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Comparative Analysis of Factor Markets
for Agriculture across the Member States

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The Market for Tractors in the EU Price Differences and Convergence

ABSTRACT

This study evaluates the degree of segmentation of the market for agricultural machinery and equipment in the EU. We focus on agricultural tractors, the most common and biggest investment in machinery and equipment in the agricultural sector. By using country price data for individual tractor models, we test the law of one price, i.e. the existence of a common price for tractors across EU member states. We find that significant price differences exist, yet unlike most other studies we find that large price deviations are penalised within a short time. The study also shows that transport costs are an important source of price differences, as domestic production leads to lower prices on the domestic market and as price convergence is negatively correlated with distance. Finally, price differences should not solely be understood from a geographical perspective, as evidence supports the idea that farmers' buying power is significant in explaining price differences within countries.

Keywords: Agricultural machinery, tractors, European Union, segmentation, price differences, convergence.

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The Market for Tractors in the EU

Price Differences and Convergence

Christian Jörgensen and Morten Persson*

Factor Markets Working Paper No. 35/February 2013

1. Introduction

The EU has a long history of ambitious measures to spur internal trade. Although custom duties on internal trade were removed as early as 1968, the research project “Costs of non-Europe” showed that considerable gains could be achieved by abolishing non-tariff barriers. The Single Market Programme had the ambition to remove the remaining trade obstacles, such as border controls and divergent technical standards, by 1992. Although it has been successful, revitalisation strategies were launched in the 1990s and 2000s to deepen the economic integration process and obtain further economic gains. The economic gains from a common market include the efficient allocation of resources and a high level of competition, which among other things results in low prices to the final consumer. Studies show, however, that complex administrative and legal requirements still obstruct trade in services in particular, but also trade in goods across EU member states. Chen and Novy (2011), for instance, found that in the early 2000s substantial technical barriers to trade continued to restrict intra-industry trade in manufactured goods in the EU. The observation that price differences are four to six times larger across than within member states in the 2000s supports the idea that the barriers to trade in goods remain considerable.

One market that has received particular interest from both the European Commission and scholars is the car market – a market that the Commission has monitored closely and for which it has taken concrete actions to end market fragmentation. Although significant progress has been achieved, studies conclude that even the EU market for cars cannot be characterised as completed, as price differences can still be attributed to the segmentation by national borders seen in the early 2000s. Yet as Goldberg and Verboven (2005) note, the results for the car market cannot be generalised, especially given that major steps and monitoring of the market have been undertaken to stimulate economic integration. They therefore call for more studies covering other markets in the European Union in the light of integration efforts.

The purpose of this paper is to help fill this gap by studying the market for agricultural tractors. To our knowledge, research on market fragmentation of the market for tractors or any other agricultural machinery in the EU by using price data has not previously been conducted. Focusing on seven EU countries – Finland, France, Germany, Italy, the Netherlands, Sweden and the UK – this paper sheds some light on the functioning of a market that is important for both the manufacturing industry and farmers in the EU – a market that is dominated by a very few actors at the EU level, and even fewer at the level of individual national markets. Concentration, together with a pronounced brand loyalty,

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suggests that trade obstacles across national borders add to the possibility of firms exercising market power.

The paper proceeds in section 2 with a brief overview of the market for agricultural machinery and equipment. Section 3 surveys the market integration literature. In section 4 the data are introduced. Section 5 provides the descriptions and origins of price differences, and section 6 presents the empirical approach and results for price convergence. Section 7 completes the paper with a summary and conclusions.

2. The EU market for tractors and other machinery equipment

The agricultural machinery industry is a diversified industry with the production of an array of products, from irrigation equipment to milking robots. Parallel with the globalisation of the world economy, the industry has experienced large mergers and acquisitions over the last 20-30 years. Now three major full-line corporations (John Deere, CNH and Agco) are dominant players on the world market, not least for heavy fieldwork machinery such as tractors (Christensen, 2009).

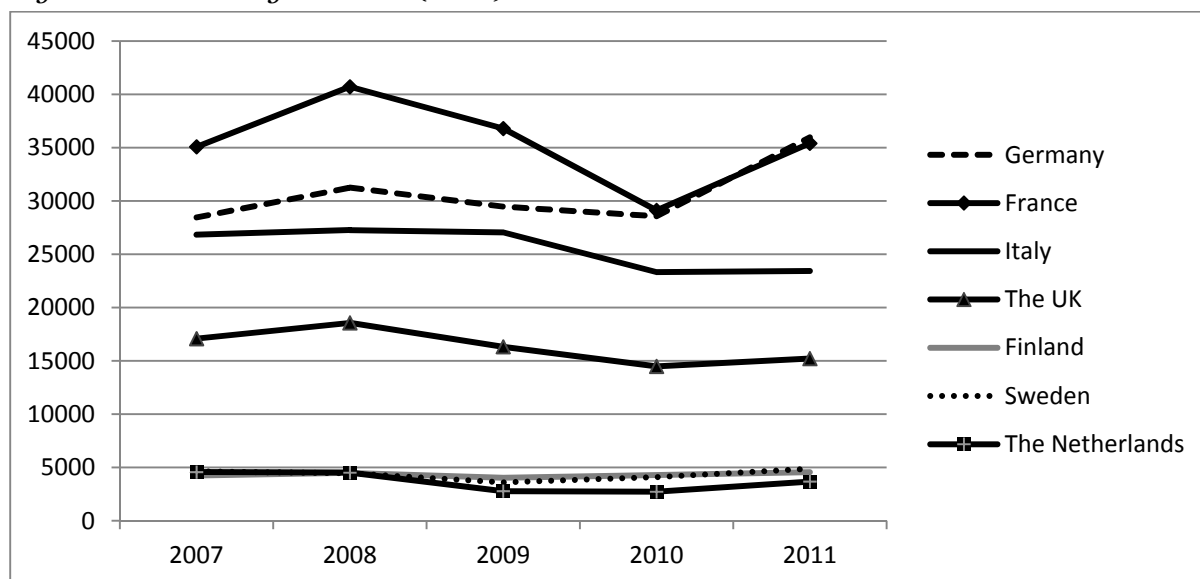
The EU is a major market for agricultural machinery, with a turnover of €24.2 billion in 2011 – equivalent to 30% of global turnover (VDMA, 2012). The EU is the biggest producer of agricultural machinery, with a sales value of more than €26 billion in 2011, and it is estimated that production in the EU corresponds to a third of world production (VDMA, 2012). In 2006, Germany was the major producer of agricultural and forestry machinery with a share of 26.8% value added in the EU-27, followed in descending order by Italy (17.7%), France (13.7%) and the UK (5.0%). With an export value of €6.9 billion in 2007 for agricultural and forestry equipment, the EU was a net exporter of €4.3 billion (Eurostat, 2009). Furthermore, in 2008 the EU intra-trade in agricultural machinery corresponded to €4.2 billion, which equated to about 57% of all world trade in agricultural machinery.¹

Tractors are by far the major product category of agricultural equipment, with combined harvesters in second place. With a sales value of about €20 billion, the global market for tractors corresponds roughly to a third of total sales of agricultural machinery and equipment when excluding parts and attachments (Mehta and Gross, 2007). The EU is also the biggest tractor manufacturer in the world, with a production value of €7.3 billion in 2006 (Eurostat, 2009). Germany is the largest exporter of tractors in the world, with an export share of 21% of total world exports in 2011 (VDMA, 2012). Italy, the UK and France are also major exporters of tractors, each with a share of world exports corresponding to roughly 10%.

Furthermore, the EU is one of the major markets, with more than 150,000 new tractors registered on a yearly basis the last decade and an annual sales value of more than €7 billion (VDMA, 2012). As Figure 1 shows, the number of tractors sold has been fairly stable, although sales have fallen amid with the financial crisis. Tractor sales in the EU in 2011 were highest in Germany and France, which tie at about 35,000 units sold. Italy and the UK are ranked in third and fourth place, with 23,000 and 15,000 tractors sold respectively. Our three other markets of special interest in this paper – Sweden, Finland and the Netherlands – have annual sales corresponding to 4,000-5,000 units. In 2011, the tractor sales in the seven countries corresponded to 81% of all sales in the EU-15.

¹ Data for trade in tractors are found in FAOSTAT. See the appendix for details.

Figure 1. Tractor registrations (units)



Source: VDMA (2012).

As the price of a tractor differs from about €10,000 to more than €300,000, however, the number of units sold is only a crude approximation of market size in terms of value.² Larger farms, for example, are expected to have larger tractors on average and as farm size differs substantially in terms of hectares (ha) across countries, so may the demand and sales of tractors corresponding to size. As Table 1 shows, farms are almost seven times larger in the UK (with an average farm size of 54 ha) and France (52 ha) than in Italy (8 ha). The value of tractor sales may hence be equivalent in the UK and Italy.

Table 1. Farm size in 2007 and market concentration

	Average hectare (ha)	Average size of larger farms (20% of the utilised area)	Number of large farms utilising 20% of the area	Total market share of the three largest tractor manufacturers *
Finland	34	146	3,141	97% (2004)
France	52	274	20,032	68% (2011)
Germany	46	1,391	2,434	56% (2011)
Italy	8	337	7,560	56% (2011)
Netherlands	25	135	2,826	84% (2011)
Sweden	43	388	1,605	88% (2011)
The UK	54	2,416	1,335	75% (2011)

Note: * The year is shown in parentheses in this column and sources are given in the appendix.

Sources: See the appendix; farm size taken from Eurostat (2011).

Eurostat defines large farms in a country according to the largest farms that utilise 20% of the area. In the UK and Germany, with relatively few and large farms, farms larger than 1,000 ha on average cover 20% of the utilised area. The opposite is true mainly for Finland and the Netherlands, where, according to this division, there are many large farms that are on average less than 150 ha. Our expectation is therefore that the demand for bigger tractors is mainly found in the UK and Germany, while the segment of smaller tractors primarily

² The price range refers to the sales value for tractors on the German market found in *Schlepperkatalog* (2012). See the appendix for more details.

dominates the markets in Finland, the Netherlands and not least in Italy. This idea is supported by actual sales figures for bigger tractors, i.e. tractors with more than 160 horsepower. In 2011, the share of big tractors represented a mere 8% of total sales in Italy, 21% in France and 31% in the UK (VDMA, 2012). In German states with relatively large farms, big tractors have a greater market share than in other states. In the north-east states of Mecklenburg-Vorpommern, Brandenburg and Sachsen-Anhalt, which are dominated by large farms, tractors with more than 200 PS make up the main tractor category, while the majority of tractors sold in the southern states of Baden-Württemberg and Bayern are tractors up to 100 PS (*profi*, 2012).

Although data for market sales by manufacturer in the EU as a single market is not exhaustive, evidence strongly suggests that tractor sales in the EU are dominated by a few manufacturers. It is estimated that the six largest manufacturers accounted for 85% of the sales of tractor units in Western Europe in 2007 (*Farmers Guardian*, 2008). The high concentration is further highlighted by the fact that the market share of the three largest manufacturers corresponds to two-thirds of the market. The sales of the big six were in descending order Case IH (sales of 37,000 units), Agco (34,000), John Deere (30,000), SAME Deutz-Fahr (21,500), Argo (10,000) and Claas (9,500).

The concentration is even more pronounced in some national markets. The top three makers in 2011 almost wholly dominated the markets in Finland, Sweden and the Netherlands, with total market shares of 97%, 88% and 84% respectively as shown in Table 1. The market concentration in Finland is demonstrated by sales of the brand Valtra (a part of the Agco concern) making up almost half of the market (46.4%), while the combined sales of John Deere and Valtra constitute about half of the sales on the Swedish tractor market. In the other countries, i.e. France, Italy, Germany and the UK, the dominance of a few is also pronounced, with the three largest manufacturers having a total market share ranging from 56% (Italy) to 75% (the UK).

One reason for the high market concentration is certainly the noticeable economies of scale in production, which imply high barriers to entry and stimulate mergers and acquisitions. Tractors have not only become bigger, but also progressively more technically advanced, not least in the last decades as a result of large investments in research and development (R&D). Between 1994 and 2009, global spending on R&D in farm machinery as a share of total sales increased from 1.9% to 2.7% (USDA, 2011). For instance, in 2010 the largest global manufacturer of commercial vehicles and trucks, John Deere, invested €784 million in R&D, corresponding to 4% of its sales value (European Commission, 2011).³ Another important restriction on competition for many on national and local markets concerns the costs of distribution and service. High barriers to entry emerge from the requirement of dense distribution and service networks, as dealers have to be located in a 25 to 35 km radius of the farmer in order to comply with an immediate demand for service (European Commission, 1992). For example, it is estimated that 120 sales outlets are required to cover the UK market. The spatial limitation in distribution implies that some manufacturers only focus on regions within countries. Competition on local markets may therefore be restricted to only a subset of the national distributors, amplifying high concentration. In addition, brand loyalty is important in farmers' choice of tractors, suggesting substantial fixed costs for reputation and facilitating manufacturers' ability to exploit a low elasticity of demand (Wally et al., 2007). The need to build a reputation may dissuade manufacturers from entering new markets at both the local and national levels. One interesting feature that emerges from Table 1 is that smaller, sparsely populated countries tend to have higher levels of concentration than larger countries; a similar pattern is evident, for example, in food retailing across Europe (Dobson et al., 2003). This could be due to the high fixed costs of distribution, implying that only a minor fraction of firms find it economically viable to enter small and sparsely populated markets like Finland and Sweden.

³ The investment made it the 116th largest investor in R&D of all companies in the world (European Commission, 2011).

High barriers to entry and anticompetitive practices at the national or more local level have been recognised by the EU. The European Commission argued, prior to the mid-1990s, that the largest manufacturers exchanged information in order to survey the market and reduce competition in the sales of agricultural tractors in the UK.⁴ Furthermore, the Commission recognised non-tariff barriers to trade for agricultural and forestry vehicles, suggesting market fragmentation by national borders as recently as 2008. In 2010, the Commission therefore proposed a so-called 'Mother Regulation' to replace more than 50 Directives in order to cut red tape and prevent fragmentation of the internal market resulting from varying product standards across the member states (European Commission, 2010). The integration efforts are expected to reduce transaction costs, spur competition and make farmers' investment in tractors less dependent on the member state in which the tractor is acquired. Hence, any progress in creating a single market for agricultural tractors would in turn increase industry efficiency and farmers' competitiveness in the EU.

3. Studies on market integration

Measuring market integration has much to do with singling out the costs of crossing a national border. Price comparisons and trade flows are often used as indirect measures of trade costs, because direct measures of trade costs (although of great value) are often sparse and frequently inaccurate (Anderson and van Wincoop, 2011). Although direct measures for trade costs exist, such as the difference between cif and fob values, data on tariffs and measures of non-tariff barriers to trade are scarce and cover only a limited number of industries, years and countries (Chen and Novy, 2011). An obvious, second-best candidate is the indirect measure of how trade flows are affected by the border. For example, studies have been conducted measuring the difference between trade flows within a country compared with trade between countries. Studies analysing trade between Canadian provinces and between Canada and the US, for instance, suggest a significant, negative border effect, i.e. the border substantially impedes trade between the two countries. Anderson and Wincoop (2003) found that the national border between the countries reduces trade by as much as 44% and about 20-50% for other industrialised countries.

One approach is to estimate the freeness measure (also known as the *phi*-ness measure) in the frequently used gravity equation in the study of international trade to assess the bilateral trade costs above the costs involved in intra-national trade. An advantage of this approach is that it can be extended to a number of years and countries. Chen and Novy (2011) base their work on the gravity framework and incorporate a micro-founded measure that allows cross-industry heterogeneity. They find that trade integration differed considerably among 163 industries in the years 1999 to 2003. The bilateral barriers to trade for *agricultural tractors*, for instance, are found to be 35% higher than domestic barriers to trade, while the corresponding estimate for *other agricultural machinery* is as high as 93%. The relatively low barrier to trade for agricultural tractors can be explained by low transport costs to value, which is common for high-tech industries, such as tractors. Still, their analysis shows that technical barriers to trade have a significant impact on overall trade flows, which suggests that further integration efforts can be of considerable value.

Another important strand of estimating market fragmentation is to focus on prices. If arbitrage possibilities are prevalent, large price differences across destinations will, *ceteris paribus*, be disciplined by economic agents over a short period. If on the other hand transport costs are large or a parallel import is prohibited so that firms can engage in pricing to market, large price differences may persist. Spatial price analysis is a means to study market integration departures from the law of one price (LOOP), which, abstracting from transport costs, states that if two locations are linked by trade and arbitrage they will have a unique price for a homogenous good (Fackler and Goodwin, 2001). The underlying

⁴ Prior to the Commission's investigations, UK tractor prices were 20 to 30 % higher than in the rest of the EU (Georgantzis and Sabater-Grande, 2002).

assumption is that market fragmentation is strongly correlated with the violation of the law of one price, as barriers to arbitrage deter economic agents from taking advantage of price differences and hence level prices. If the price difference of a good exceeds the cost of moving the product (r) between two locations, it will be transported from the lower-priced location (i) to the higher-priced location (j).

$$p_j - p_i \leq r_{ij} \quad (1)$$

The condition will hold as equality if the locations trade directly, implying the strong version of LOOP, while inequality is the basis for the weaker version. It is an equilibrium concept, yet arbitrage possibilities will tend to move actual price differences towards the transport cost in an integrated market. Also, it should be noted that although the locations might be perfectly integrated economically, they might not trade with each other (Fackler and Goodwin, 2001). If r_{ij} is substantial enough, trade between two regions may be prohibitive even though no red tape exists. Such conditions may prevail for the market for low-value bulk products. The most tested version of LOOP is the relative version, which implies that equation 1 is expressed in logs, i.e. the price difference is expressed as a fraction. The relative version does not depend upon the goods being identical (the homogeneity assumption) – the price in one location may be higher due to the higher quality of the good. The relative version therefore applies to a wider range of price data (such as price indices), and is more common in studies with cross-country data, given that prices across countries are not easily matched (Goldberg and Verboven, 2005).

Price differences across countries do not, however, solely originate from barriers to trade between countries. Varying service costs, taxes and so forth invalidate the law of one price especially across countries. Not controlling for tax differences or non-traded local costs, such as rents, exaggerates border effects when examining price dispersion, especially for consumer prices that include a larger non-traded component. Price dispersion across countries not only depends on whether the good is sold for consumption. Tradability is directly associated with arbitrage possibilities and it varies a lot among goods depending on large weight-to-value ratios as recognised by Chen and Novy (2011). Yet studies suggest that the manufacturer's price only to a minor extent mirrors the consumer price of internationally traded goods. Anderson and van Wincoop (2011) calculate that trade costs, i.e. all the costs of getting the good to the final user, are equivalent to an *ad valorem* tax of roughly 170%. Breaking down these costs, 55% pertains to local distribution costs and 74% to international trade costs.⁵ Trade costs within the EU, however, are probably significantly lower because of integration efforts and smaller distances.

Service costs differ widely among goods and countries. Giri (2012) finds that while tradability is crucial in explaining price differences, variations in local distribution costs are the most important factor explaining moments of price dispersion. He also shows that the distribution margin (excluding value added taxes), computed as a ratio of retail value, not only differs among goods, but also among countries (in the OECD). Even across old EU member states (EU-15), the average distribution margin varies from about 10% (Ireland) to roughly 20% (Greece). Heterogeneity in the average of distribution margins for goods is also pronounced in his study, ranging from 8.2% (“Other transport equipment”) to 39.8% (“Wearing apparel; furs”).⁶ The classification “Machinery and equipment”, of which agricultural tractors are part and thus deserves special interest from our point of view, has a relatively low but still significant average distribution margin of 15.0% across countries.⁷

⁵ A mark-up component, if any, is included in the distribution costs.

⁶ Goods are classified according to the Classification of Products by Activity at the 1-digit level.

⁷ The average distribution margin across the 29 product categories is 19.1%. The category “Machinery and vehicles” is heterogeneous and the average distribution margin of tractors could be compared with “Motor vehicles, trailers and semi-trailers”, with an estimate of 18.2%.

4. Data

Our data consist of list prices of tractor models in seven EU member states: Germany, France, Italy, the UK, the Netherlands, Sweden and Finland, as well as price indices for “Agricultural tractors” corresponding to these countries provided by Eurostat.⁸ Prices for more countries have not been gathered due to data availability limitations. The sample of countries nonetheless covers the major part of the EU tractor market and offers the largest core markets in Europe as well as smaller ones located on the periphery. The sample also consists of more or less old EU member states, which makes inference possible from countries that have belonged to a mutual integration process for a long time.⁹

The prices of individual models have been collected manually based on Internet data or paper versions of price lists depending on availability. The reference country chosen in our study is Germany, and price observations in the other countries have therefore been registered only if a corresponding price notice was found for Germany. The motivation for choosing Germany is twofold. For a start, Germany is a core market that is more or less close to all countries in the study. Yet most importantly, the preference for Germany is based on data availability. The yearly catalogue for tractors marketed in Germany (*Schlepperkatalog*) includes prices and other data for roughly a thousand tractors, which comprises a far richer data set than for the other countries. The choice of Germany as the reference country thus maximises the number of feasible price comparisons.

The prices of individual tractors are yearly list prices mainly for the years 2009 and 2011, with the exception of German tractor prices, which are stated as actual sale prices, i.e. list prices with a discount.¹⁰ The main objective is to calculate price-level differences across the selected countries for tractors that are as homogenous as possible (excluding value added taxes). We have information on brand and model, but other quality differences are only partly revealed. Studies of the EU car market often include hedonic regressions to control for quality differences, as car models across EU member states differ according to equipment (see for example Lutz, 2004, as well as Goldberg and Verboven, 2005). In our case, the disparate data sources do not allow such extensive considerations, but to reduce the degree of heterogeneity no price comparisons have been made if the choice of transmission, body shape or drive has been found to differ on any account. A total of 1,569 price comparisons with Germany as a reference country have been conducted. Price data for the Netherlands have only been found for the year 2007 and as no price data were available for Germany for the corresponding year, price comparisons have been made between Finland and the Netherlands to provide an estimate of the price level for the Netherlands.¹¹

Our second set of data has been derived by Eurostat. Eurostat takes account of quality changes and provides price indices for tractors on a quarterly basis, from the beginning of 2005 onwards, with the objective of facilitating comparisons of price trends across member states (Eurostat, 2008). The price indices do not enable actual price comparisons among countries, however. By inserting the estimated price levels, based on the list prices, into the price indices we are able to assess actual price movements over time. By doing so, we can measure price differences across countries on a quarterly basis to infer the degree to which prices and hence markets are interlinked. As the demand and sales for tractors differ across countries, ‘the bundle of tractors’ in the Eurostat price indices may also differ somewhat across countries, which we discuss in the data analysis.

⁸ See the appendix for data sources.

⁹ Finland and Sweden became EU member states in 1995 and are the latest EU members in the sample. As members of EFTA, however, they had a free trade agreement with the European Community on manufactured goods.

¹⁰ Based on information from the editor for *Schlepperkatalog*, we estimate the average discount rate to be 8%. The discount rate does differ (from about 3 to 15%) across brands, though, and to some extent depends on individual models within brands.

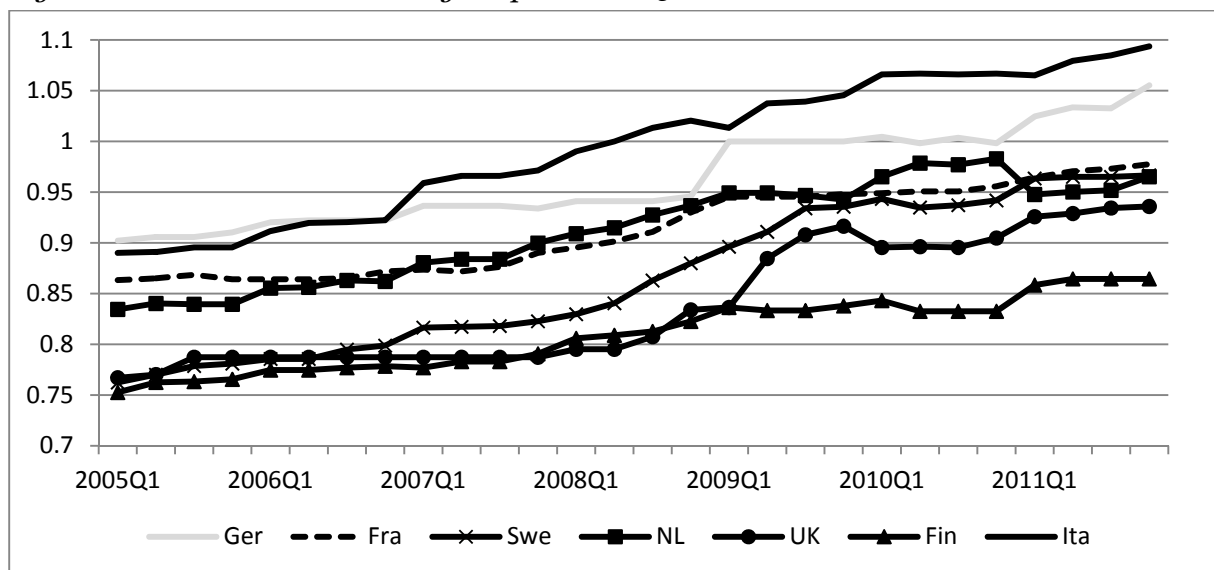
¹¹ Price comparisons were made for 90 tractor models. Finland is the only other sampled country for which we have price information for the corresponding year.

5. Price differences and their causes

Buying a tractor is a major investment for an individual farmer. The average list price across the 790 price observations in the sample for the reference country Germany in 2011 was €118,200. The average pre-tax price difference in absolute value *vis-à-vis* France, Italy, the UK, Finland and Sweden in the corresponding year was €11,380 (no price observations for the Netherlands for the corresponding year) or 10.3%.¹² Price differences hence are significant and can hardly be justified solely by transport costs. Moreover, for some tractors the price difference exceeded €40,000 – a difference that by itself signals substantial restrictions in cross-country arbitrage. This average price difference exceeds the quality-adjusted car price differentials of 8.4% in Lutz (2004). Nevertheless, given that we do not take into account such extensive considerations regarding quality differences as in Lutz (2004), an average price difference of 10.3% does not seem unexpectedly large.

As the number of observations differs considerably across brands, the average price of the brands is used to calculate the price level *vis-à-vis* Germany. Inserting our estimated value of absolute price differences into Eurostat price indices, we can assess price differences across time. In Figure 2, the quarterly price movements from 2005 to 2011 are illustrated with the price of Germany in 2009 as the reference point. Tractor prices are found to be highest in Italy from 2007 onwards, whereas prices are lowest in Finland with the exception of 2008. Price movements across countries are fairly matched with a few exceptions. The UK price level increased sharply in 2009, while prices in the Netherlands rose temporarily in 2010. The prices in Sweden and Italy increased most during the period, about 26%, followed by the UK and Italy (about 19%). Price inflation has been roughly the same for the other four countries, between 13 and 17%.

Figure 2. Price movements during the period 2005–11



Source: Based on Eurostat and own calculations.

It is noticeable that the price spread between France, the Netherlands, Sweden and the UK is indeed minor by the end of the period, while on the other hand, tractor prices in Italy and Germany are 10 to 15% higher than the sample average by that time. Price differences are substantially higher in Italy compared with Finland by the end of the period, more than 30%, which indicates at least a partially fragmented EU market for tractors.

Different discount practices may explain observed price differences. Given that with the exception of Germany, we do not have information on discount practices, this may pose a

¹² Tractors are exempted from taxes with the exception of value added taxes on tractors in Finland.

problem in inferring price differences. Still, average customer discount rates in car sales across France, Germany, the UK, Italy and the Netherlands have been found to be very similar, which suggests that the problem may also be less important in our case.¹³

A focus on average price differences obscures the point that bilateral price differences are greater for individual brands. In Italy, for instance, JCB tractors were 21% more expensive than in Germany, while Landini tractors were 15% cheaper – a difference of almost 40% between individual brands. A similar pattern is evident for all countries for relative price differences *vis-à-vis* Germany in Table 2. The coefficient of variation for bilateral price differences across all models spans from 7% in France to 14% in Sweden. The mean of the coefficient of variation across models within brands is substantially smaller, although present, from 3% (Sweden) to 6% (Finland). Variations in price differences across models, and even more so across models within brands, are not likely to be simply explained by different discount rates across countries. One possible explanation is that dealers practise pricing to market depending on the brand, but also to a smaller extent within a model range. Such an explanation is credible, as farmers have been reported to be noticeably loyal to brands. Exploiting a low price elasticity of demand for domestic car brands (Fiat in Italy) for example, was found to generate large mark-ups and to be the main reason for the relatively high car prices in Italy (Goldberg and Verboven, 2001).

Table 2. Price differences *vis-à-vis* Germany (2009 and 2011)

	Coefficient of variation (CoV)	Average CoV within brands	Number of observations
France	0.07	0.03	205
Italy	0.10	0.05	538
UK	0.11	0.05	534
Sweden [†]	0.14	0.06	61
Finland	0.09	0.05	271

[†] Price comparisons are only for the year 2011.

Source: Own calculations.

Origins of price differences

More data on sales to estimate demand elasticities (sales data) and distribution costs would enable us to analyse in detail the origins of price differences. One obvious source of price differences is transport costs, which we are able to infer somewhat as we have information regarding the country of origin of individual models for some brands. For instance, the major global manufacturers in the US produce medium-sized tractors in Europe for the European market, but also for shipments to North America and Asia (Christiansen, 2009). Such major brands as New Holland, Massey Ferguson and John Deere also have production in more than one country in our sample, and by a simple regression we are able to estimate the impact on price differences depending on whether the tractor is manufactured in Germany or in Finland, France, Italy or the UK.¹⁴ As models within brands share both a common distribution network and reasonably the same preference for brand loyalty, the information on country of origin enables us to infer transport costs for the price of the final good. If a tractor is produced in Germany, it is expected to reduce the price in Germany *vis-à-vis* other countries; likewise, if a tractor is made in one of the other countries it is hypothesised to

¹³ Goldberg and Verboven (2001) report that discount rates for cars were similar across countries (about 10-15%) and steady over time. Likewise, Lutz (2004) reports small deviations for dealer margins across countries, from 7.5% in Netherlands to 10.4% in Italy.

¹⁴ The brands are John Deere, New Holland, Case, Deutz-Fahr, Massey Ferguson and Valtra. The manufacturing country for individual models is published on the internet by the Finnish magazine *Käytännön Maamies*. There is no production of agricultural tractors in Sweden.

increase the price in Germany *vis-à-vis* the country in which it is assembled (which we further on denote as *Home*). Reducing the sample to brands that are produced in more than one country and of which at least one is Germany and/or any of our sampled countries, we extend equation 1 and estimate the following equation:

$$p_{ik} = \alpha + \beta_1 Home + \beta_2 Germany + \beta_4 country_k + \beta_5 pricelevel_G * country_k + \beta_6 y_{11} * country_k + \beta_7 Brand * country_k \quad (2)$$

where p_k is the price quotient for model i between country k and Germany (the German price in the denominator). If the model is produced in the home country, i.e. Finland, France, Germany, Italy or the UK, *Home* takes the value one and zero otherwise. The benchmark is that the tractor is manufactured in a third country, for example the US. Our hypothesis is that the coefficient for *Home* should have a negative sign, i.e. reduce the price compared with Germany, while the coefficient for *Germany* is expected to be positive, i.e. have a positive impact on the price quotient (remember that the tractor price in Germany is in the denominator).

The estimation also includes a set of dummy variables to control for differences in the pricing of manufacturers across countries, farmers' demand and time. The variable $Brand * country_k$ is an interaction variable that controls for the pricing of brands in Germany *vis-à-vis* country k . The price level expressed in logs, $pricelevel_G$, of the tractor (in Germany) is interacted with the country dummies in order to control for the demand of tractors in terms of size. This could be important, as the location of manufacturing may depend on demand according to the size of tractors. For instance, small models of New Holland, Case, John Deere and Massey Ferguson are manufactured in Italy, which has comparatively small farms. The production of medium- and large-sized tractors, on the other hand, is located in Germany, France and the UK – countries with a greater share of large farms. The production of tractors in terms of size is therefore probably correlated with country farm size, which could be attributed to the benefits of locating production close to demand.

The coefficients for *Home* and *Germany* are both highly significant. The results in Table 3 show that if a model is produced in Germany it adds about 3.6% to the price (in relation to the German price) compared with the case of it having been assembled in a third country. Likewise, if the tractor is manufactured in the home country (k) it lowers the price by roughly 2.8% compared with the German price, or about 6% (2.8% plus 3.6%) compared with the tractor having been assembled in Germany.¹⁵ The total effect (about 6%) could be interpreted as the additional average cost of transporting a tractor across national borders (in our sample of EU countries excluding the Netherlands) *within* an existing distribution network, as models with a common brand are expected to share a sales network. One could thus argue that it is a consistent estimate of transportation costs. The price premium of crossing a national border can be attributed to costs related to red tape as well as additional freight and insurance costs due to the transport distance across countries. The results also reveal that the size of a tractor (in terms of value) adds to the price (in percentages) in Finland and Italy (in Sweden only according to a significance level of 10%), while tractors are priced lower in terms of size in the UK. One explanation may be that tractors are priced inversely to demand, according to size. A reason for this may be that the distribution of rarely sold models incorporates higher distribution costs, as in the case of big tractors in Italy and small tractors in the UK. Therefore, increasing returns to scale may be apparent in selling individual models within an existing distribution network.

¹⁵ We find, as expected, by a Wald test, that the absolute value of the coefficients for *Germany* and *Domestic* do not differ.

Table 3. The impact of tractor size and manufacturing country on price level

	P-value	
<i>Constant</i>	0.989***	0.000
<i>Domestic</i>	-0.028***	0.006
<i>Germany</i>	0.036***	0.000
<i>Pricelevel</i>	-0.018	0.030
<i>Pricelevel*Finland</i>	0.071***	0.000
<i>Pricelevel*France</i>	-0.001	0.943
<i>Pricelevel*Italy</i>	0.043***	0.001
<i>Pricelevel*Sweden</i>	0.086**	0.020
Adjusted R ²	0.71	
No. of observations	970	
Brand dummies	Yes	
Country dummies	Yes	
Year*country dummies	Yes	

***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively; robust standard errors

Yet, prices not only differ between countries, but also within countries. *Schlepperkatalog* publish both the maximum and minimum *actual* regional prices for every tractor. Based on own calculations from price information in *Schlepperkatalog* (2011), the average price difference is about 5% and the maximum price difference for an individual tractor model is as high as €27,000, which for this particular model represents a price premium of 14%.¹⁶ One interpretation is that if a farmer in Germany can choose a dealer according to region, the arbitrage possibility could in some cases be substantial. Moreover, as price differences and price level are not correlated, price differences expressed as percentages do not seem to depend on the price level of a model. In addition, the regional price difference is more or less the same for all models as the coefficient of variation is only 1.5%. It is consequently suggested that if local distribution costs are not proportional to the price level or the size of the tractor, price differences emanate mainly from regional differences in discount practices (mark-ups) and not so much from variation in regional distribution costs. Nevertheless, one reason for regional differences in discount practices in Germany may be buying power, and not spatial segmentation. According to the editor of *Schlepperkatalog*, list prices are the same across Germany, but actual prices are lower in the northern part of Germany, i.e. the discount rate is higher in northern Germany. An explanation could be that farms in northern Germany are in a significantly better bargaining position and thus enjoy a larger discount because of size. This is a plausible interpretation, as farms in northern Germany, in terms of hectare, are almost five times as large as those in the southern part of Germany.¹⁷ As list prices do not differ according to region, price differences hence may not be caused by pricing to region, but by pricing to customer.

6. Analysis of price movements

As we have price data from Eurostat for a number of periods, our next analysis focuses on price movements. Our point of reference is the study of the EU car market by Goldberg and Verboven (2005). Their study, like ours, measures the fragmentation of a market for vehicles in the EU with the help of panel data and cointegration analysis. As in their study, data allow us to test the relative version and absolute version of LOOP, with the former expressing the

¹⁶ Based on price comparisons of 562 tractors.

¹⁷ Based on the difference between the weighted average of the northern states (Schleswig-Holstein, Mecklenburg-Vorpommern, Niedersachsen and Sachsen-Anhalt) and the southern states (Baden-Württemberg, Bayern, Hessen, Rheinland-Pfalz and Saarland) calculated from Deutscher Bauerverband (2012).

price deviations as proportional to prices. Our analysis partly departs from Goldberg and Verboven (2005), as we are restricted to a single combined good, “Agricultural tractors”, and not a number of individual models. Another limitation is that inference of the progress of market integration is not possible due to the short time period (seven years). What we thus can deliver is an estimate of the state of the market in terms of market segmentation during the period 2005 to 2011.

It is fairly reasonable to argue that cointegration analysis is more valid if transaction costs are relatively modest. If prices include a large non-tradable component, the threshold for triggering arbitrage activity is high and co-movements might be hard to detect. If prices largely reflect non-tradable service costs, inference of market integration for the tradable component may be difficult. It is plausible, however, that transport costs for agricultural tractors are comparatively low (our crude estimate is 6% of the final sales value), as agricultural tractors can be regarded as high-tech products, which usually implies a low transport cost-to-value ratio. Hummels (1999), for example, finds that the unweighted freight rate for transport equipment and machinery imported into the US is as low as 5.7% of the value of the good. Local distribution costs are also expected to be much less than the average estimated 55% of the final product price in Anderson and van Wincoop (2011). Still, local trade costs for tractors may not be negligible, as studies suggest that the dealer margin for cars in the EU is about 7-10% (Lutz, 2004), and hence it is important to control for fluctuations of distribution costs. As data on actual distribution costs for tractors are not available, we use national quarterly data on labour costs, also provided by Eurostat, as a proxy for the costs of the final stage of distribution, i.e. domestic distribution costs.

The set-up used in this study follows that of Goldberg and Verboven (2005). An adequate method to examine whether prices between countries follow each other is to study the persistence of long-term price differences between countries and how fast deviations from this long-run equilibrium are eliminated, i.e. the speed of convergence. To estimate the speed of convergence we use the following equation:

$$\Delta p_{k,t} = \alpha_{i,k} + \beta p_{k,t-1} + \sum_{l=1}^L \gamma_l \Delta p_{k,t-1} + \sum_{m=0}^M \delta_m \Delta e_{k,t-m} + \theta \Delta L_{k,t} + \varepsilon_{k,t} \quad (3)$$

where the dependent variable, $\Delta p_{i,k,t}$, refers to the differences of a country's prices from the prices of a benchmark country (Germany), i.e. $\Delta p_{k,t} = q_{k,t} - q_{G,t}$, where k refers to country k , and G to Germany, $e_{k,t}$ refers to the exchange rate of country k 's currency (the UK and Sweden) relative to the euro, and $L_{k,t}$ refers to the labour cost in country k relative to the labour cost in Germany. The dependent variable is expressed in first differences; this is to relate the first-difference to the price of the previous period. With this procedure one can see whether price differences between countries decrease over time, i.e. if the last period's price coefficient is negative. If this is the case, the hypothesis of a unit root can be rejected and price convergence between countries exists. The parameter that controls for this is β , which represents the speed of convergence. If European tractor prices do converge, the β -estimate is negative. If the β -value is significant it is possible to calculate the half-life of a price shock to $p_{k,t}$ with the formula $-\ln(2)/\ln(1+\beta)$. Note that this formula is only accurate for an AR(1) process; when equation (3) includes lags the estimated half-life will be slightly lower than the actual one. The difference is not that large, however. Goldberg and Verboven (2005) find that the half-life changes from 1.35 to 1.66 years when they exclude the lags. Under these circumstances one must balance half-life accuracy against modelling considerations, i.e. the cost of ignoring potential serial correlation. Since our time series data are characterised by serial correlation, we chose to ignore these aspects of the half-life. If β is insignificant, and equal to zero, a price shock to $p_{k,t}$ is permanent, meaning that the new price difference will persist in the long run.

Equation (3) is a fixed effects panel regression, so the intercept terms, α_k , capture the fixed country effects independent of time, in relation to price differences across countries. The fixed country effects in equation (3) also imply that it is the relative version of LOOP that is

tested. If we find that α_k do not differ from zero, we reject the absolute version of LOOP. In addition to the β -value, the α -values are interesting, because significant α -values indicate market segmentation as they reject the absolute version of LOOP.

Following Goldberg and Verboven (2005), the panel fixed effects regression is accompanied by bilateral regressions where we estimate the speed of convergence for each country pair independently. In these regressions the individual country fixed effects of the panel regression are dropped, i.e. an ordinary time series regression.

Results for tractors

The estimated results from equation (3) are presented in Table 4. The β -coefficient is estimated to -0.357 and is highly significant with a P-value of 0.000. Hence, we can reject the null of no convergence. A β -coefficient of -0.357 gives a half-life to a price shock of approximately one year and seven months. This corresponds to the estimated half-life of Goldberg and Verboven (2005) and Parsley and Wei (1996), who estimate convergences for the prices of tradable goods in the US, a market that is considered to be more integrated than the EU. Otherwise, international data generally estimate a longer time horizon, five to six years, for half-lives (Goldberg and Verboven, 2005).

Table 4. The speed of price adjustment for tractor prices

Dependent variable:	Base: GE	P-value	Half-life	$p_{k,t}/-\beta$	P-value
$\Delta p_{k,t}$					
$p_{k,t}$	-0.357 ***	0,000	1.572***	—	—
$\Delta p_{k,t-1}$	0.549 ***	0,000	—	—	—
labor	0.174 **	0.018	—	—	—
ex	-0.077	0.235	—	—	—
fra	-0.030 ***	0.000	—	-0.084 ***	0.000
ita	0.050 ***	0.000	—	0.141 ***	0.000
nl	0.012 ***	0.008	—	0.035 ***	0.001
swe	-0.003	0.473	—	-0.008	0.471
uk	0.014 ***	0.003	—	0.040 ***	0.000
fin	-0.016 ***	0.001	—	-0.044 ***	0.000

The individual α 's, representing the country fixed effects in the regression, with the exception of *Sweden*, are significant at least at the 5% level. We can therefore reject the absolute version of LOOP. From the α -values it is possible to obtain the long-term systematic price differentials by dividing α by $-\beta$. These estimates are also presented in Table 4 and take values between -0.044 and 0.141, and are significant for all coefficients except *Sweden*. These values can be interpreted as how persistent price differences are relative to Germany. For example, the UK estimate of 0.040 implies that, during this sample period, the tractor prices are approximately 4.0% higher in the UK than in Germany. The estimate for Italy stands out with a much higher estimate of 0.141, or 14.1% higher prices compared with Germany. Such a large price difference might seem strange considering the fairly high, overall convergence estimate. Nevertheless, our estimates are on par with Goldberg and Verboven (2005), whose estimates range between 0.05 and 0.17. They explain this by the fact that the speed of price adjustment can be fairly high even though there is a permanent price difference at a certain level. This could, for example, be explained by differences in discount rates or quality differences across countries that do not vary across time. The negative coefficients for *France* and *Finland* imply that the prices in these countries, on average, are below the German prices. As a robustness check, we use the Netherlands as a benchmark country. The Netherlands is a core EU member state in terms of geographical location as well as being one

of the founding nations. The estimated rate of convergence is identical to using Germany as a benchmark country, and hence the convergence rate does not seem to be sensitive regarding the choice of benchmark country.

The exchange rate has been an important factor in previous studies in explaining price differences among countries. But, as Table 4 shows, our estimate is insignificant and has only a marginal effect on the β -value, while differences in labour costs according to our estimation contribute to price differences. The estimate is 0.17, which can be interpreted that the average price of a tractor increases by 1.7% (in relation to prices in Germany) if the labour costs increase by 10% (in relation to labour costs in Germany).

Turning to the convergence estimates for each country pair in Table 5, the first row of estimates were obtained using Germany as the base country, the second row by using Finland as the base country, the third row by using Italy as the base country, and so on. All results are significant, at least at the 10% level. With values stretching from of -0.225 (Italy–the Netherlands) to -0.904 (the UK–Netherlands), the estimates range over a fairly large interval across country pairs. The high value for the country pair involving the UK and the Netherlands implies a half-life to a price shock of only about three and a half months. The mean of the bilateral estimates is -0.644, which corresponds to a half-life to a price shock of approximately eight months. As we mentioned earlier, we only utilise the time variations in price differences in these estimates. Obtaining such strong results in favour of convergence without making use of the cross-sectional dimension, the results confirm the presence of price convergence across national tractor markets.

Table 5. The speed of price adjustment for tractors across country pairs

	Fin	Ita	UK	Fra	Swe	NL
Ger	-0.715***	-0.434***	-0.583***	-0.801***	-0.554***	-0.740**
Fin		-0.355***	-0.268**	-0.607***	-0.739***	-0.762***
Ita			-0.576***	-0.724***	-0.613***	-0.934*
UK				-0.372**	-0.784***	-0.614**
Fra					-0.714***	-0.860***
Swe						-0.527*

***, ** and * indicate a significance at the 1%, 5% and 10% levels, respectively

We find a negative correlation between distance (measured as kilometres between countries) and the convergence estimates (the coefficient of correlation equals -0.40).¹⁸ This might be due to the comparatively large transport costs between distant locations, and/or differences in demand between not least Italy (with its large fraction of small farms) and the other countries (with their higher shares of large farms).

Results for machinery and other agricultural equipment

We have additionally used our estimated tractor price level as a proxy for the price index for machinery and other agricultural equipment (also provided by Eurostat). Apart from the price level for tractor prices being a poorer proxy for the actual price level, it is moreover most likely that this index includes a much more heterogeneous product group than “Tractors”, as the demand for machinery and equipment probably differs significantly across countries. The estimates, hence, are not as reliable as for tractors, but they may serve as a weak indication of market integration.

The regression is performed in the same manner as in the previous part, but Finland had to be dropped due to lack of data. As shown in Table 6, the estimated β -value of -0.140 is, as

¹⁸ We have used the different measures for distance between countries provided by Head et al. (2010) at GeoDist (CEPII). The results are similar regardless of the measure.

expected, considerably lower compared with the β -value in the tractor estimation. Note also that the individual α :s for the Netherlands, the UK and France are all insignificant, i.e. only *Italy* and *Sweden* are significant with a remaining positive price difference relative to Germany of 16.1 and 7.7% respectively. The results for machinery and other agricultural equipment are therefore not as significant, which could be expected given the diversity of the category and because the price level of tractors has been used as a proxy for the price level.

Table 6. The speed of price adjustment for other agricultural equipment

Dependent variable:	Base: GE	P-value	Half-life	$p_{k,t}/-\beta$	P-value
$\Delta p_{k,t}$					
$p_{k,t}$	-0.140 **	0.014	4.588**	—	
$\Delta p_{k,t-1}$	1.192 ***	0.000	—	—	
$\Delta p_{k,t-2}$	-0.713 ***	0.000	—	—	
$\Delta p_{k,t-4}$	0.131 *	0.060	—	—	
Ita	-0.023 ***	0.004	—	0.161 ***	0.000
NL	-0.007	0.169	—	0.048	0.140
Swe	-0.011 **	0.050	—	0.077 **	0.027
UK	0.0002	0.967	—	-0.002	0.967
Fra	-0.006	0.255	—	0.041	0.206

7. Summary and conclusions

An integrated market for agricultural machinery and equipment is important for farmers, as tractors and other agricultural machinery are big investments. Recent integration efforts to smooth intra-EU trade of agricultural tractors can therefore increase the competitiveness of European agriculture as well as the agricultural equipment industry. By focusing on price data for tractors in Finland, France, Germany, Italy, the Netherlands, Sweden and the UK, this study has assessed the state of market integration for this particular type of agricultural machinery.

Using Germany as our benchmark country, we find that the mean price difference in the year 2011 equals 10.3%. Between some countries, the mean price difference is as large as 30%. We also find evidence of price divergence from 2005 to 2011, although the opposite is true for some countries. We find that price differentials between two countries vary significantly across models, and to a smaller extent between models that share a common brand.

Although large price differences prevail, our results show that on average they converge relatively quickly on a steady state price differential. The half-life of a price shock is estimated to be about a year and four months, and in the bilateral case the speed of convergence is significantly higher for some country pairs. The results resemble the outcomes of studies regarding the EU car market and traded goods between US states, although we find that the convergence rate for country pairs in close proximity is far higher compared with previous studies. One explanation may be that tractors are a relatively large, tradable component compared with most other manufactured goods and even cars. For other agricultural equipment, the convergence rate is present although significantly slower. The results for other equipment are flawed, however, by the very heterogeneous nature of the product group, for which we have poorer data quality.

Although the rate of price convergence is comparably high, the price differences for some country pairs are indeed small by the end of 2011, while price differences between such countries as Finland and Italy are still substantial. There are a number of plausible explanations for the price differences estimated. Even though we control for some quality

differences, there are likely some unobserved quality differences across countries. Another reason may be that distributors and manufacturers are able to exploit market power, a possibility that is prevalent concerning domination by a few. Some studies suggest that local distribution costs are vital for explaining price differences, for which we test and find some support. Differences in demand may be another factor, as we find that prices seem to be determined by the demand regarding size. In countries that have predominately small farms, the prices of smaller tractors are comparatively low. The distribution costs of infrequently sold tractors may inflict additional costs, although the price differences seem too large to be fully explained by such a consideration.

Another possible explanation for the price differences is transport costs. The negative correlation between price convergence and distance supports this idea. This notion is further confirmed as we find that a tractor model in the country in which it is assembled is priced lower compared with other models of the same brand. The proportion of the price difference that is attributable to whether the tractor is manufactured in the domestic country or another EU country suggests that the cost of transporting a tractor across EU countries represents about 6% of the final price.

Finally, our analysis shows that tractor prices may also vary significantly within countries, although to a smaller extent, than across countries. The finding that tractor prices seem to be lower in German states with large farms than in states with small farms suggests that buying power is a key observation explaining tractor prices within countries. As these regional prices within Germany are calculated as final prices and not list prices, they also shed some light on the extent to which list prices may obscure actual prices. This finding also adds to the insight that markets are not only segmented across national borders, but also among farmers according to buying power, although integration efforts will continue.

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Appendix. Data sources

Dutch tractor list prices are found in *Landbouw Trekkers 2007* as a supplement to the magazine *Boerderij*. Finnish list prices are published by OTAVAMEDIA on the website for the magazine *Käytännön Maamies* (www.kaytannonmaamies.fi). French list prices are provided by BCMA-TRAME. German prices are found in the yearly tractor catalogue *Schlepperkatalog* and recalculated to list prices based on the editor's estimate of the discount rate of list prices. Italian list prices are found in supplements to the Italian magazine *L'Informatore Agrario*. Swedish list prices are published by LRF Media (see "Traktorkalendern" at www.dinbonus.se). UK list prices are found in the magazine *Farmers Weekly* published by Reed Business Information Limited.

Price indices for "Agricultural tractors", "Machinery and other agricultural equipment" and "Labour costs" were derived from Eurostat (<http://epp.eurostat.ec.europa.eu>). Data on the international trade of tractors were taken from FAOSTAT (<http://faostat.fao.org/site/576/default.aspx#ancor>).

Market concentration for individual national tractor markets was calculated based on data from *ATL* (www.atl.nu) for Sweden and Finland, the *Farmers Guardian* (www.farmersguardian.com) for the UK, *Terre-net.fr* (www.terre-net.fr) for France, *profi* (www.profi.de) for Germany, Federatie Agrotechniek (www.agrotechniek.org) for the Netherlands, and *Macchine Trattori* (www.machinettrattori.inf) for Italy.



Comparative Analysis of Factor Markets for Agriculture across the Member States

245123-FP7-KBBE-2009-3

The Factor Markets project in a nutshell

Title	Comparative Analysis of Factor Markets for Agriculture across the Member States
Funding scheme	Collaborative Project (CP) / Small or medium scale focused research project
Coordinator	CEPS, Prof. Johan F.M. Swinnen
Duration	01/09/2010 – 31/08/2013 (36 months)
Short description	<p>Well functioning factor markets are a crucial condition for the competitiveness and growth of agriculture and for rural development. At the same time, the functioning of the factor markets themselves are influenced by changes in agriculture and the rural economy, and in EU policies. Member state regulations and institutions affecting land, labour, and capital markets may cause important heterogeneity in the factor markets, which may have important effects on the functioning of the factor markets and on the interactions between factor markets and EU policies.</p> <p>The general objective of the FACTOR MARKETS project is to analyse the functioning of factor markets for agriculture in the EU-27, including the Candidate Countries. The FACTOR MARKETS project will compare the different markets, their institutional framework and their impact on agricultural development and structural change, as well as their impact on rural economies, for the Member States, Candidate Countries and the EU as a whole. The FACTOR MARKETS project will focus on capital, labour and land markets. The results of this study will contribute to a better understanding of the fundamental economic factors affecting EU agriculture, thus allowing better targeting of policies to improve the competitiveness of the sector.</p>
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Website	www.factormarkets.eu
Partners	17 (13 countries)
EU funding	1,979,023 €
EC Scientific officer	Dr. Hans-Jörg Lutzeyer

