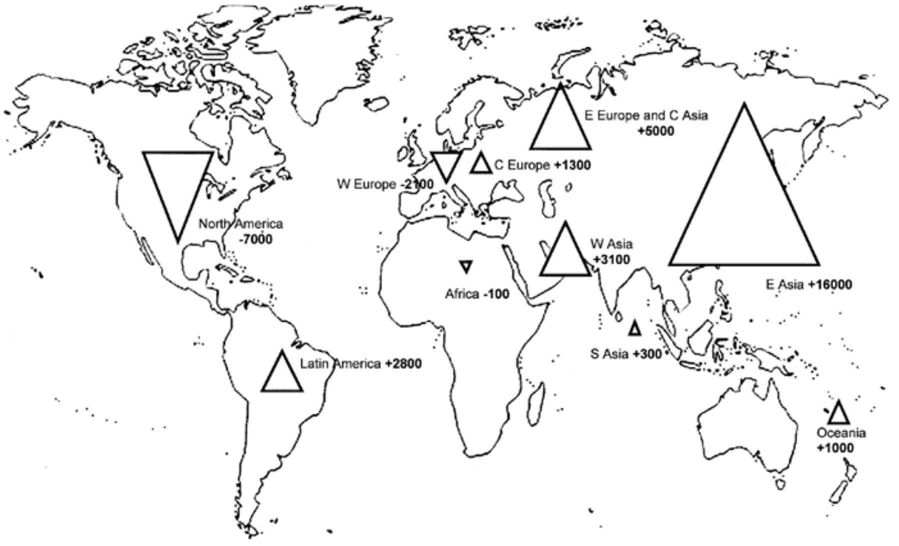


Figure 3.1. *Change in Ammonia production from 1999 to 2006 by regions (1000 tons), (Source: IFA).*

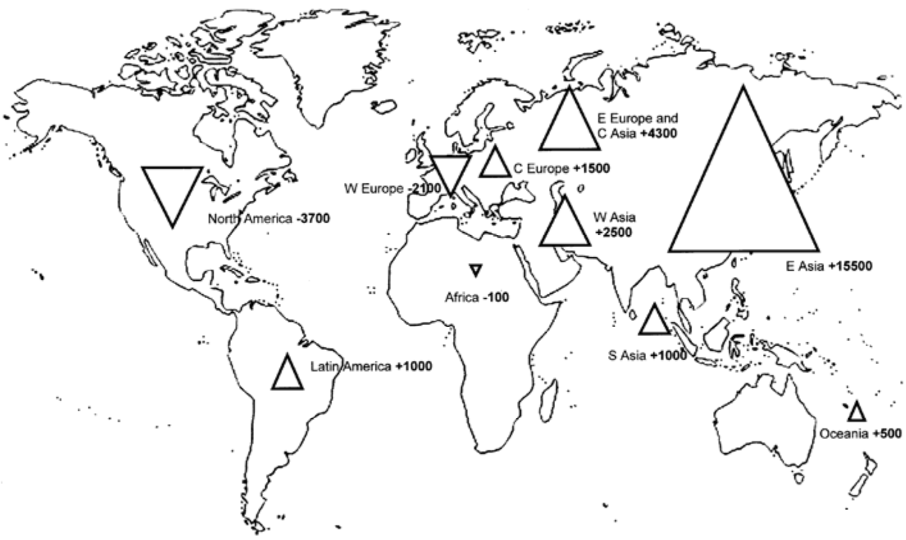


Figure 3.2. *Change in ammonia consumption from 1999 to 2006 according to region (1000 tons), (Source: IFA).*

3.2. World trade in the urea market

The most traded product in the global fertilizer markets during the period from 1996-2006 was urea. The biggest exporters included Russia, Ukraine and Qatar. While the EU-15 and CEEC-10 are both big traders, the biggest share of trade was between or within these countries. The biggest importers were Brazil, India and the EU. It is worth noting that China, the world largest urea consumer, does not import amounts that would comprise a significant share in world trade. A major trend in the world markets is that the amount of ammonia and urea traded has increased rapidly. This trend is expected to remain strong in the coming years.

Table 3.1. *Main urea exporters and their partners 1996-2006 (UN Comtrade)*

Exporter	Russia	Ukraine	Qatar	CEEC-10	EU-15
Importer	Brazil	India	Australia	EU-15	Canada
	EU-15	Turkey	USA	Turkey	CEEC-10
	Mexico	Pakistan	Thailand	USA	USA
	Peru	Brazil	India	India	Ecuador
	Turkey	Mexico	South Africa	Philippines	Norway

The global average growth in urea consumption growth has been 3.6 % for the last ten years (2.5% excluding China). Most of the new nitrogen capacity in the world is urea, so it is natural that production/consumption growth rates are high. In addition, a major share of the capacity shutdowns in high energy cost regions has comprised stand-alone ammonia plants, while the investments in low cost gas areas have focused on both ammonia and urea production. Overall, close to 4.5 million tons of new urea capacity was commissioned in 2007, mostly in China, Egypt, and Iran. The global urea capacity is projected to further increase in 2008 to 165.7 million tons, with China accounting for one-half of the increase. The world urea capacity is forecast to grow to some 192 million tons of urea in 2011. The driving regions in urea production growth are China, Oman, Iran, Trinidad, Egypt, Vietnam and Pakistan.

North Africa is forecast to overtake the EU in terms of urea capacity by 2015. North Africa and the Middle East will double their ammonia and urea capacity in the next eight years while capacity in the EU will remain unchanged.[2]

Transportation of urea is relatively inexpensive. It is transported in large ocean vessels between the continents and traded on a worldwide basis. There are two main hubs in urea trade, the Black Sea and Arab Gulf. The trade flows from these areas define the world market prices. Overall, major trade flows are from Black Sea region to Europe, Latin America and India, from the Arab Gulf to North America and Africa, and from North Africa to Europe (Figure 3.3).

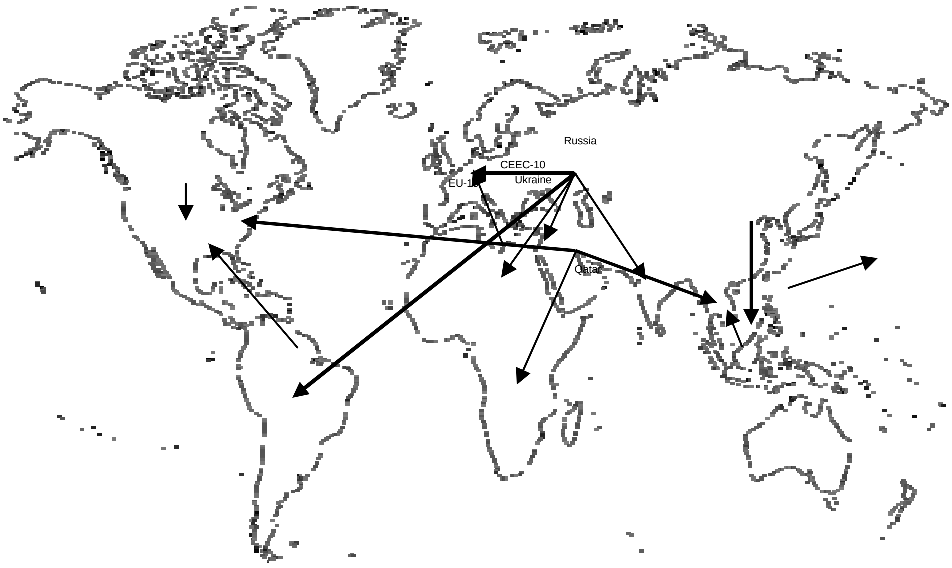


Figure 3.3. *Main urea trade flows and the biggest exporters during 1996-2006 (Souce: UN Comtrade)*

2 Fertecon Ammonia Outlook 2007/1, Fertecon Urea Outlook 2007/1.

4. COMPETITION IN THE FERTILIZER MARKET

4.1. Overview of the market structure and market shares

Although there are regional differences particularly in fertilizer consumption patterns, the fertilizer market cannot be comprehensively analyzed on a regional basis. Two distinct features need to be taken into account. Firstly, the fertilizer market is *highly cyclical* driven by the supply-demand balance. In times of relatively high prices, additional capacities are built up until supply outstrips demand. Respectively, in times of relatively low prices, sufficient capacity has to be taken out of the market until demand catches up with supply. Secondly, due to the transportability of fertilizers, the market is *highly global,* meaning that it is important to focus on the global supply-demand balance. This balance also forms the basis of fertilizer prices. For example, for ammonia and urea there is a highly developed spot market. Information on these global pricing benchmarks is widely available in the market place.

The purpose of this chapter is to analyse whether the fertilizer market is also competitive. On a global basis the market is often suggested to be fragmented with relatively small producers. We provide some firm-level indicators of the market shares and concentration in the industry and also present the development in the economic performance of the top fertilizer firms in recent years.

According to theory, in a perfectly competitive market, a firm has no market power: the firm's demand curve is perfectly elastic and the price equals the marginal cost. In other words, firm is a price taker: it cannot influence the price that is paid for its product. Therefore, firms in a competitive environment are more hard-pressed to reduce costs and become more efficient. A firm that makes inefficient decisions incurs losses because it cannot transmit its extra costs to the consumers. Government interventions also reduce the efficiency of competitive markets.

It is widely accepted that large market shares and a high degree of market concentration would curb competition within a market. The more concentrated a market is, the more likely it is that the market actors can utilize market power. Thus, the market concentration ratio is an important index to consider when analyzing competition and market structure. Perhaps the most common way to measure market concentration is to calculate the market shares of the largest actors.

The five largest fertilizer companies in the world are Yara (Norway), The Mosaic Company (USA), Agrium, Inc (Canada), Potash Corporation (Canada) and The Kali & Salz Group (Germany).

Fertilizer company presentation

Yara is the largest fertilizer company measured by revenues and the leading fertilizer company in Europe, with approximately 23% of the European market. In total, Yara has a physical presence in 50 and sales to 120 countries.

Yara is the global leader in nitrogen fertilizers with capacities of ammonia 5.8 million tonnes of ammonia, n 4.8 million tonnes of nitrates (CAN and AN) and 4,1 million tonnes of NPK. Yara has a one-third share of the global ammonia trade.

Yara's target is to achieve a 10% market share in the global fertilizer market within a business cycle.

Yara owns two large ammonia production facilities in Trinidad and Qafco fertilizer complex in Qatar. Major developments for Yara in the last year included the acquisition of Kemira GrowHow, the signing of a Heads of Agreement for establishing a joint venture in Libya, a decision to upgrade Yara's urea facility in the Netherlands, and contracting for the construction of new ammonia and urea capacity in Qatar.

The Mosaic Company was formed in 2004 by the business combination of IMC Global Inc. and the crop nutrition business of Cargill, Incorporated.

Mosaic is the world's top producer of phosphates, with an annual effective capacity of about 9.4 million tonnes, larger than the next three largest producers combined. Mosaic's potash production capabilities are the second-largest in the world, with an annual capacity of approximately 10.4 million tonnes. In addition, Mosaic has an annual nitrogen capacity of 1.2 million tonnes.

Mosaic operates 5 phosphate mines in Florida and 4 potash mines within Saskatchewan, Canada, including the world's largest potash mine, and a potash mine in New Mexico. Approximately one-third of production is shipped within North America, with the remainder exported around the world to some 45 countries.

Mosaic's offshore interests form a production and distribution network in key agricultural markets around the world. Assets within this segment include 20% stake in Fosfertil S.A. in Brazil, 35% equity ownership in a DAP granulation plant in China and GSSP plant in Argentina.

Large investments in potash capacity will result in a nearly 30% increase in production capacity in the coming years.

Agrium, Inc has annual capacities of 6.5 million tonnes of nitrogen, 2.1 million tonnes of potash and 1.3 million tonnes of phosphate. Agrium operates mainly in North America.

Agrium owns two nitrogen facilities that target international markets, one in Argentina and the other at Kenai, Alaska. Primary markets are South Korea, Mexico and Taiwan. Key potash exports markets include China, Brazil and India.

Presently, Agrium is investing in Egypt as part of international diversification. It has also expanded into China through the purchase of a stake in the Chinese fertilizer company Hanfeng Evergreen.

Potash Corporation has a 22% share of the global potash capacity. In response to global demand, projects announced by PotashCorp will raise the annual operational capacity from10.8 million tonnes in 2007 to 17.2 by the end of 2015.

PotashCorp have strategic investments in four offshore potash businesses: 28% of Arab Potash Company Ltd. (APC), Jordan; 10% of Israel Chemicals Ltd. (ICL), Israel; 32% of Sociedad Química y Minera de Chile S.A. Chile; and 20% of Sinofert Holdings Limited (Sinofert), China.

The Kali & Salz Group extracts potash and magnesium crude salts at six mines in Germany, with an annual output amounting to about 8 million tonnes of products.

With a potash production share of about 12%, The K + S is the fourth-largest producer in the world and the leading provider in Europe. In addition, K+S is the global leader in potassium sulphate and magnesium. In the case of N fertilizers, K + S Fertiva is an important supplier in Europe and its position is particularly strong in the area of nitrogen fertilizers containing sulphur.

The firm's focus is on the European market but it exports overseas about 40% of production mainly to Latin America. The K+S Group has become more international with the acquisition of Chilean salt producer SPL in 2006. It is trying to enhance its market position in the established business sectors especially by intensifying the marketing of speciality products. In addition, K+S is seeking growth through cooperation arrangements.

In firm-level analysis it is difficult to distinguish the producers of nitrogen (N), phosphate (P) and potash (K) fertilizers. However, the leading producer is different in all three nutrient markets. Table 4.1 presents the market impacts of the five largest fertilizer companies per class of nutrient. Yara is an obvious leader in nitrogen products. Similarly, Mosaic Company is a leader in phosphate and Potash Corporation in potash fertilizers. On the one hand, it might be justifiable to ask whether these firms really are competitors. On the other hand, all these firms are present in more than one nutrient market and form at least a threat to other firms in any particular nutrient market

Table 4.1. *Market impact of Fertilizer companies*

	Market impact		
	Nitrogen (N)	Phospate (P)	Potash (K)
Yara	**+++**	**+**	**o**
Mosaic	**+**	**+++**	**++**
Agrium	**+++**	**+**	**+**
Potash	**++**	**++**	**+++**
K + S	**+**	**o**	**+++**

+++ very strong; ++ strong; + low; o none

Figure 4.1 illustrates the nominal turnover of the five largest fertilizer companies from 2000 to 2007. Yara is clearly the largest fertilizer company measured by turnover. The growth of Yara's turnover in 2007 was partly related to the acquisition of Kemira GrowHow. The Mosaic Company was formed in 2004 and turnover statistics before that are annual turnovers of IMC Global Inc. All in all, there are no significant differences between these firms in the development of their turnover statistics. Starting from 2002, turnovers have developed positively in all five firms.

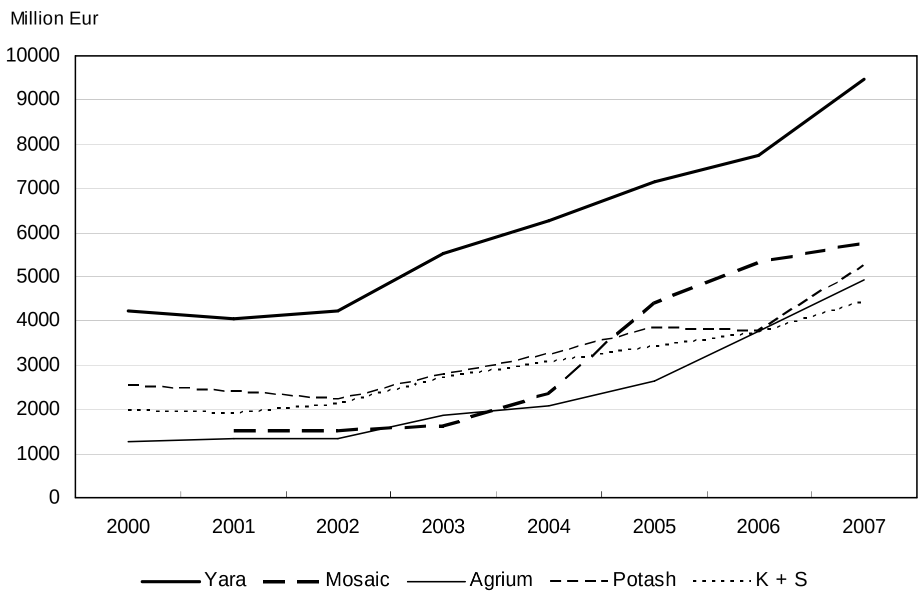


Figure 4.1. *Turnover of the top 5 firms in the fertilizer industry during 2000-2007.*

The profitability of companies in the fertilizer industry companies has been very volatile, indicating that the fertilizer market is highly sensitive. Factors that affect the economic performance of the firms include the rate of construction of new production facilities, the operating rates of existing facilities, market conditions in the grain and raw material markets and government intervention. The profitability – measured by the profits after taxes on annual sales – of the top 5 fertilizer industry companies varied from -5% to 22% during the period from 2000-2007 (Figure 4.2). The average profitability ratio since 2000 has been approximately 5%, although there have been significant differences between years. The year 2007 seems to have been the best year in the fertilizer industry in this century measured in terms of the profitability of the five largest fertilizer companies.

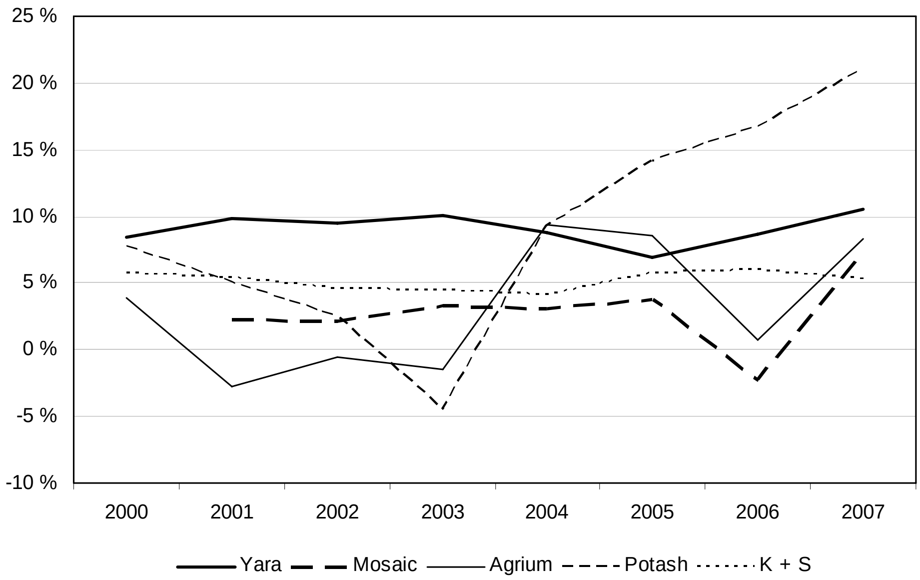


Figure 4.2. *Net profits of the top 5 firms in fertilizer industry during 2000-2007.*

During recent years the market shares of the main global fertilizer industry companies have remained relatively unchanged (Figure 4.3). Only Mosaic Corporation has succeeded in considerably increasing its market share. The production share of the top 5 fertilizer firms was 27% in 2002 and 33% in 2007. Altogether, market shares of the largest fertilizer companies are quite small. The 5-firm HHI-concentration ratio in 2007 was less than 250 indicating un-concentrated markets[3]: no fertilizer company has market power. These numbers indicate strong competition in the global fertilizer markets.

In summary, the largest fertilizer companies also face fluctuations in the fertilizer market. The supply-demand balance in the industry, and therefore also the fertilizer prices, cannot be influenced by any single producer. The fertilizer industry operates in a global market, where only companies that manage to increase productivity can prosper in the face of global competition.

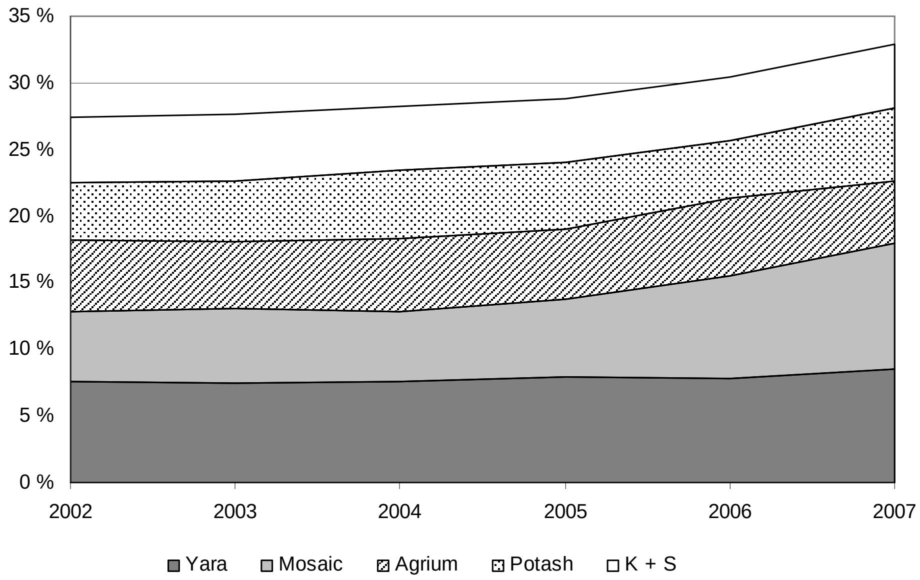


Figure 4. *The share of total production of the top5 firms in the global fertilizer market.*

Let us consider more closely the situation in the European fertilizer industry. In the past, the fertilizer industry has been affected by weak fertilizer

[3] The Herfindahl-Hirschman Index (HHI) is a measure of market concentration. The HHI of a market is calculated by summing the squares of the percentage market shares held by the respective firms. When HHI is below 1000 the market is "unconcentrated", between 1000 and 1800 it is "moderately concentrated", and above 1800 it is "highly concentrated." In this case, the market share is measured in terms of production (tons).

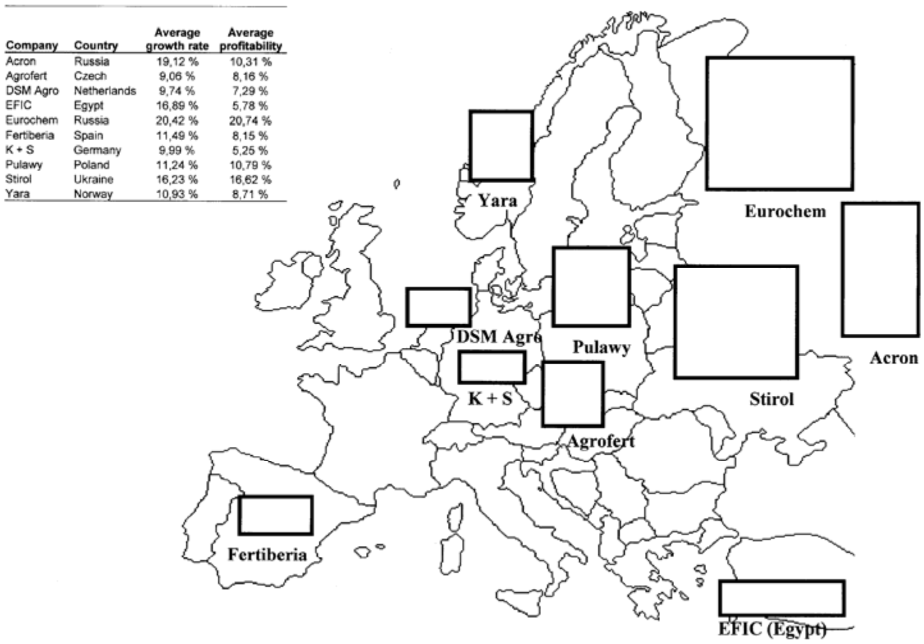
companies that existed as part of government-owned enterprises or conglomerates. The fertilizer industry was seen from a food security point of view rather than from a business point of view. As state involvement is declining, there is a trend towards market orientation and more financial discipline across the industry.

Nowadays, it is important to achieve cost savings and efficiencies that enable companies to continue to compete strongly in the worldwide fertilizers market, particularly in the face of intense competition from N fertilizer producers established in countries with low gas feedstock costs for their ammonia production. Imports of competitively priced N fertilizers from Russia, Ukraine, North Africa and the Middle East will continue to act as a strong competitive constraint on the fertilizer companies in Europe.

Indeed, large European companies have not been as profitable as their Russian and Ukrainian competitors in recent years. Also, the average turnover growth rates of European firms have been lower than their competitors' growth rates in the neighbouring areas. These points have been illustrated in the figure below.

Figure 4.4 presents some large European fertilizer companies and some fertilizer companies from neighbouring areas. Every company has been marked by a box placed in firm's home country. The height of the box illustrates firm's average profitability (net income/turnover) during the four/five last years (2003/2004-2006/2007). Respectively, the width of the box illustrates firm's average growth of turnover during the same period.

From the figure, we can conclude that the import of competitively priced N fertilizers from neighbouring regions act as a strong competitive constraint on the European firms. Only efficiency and cost savings will enable the European fertilizer industry to remain competitive.



Company	Country	Average growth rate	Average profitability
Acron	Russia	19,12 %	10,31 %
Agrofert	Czech	9,06 %	8,16 %
DSM Agro	Netherlands	9,74 %	7,29 %
EFIC	Egypt	16,89 %	5,78 %
Eurochem	Russia	20,42 %	20,74 %
Fertiberia	Spain	11,49 %	8,15 %
K + S	Germany	9,99 %	5,25 %
Pulawy	Poland	11,24 %	10,79 %
Stirol	Ukraine	16,23 %	16,62 %
Yara	Norway	10,93 %	8,71 %

Figure 4.4. *Large fertilizer companies in Europe and neighbouring countries during the four/five last years (2003/2004-2006/2007): Average profitability (height) and growth (width).*

4.2 Intense global competition

In this section, we take another view of the global competition in the fertilizer industry. We compare profitability and growth between the top 5 firms introduced in the previous chapter and 10 other large fertilizer firms. The question is whether these 8 firms are able to challenge the world's leading fertilizer companies in terms of profitability and growth. If the answer is positive, we can conclude that the leading firms are also hard-pressed to become more efficient in this highly competitive industry.

The following table presents the firms in our analysis.

Table 4.2. *Established firm groups.*

TOP 5 FIRMS	COUNTRY
Yara	Norway
Mosaic	USA
Agrium	Canada
Potash	Canada
K + S	Germany
8 CHALLENGERS	
Eurochem	Russia
Acron	Russia
Stirol	Ukraine
Sinochem	China
IFCCO	India
SABIC	Saudi Arabia
Fosfertil	Brasil
EFIC	Egypt

There are some important points to be noted. Countries follow different accounting practices and compatibility of the financial statement information is therefore problematic. For this reason we collect only a small number of variables (turnover, operating profit, net profit, balance), we use long-term mean values (2004-2007) and we present only ratios.

Figure 4.5 illustrates the market shares of the top 5 firms and the 8 strong challengers in 2006 measured in terms of production. In total, the market share of these two firm groups exceeds 52%. We have managed to capture a considerable proportion of the fertilizer industry measured by production.

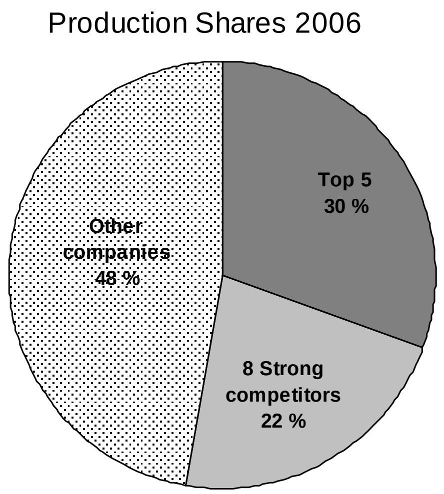


Figure 4.5. *Market shares of the top 5 firms and the 8 strong challengers in 2006.*

Figures 4.6-4.8 below present each firm's average operating income/turnover ratio, average net income/total assets ratio and average turnover growth rate in the period from 2004-2007.

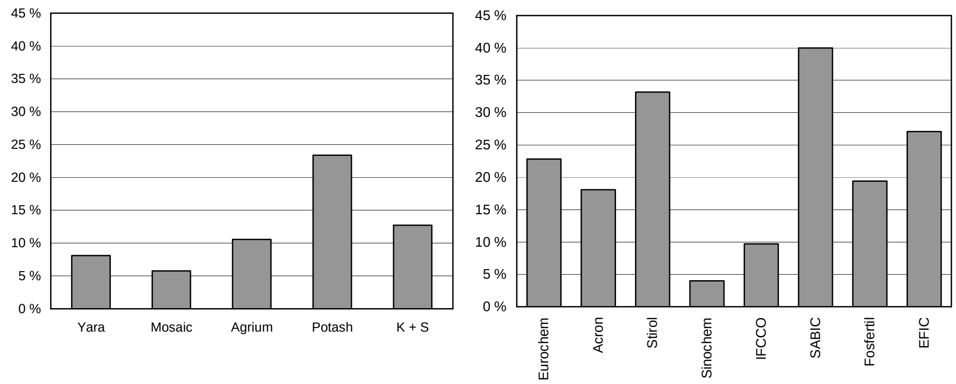


Figure 4.6. *Operating Income / Turnover (%): Annual average during 2004-2007.*

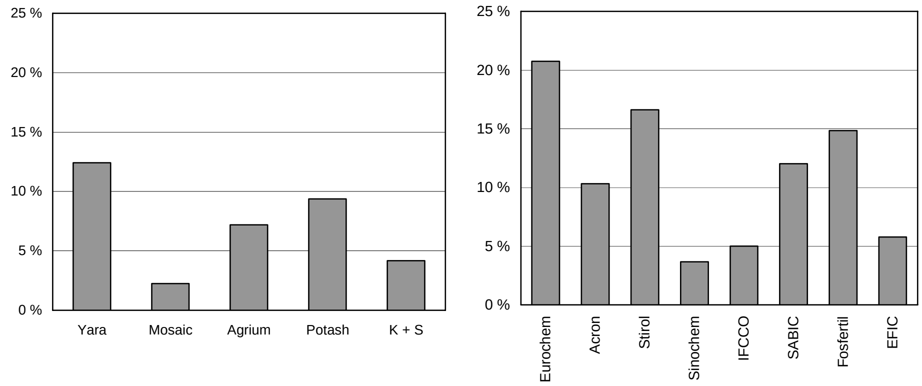


Figure 4.7. *Net Income / Total Assets (%): Annual average during 2004-2007.*

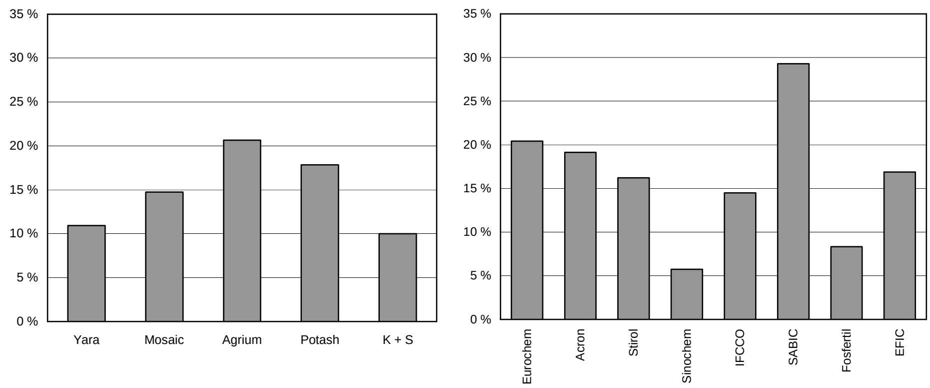


Figure 4.8. *Growth of turnover: Annual average during 2004-2007.*

According to the figures, the challenger firms have been more profitable during the past years than the top 5 fertilizer firms. The average operating income/turnover ratio for top five firms is 12% and for challenger firms 22%. Similarly, the average net income/total assets ratio is 7.5% for the top 5 firms and 13% for the challenger firms.

The average rate of growth in turnover is high in both groups - about 15% - indicating positive development in the fertilizer market during recent years.

We can summarize these observations by noting that the world's five largest fertilizer companies face strong competition and are challenged by firms located mainly in regions having relatively cheap gas. The results suggest that relatively smaller firms are able to compete with the giants in the fertilizer market. Intensive global competition also forces large firms to examine their business practices and to evaluate how to meet the global challenges in the industry.

5. PRICE ELASTICITIES IN THE WORLD FERTILIZER MARKET

Estimating the price elasticities of export demand provides one approach for investigating the pricing power of fertilizer companies. The pricing power, in turn, can be used as a measure of the degree of global competitiveness of the industry. To be more concrete, if a one percent increase in the price of the raw material of fertilizers decreases the export demand by more than one percent, the value of the export decreases. This means that fertilizer companies may not be able to fully transfer an increase in their marginal costs due to a revision of the EDT to their output prices.

In the following, we estimate the price elasiticities of the export demand for urea, ammonium nitrate, phosphate and potash. Anticipating the results, the estimates for the elasticities for all the examined four different raw materials were greater than one in the absolute value, indicating a high degree of competitiveness in the industry. Moreover, the result of relatively high price elasticity turned out to be fairly robust to the estimation method used.

5.1 Model

To obtain the price elasticities for export flows in the fertilizer industry, we built a simple regression model. The model explained the export demands for the raw materials with their prices. To control for the potential factors affecting demand, other than price, and to avoid possible omitted variable bias in estimation, we ended up by specifying our model as a well-known gravity model of international trade, augmented by the price of the raw materials. The gravity model builds on the idea that variation in the volume of trade between two economies increases with their size (the usual proxies are GDP, population and land area) and decreases with transaction costs (commonly measured as bilateral distance, adjacency and cultural similarities such as common language) (e.g. Cipollina and Salvatici 2006). The GDPs and populations in the model can be interpreted as reflecting the demand of the importing country and supply of the exporting country. The pioneers in using the gravity model in bilateral analysis were Tinbergen

(1962) and Pöyhönen (1963). Since then, gravity models have been widely applied for explaining bilateral trade. Kangas & Niskanen (2003), for instance, examined the trade of forest products between the European Union and Central and Eastern Europe accession countries (CEE) using a gravity model. The gravity model did not include any price variables, but it still explained 66 % of the variation in the bilateral trade volumes.

It should be stressed, however, that the parameter estimates of the gravity variables, that is, populations and GDPs of the countries, were not of interest to us. Rather, the variables are included in the model to control for the factors affecting export demand other than prices.

Thus, our equations to be estimated take the form of equations 5.1 and 5.2 below. Technically, the latter specification with per capita GDPs as explanatory variables instead of GDPs and populations as such, simply restricts the absolute values of the coefficients of population and GDP of a country to be equal.

5.1 $$x_{ijt} = \alpha + \beta_1 gdp_{ijt}^{\exp} + \beta_2 gdp_{ijt}^{imp} + \beta_3 pop_{ijt}^{\exp} + \beta_4 pop_{ijt}^{imp} + d_{ij} + \beta_5 p_{ijt} + \varepsilon_{ijt}$$

5.2 $$x_{ijt} = \alpha + \beta_1 \frac{gdp_{ijt}^{\exp}}{pop_{ijt}^{\exp}} + \beta_2 \frac{gdp_{ijt}^{imp}}{pop_{ijt}^{imp}} + d_{ij} + \beta_3 p_{ijt} + \varepsilon_{ijt}$$

where $gdp_{ijt}^{\exp}$ and gdp_{ijt}^{imp} are the (logs of) GDPs of the exporting and importing countries in year t, $pop_{ijt}^{\exp}$ and pop_{ijt}^{imp} are the (logs of) the populations of the countries, d_{ij} is the distance between the capital cities of the trade partners and p_{itj} is the price of the given raw material.

5.2 Data and methods

We used panel data, where the dependent variable consisted of annual observations on the export volumes of urea, ammonium nitrate, phosphate and potash from a number of countries to the corresponding importing countries in the period spanning from 1996 to 2006. The panel data were unbalanced, that is, there was variation in the number of country pairs between different years. All the most important export countries were considered in the estimations, however. The number of bilateral trade flows ranged between 20 and 45 so that the trade flows covered more than 90 % of world trade in the four fertilizers examined. The exports data from the EU-15 and the CEE countries were aggregated into two area-wide aggregates in the estimations. The export series were attained from the UN Com Trade database.

Turning next to the independent variables of the model, they included the fertilizer prices, the GDPs and populations of both exporting and importing countries, and the distances between the capital cities of the countries. The time series of the variables were also obtained from the United Nations Comtrade database. As the price measure we simply used the nominal export price. All price series were expressed in US dollars.

The robustness of the results was examined by estimating both Equations 1.1 and 1.2 in three different ways: by a fixed effect (FE) model, by a random effect (RE) model, and by pooled OLS. Since the exports, their price and the GDP of the exporting country are likely to be determined simultaneously, an endogeneity problem emerged in our empirical model. We handled this problem by also estimating the FE and the RE models using the 2SLS instrumental variable method. The instrument set for the GDPs and prices included three lagged values of these variables.

5.3 Results

The export demand for fertilizers seems to be rather price elastic. The point estimates for the price elasticities obtain values greater than one measured in the absolute value. The result holds irrespective of the model specification and the price series used, with some models for ammonium nitrate and potash as the only exceptions. Thus, a one per cent increase in the price of the fertilizers reduces the value of the exports more than one per cent. The elasticities also tend to exceed unity by more than two standard deviations. The estimated price elasticities from our all model specifications are presented in Tables 5.1 and 5.2 below with the standard errors of the coefficient estimates in parentheses. To save space, the detailed estimation results for all the other estimated models are available from the authors upon request. Overall, the estimation results for these parameters, in terms of their sign and significance, remained mixed.

Table 5.1. *Estimates of the price elasticities of the export demand for the main fertilizers. The gravity model was estimated as a fixed effect (FE) model, a random effect (RE) model, and by pooled OLS. Each cell for the FE and RE models includes estimates obtained both by OLS and the 2-SLS estimation models. Specifications 1 and 2 refer to equations (5.1) and (5.2), respectively.*

Nominal prices	Fixed effect model	Random effect model	Pooled OLS
Urea	-1,14 - -1,28	-1,26 - -1,23	-1,87
Specification 1	(0,06) (0,10)	(0,06) (0,13)	(0,07)
Urea	-1,12 - -1,21	-1,27 - -1,31	-2,09
Specification 2	(0,06) (0,10)	(0,06) (0,09)	(0,07)
Ammoniumni trate	-1,14 - -0,98	-1,20 - -1,16	-1,95
Specification 1	(0,09) (0,25)	(0,09) (0,22)	(0,11)
Ammonium nitrate	-1,10 - -0,95	-1,19 - -1,10	-1,90
Specification 2	(0,09) (0,24)	(0,09) (0,22)	(0,11)

Table 5.2.

Nominal prices	Fixed effect model	Random effect model	Pooled OLS
Phosphate	-1,11 - -0,61	-1,30 - -0,93	-1,92
Specification 1	(0,10) (0,20)	(0,10) (0,20)	(0,12)
Phosphate	-1,11 - -0,59	-1,35 - -1,00	-2,05
Specification 2	(0,10) (0,21)	(0,10) (0,20)	(0,11)
Potash	-1,59 - -1,16	-1,85 - -1,43	-3,20
Specification 1	(0,09) (0,09)	(0,09) (0,09)	(0,07)
Potash	-1,58 - -1,16	-1,84 - -1,45	-3,31
Specification 2	(0,09) (0,09)	(0,09) (0,09)	(0,07)

6. THE LAW OF ONE PRICE IN THE FERTILIZER MARKET

6.1 Introduction

A parallel approach to examine the competitiveness of global fertilizer markets is to test the Law of One Price (LOP), which was first proposed by early economists. In its strict sense, the LOPP states that abstracting from transportation costs, all identical goods must have only one price in the same currency unit if the markets are to be efficient. In the following, we will test the LOP econometrically to examine the efficiency of the global fertilizer markets. Instead of the strict version of the law, however, we assume and test the weak version, which also takes into account the transaction costs.

Our econometric model is estimated using time series data on the prices of fertilizer. Such data tend to be non-stationary, meaning that the means and variances of the price series often depend on time (non-stationarity). Accordingly, problems of spurious correlation and spurious regression arise, so that normal statistical inference is not valid. Fortunately, Engle & Granger (1987), Stock & Watson (1988) and Johansen (1988) have developed a method of co-integration analysis for handling non-stationary time series.

Loosely speaking, two or more non-stationary time series with a unit root are said to be co-integrated if at least one linear combination of the series is stationary. (A more formal definition of co-integration can be found in Appendix 1.1.) In the case of non-stationary price series, co-integration analysis provides a straightforward means of testing the LOP: If price series turn out to be co-integrated, we can conclude that the markets are efficient and competitive. The efficiency and competitiveness of the market means, moreover, that no company can increase its prices without losing its market share. Both weak and strong versions of the LOP have been examined in the previous literature (for a review, see Goldberg and Knetter 1997).

6.2 Data

Our data include weekly price series of fertilizer from the following market places or market regions: 1) urea (Eastern Europe, the Black Sea, South East Asia, Africa, the Baltic and the USA); 2) phosphate (the USA, Africa, the Middle East, the Black Sea and the Baltic); 3) potassium (Canada, Western Europe, the Baltic and the Black Sea. Although our primary goal was to obtain a representative sample from the global markets, our data lacks any price series from South America and China. Our data were the best available, however. The length and sample periods for the weekly price series were dictated by the availability of data, but all the observations were selected from the period of 1999 to 2007, and the number of observations ranged between 91 and 405. A detailed description of the sample periods for the different series can be found in Appendix 1.2.

We were only interested in the existence of co-integration between prices in the fertilizer markets, but not, for instance, in testing individual parameter values in the co-integration space. Thus, we used the simple two-step method of Engle and Granger (1987) (see details in Appendix 1.1) instead of the more advanced procedure for testing co-integration developed by Johansen (1988).

Figures 6.1-6.3 give some preliminary motivation for the results. Figure 6.1 illustrates the development of fertilizer (urea) prices from 2/2002 to 22/2007. According to the figure, the prices of the all series have clearly drifted together, suggesting that prices seem to be integrated and markets are efficient.

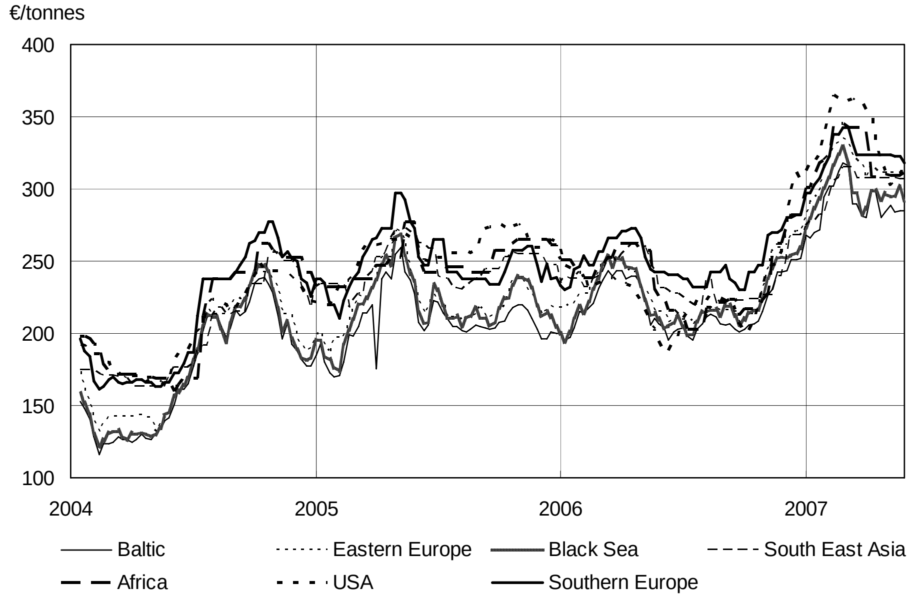


Figure 6.1. *The price development of urea in the Baltic, Eastern Europe, the Black Sea, South East Asia, Africa, the USA and Southern Europe.*

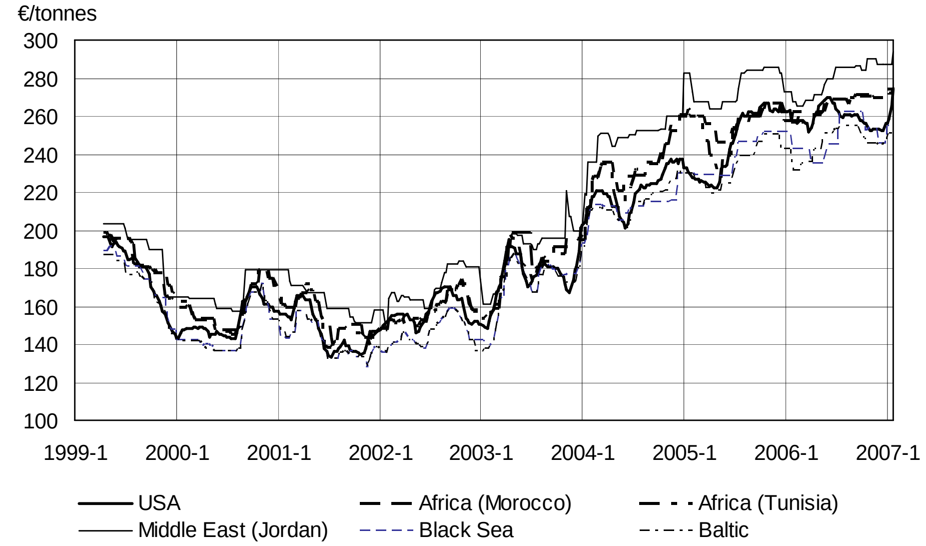


Figure 6.2. *The price development of phosphate in the USA, Africa, the Middle East, the Black Sea and the Baltic.*

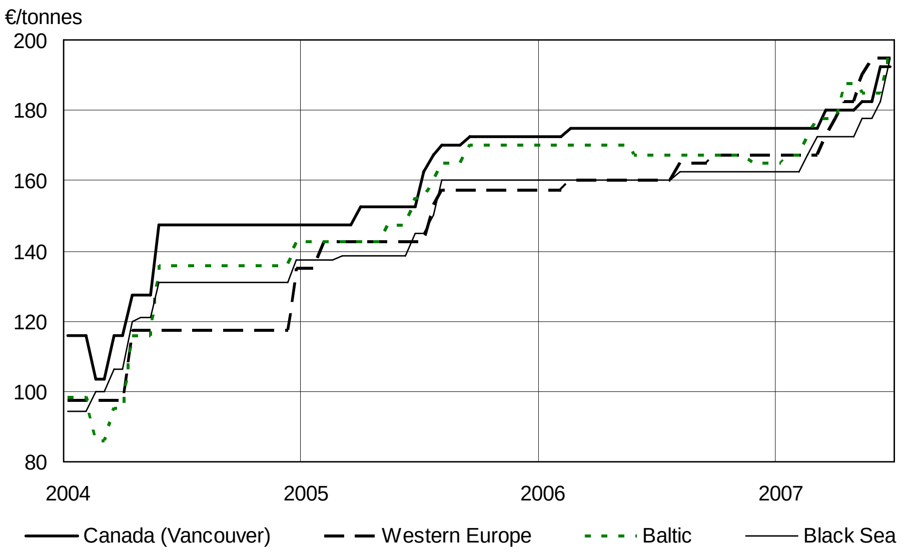


Figure 6.3. *The price development of potassium in Canada, Western Europe, the Baltic and the Black Sea.*

6.3 Results

Our estimation results, presented in Table 6.1 below, clearly validate the LOP for the fertilizer markets examined. The rows of Table 6.1 report the results of our co-integration analysis for the three fertilize product prices. As the dependent variables in the Engle-Granger estimations we used the product prices in Europe. The prices of Eastern European, Southern/Western European and Baltic market places were then regressed on the prices in other global market places. Any pairwise co-integration relation found was interpreted as a sign that the prices in the European fertilize product markets are not determined independently of the price setting of competitors outside Europe.[4]

The existence of a pairwise co-integration relation between the prices was marked by * if the relation was found to be significant at the 5% level, while ** denotes statistical significance at the 1% level.

[4] More detailed results of the co-integration analysis are available from the author upon request. However, the results of the stationarity tests for all series and for residuals of the pairwise regressions are presented in Appendix 1.3.

Overall, our results support the view of competitive European fertilizer markets, where companies cannot set their prices without taking into account the global competition originating from the USA, Africa, the Black Sea and Asia.

Table 6.1. *Co-integration of fertilizer prices between Southern/Western European, Baltic, Eastern European and other global market places.*

Dependent	Independent	Urea	Phosphate	Potassium
Southern/Western Europe	*USA*	**	n.a.	n.a.
	Asia	**	n.a.	n.a.
	Middle East	n.a.	n.a.	n.a.
	Black Sea	**	n.a.	*
	Africa	**	n.a.	n.a.
	Canada	n.a.	n.a.	*
Eastern Europe	*USA*	**	n.a.	n.a.
	Asia	**	n.a.	n.a.
	Africa	**	n.a.	n.a.
	Black Sea	**	n.a.	n.a.
The Baltic	*USA*	**	**	n.a.
	Asia	**	n.a.	n.a.
	Middle East	n.a.	**	n.a.
	Black Sea	**	**	**
	Africa	**	**	n.a.
	Canada	n.a.	n.a.	**

Note: ** denotes the 1% significance level and * the 5% significance level.

It is worth noting that especially the results for potassium fertilizers should be treated with some caution. The time series were rather short and the price variation was low. However, on the basis of this method and data, we conclude that the markets are integrated and the markets are efficient and competitive.

7. CONCLUSIONS

Nitrogen is the most important nutrient in plant production. Carbon dioxide is an unavoidable by-product in the production of nitrogen fertilizers and thus the ETS Directive would create significant pressures on the fertilizer industry. However, if the fertilizer industry in the EU would experience some significant market power, the increasing costs from the Emissions Trading Directive could be passed through to retailers and final consumers. This would depend, however, on the global market situation, competition and market power of individual firms.

Nitrogen fertilizer manufactures face increasing costs from several directions. Direct costs come from the effects of the ETS Directive on ammonia and nitric acid production, both of which are essential intermediates in the nitrogen fertilizer manufacturing process. Production costs are also highly affected by natural gas prices. Additional costs will come from higher electricity prices due to emissions trading. In our analysis we have focused on the costs of effects of the ETS Directive on ammonia and nitric acid production and thus on the overall manufacture of nitrogen fertilizers within the EU.

According to our econometric analyses, fertilizer markets are global and highly competitive. Export demand is elastic, and prices in different market places are co-integrated. This clearly indicates that if an industry somewhere (e.g. in Europe) were burdened with an extra cost compared to its competitors elsewhere, the industry could not pass through the extra cost to the selling prices of the products.

In order to be able to continue production one should be able to compensate for increasing costs with higher productivity. However, according to our calculations the probable extra cost due to the Emissions Trading Directive even in the mildest scenario would be so high that there would be no possibilities to cover the losses by increasing productivity.

Based on our calculations of the cost effects of the ETS Directive, the producer prices of the European nitrogen fertilizer industry should increase by about 21 to 34 percent of the turnover to compensate for the increase of about 30 to 48 percent in the cash manufacturing costs due to the ETS Directive with full auctioning of emission allowances. Given the global market situation, fertilizer manufacture in the EU are not able to pass these costs further.

The greatest impact of the ETS Directive would be on ammonia and nitric acid production. Urea fertilizers are manufactured directly from ammonia whereas typical European nitrogen compound fertilizers are manufactured from ammonia via nitric acid. Although nitric acid's cost share of total nitrogen fertilizer manufacturing costs is relatively small, the combined cost effects are still significantly higher for nitrate-based nitrogen fertilizers than urea. Increasing demand for urea combined with declining production within the EU would probably increase imports from low cost natural gas regions, and thus increase carbon leakages.

The European fertilizer market is relatively mature and capacities have been already declining within the EU, mainly because of decreasing demand, the lack of natural gas and the high price of natural gas within the EU. If we add the possible extra cost due to the ETS Directive, the carbon leakage would be even greater. Numerous small ammonia and nitrogen plants in Europe are under threat of being unable to continue.

The European nitrogen fertilizer capacity could easily be compensated by nearby competitors directly behind the eastern border of the EU. If the EU fertilizer production were not allowed an exemption from ETS Directive, the EU would be highly dependent on the production of Eastern European and Central Asian countries and their policy and pricing.

It is extremely important to keep the European industry alive especially now when there have been technological progress in storing natural gas as a liquid (LNG). This would make the fertilizer industry less dependent on changing energy markets and again would improve European food safety. For these reasons it would be extremely important to allow the fertilizer industry to be exempted from the ETS Directive.

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DATA SOURCES

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UN Comtrade. Statistical trade database of the United Nations. www.comtrade.un.org.
IFA statistics. www.fertilizer.org

Appendix 1 (for Chapter 5)

1.1 Econometric methods

The basic statistical relationship of the LOP is

1.1 $$p_{it} = c + \beta p_{jt} + \varepsilon_t ,$$

where $p_{.t}$ are the price series on a log scale, c is a constant, β is a coefficient and ε_t is the IID error term. In the strong version we assume that c is zero and β is one. Respectively, the weak version allows that $c \neq 0$ and $\beta \neq 1$. We can estimate Equation (1.1) by OLS. However, Granger and Newbold (1974) showed that a regression can lead to statistically significant results even when p_i and p_j are unrelated, if the price series are non-stationary (*spurious regression*).

In general, time series are said to be stationary (I(0)), when $E(p_t)$, $Var(p_t)$ and $Cov(p_t, p_{t+k})$ are constants for all t and $k \neq 0$. Most economic time series are non-stationary and usually integrated of order one (I(1)), that is, they follow a random walk. The random walk process can be written as

1.2 $$p_t = p_{t-1} + \varepsilon_t ,$$

where ε_t is IID with zero mean and variance σ_ε^2. The random walk process becomes stationary after the first differencing and, thus, it is called the I(1) process.

However, Engle & Granger (1987), Stock & Watson (1988) and Johansen (1988) have developed methods for dealing with non-stationary time series data. These methods are usually referred to as co-integration analysis. By definition, co-integration means that two I(1) series are co-integrated if and only if a linear combination of the two series is I(0). We proceed by using the Engel and Granger two-step method (1987).

At the beginning, we check that all the series are I(1), using the Augmented Dickey-Fuller tests (Dickey & Fuller 1981, 1979). The test equation is

1.3 $$\Delta p_{it} = \alpha_0 + \alpha_1 t + \delta p_{t-1} + \sum_{s=1}^{k} \theta_s \Delta p_{t-s} + e_t \ ,$$

where t is a time trend, α_0 is a constant, ϕ, δ are coefficients and e_t is an error term. When necessary, the model includes a constant, a time trend and a sufficient number of lagged differences to remove autocorrelation in residuals. The test hypotheses are

$$\begin{array}{l} H_0 : \delta = 0 \\ H_1 : \delta \neq 0 \end{array} .$$

If we cannot reject the null hypothesis, we can conclude that the price series are non-stationary and I(1).

Next, we proceed to the Engel and Granger two-step-method. As a first step, we estimate the static regression (1.1), rewritten as

1.4 $$\hat{\varepsilon}_t = \hat{c} - \hat{\beta} p_{jt} - p_{it} \ .$$

The second step is to test the stationarity of the residuals $\hat{\varepsilon}_t$ from Equation (1.4), again, by using the ADF tests. Hence, the test equation is

1.5 $$\Delta \hat{\varepsilon}_t = \delta \hat{\varepsilon}_{t-1} + \sum_{s=1}^{k} \phi_s \Delta \hat{\varepsilon}_{t-s} + u_t \ .$$

The test procedure and hypotheses are similar to those in Equation (1.3) above, but now the constant and time trend are excluded from the estimable equation.

If the residuals are stationary, we conclude that the prices are co-integrated and LOP holds. Accordingly, the markets are competitive and efficient.

1.2 Data description

Table 1.1. *Summary of the data.*

Product	Country / Region	Time period
Urea	East Europe	15.1.2004-14.6.2007 (*n* = 176)
Urea	Yuz (Black Sea)	15.1.2004-14.6.2007 (*n* = 176)
Urea	South East Asia	15.1.2004-14.6.2007 (*n* = 176)
Urea	Egypt (Africa)	15.1.2004-14.6.2007 (*n* = 176)
Urea	Baltic	15.1.2004-14.6.2007 (*n* = 176)
Urea	US. dom. gran (USA)	15.1.2004-14.6.2007 (*n* = 176)
Urea	South Europe	15.1.2004-14.6.2007 (*n* = 176)
Phosphate	US Gulf (USA)	4.3.1999-25.1.2007 (*n* = 405)
Phosphate	Morocco (Africa)	4.3.1999-25.1.2007 (*n* = 405)
Phosphate	Tunisia (Africa)	4.3.1999-25.1.2007 (*n* = 405)
Phosphate	Jordan (Middle East)	4.3.1999-25.1.2007 (*n* = 405)
Phosphate	Black Sea	4.3.1999-25.1.2007 (*n* = 405)
Phosphate	Baltic	4.3.1999-25.1.2007 (*n* = 405)
Potassium	Canada (Vancouver)	6.1.2004-19.6.2007 (*n* = 91)*
Potassium	West Europe	6.1.2004-19.6.2007 (*n* = 91)*
Potassium	Baltic	6.1.2004-19.6.2007 (*n* = 91)*
Potassium	Black Sea	6.1.2004-19.6.2007 (*n* = 91)*

Source: EFMA 2008. *Data does not include all week observations.

1.3 Estimation results

Table 1.2. *Stationary tests for all series.*

Level	**Urea**	**Phosphate**	**Potassium**	***1. difference***	**Urea**	**Phosphate**	**Potassium**
East Europe	n.a.	n.a.	n.a.		n.a.	n.a.	n.a.
Baltic	-2.43	-0.79	-0.74		-4.61**	-6.31**	-4.11**
South East Asia	-1.74	n.a.	n.a.		-4.07**	n.a.	n.a.
Africa							
- Tunisia	n.a.	-0.52	n.a.		n.a.	-6.92**	n.a.
- Egypt	-1.69	n.a.	n.a.		-4.79**	n.a.	n.a.
- Morocco	n.a.	-0.30	n.a.		n.a.	-7.88**	n.a.
Middle East							
- Jordan	n.a.	-0.17	n.a.		n.a.	-9.91**	n.a.
Black Sea							
- Yuz	-2.30	n.a.	n.a.		-4.16**	n.a.	n.a.
- Black Sea	n.a.	-0.68	-0.28		n.a.	-7.38**	-3.55**
USA							
-US Gulf	n.a.	-0.60	n.a.		n.a.	-6.19**	n.a.
-US dom. gran	-1.68	n.a.	n.a.		-3.43*	n.a.	n.a.
South Europe	-2.02	n.a.	n.a.		-4.12**	n.a.	n.a.
West Europe	n.a.	n.a.	-0.40		n.a.	n.a.	-5.18**
Canada (Vancouver)	n.a.	n.a.	-1.78		n.a.	n.a.	-3.84**

The level series include: a constant and necessarily number of lags.
The 1. Difference series were no deterministic terms and necessarily number of lags.
** denotes the 1 % significance level and * the 5 % significance level.

Table 1.3. *Residual tests for LOP.*

Product	Dependent variable	Independent variable	Residual	Concluding
Urea	Baltic	East Europe	-3.41**	LOP holds
Urea	Baltic	Yuz	-4.28**	LOP holds
Urea	Baltic	South East Asia	-3.70**	LOP holds
Urea	Baltic	Egypt	-4.11**	LOP holds
Urea	Baltic	US. dom. gran	-3.35**	LOP holds
Urea	Baltic	South Europe	-3.27**	LOP holds
Urea	East Europe	Yuz	-4.39**	LOP holds
Urea	East Europe	South East Asia	-3.82**	LOP holds
Urea	East Europe	Egypt	-4.39**	LOP holds
Urea	East Europe	US. dom. gran	-3.21**	LOP holds
Urea	East Europe	South Europe	-3.40**	LOP holds
Urea	South Europe	Yuz	-3.39**	LOP holds
Urea	South Europe	South East Asia	-4.33**	LOP holds
Urea	South Europe	Egypt	-4.13**	LOP holds
Urea	South Europe	US. dom. gran	-3.05**	LOP holds
Urea	Yuz	South East Asia	-4.21**	LOP holds
Urea	Yuz	Egypt	-4.56**	LOP holds
Urea	Yuz	US. dom. gran	-3.45**	LOP holds
Urea	South East Asia	Egypt	-4.02**	LOP holds
Urea	South East Asia	US. dom. gran	-3.08**	LOP holds
Urea	Egypt	US. dom. gran	-3.41**	LOP holds
Phosphate	Baltic	US. Gulf	-4.15**	LOP holds
Phosphate	Baltic	Morocco	-5.36**	LOP holds
Phosphate	Baltic	Tunisia	-5.50**	LOP holds
Phosphate	Baltic	Jordan	-4.95**	LOP holds
Phosphate	Baltic	Black Sea	-5.23**	LOP holds
Phosphate	US. Gulf	Morocco	-4.56**	LOP holds
Phosphate	US. Gulf	Tunisia	-4.21**	LOP holds
Phosphate	US. Gulf	Jordan	-4.91**	LOP holds
Phosphate	US. Gulf	Black Sea	-4.56**	LOP holds
Phosphate	Morocco	Tunisia	-6.14**	LOP holds
Phosphate	Morocco	Jordan	-5.96**	LOP holds
Phosphate	Morocco	Black Sea	-5.00**	LOP holds
Phosphate	Tunisia	Jordan	-5.77**	LOP holds
Phosphate	Tunisia	Black Sea	-5.24**	LOP holds
Phosphate	Jordan	Black Sea	-4.75**	LOP holds
Potassium	West Europe	Canada (Vanc.)	-2.01*	LOP holds
Potassium	West Europe	Baltic	-2.30*	LOP holds
Potassium	West Europe	Black Sea	-2.24*	LOP holds
Potassium	Baltic	Canada (Vanc.)	-3.15**	LOP holds
Potassium	Baltic	Black Sea	-4.60**	LOP holds
Potassium	Canada (Vanc.)	Black Sea	-2.83*	LOP holds

** denotes the 1 % significance level and * the 5 % significance level.

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