Report

Effects of import duty elimination on competition in the European Union (EU) Fertilizer Market

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Executive Summary

1 This report studies the current condition of competition in the European Union's fertilizer market, and its impact on fertilizers prices.

2 A review of literature shows that prices of fertilizers in Western European countries increased by 123% between 1970 and 2002, while prices in other countries like Brazil decreased by 65%; it also shows that increased concentration is correlated with higher prices or, alternatively, more competition is associated with lower prices.

3 Economic theory suggests that an elimination of European customs and anti-dumping ("import duties") on fertilizers will lead to a loss for European fertilizer producers, a gain for European farmers, a loss of public revenues, and a decrease of the degree of concentration in the sector.

4 Based on a partial equilibrium model calibrated on recent data characterizing the world and EU fertilizer markets, this report evaluates the potential impact of an elimination of import duties on the conditions of competition in the EU market, including the impact on concentration and fertilizer prices, and an estimation of the overall net welfare effect associated with an elimination of import duties; this includes an assessment of the consumer surplus for EU agricultural producers and a potential for the additional job creation in EU agriculture.

5 According to our simulation the removal of import duties at the European border implies an average decrease of 5.3% in domestic fertilizer prices in Europe, with price decreases ranging from 2% (superphosphates - TSP) to 5.9% (compound NPK - NPK).

6 This policy reform leads to an increase of consumption of Phosphorus (P) by 1.3%, an increase of consumption of Potassium (K) by 1.3% and a quasi-stability in the consumption of Nitrogen (+0.4%).

7 The removal of import duties is beneficial for the European Union, with approximately € 481 Million in net welfare gains. Behind these global gains, there are losses for the fertilizer industry (€ 123 Million) and the European government in terms of public revenue (€ 315 Million) and gains for the agricultural sector (€ 920 Million).

8 This scenario leads to the creation of 17,245 jobs (conservative estimation). Most of the new jobs are created in the cereal, plant fiber (cotton) and agrifood sectors. The agrifood sector value-added is increased by 0.7%.

1 Introductory remarks

Fertilizer is an important product for both the European economy and the net income of European farmers. Fertilizers, together with soil improvers, represent 26% of total variable production costs for an average cereal farmer in the European Union (Thelle et al., 2013). Fertilizers are also key for agricultural yield, which is so important in today's context of increasing food demand, environmental constraints, and limited land resources. Therefore, understanding the drivers of fertilizer prices in Europe and finding efficient way to reduce these input prices for farmers is critical.

Europe's fertilizer production is affected by a certain number of negative factors that impede competitiveness. In particular, producing fertilizer requires natural gas (for nitrogenous products) or mining products (e.g. phosphate rocks), the European supply of which is limited and/or domestic prices of which are relatively high. Lack of competitiveness and the large needs of EU agriculture has led Europe to become a net nutrient importer. We estimate that in terms of nutrients, the EU's consumption of fertilizers represents 16,140 thousand tonnes, of which 2,472 thousand tonnes are imported.

However, instead of importing fertilizers free of any tax, which would reduce the domestic price of this important input, the EU implements various import duties. European imports of ammonium, urea, and NPK (i.e., mineral or chemical fertilizers containing the three fertilizing elements nitrogen, phosphorus, and potassium) are taxed with a Most Favoured Nation (MFN) tariff of 6.5%. In addition to this multilateral protectionism, the EU has implemented anti-dumping duties targeting Russian companies, ranging from 32.83 Euro/tonne to 47.07 Euro/tonne for ammonium nitrate.

This trade policy must be put in the context of fertilizer price increases. Within the European Union, the rise in fertilizer prices compared to other input prices over the last decade appears disproportionate. According to the Irish Central Statistics Office's (CSO) Agricultural Input Price Index, fertilizer prices rose at twice the rate of other input prices from 2005 to 2014. Fertecon (2014) notes that the European Union has some of the highest production costs for nitrogen and urea.[1] Furthermore, the European Commission recently wondered why EU fertilizer prices are still high despite currently cheap oil prices.[2]

Therefore it is reasonable to wonder whether the application of anti-dumping and customs duties on some non-EU-origin fertilizers has put EU grain producers at a significant

[1] https://www.nomura.com/events/nomura-global-chemical-industry-leaders-conference-2013/resources/upload/fertecon.pdf
[2] See http://ec.europa.eu/agriculture/markets-and-prices/short-term-outlook/pdf/2015-03_en.pdf

competitive disadvantage, as their main competitors (e.g., producers in the Ukraine and Russia) have access to cheaper fertilizer. In recent years, grain from the Baltics / Black Sea region has become increasingly competitive, displacing grain from traditional origins such as France in key export markets.[3]

So why does the European Union still apply import duties on fertilizers?

The impact of an import duty is well-known. By pushing up the price of foreign commodities in competition with local ones, an import duty has a protective effect on local industry. It leads to a concentration of production by increasing the market share of domestic firms, and it also helps uncompetitive firms remain in business. Simultaneously, import duties raise public revenues and increase local consumption prices; in the case of fertilizers, import duties augment the prices of key inputs for the agricultural sector.

This last element is important. Protectionism typically has a positive effect on local production to the detriment of local consumers. With the protection of the fertilizer sector, the European Union protects local fertilizer firms to the detriment of other producers, i.e. farmers and food sector companies. Thus, the current EU trade policy has both efficiency and redistributive impacts that deserve to be assessed.

This study addresses the following issues.

1 The current condition of competition in the European Union's fertilizer market, and its impact on fertilizers prices;
2 The potential impact of an elimination of import duties on the conditions of competition in the EU market, including the impact on concentration and fertilizer prices;
3 An estimation of the overall net welfare effect associated with an elimination of import duties, including an assessment of the consumer surplus for EU agricultural producers and a potential for the additional job creation in EU agriculture.

This evaluation utilizes a partial equilibrium model calibrated on recent data characterizing the world and EU fertilizer markets. Behavioural parameters (elasticities) are collected through a review of literature. In addition, the partial equilibrium model is linked to a global general equilibrium model to provide overall welfare and macroeconomic results.

Sections 2 gives a background of the study, with a presentation of the current conditions of competition in the EU fertilizer market and a review of literature. Section 3 describes the

[3] See http://www.franceagrimer.fr/content/download/31044/277682/file/CP%20FranceAgriMer-cereales-avril%202014.pdf; http://www.franceagrimer.fr/content/download/17930/141689/file/04-etude-competitivite.pdf.

methodology used in this report to conduct an evaluation of the impact of an elimination of EU border protection on fertilizers. Section 4 provides the main results of the study. Section 5 concludes. A technical appendix presents all the equations of the partial equilibrium model in Section 6.

2 Background

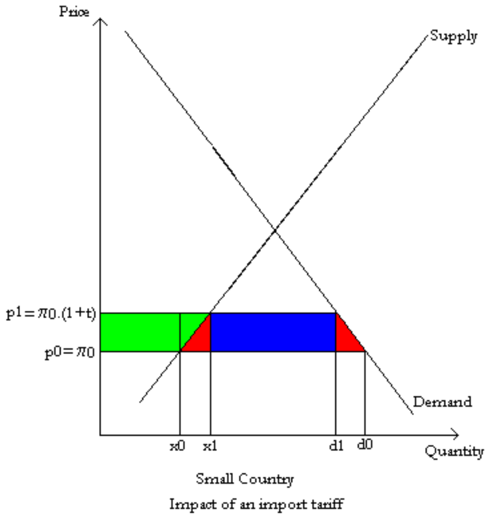
In this section, we first conduct a literature review on the links among trade policy, concentration, and prices before assessing the current price and competition conditions in the EU fertilizer market.

2.1 Trade policy, concentration, and prices: a review of literature

2.1.1 Understanding the effects of import duties under perfect competition

Simply put, trade policy consists of implementing taxes/quotas at a country's border, either on imports or on exports. The impact of an import duty on imports on a country's competitiveness, prices, local consumption, production, and public revenues has long been investigated in the literature. Figure 1 illustrates these potential impacts in a sector that could represent the fertilizer sector. Local demand for fertilizers is illustrated by a decreasing relationship between quantity demanded and local price: the higher the price, the smaller the quantity demanded. On the other hand, local supply is illustrated by an increasing relationship: the higher the price, the higher the quantity supplied by local producers. Let us suppose that the world price is at π_0. This price is lower than the autarky price, i.e. the price that makes local demand equal to local supply. The local supply is not competitive compared to foreign supply, implying that to satisfy local demand expressed at a price of π_0, which is d_0, local production x_0 has to be complemented by imports from abroad equal here to $d_0 - x_0$.[4]

Figure 1. The impact of a customs duty on imports



[4] This example supposes that local and foreign fertilizers are perfect substitutes. A change of this assumption would not significantly modify the conclusions.

Let us consider the implementation of a customs duty on imports, t, expressed in ad valorem (%) terms. Consequently, the local price of imports becomes $\pi_0(1+t)$. Local producers are now in a position to raise the price of the products they sell and align that price with the local price of imports; the domestic price is raised from p_0 to p_1. So the customs duty on imports has a protective effect: it partly shelters local producers from foreign competition. Local producers increase their production from x_0 to x_1.

However, while the customs duty has a positive impact on local producers, it has a negative impact on local demand. Consumers (here the local farmers who buy fertilizer as an input) have to pay more for the same product. Thus, the increase in price reduces local demand from d_0 to d_1.[5] Finally, a customs duty has a positive impact on public revenues since new receipts benefit the local government.

So a **customs duty on fertilizer imports** is expected to:

- **Augment local production and benefit local firms producing fertilizers**; the magnitude of these benefits are usually valued by the green area in Figure 1;[6]
- **Augment the local consumption price of fertilizers and consequently reduce consumption to the detriment of local consumers**. The magnitude of these losses is illustrated in Figure 1 by the sum of the green area, the red areas, and the blue area[7]; here the input price for farmers is raised. This effect depends strongly on the intensity of farmers' reactions to the variation in prices (i.e. the demand elasticity of fertilizers);
- **Increase public revenues;** this is evaluated in Figure 1 by the blue area.[8]

From the model, we expect that **an elimination of European import duties on fertilizers will lead to a loss for European fertilizer producers, a gain for European farmers, and a loss of public revenues**.

It must be noted that the previous example was developed by focusing on one fertilizer product. However, farmers and producers have access to different fertilizer products with different degrees of substitutability and complementarity. Since these products are impacted

[5] The negative impact of an import duty applied on a commodity used as an input by a manufacturer has been pointed out by Corden (1971). This is called the theory of effective protection.

[6] This is what economists call the variation in producers' surplus and consists of how the revenues of local producers minus their total cost of production is affected by the customs duty.

[7] This is what economists call the variation in consumers' surplus and consists of how the difference between the value given by consumers to this product – the demand curve - and the consumer price that they pay for the product is affected by the policy reform. In the context of intermediate demand, the assessment will be more complicated (see Section 6- Annex) even if based on the same mechanism.

[8] This area is simply the product of the quantity imported d_1-x_1 and the difference between the domestic price p_1 and the world price □$_0$, i.e. p_1- □$_0$= □$_0$.t.

by different tariffs and originate from different regions, their prices will react differently to any variation in customs duties. Thus, we also expect a reallocation of both consumption and production across the fertilizer product space. For instance, EU fertilizer production can shift to more compound fertilizers that benefit from lower prices for ammonia-related inputs.

2.1.2 The large country argument: market power at the country level

When a country applying a customs duty on imports is large, an assumption that can be taken for granted in the case of the EU, a variation of its imports may have a significant impact on world markets. Applying a customs duty on imports reduces this country's overall imports and consequently reduces demand for fertilizers on the world market. The global price of the commodity is reduced, which means an improvement in *terms of trade*[9] for the importing country. Thus, we expect **the elimination of a tariff on imports by a large country like the EU to lead to an augmentation of the world price of imports and, as such, a deterioration in this country's terms of trade**. This effect will have a negative impact in terms of welfare gains for the EU.

2.1.3 Imperfect competition and market power at the firm level

We study the impact of a removal of import duties in the fertilizer sector. This sector may be characterized by imperfect competition: a few firms control most of the market share and draw excess profits from this activity. In the case of imperfect competition, a policy intervention (an import tariff, a production subsidy, an export subsidy, or an R&D subsidy) may substantially increase the amount of these excess profits captured by local firms.

This is what the economic literature calls strategic trade policy.[10] Let us give a few examples of strategic trade policy:

- A government may subsidize the production of a national firm engaged in a rivalry with a foreign competitor. The production subsidy decreases the national firm's marginal cost. Thanks to this policy reform, the national firm may capture a larger share of the world market and thus excess profits.[11]
- A government may reserve the domestic country's market for a national firm that is also engaged in rivalries with foreign competitors in many countries. This intervention may be beneficial if there is a dynamic scale economy in this industry. Thanks to this intervention, the national firm will sell more on the domestic market; due to the dynamic scale economy, its marginal cost will decrease, which makes it

[9] The ratio of an index of a country's export prices to an index of its import prices.
[10] See, for example, Berthoumieu and Bouët, 2015.
[11] Brander and Spencer, 1985.

more competitive and augments its share of sales in every market. In this case, import protection implies export promotion thanks to decreasing marginal costs.[12]

The model that we designed here may show a few features of the strategic trade policy literature. **We may expect the removal of EU tariffs on fertilizers to lead to a reduction of European firms' sales on the European market and a related contraction of excess profits gained by local firms.** However, other forces are at play. In our model, marginal cost does not decrease with production but is rather related to the price of a certain number of inputs (CH4, NPK, NH3). **The liberalisation of imports of these inputs in the European Union may decrease European firms' marginal cost; this could bolster European firms' competitiveness and increase their exports to foreign markets**.

Concentration of production is a key aspect of the mechanisms at play here. How do economists measure production concentration? One option is to calculate the market share of the n largest firms, n being equal to 3, 4, 5, or 10. Concentration should increase with this market share.

Another possibility is the Herfindahl-Hirschman index (HHI), which is widely applied in competition law. An HHI is defined as the sum of the squares of the market shares of the firms within a sector and can range from 0 to 1. Zero (or close to 0) means that there is a very large number of firms, each having a tiny market share, while 1 represents a situation in which a pure monopoly supplies the entirety of the market. Increases (respectively, decreases) in HHI indicate an increase (respectively, a decrease) in concentration.

Antagonistic forces are at play in the relationship between concentration and prices. On one side, less concentration means more competition, and more competition means lower prices. On the other side, the presence of economies of scale in a sector may imply that the most efficient unit of production is obtained from a single firm supplying the entire market. If this firm establishes a price equal to its average cost, then a sector with a single firm may result in the lowest price possible. However, this scenario is very unusual since a monopolistic firm is in a position to implement high prices in order to get more profits.

Consequently, it is sound to consider that the relationship between concentration and price is monotonically increasing: prices increase with the degree of concentration within a sector.

Let us first consider a monopoly. Without any competition, a monopolistic firm may implement the best price with which to maximize its profits, that is to say, the price such that marginal revenue is equal to marginal cost. With two firms (a duopoly), the equilibrium price

[12] Krugman, 1984.

is less than the monopoly price but still implies excess profits. The more firms that are active on the market, the smaller the equilibrium price will be. Of course, other forces impact the determination of prices, such as the size of the market, the price-elasticity of demand, the mode of competition (quantity, price), required production capacities, the degree of potential differentiation, etc. However, in general, economic theory suggests that, other things being equal, decreasing concentration of supply goes with lower market prices.

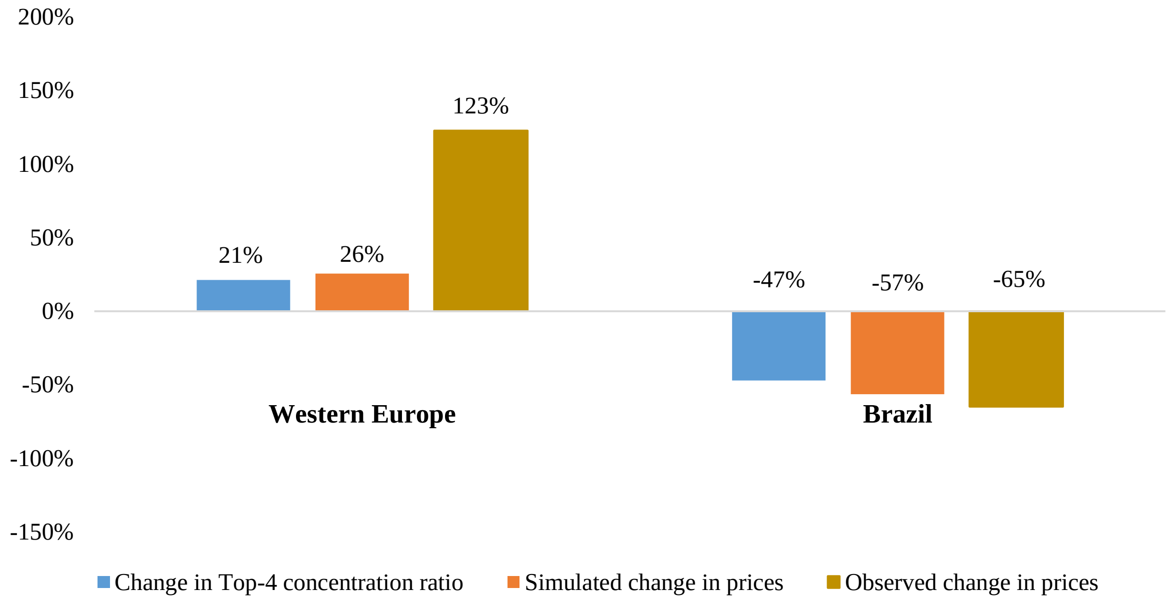
1.1 The degree of competition in the EU fertilizer market

The economic literature on fertilizers is not plentiful. Kim et al. (2001) evaluate structural changes in the US fertilizer industry and show that this industry can be characterized by a price leadership in oligopoly. Kim et al. (2002) study the US nitrogen fertilizer industry and examine the effects of increasing market concentration. They show that the costs of market power are greater than the benefits of market concentration in terms of manufacturing cost efficiency and prices.

More recently, Hernandez and Torero (2013) provide an overview of the current market situation in the global fertilizer industry. They show that the fertilizer industry is a global market with high levels of concentration and increasing trade and provide some evidence that urea prices tend to be higher in less competitive (more concentrated) markets. They formally examine the relationship between market concentration and urea prices using a panel dataset of 38 countries for the period 1970-2002.[13] The annual price data are average bagged retail urea prices obtained from the online Fertilizer Archives of the Food and Agriculture Organization. The prices are converted into US$ per metric tonne using the real historical exchange rate series (base year 2005) from the Economic Research Service of the U.S. Department of Agriculture. Market concentration is based on urea production capacity by company and country from the Tennessee Valley Authority for 1970–1995 and from the International Fertilizer Development Center for 1996-2002.

[13] Hernandez and Torero, 2013.

Figure 2. Changes between 1970 and 2002 in Market Concentration and Prices in Urea for Western Europe and Brazil



Note: The countries in Western Europe include Finland, Germany, Greece, Ireland, Italy, Portugal, Spain, Sweden, and Switzerland. The top-4 concentration ratio for a country is calculated based on the level of concentration in production capacity in the country or region where the country is located, depending on whether most of the urea consumed in the country is from local production or imports. Similar results are obtained when using instead the weighted average of concentration in the country and region, using as weights the relative amount of urea consumed from local production and imports. The simulated change in prices considers a price-market concentration elasticity of 1.2 obtained from a dynamic panel estimation of 38 countries for the period 1970-2002. Prices obtained from the online Fertilizer Archives of the Food and Agriculture Organization; from the Tennessee Valley Authority for 1970–1995 and from the International Fertilizer Development Center for 1996-2002. See Hernandez and Torero (2013) for further details.[14]

Hernandez and Torero find a price-market concentration elasticity of around 1.2 using the top-4 concentration ratio as the measure of market concentration (i.e. the sum of market shares of the four largest firms competing in a market). That is, a 10% increase in the level of concentration in a market will result in a 12% increase in prices in the same market.

Based on this estimate and considering that the top-4 concentration ratio in the countries in Western Europe increased on average by 21% during the period of analysis, prices were then expected to increase by 26% in the region. Brazil, in contrast, saw a 47% decrease in the level of concentration, which implies a simulated decrease in prices of 57%.

Based on the observed data, prices in Western European countries actually increased by 123%, while prices in Brazil decreased by 65%; this further suggests that additional factors, such as price fixing and cartels, might be operating in highly concentrated markets such as

[14] In this report a region means a group of countries which is explicitly defined. For example, in Figure 2, we explain that in this graph, Western Europe includes Finland, Germany, Greece, Ireland, Italy, Portugal, Spain, Sweden, and Switzerland. These definitions of regions may differ from one section to the other.

Western Europe and calls for the need to further examine pricing behaviour and potential market power exertion in the industry. At the very least, it is clear that increased concentration is correlated with higher prices or, alternatively, more competition is associated with lower prices.

The economic literature tends to show that the EU fertilizer sector is highly concentrated and that, as a result, fertilizer prices are relatively high within this region, to the detriment of farmers and food consumers. Of course, this could be the result of the EU's protectionist trade policy, as illustrated in Table 1. European imports of major fertilizers like urea, di-ammonium phosphate (DAP), mono-ammonium phosphate (MAP), ammonium nitrate, NP, and Ammonium Polyphosphate APP are all taxed with a 6.5% ad valorem tariff. It is noteworthy that EU import duties for potassium fertilizers are zero.

Table 1. Products covered by the study and MFN import duties applied in the EU

Product	**MFN customs duty**
Ammonia	5,5%
Ammonium sulphate	6,5%
Ammonium nitrate	6,5%
Calcium ammonium nitrate	6,5%
Calcium nitrate	6,5%
Ammonium nitrate	6,5%
Urea	6,5%
Urea ammonium nitrate	6,5%
Superphosphates	4,8%
DAP (di-ammonium phosphate)	6,5%
MAP (mono-ammonium phosphate)	6,5%
NP(S)and APP (ammonium polyphosphate)	6,5%
Superphosphates	4,8%
MCP (mono-calcium phosphate)	5,5%
NPK	3,2%
Potassium Nitrate	3,0%

The Copenhagen Economics unit has conducted an evaluation of a tariff suspension on fertilizers in the EU, with implied both positive and negative impacts for consumers, producers, and tariff revenues and consequences for social welfare and employment (Thelle et al., 2013). The study finds that a suspension of EU's import duties on fertilizers would imply positive net welfare effects for the EU, with fertilizer consumers benefitting from lower prices and more competition in the fertilizer market. Such a suspension is also expected to increase the EU's agricultural employment with around 100,000 full-time equivalent employees in the long run.

3 Methodology

This section presents the model that will serve as a basis for the evaluation of the potential impact of a suspension of EU import duties on fertilizers.

1.2 The model

We design an international multi-market partial equilibrium sectoral model representing the value chain from natural gas, phosphorus, and potassium to the agricultural sector via the fertilizer sector. In particular, we consider three stages in this value chain:

Stage 1: Natural gas, potash, carbonate calcium, phosphoric acid, and sulfuric acid

Stage 2: Superphosphates (TSP), compound NPK (NPK), urea (UREA), ammonium sulphate (AS), calcium ammonium nitrate (CAN), ammonium nitrate (AN), monoammonium phosphate (MAP), diammonium phosphate (DAP), compound PK (PK), anhydrous NH3 (NH3)

Stage 3: Agricultural goods (Composite)

At stages 1 and 3, competition is perfect; there is a large number of small firms, none of them with market power. Consequently, price is equal to marginal cost. Natural gas, potash, carbonate calcium, phosphoric acid, and sulfuric acid are supplied thanks to an iso-elastic function.[15] Demand comes from the fertilizer sectors as well as from other sectors of the economy thanks to an iso-elastic function. There is perfect substitutability between local and foreign natural gas, potash, carbonate calcium, phosphoric acid, and sulfuric acid. The international trade of each of these products is modelled as a spatial model with trade being strictly positive on a specific flow when the production price at origin plus the trading costs (border taxes and transportation costs) is equal to the consumption price at destination.

Stage 3 is the agricultural sector and is modelled through a demand for fertilizers. This demand is linear, with fertilizers being substitutes and with very low elasticity of substitution. At stage 2, we consider a Cournot-type oligopolistic competition with segmented markets. In the short term, there is a fixed number of firms engaged in multi-product activity. All firms

[15] An iso-elastic function is a function with a constant elasticity. Let y be a function of x, with $y=A.x^{□}$. A and □ are constant positive parameters. Then the elasticity of y to x, i.e. $e_{y/x}$ is equal to $e_{y/x}=(dy/dx).x/y=□$.

produce all fertilizers included in this model (NPK, urea, ammonia, MAP, DAP, etc.);[16] some commodities are only produced and sold to the agricultural sector, while others are sold on the market and also used as an input for the production of other fertilizers (for example ammonia is used for the fabrication of NPK and urea). In the short term, each firm considers selling each commodity on each market and determines the optimal quantity of each commodity to sell on each market, i.e. the quantity that maximizes total profit.

In each region, there is a specific demand function. Each firm supports different transportation costs and distribution costs in its sale to each market. In addition, trade policy may imply that some imports are taxed at the border; tariffs may be MFN, i.e. applied to all sources, or specifically applied to products coming from a specific origin (anti-dumping or countervailing duties). Tariffs are either ad valorem (defined in percentage of the Cost-Insurance-Freight - CIF) value of the commodity or specific (defined by monetary units by units). There is perfect substitutability between local and imported fertilizers.

In the long term, the number of firms is endogenous; there is entry of new firms on the market if the total profit of incumbent firms is positive and exit of new firms if it is negative.

1.3 Data and behavioural parameters

We now present the data sources on which the calibration of the model is based. Data on fertilizer balances come from FAO Stat. Data on production and capacity of production of fertilizer come from the International Fertilizer Association and the International Fertilizer Development Center. Data on prices, sales, and costs of fertilizer come from Bloomberg. Data on technical coefficients come from the engineering literature. Data on trade in fertilizers come from COMEXT for the European Union and COMTRADE for other countries. Import tariffs come from TARIC for the European Union and TRAINS for other countries. Data on transportation costs for fertilizers come from the OECD Maritime Trade Cost database and the *Argus* Fertilizer Freight Costs database.

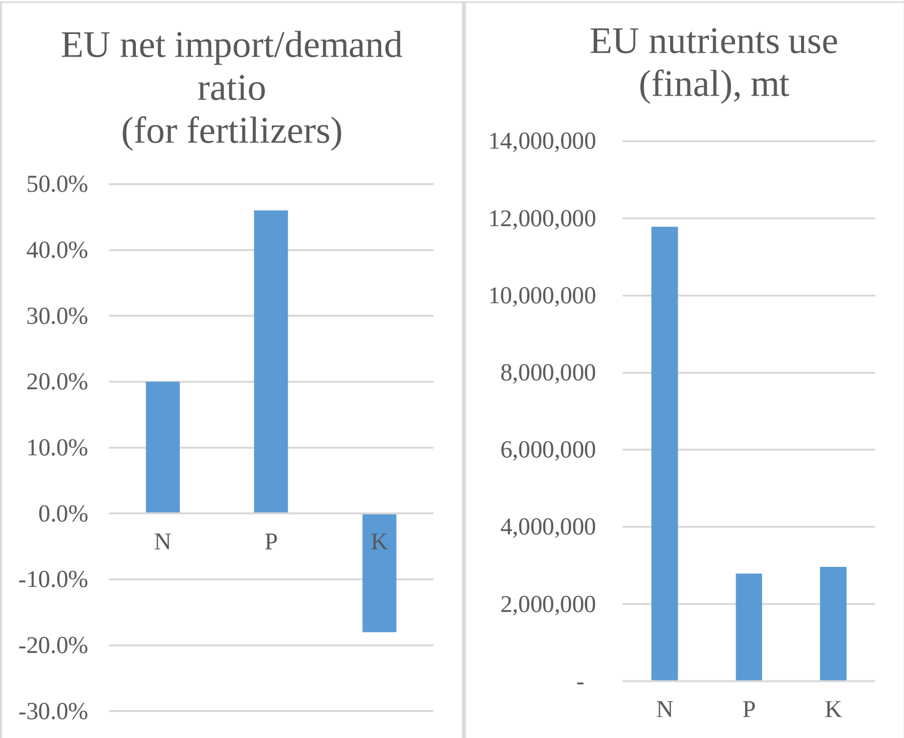
Data on natural gas come from the International Energy Agency and the US Energy Information Administration. Data on spot prices come from GAZPROM financial reports and press releases, and from the Federal Tariff Service of Russian Federation for Russia.

Behavioural parameters (elasticities) come from Oosterhuis et al. (2000) and Rendleman (1993).

[16] This does not obviously correspond to the reality of the sector, several major EU manufacturers being specialized in either AN/CAN (OCI, Eurochem) or on (N)PK (ICL, Roullier). It is hard, if not impossible, to take into account this heterogeneity of firms due to a lack of individual data. So the assumption is an approximation of reality.

We give a few illustrative statistics coming from our data collection. Figure 3 indicates the net import demand ratio and nutrient use of NPK in the European Union in 2013. In this year, the most important fertilizer in the European Union in terms of nutrients was nitrogen, and around 20% of nitrogen demand was met with imports. Phosphorus (P) and potassium (K) played a less important role. Phosphorus was imported for more than 45% of demand, while potassium was exported.

Figure 3. Net Import demand ratio and nutrients use of NPK in the European Union - 2013



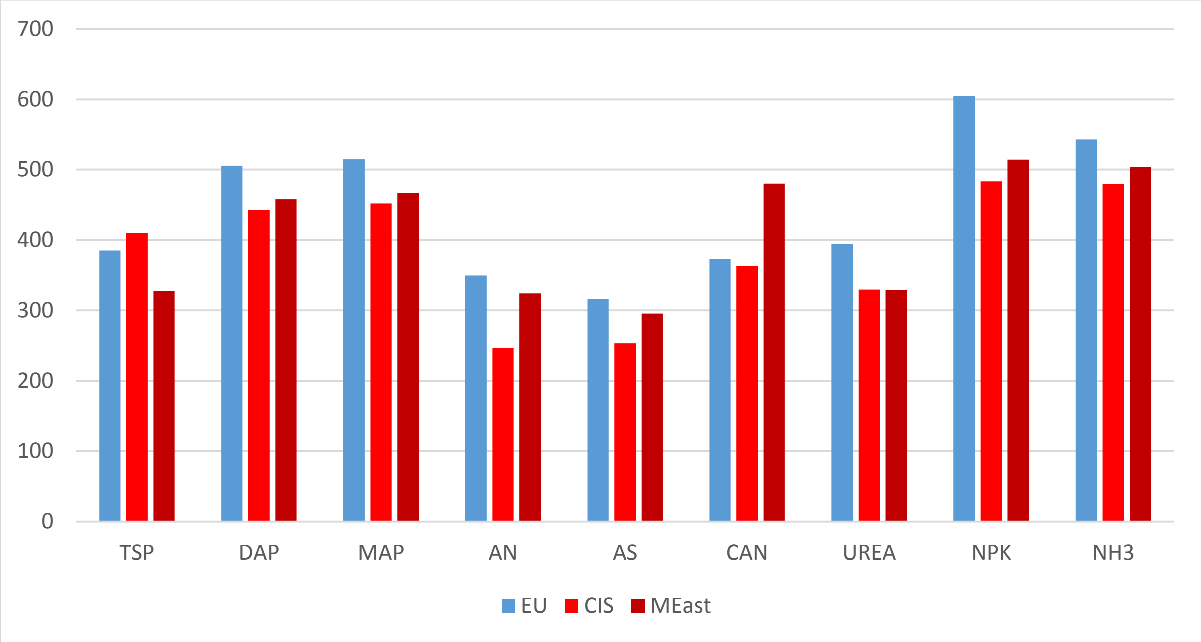
Source: authors' calculation from various sources

Figure 4 shows the disparity of domestic fertilizer prices in 2013. This disparity is particularly pronounced for ammonium nitrate (AN), where prices are in a range of 246 US$/tonne (CIS), but also for Urea and Superphosphates (TSP).

The Community of Independent States (CIS) sees the lowest price for di-ammonium phosphate (DAP), monoammonium phosphate (MAP), ammonium nitrate (AN), ammonium sulphate (AS), calcium ammonium nitrate (CAN), compound NPK (NPK) and anhydrous NH3 (NH3).

In the European Union, prices of ammonium nitrate (AN), ammonium sulphate (AS) and compound NPK (NPK) are relatively high, respectively 42%, 25% and 25% higher than the lowest price worldwide.

Figure 4. Domestic Prices, USD/Tonne – 2013



Source: authors' calculation from various sources – EU means European Union; CIS means Community of Independent States; MEast means Middle-East.

4 Results

We study a complete removal of all import duties (including anti-dumping duties and preferential duties, particularly GSP duties) on European fertilizer imports from all sources.[17] This scenario is studied under the assumption that the number of firms varies in the fertilizer sector, due to changes in the profit rate related to import duty liberalisation.

Results concerning the rate of variation in demand (%), the variation of production (in mt), the rate of variation of production (%), and the rate of variation of prices (%) in the European Union are indicated in Table 2.

The removal of import duties at the European border implies a decrease in domestic fertilizer prices in Europe. With the complete removal of import duties, domestic prices decreases range from 2% (superphosphates - TSP) to 5.9% (compound NPK - NPK), for an average decrease of 5.3%.

As demand for fertilizers is relatively inelastic, the augmentation of local demand is lower, in a range of 0.3% (calcium ammonium nitrate - CAN –and Urea) to 1.5% (monoammonium phosphate - MAP), for an average demand increase of 0.6%. In terms of nutrient consumption in Europe, this liberalisation leads to an increase of consumption of

[17] So this scenario means that all European import duties are removed. We take into account GSP rates and other preferential duties given by the EU to developing countries. Therefore, the model takes account of actual, real import duties.

Phosphorus (P) by 1.3%, an increase of consumption of Potassium (K) by 1.3% and a quasi-stability in the consumption of nitrogen (+0.4%).

Table 2. Results from simulation- Changes in EU demand, production, and prices

	Demand, %	Production, mt	Production, %	Domestic Prices, %
TSP	0.4	-21,596	-21.9	-2
DAP	1.3	-462,466	-40.2	-5.6
MAP	1.5	-170,187	-57.1	-5.4
AN	0.4	-2,120,070	-20.2	-5.8
AS	0.6	-933,836	-20.5	-5.3
CAN	0.3	-2,209,770	-19.0	-5.7
UREA	0.3	-2,115,913	-21.4	-4.8
PK	0.6	-3,235	-21.5	-2.8
NPK	1.3	-876,769	-28.9	-5.9
NH3		-82,901	-19.1	-0.2
ALL	0.6		-22.3	-5.3
P, %	1.3%			
N, %	0.4%			
K, %	1.3%			

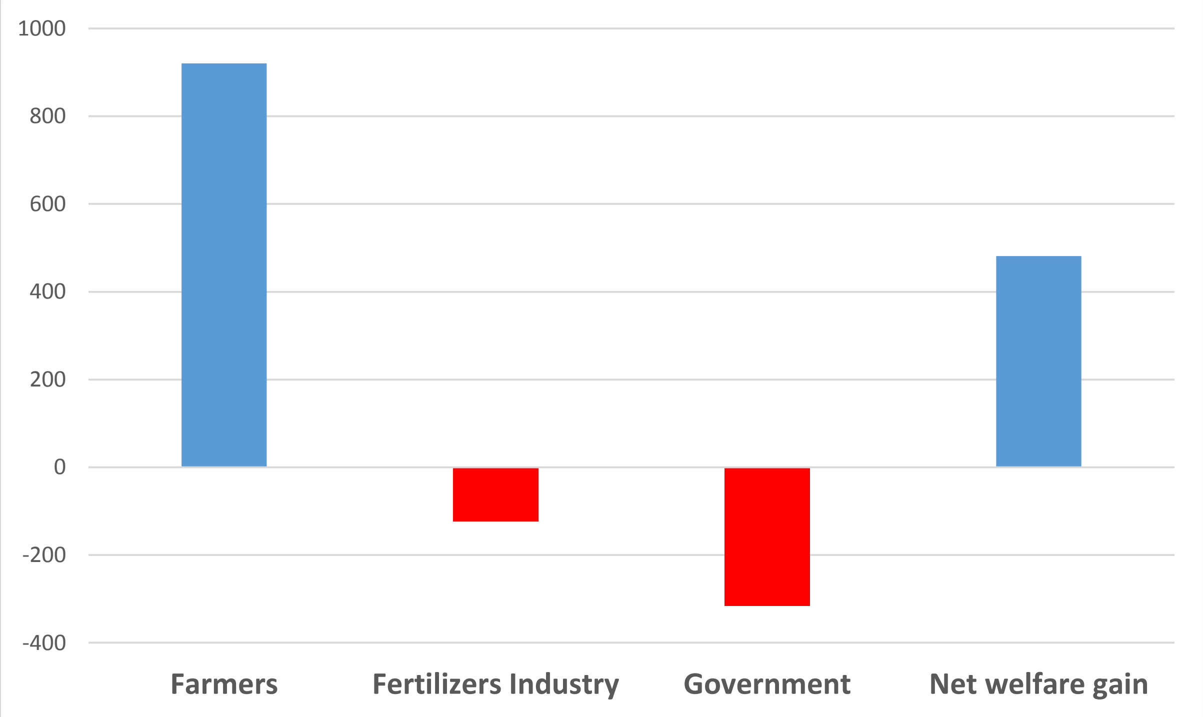
Source: authors' calculation
Note: Demand is from both domestic production and imports; production is to both the domestic market and exports.

A decrease in domestic fertilizer price and an associated augmentation of local fertilizer demand is obviously a positive implication of this reform, benefiting the agricultural sector. It is worth noting that this result is obtained when we consider the demand for fertilizers relatively inelastic; globally, the composite price of fertilizers decreases by 5.3% thanks to this reform, which leads to an increase in domestic composite demand of only 0.6%.

The impact on production differs from one commodity to the other. On the one hand, European firms are more exposed to foreign competition; this policy gives foreign firms better access to the European market, which has a negative impact on local sales and production of European firms. On the other hand, the removal of import duties also concerns commodities that are used as inputs by European firms: anhydrous NH3 (NH3) and ammonium nitrate (AN) in particular. This decreases European firms' marginal costs. There are two implications of this latter result: the decreases compensate, at least in part, for the advantage given to foreign firms by border liberalisation and gives an advantage to European firms in terms of exports to foreign markets.

Figure 5 indicates the welfare implication of a complete removal of import duties on fertilizers for the European Union. With the restructuring of the fertilizer industry, the removal of import duties is beneficial for the European Union, with around US$ 528 Million (€ 481 Million) in net welfare gains. Behind these global gains, there are losses for the fertilizer industry (US$ -135 Million or € 123 Million) and the European government in terms of public revenues (US$ -346 Million or € 315 Million) and gains for the agricultural sector (US$ 1,009 Million or € 920 Million).

Figure 5. Welfare Analysis – Fertilizer markets - € Millions



Source: authors' calculation.

This liberalisation leads to less concentration in the fertilizer sectors in Europe concerning all products except compound NPK (NPK) where a slight increase in concentration occurs as measured by the Herfindahl-Hirschman index (HHI): this is due to the restructuring of the industry. Decreases in concentration are important concerning ammonium sulphate (AS), calcium ammonium nitrate (CAN) and Urea.

Table 3 points out the potential macroeconomic benefits that can be drawn from this reform. Results have been plugged into a macroeconomic model, MIRAGRODEP, to determine the potential macroeconomic consequences of this reform.

Table 3. Macroeconomic results – European Union

	Long Term /restructuring	Agrifood Value Added (%)	Job Full Time equivalent
Fixed unemployment	No	0.69	16,895
Fixed wage	Yes	0.68	17,245

Source: authors' calculation

The macroeconomic model is run either under a fixed unemployment hypothesis in which adjustments are only made through prices (wages) or under a fixed wage hypothesis in which adjustments of the labor market are only made through quantities (jobs).

The second assumption has the highest positive impact on employment, with 17,245 jobs created.[18] Most of the new jobs are created in the cereal, plant fiber (cotton) and agrifood sectors. The agrifood sector value-added is increased in both simulations by 0.7%.

The magnitude of these macroeconomic gains is crucially dependent on the level of the price-elasticity of demand for fertilizers. In this research it can be considered that globally this elasticity is about 0.1: it results from a review of literature and a discussion with experts of the sector. This may be considered a conservative scenario. We conducted another exercise where this elasticity was about 0.3. Results are not directly comparable because the set of price data is different but macroeconomic gains were significantly higher in this scenario. In particular the removal of import duties led to the creation of approximately 100,000 jobs. This may be considered the best-case scenario.

These results come from a scenario where all European import duties on fertilizers are removed. This includes a removal of Most Favoured Nation duties as well as anti-dumping duties. It is possible to simulate separately the removal of MFN duties and the removal of anti-dumping duties. In the former case European net welfare gains are worth US$ 633 Million (€ 577 Million). In the latter case, these net welfare gains are worth US$ 262 Million (€ 239 Million).

The best scenario for European farmers is to remove both Most Favoured Nation duties and anti-dumping duties since this is the scenario that leads to the maximum reduction in local fertilizers prices. It is worth noting that the sum of the net welfare gains of both

[18] In this scenario more than 24,000 jobs are created in the crops sector. We do not have a country-by-country breakdown of this jobs creation but we can reasonably consider that this would mainly benefit France, Germany, Spain, United Kingdom, Italy and Ireland.

scenarios (US$ 633 Million + US$ 262 Million or € 577 Million + € 239 Million) is greater than the net welfare gain obtained when all import duties are removed (US$ 528 Million or (€ 481 Million). When all import duties are removed, the impact on the fertilizers sector is substantial: in particular this scenario leads to a significant restructuring and loss of profits. Total profits of the fertilizers sector are reduced by US$ 123 Million (€ 112 Million) when all import duties are removed while this reduction is US$ 41 Million (€ 37 Million) when only Most Favoured Nation duties are removed and US$ 15 Million (€ 14 Million) when only anti-dumping duties are removed.

5 Conclusion

In this study, we characterize the fertilizer market in the European Union and evaluate the potential impact of border liberalisation, i.e. a complete removal of all duties (including MFN and anti-dumping duties) on the imports of fertilizers into the region.

The fertilizer market in the European Union is relatively concentrated and consequently, fertilizer prices are relatively high. This may be, at least partly, the result of a protectionist trade policy which benefits the European fertilizer sector to the detriment of the agricultural sector which use fertilizers as an input.

In order to evaluate the cost of this policy, we design a partial equilibrium model in which fertilizer is characterized by imperfect competition with a few firms in each region producing several products and selling them to the agricultural sector. This model is calibrated using sectoral data from 2013 regarding the production of 10 fertilizers. We simulate the removal of import duties at the European border and calculate the consequences in terms of domestic fertilizer prices, demand for fertilizers, local production, imports, and exports. We also evaluate the impact on total welfare, taking into account the impact on customs revenues, the potential losses of profits for European fertilizer firms due to increased competition from abroad, and the positive impact on the agricultural sector for which the liberalisation of the fertilizer sector implies better access to an important input.

Considering the long-term impact of a scenario in which all European import duties on fertilizers are removed, we estimate that this reform could imply US$ 528 Million (€ 481 Million) in welfare gains and more than 17,245 jobs created in the European Union. These macroeconomic gains are accompanied by a 0.7% increase in agrifood value-added. Consequently, the liberalisation of this sector appears to be a beneficial reform for the European economy.

6 Annex

We consider a set of regions $r \in \{EU, US, CIS, ROWE, ROWI\}$, a set of inputs i (i.e., commodities used only as inputs by the fertilizer sector in the model, $i \in \{Gas, Potassium, Phosphorus\}$ and a set of outputs o (i.e., commodities transformed from i and sold on the market by the agricultural sector or used as inputs to fabricate another fertilizer $o \in \{TSP, NPK, UREA, AS, CAN, AN, MAP, DAP, PK, NH3\}$.

Each region r has n_r firms, indexed by *f*, entering in Cournot competition on each market. Firms are engaged in multi-products activity, by producing all commodities o from inputs i and also from o. They potentially sell all commodities o in each market r. Markets are segmented due to trade costs and imperfect competition, allowing for pricing to market strategy.

There is an aggregated fertilizer demand by market: it is a linear demand coming from the farm sector for agricultural production.

$$P_{o,r} = \sum_{oo} \alpha_{o,oo,r} D_{oo,r} + \beta_{o,r} \quad (1)$$

where oo is another index similar to o; $P_{o,r}$ is the price of commodity o in country r; $\alpha_{o,oo,r}$ the slope of the inverted demand function (price of o with respect to demand of oo) in country r; $D_{oo,r}$ is the demand of fertilizer oo in country r and $\beta_{o,r}$ is a positive coefficient.

Each firm *f* from region *r* deliver a supply $y_{o,f,s}$ of commodity o in country *s*.

Firm *f* ‘s cost function in producing o consists in a marginal cost $mc_{o,f}$ and a fixed cost FC_f. Firm *f* also supports trading costs when delivering commodity o on market r, in particular a unit unit transportation cost to market *s* and commodity o: $tc_{o,f,s}$, a distribution cost $dc_{o,f,s}$, and potentially a policy trade costs.

Policy trade costs could include:

- both specific tariff (*spet*, per unit), and ad valorem component (*advt*), these two instruments affect the pricing strategy differently.
- statutory measures (MFN and preferential, indexed “MFN” for simplicity) and anti-dumping components (indexed “ad”).

Let us call $advt_{o,f,s}$ the trading costs corresponding to ad valorem duties imposed on trade of commodity o from firm f to country s and $spet_{o,f,s}$ those corresponding to specific duties imposed on trade of commodity o from firm f to country s.

Firm *f* maximizes total profit on all sales of o towards all market s:

$$\Pi_f = \sum_{o,s} \left\{ \frac{P_{o,s} y_{o,f,s}}{1+advt_{o,f,s}} - \left[mc_{o,f} + tc_{o,f,s} + dc_{o,f,s} + spet_{o,f,s} - \frac{spet_{o,f,s} advt_{o,f,s}}{1+advt_{o,f,s}} \right] y_{o,f,s} \right\} - FC_f \qquad (2)$$

In the marginal cost of each fertilizer, in addition to an additional component supported by f on production of o $\mathrm{AdCostperUnit1}(\mathrm{o},\mathrm{f})$, there are two series of input-output coefficients, first the quantity of input i in the production of output o $IO_{i,o}$, second the quantity of commodity oo in the production of output o $IO_{oo,o}$:

$$mc_{o,f} = \sum_{r,oo} P_{oo,r} IO_{oo,o} + \sum_{r,oo} Pi_{i,r} IO_{i,o} + \mathrm{AdCostperUnit1}(\mathrm{o},\mathrm{f}) \qquad (3)$$

First-order condition gives:

$$\frac{P_{o,s} + \sum_{oo} \alpha_{oo,o,r} y_{oo,f,s}}{1+advt_{o,f,s}} = mc_{o,f} + tc_{o,f,s} + dc_{o,f,s} + \frac{spet_{o,f,s} - spet_{o,f,s} advt_{o,f,s}}{1+advt_{o,f,s}} - \sum_{Products} \sum_{r,oo} \alpha_{Products,o,s} y_{oo,f,r} IO_{Products,oo} \qquad (4)$$

This equation states that when determining the optimal quantity supplied of commodity o towards country s, firm f takes into account the impact of an increased supply of o in s: (i) on revenues from sales of o in s, the price of o in s being constant; (ii) on prices of all outputs oo sold in s, o included; (iii) on production, transportation, distribution and other trading costs, with prices of all outputs being constant; (iv) on the marginal costs of all outputs since prices of all outputs o are affected, o being potentially used in the production of other outputs oo.

The equilibrium condition of market of commodity o in country r is:

$$\sum_{f \in s} n_s y_{o,f,r} = D_{o,r} + ID_{o,r} \qquad (5)$$

It states that supplies of commodity o from all firms f in the world to country r must be equal to the sum of the demand for fertilizer o by the agricultural sector in country r, $D_{o,r}$, plus the intermediate demand of commodity o by the fertilizer sector in country r $ID_{o,r}$.

Concerning inputs i, $i = K2O, CH4, CC, PA, SA$, price of input i in country *r* is constant.

The short term model (with a fixed number of fertilizer firms by region) consists in equations (1) to (5) which determine respectively $D_{o,r}$, Π_f, $mc_{o,f}$, $y_{o,f,r}$, $P_{o,r}$. With a long term model, the number of firms n_r acting on market s is determined by the zero profit condition:

$$\Pi_f = 0 \tag{6}$$

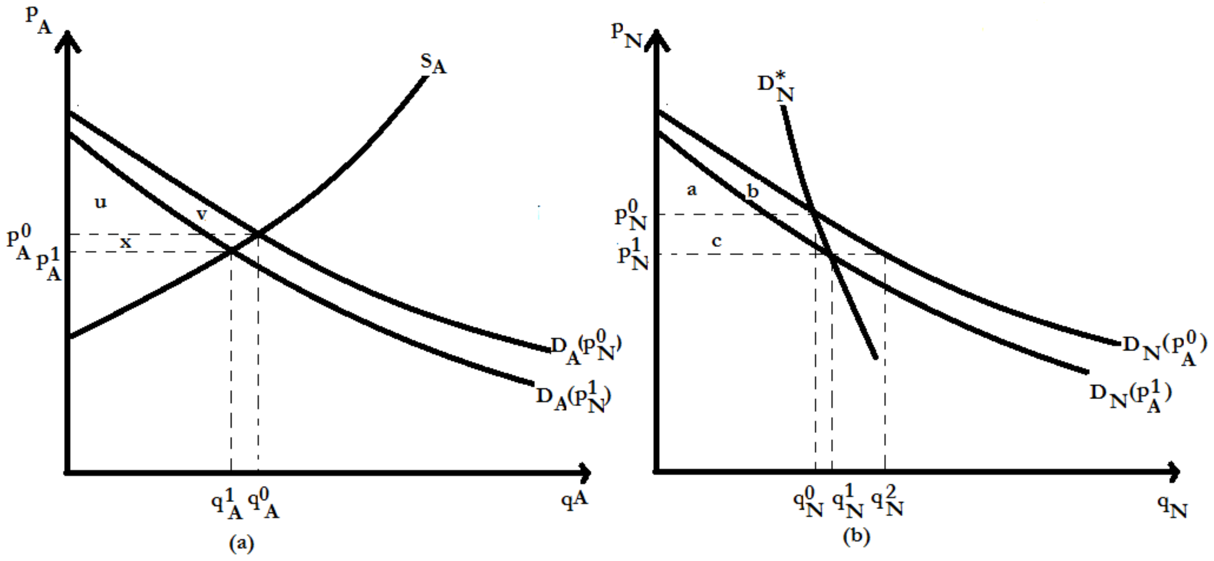
In order to evaluate the impact on global welfare we first only consider the fertilizer market. Global welfare is the sum of the profits from the fertilizing industry, of consumers' surplus and public revenues (custom duties).

As far as the consumers' surplus is concerned, we take into account that the agricultural sector (consumer) is using in this case multiple inputs which are horizontally differentiated.[19] Let us consider for the simplicity of exposition that there are only two inputs (N et A) used in quantities q_N and q_A by the agricultural sector which faces perfectly elastic demand. N and A are substitutes such that a price variation of N, which affects the agricultural sector's surplus, implies a change in the price of A, which also affects the agricultural sector's surplus. Let us suppose that the supply of q_A is represented by S_A in Figure 1.b. The demand for inputs N and A are initially $D_N(p_A^0)$ and $D_A(p_N^0)$, *i.e.* the initial level of demand for N (respectively A) depends on the initial price of A - p_A^0 - (respectively the initial price of N - p_N^0 -). On the market of A, the intersection of S_A and $D_A(p_N^0)$ gives the equilibrium price and quantity p_A^0 and q_A^0. On the market of N, the price is initially p_N^0 and the quantity demanded by the agricultural sector at this price is q_N^0.

Let us suppose that an intervention from the government (the removal of a border duty) implies a decrease of the price of N from p_N^0 to p_N^1. It implies an increase in the quantity of N demanded by the agricultural sector from q_N^0 to q_N^2. However this also implies a contraction of the demand for A by the agricultural sector, from $D_A(p_N^0)$ to $D_A(p_N^1)$, since A and N are substitutes and the price of N has decreased. The new equilibrium price for A is p_A^1 , smaller than p_A^0 . This implies a contraction of the demand for N by the agricultural sector, from $D_N(p_A^0)$ to $D_N(p_A^1)$. The long-term demand for N by the agricultural sector is D_N^*.

The agricultural surplus from the intermediate consumption of A is initially (u+v) and its is changed to (u+x), implying a variation by (x-v). The agricultural surplus from the intermediate consumption of N is initially (a+b) and its is changed to (a+c), implying a variation by (c-b).

[19] See Just, Hueth and Schmitz, 2004, chapter 9.



Therefore we measure the variation in the agricultural surplus from changes in the prices of intermediate consumption of products o in country r by:

$$VarSurplusAg(r) = \sum_o \left\{ \frac{D^1_{o,r}\left[\beta_{o,r} + \sum_{oo\neq o} \alpha_{o,oo,r} D^1_{oo,r} - P^1_{o,r}\right]}{2} - \frac{D^0_{o,r}\left[\beta_{o,r} + \sum_{oo\neq o} \alpha_{o,oo,r} D^0_{oo,r} - P^0_{o,r}\right]}{2} \right\} \quad (7)$$

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