And/or Markets:

Is there a Belgian Wholesale Electricity Market?

Dr. E. Dijkgraaf

Prof. dr. M.C.W. Janssen

Erasmus Competition and Regulation institute

Erasmus University Rotterdam

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Contact:
Elbert Dijkgraaf
SEOR-ECRi
Erasmus University Rotterdam
Room H 7-25
P.O. Box 1738
3000 DR Rotterdam
The Netherlands
Email: dijkgraaf@few.eur.nl
Phone: (31) 10 4082590

1. Introduction

Relevant markets are typically defined by answering the question whether two products are substitutes for each other. Demand substitution between product A and B implies that given the relevant price ranges (many) consumers will likely switch to product B if firms producing product A will raise their prices by a non-marginal amount. Supply substitution between product A and B implies that potential suppliers of B do not face substantial obstacles to supplying products or services on market A if the price of A would increase by a non-marginal amount. The relevant market combines the product market and the geographic market, defined as follows (EU, 1997):

- a relevant product market comprises all those products and/or services which are regarded as interchangeable or substitutable by the consumer by reason of the products' characteristics, their prices and their intended use;
- a relevant geographic market comprises the area in which the firms concerned are involved in the supply of products or services and in which the conditions of competition are sufficiently homogeneous.

If a competition authority concludes that no single product acts as a full substitute, then the product under consideration is considered to constitute its own relevant product market and the HHI calculated in that market is considered to be a proper indication of whether that market is concentrated and a firm's market share in that market a proper indication of whether a firm has a dominant position.

In this paper we want to provide an example of a product for which no single alternative product can act as a full substitute, but a combination of these same products can. The importance of the example is that in certain circumstances we have to reconsider the standard procedure used for defining the relevant market.

The example we have in mind is wholesale electricity in Belgium and the question we want to address is whether there is a Belgian wholesale market for electricity, or whether the market should be considered more widely. This is a very relevant question in the light of the European program on the liberalization of electricity markets. In the past, the production (and distribution) of electricity in each individual European country was in the hands of local government-owned agencies. The capacity to import and export electricity was also rather limited. Part of the liberalization of electricity markets involved enlarging the capacity to trade electricity across borders and an important question now is whether this enlarged capacity is such that electricity produced in neighboring countries can act as a substitute for domestically produced electricity in satisfying local demand.

Electricity itself is of course a homogeneous good. The question concerning the definition of the relevant market is thus mainly a question concerning the definition of the geographical market (and whether import capacity is large enough). Due to the arbitrage possibilities, electricity prices in the different countries should be identical if import capacity is abundant so that there is one geographical market. Even more, since November 21, 2006 the power exchanges of the Netherlands, Belgium and France are linked and the interconnection capacity is optimally used in the bidding process so that arbitrage possibilities are automatically exploited if existing. Electricity prices can only be different across different neighboring countries if import capacity forms a bottleneck.

However, due to the fact that electricity cannot be stored, there is also a time dimension in defining the market: the electricity market between 8 and 9 am, for example, is different from the market between 9 and 10 pm. Import capacity may be large enough in non-peak hours to be able to speak about an non-peak market that is larger than an individual country, but if this capacity is still too small in peak hours to be able to provide domestic users an alternative supply, then the conclusion may be that one should stick to a narrowly defined market (certainly for peak hours). This is especially the case as large firms may benefit tremendously from a dominant position during peak hours. The fact that overall the different national electricity wholesale prices seem to be close to each other may not be enough reason for competition authorities to conclude that there is one (large) relevant market as market power (if existing) can imply very high profits in a relatively small period.

In this paper we show that the French and Dutch electricity production by itself cannot be considered a full substitute for electricity produced in Belgium as there are hours during the day where import capacity forms a bottleneck for an integrated market. However, at each point in time, French *or* Dutch electricity production (together) can be considered a full substitute for Belgian produced electricity as the wholesale electricity prices in Belgium are always almost identical to French or Dutch prices.

The definition of the relevant electricity market has important repercussion for how to consider firm conduct or possible (horizontal or vertical) mergers. If Belgium is the relevant product market, a firm like Electrabel has a dominant position in the wholesale market which they could potentially exploit. If the geographical market is wider, however, then Electrabel may not be considered a dominant firm and its behavior is constrained by French and-or Dutch electricity producers.

It is clear that a firm producing electricity in country A is more constraint in its behavior by electricity producers in countries B and/or C than by producers in countries B only or C only. How large the "and/or" effect is depends on the size of the different cross border interconnection capacities in relation to the size and form (nuclear, gas, coal) of domestic electricity demand and supply. We show that in comparison to other countries Belgium has a relatively large cross border interconnection capacity implying that the "and/or" effect in Belgium should be larger than in neighboring countries. The analysis shows that the effect for Belgium is so large that at any point in time, there is always some other country that forms a competitive constraint on the Belgian wholesale market.[1] Thus, the HHI index calculated using Belgian market shares only does not provide a measure of whether the Belgian wholesale electricity market is concentrated and a large market share in Belgium does not mean that that producer has a dominant position, as the market is always larger than Belgium. This, of course, does not mean that we may never expect to observe high prices in the Belgian wholesale market. However, when the Belgian wholesale prices are high the corresponding prices in France and/or The Netherlands are also high.

As far as we know, this is the first article analyzing the issue of market definition by taking the possibility of a competitive constraint imposed by multiple alternative products (countries) into account. There exists, of course, some literature taking a more traditional approach toward market definition analyzing the process of price convergence in wholesale European electricity markets.[2] For instance, Zachmann (2005) finds, using hourly data up to 2004, clear convergence between Germany and the Netherlands for 12 out of 24 hours. However, there

[1] A similar analysis for other countries such as The Netherlands shows that there are moments in time when the Dutch wholesale electricity market behaves independently of any of the French, Belgian or German markets. See also appendix C.

[2] Many papers analyze the price level itself as electricity has some characteristics that result in a different pricing behavior compared with other products (e.g. Knittel and Roberts, 2005 and Mount et al. 2006). As long as electricity producers belong to the same market this literature does not interfere with our study. However, it might explain why prices in countries differ at some points of time.

was no full convergence at the end of this period, since significant price differentials for peak hours were still present. Armstrong and Galli (2005) find that also for peak hours the differential decreased between 2002 and 2004. They used hourly data for Germany, France, the Netherlands and Spain. Bosco et al (2006) find strong, but not perfect, integration of the German, French, Austrian and Dutch market using weekly median data for the period March 2002 till June 2006. Dijkgraaf and Janssen (2007) explore price convergence further as new hourly data are available for 2007. Their paper shows that the process of price convergence has continued since 2005 also for peak hours and that it is likely that in some years from now there will be a fully integrated European wholesale electricity market. Robinson (2007) uses yearly data as this makes it possible to study convergence from a longer historical perspective. He concludes that a process towards convergence is present using yearly data for nine EU-countries from 1978 till 2003.

The rest of the paper is as follows. In Section 2 we describe the methodology employed, the data used and some descriptive statistics. Section 3 gives the results and Section 4 concludes.

2. Methodology, data and descriptive statistics

As explained in the introduction, electricity prices vary by the hour as electricity is a non-storable product. Daily per hour wholesale prices for the one-day-ahead market in Belgium, France, Germany and The Netherlands over the period of 21 November 2006 until 31 December 2007 (405 observations for each hour in four countries) are publicly available.[3] The starting date is chosen to be 21 November 2006 as this is the date that the Belgian power exchange started and the power exchanges of the Netherlands, Belgium and France were coupled. These prices are taken from the respective national electricity power exchanges BELPEX, PWXT, EEX and APX. To get some feeling for these data, Figure 1 gives a picture of how average electricity prices per hour vary over the 24 hours of a day. Figure 2 provides a few time series of how hourly electricity prices have varied over the time horizon.

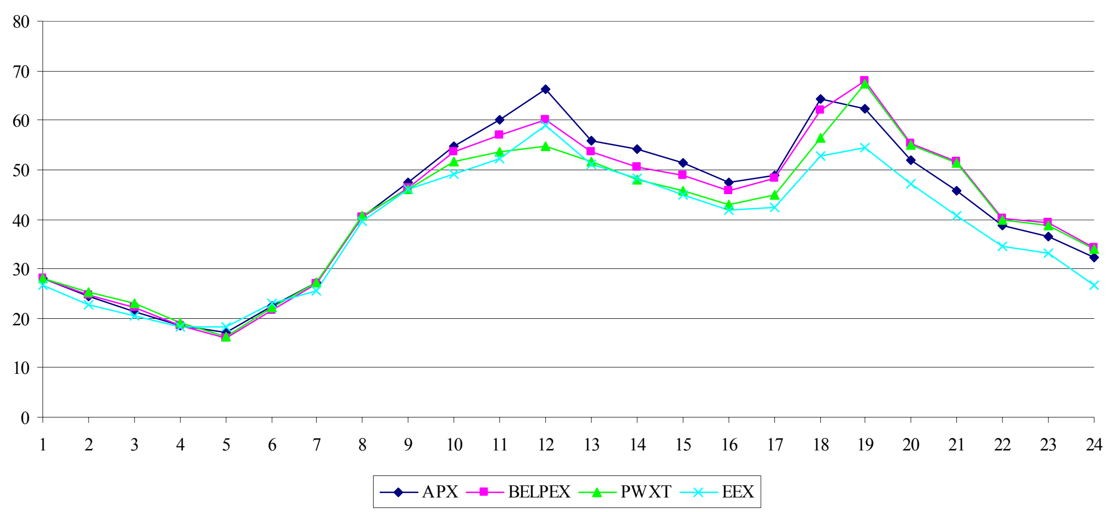
These descriptive statistics make two things very clear. First, from Figure 1 it is clear that there is a difference between peak hours and non-peak hours, with peak hours being defined as the 9th till the 20th hour.[4] Prices in peak hours are around €45/MWh and higher. Prices in

[3] See www.apx.nl, www.eex.com, www.belpex.be and www.powernext.fr.

[4] Of course, one can argue where the exact boundary between peak and non-peak hours is. This is not to deny, however, that there is a marked difference between the two periods.

non-peak hours are typically around €40/MWh and lower. Prices in the peak period itself have two marked peaks, around noon and around the 19th hour. This difference plays also some role in the details of the interpretation of our results in the next Section. Second, in Figures 2a and 2b, we have depicted a typical time series of one peak and one non-peak hour as a function of time. From the Figures it is clear that there is much more variation in the peak hour series than in the non-peak hour series.[5] Moreover, the two pictures convey the idea that the time series we are dealing with are stationary. If we want to be justified in simply regressing hourly wholesale electricity prices in one country on (composite) hourly wholesale electricity prices of (a set of) other countries using OLS, then we should exclude the possibility of the time series being non-stationary. Of course, we will provide more formal tests of the stationary of the time series later on.

Figure 1. Average price in €/MWh per hour



So, in the next section we test for stationarity using $y_t = \alpha + \beta t + \gamma y_{t-1} + \varepsilon_t$ (or an adaptation of this form with α=0 and/or β=0), where y_t is the price of wholesale electricity in a certain country and a certain hour at day *t* and α, β and γ are parameters to be estimated, and show, using an augmented Dickey-Fuller test (see, e.g., Greene, 2000), that we can reject the hypothesis that there is a unit root.[6] Accordingly, we subsequently perform the standard

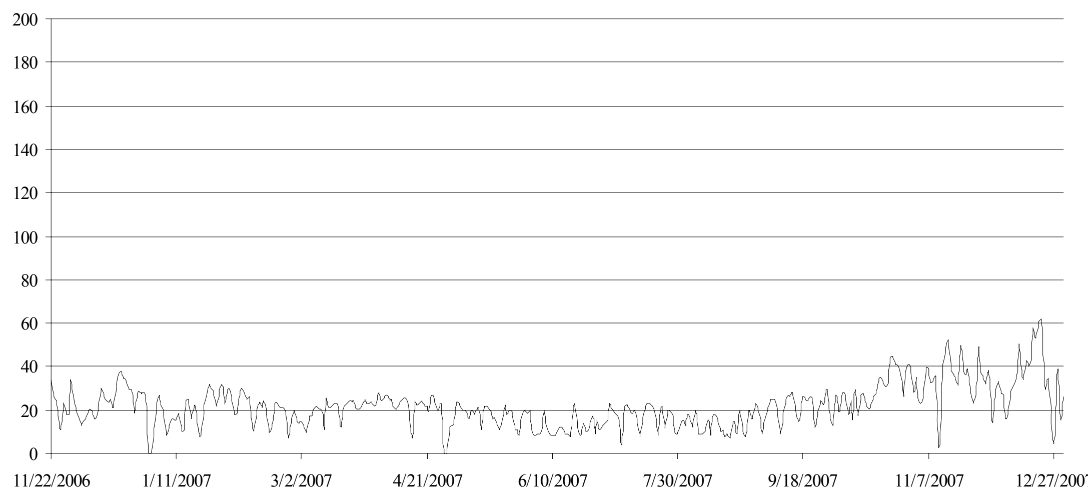
[5] To make the figures comparable, the horizontal axis has a maximal value of 200 euro per MW. For the 18th hour 16 days show a higher price than this maximum. Note that price spikes are a regular phenomenon in electricity markets (Huisman and Mahieu, 2003).
[6] If we would allow for specifications with very flexible lag structures, one may find some periods for which the null hypothesis of the existence of unit roots cannot be rejected. However, there does not seem to be a very good explanation of why we should allow for these very flexible structures. Furthermore, we analyze whether our

approach in the literature (e.g. Armstrong and Galli, 2005 and Zachman, 2005) and do a simple regression analysis of the form

$$P_{h,t}^{j} = \alpha + \beta P_{h,t}^{i \neq j} + \varepsilon \qquad (1)$$

where $P_{h,t}^{j}$ are the price of wholesale electricity in country *j* at a certain hour *h* at day *t*.[7] If the two countries have one fully integrated market, one should expect to find that α=0 and β=1. Apart from the coefficients, the R^2 is also a very relevant indicator of how tight electricity prices in two countries are connected to each other. Even if the coefficients are close to what is expected it may be that the R^2 is still not very high, indicating that there are days in which the prices in the two countries show a significant difference. Only when α=0, β=1 and the R^2 is close to 1, can we speak of an integrated market where the price in one country imposes a competitive constraint on the price of another country at (almost) every moment.

Figure 2a. Price hour 6 in €/MWh at BELPEX per day



To test the idea that a competitive constraint is imposed by a combination of countries, but not by one country on its own, we perform a similar analysis but we replace the price of one other country as "explanatory" variable, by a composite variable (MIX), where for each day we take that observation from the set of three observations for other countries that is closest to the price observation of the country that needs to be explained.

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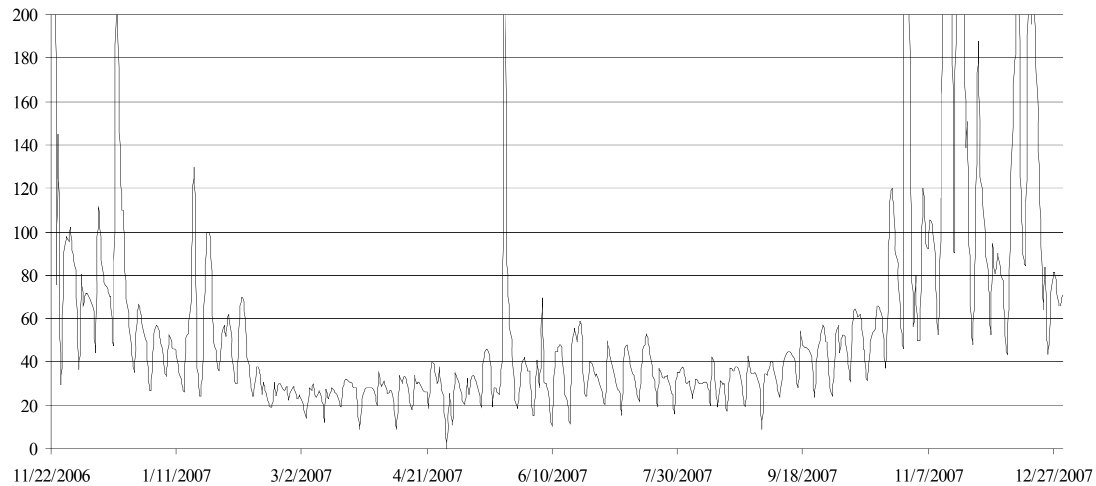
conclusions are robust for estimations in first differences while tests show that prices in first differences are always stationary.

[7] Including a trend in the estimations does not change our conclusions.

Figure 2b. Price hour 18 in €/MWh at BELPEX per day



Of course, one already can get some idea whether prices are significantly similar to each other by simply looking what percentage of the days electricity prices in two countries differ less than 1% or 5% from each other or from the composite prices. These descriptive statistics for all four countries are presented in Table 1 for a 1% difference.

Table 1a. Observations (%) with less than 1% price difference: all hours

	APX	BELPEX	EEX	PWXT
APX	-	74	6	63
BELPEX	74	-	6	88
EEX	6	6	-	6
PWXT	63	88	6	-
MIX	75	98	8	89

Table 1b. Observations (%) with less than 1% price difference: peak hours

	APX	BELPEX	EEX	PWXT
APX	-	72	6	60
BELPEX	72	-	6	87
EEX	6	6	-	6
PWXT	60	86	6	-
MIX	73	98	8	87

Table 1a clearly shows that Belgian wholesale electricity prices differ almost always less than 1% from either the Dutch or the French electricity prices. Comparing the Belgian wholesale electricity prices with the composite price of Dutch, French and German prices (MIX) shows that the fit is almost perfect. This is not nearly so perfect the case for other countries. Note, however, that the focus of our paper is on the Belgian market. For France or Germany other markets (like Austria, Italy and Spain) are potentially relevant as well.

Table 1b repeats the same analysis but now for peak hours. The differences between the two tables are remarkably small.

One explanation for this almost perfect fit between the Belgian electricity prices and the composite price of French, Dutch and German electricity prices is that the interconnection capacity, expressed as a percentage of the total nationwide available production capacity is indeed the highest in Belgium as described in Table 2.

Table 2. Interconnection capacity (% of installed production)

Country	Interconnection capacity 2005
Belgium	29
Netherlands	17
France	13
Germany	11

Source: Schwarz and Lang (2006)

3. Results

In this section we first provide three sets of results for Belgium. The first set of results concerns the preliminary test on the stationarity of the time series involved. As we can clearly reject the hypothesis that the time series are non-stationary, we can simply perform an OLS analysis of the relation between Belgian electricity prices and corresponding prices in neighboring countries. Although the analysis shows that at most time moments, electricity prices are very close to each other, there are also notable exceptions where potentially large players could benefit from their position in the market. When the individual comparisons between countries are replaced by a comparison between the Belgian wholesale prices and a composite price that is constructed in such a way that at each moment the price of the country that is the closest to the Belgian price is taken, even these periods of notable exceptions disappear.

Testing for non-stationarity (unit roots)

As described in the former section we test for stationarity using the augmented Dickey-Fuller test. Table 3 presents the result for the hypothesis of a unit root in the BELPEX prices. This hypothesis is rejected for nearly all 24 hours. Only for hours 1, 2, 23 and 24 when no constant and no trend are included, a unit root is not rejected at the usual level of 5%.[8] As unit-root tests for APX, EEX and PWXT reveal the same pattern, we have ample evidence that OLS estimations are allowed.[9] Nevertheless, we present also estimation results for data in first differences.

Table 3. Stationarity test BELPEX

	Constant and trend		Constant		No constant, no trend	
	Test	Prob.	Test	Prob.	Test	Prob.
1	**-5.58**	0.00	**-4.83**	0.00	-1.67	0.09
2	**-5.86**	0.00	**-5.27**	0.00	-1.87	0.06
3	**-6.27**	0.00	**-5.68**	0.00	**-2.06**	0.04
4	**-6.79**	0.00	**-6.34**	0.00	**-2.49**	0.01
5	**-7.39**	0.00	**-6.93**	0.00	**-2.91**	0.00
6	**-7.62**	0.00	**-7.04**	0.00	**-2.62**	0.01
7	**-8.75**	0.00	**-7.89**	0.00	**-3.57**	0.00
8	**-9.07**	0.00	**-8.20**	0.00	**-4.08**	0.00
9	**-9.58**	0.00	**-8.31**	0.00	**-3.91**	0.00
10	**-10.49**	0.00	**-9.39**	0.00	**-5.11**	0.00
11	**-11.58**	0.00	**-10.67**	0.00	**-6.22**	0.00
12	**-11.17**	0.00	**-10.45**	0.00	**-6.08**	0.00
13	**-9.77**	0.00	**-8.54**	0.00	**-3.63**	0.00
14	**-10.84**	0.00	**-9.89**	0.00	**-4.56**	0.00
15	**-12.35**	0.00	**-11.78**	0.00	**-6.68**	0.00
16	**-12.59**	0.00	**-12.03**	0.00	**-7.07**	0.00
17	**-12.20**	0.00	**-11.65**	0.00	**-7.42**	0.00
18	**-12.56**	0.00	**-11.82**	0.00	**-8.74**	0.00
19	**-10.81**	0.00	**-10.22**	0.00	**-8.16**	0.00
20	**-10.09**	0.00	**-9.33**	0.00	**-6.15**	0.00
21	**-13.42**	0.00	**-13.00**	0.00	**-10.75**	0.00
22	**-7.51**	0.00	**-6.22**	0.00	**-2.71**	0.01
23	**-5.75**	0.00	**-4.65**	0.00	-1.67	0.09
24	**-5.99**	0.00	**-5.00**	0.00	-1.90	0.05

Bold test statistics are significant at 5%. Probability is based on MacKinnon (1996) one-sided test-statistic

Individual comparisons between Belgium and France

We next present the results of the analysis where Belgian wholesale electricity prices are compared with similar prices in the surrounding countries In the tables we present, we focus on the relation with France (as this is the strongest link) and in the text we also comment on what we see in a similar analysis for other countries (The Netherlands and Germany). For every hour of the data, the analysis is based on estimating the coefficients of equation (1). Table 4 presents the estimation results for estimating equation (1) for every hour separately

[8] Note that a unit root is rejected at 10% in all cases.
[9] For full results see Appendix A.

with French PWXT prices as explanatory variables and Belgian prices as the variable to be explained and we use a Wald-test to test the hypothesis that the coefficients are equal to 0 and 1, respectively.

It becomes clear from reading the table that in almost all peak hours (except for hours 12 and 13) we cannot reject the hypothesis that the coefficients are indeed equal to 0 and 1 (what needs to be the case when markets are fully integrated). In non-peak hours, this null hypothesis should be rejected, however. These first observations should be treated with some care, however. First, the estimated values are almost never equal to 0 and 1 and, moreover, the R^2 is reasonably high, but also not very close to 1 indicating that there is no perfect match between the prices in the two countries even in peak hours (where the test result is positive).

Table 4. Estimation results BELPEX as function of PWXT

	PWXT		Constant			Wald-test[1]		Difference		
	Coef	St. error	Coeff	St. error	R^2	Stat	Prob	Effect[2]	% mean	Conclusion
1	**0.97**	0.01	**0.99**	0.26	0.97	**7.97**	0.00	0.03	0.12	Rejected
2	**0.91**	0.01	**1.53**	0.34	0.93	**35.01**	0.00	-0.64	-2.52	Rejected
3	**0.84**	0.02	**2.68**	0.43	0.86	**59.87**	0.00	-1.03	-4.47	Rejected
4	**0.88**	0.02	**1.65**	0.35	0.88	**31.19**	0.00	-0.56	-2.92	Rejected
5	**0.95**	0.01	**0.57**	0.25	0.92	**7.03**	0.00	-0.19	-1.18	Rejected
6	**0.92**	0.02	**1.20**	0.40	0.89	**16.21**	0.00	-0.52	-2.33	Rejected
7	**0.97**	0.01	0.32	0.31	0.96	**6.70**	0.00	-0.39	-1.44	Rejected
8	**0.99**	0.01	0.18	0.43	0.97	2.09	0.12	-0.34	-0.83	OK
9	**1.00**	0.01	0.50	0.49	0.97	1.25	0.29	0.40	0.87	OK
10	**1.00**	0.02	1.53	1.43	0.84	1.94	0.14	1.73	3.35	OK
11	**1.01**	0.04	2.89	2.98	0.57	1.49	0.23	3.20	5.95	OK
12	**1.05**	0.06	2.41	3.94	0.44	**3.12**	0.05	5.18	9.46	Rejected
13	**1.02**	0.03	0.45	1.54	0.79	**3.35**	0.04	1.72	3.32	Rejected
14	**1.04**	0.05	0.73	2.85	0.48	2.34	0.10	2.47	5.14	OK
15	**1.08**	0.10	-0.27	5.18	0.21	1.29	0.28	3.17	6.94	OK
16	**1.06**	0.10	0.07	4.96	0.21	0.97	0.38	2.78	6.48	OK
17	**1.02**	0.07	2.61	3.75	0.37	1.07	0.34	3.29	7.32	OK
18	**1.01**	0.04	4.95	3.16	0.66	2.69	0.07	5.53	9.80	OK
19	**1.00**	0.00	0.50	0.29	1.00	2.10	0.12	0.51	0.76	OK
20	**1.00**	0.00	0.09	0.17	1.00	0.18	0.84	0.07	0.13	OK
21	**1.00**	0.00	0.24	0.15	1.00	1.41	0.25	0.22	0.44	OK
22	**0.98**	0.01	**1.03**	0.39	0.97	**4.22**	0.02	0.05	0.13	Rejected
23	**0.95**	0.01	**2.25**	0.45	0.95	**12.83**	0.00	0.43	1.11	Rejected
24	**0.97**	0.01	**1.47**	0.31	0.97	**11.45**	0.00	0.39	1.15	Rejected

1. Wald test is the test that the coefficient for PWXT = 1 and the constant =0.
2. The effect is calculated at the sample mean and given in euro per MWh difference with the sample mean. Bold coefficients and test-statistics are significant at 5%.

Moreover, we have also estimated the average price difference and it turns out that this average price difference can be larger in peak hours where the test result is positive than in non-peak hours where the test result shows that the two series are not identical. Economic significance (in terms of whether or not firms can gain significant profits because of price margins) is thus not identical to statistical significance. For instance, Table 4 shows that the average price difference in hour 1 is €0.03 per MWh and a statistical test result indicating that the two series are not identical, whereas the average price difference in hour 18 is €5.53 and a statistical test result indicating that the two series are identical. The reason for this is that the prices in non-peak hours are very stable (see Figure 2a in the previous section) so that small deviations may have a larger impact on the estimation results. Peak prices vary so much over time that relative small deviations do not impact on the estimated values of coefficients. This is reflected in the value of the R^2, which is often lower in peak hours than in non-peak hours. Overall, we conclude from Table 4 that the wholesale electricity prices in Belgian and France are somewhat close to each other on many moments, but that there are still some significant differences.

The overall picture with respect to German and Dutch prices as explanatory variables reveals that the relation with Belgian electricity prices is less tight than that with France. Full integration is rejected in nearly all hours (21 for German versus Belgian prices and 22 for Dutch versus Belgian prices).[10] Although full integration is rejected for many hours, price differences between the Netherlands and Belgium are very small in the majority of time periods (Table 1).

Comparing Belgian prices with a composite price

Next, we present the results of a similar analysis as before, but now with the French prices replaced by a composite price, where this composite price is constructed out of the original French, German and Dutch prices in such a way that at each time period the composite price is either the French, German or the Dutch price, whichever is closest to the Belgian price. As explained before, the idea behind this construction is that because of the homogeneity of electricity and the perfect arbitrage possibilities, electricity flows to wherever the price is lowest if there is sufficient interconnection capacity. So, in this way we can test whether there is any moment in time where Belgian electricity prices are different from any of its three neighboring countries. If not, then one can rightfully claim that the Belgian market is always larger than Belgium itself.

[10] Full tables are provided in Appendix B.

Table 5. Estimation results BELPEX as function of MIX

	MIX		Constant			Wald-test[1]		Difference		
	Coef	St. error	Coeff	St. error	R^2	Stat	Prob	Effect[2]	% mean	Conclusion
1	**1.00**	0.00	0.02	0.04	1.00	0.68	0.51	-0.01	-0.04	OK
2	**0.99**	0.00	0.09	0.09	1.00	2.66	0.07	-0.05	-0.20	OK
3	**1.00**	0.00	0.05	0.10	0.99	0.74	0.48	-0.03	-0.15	OK
4	**1.00**	0.00	0.09	0.09	0.99	1.47	0.23	-0.03	-0.16	OK
5	**1.00**	0.00	0.05	0.04	1.00	2.79	0.06	-0.02	-0.10	OK
6	**1.00**	0.00	-0.02	0.04	1.00	0.07	0.93	0.00	-0.01	OK
7	**1.00**	0.00	-0.01	0.05	1.00	0.46	0.63	-0.02	-0.09	OK
8	**1.00**	0.00	-0.04	0.06	1.00	0.67	0.51	0.01	0.03	OK
9	**1.00**	0.00	-0.03	0.12	1.00	0.72	0.49	-0.07	-0.16	OK
10	**1.00**	0.00	-0.10	0.12	1.00	0.34	0.71	-0.05	-0.09	OK
11	**1.00**	0.00	-0.08	0.08	1.00	0.49	0.61	-0.04	-0.08	OK
12	**1.00**	0.00	-0.08	0.09	1.00	0.43	0.65	-0.05	-0.08	OK
13	**1.00**	0.00	-0.11	0.09	1.00	0.84	0.43	-0.04	-0.07	OK
14	**1.00**	0.00	-0.13	0.08	1.00	1.61	0.20	-0.06	-0.11	OK
15	**1.00**	0.00	-0.06	0.04	1.00	0.86	0.42	-0.03	-0.07	OK
16	**1.00**	0.00	-0.04	0.04	1.00	0.57	0.57	-0.02	-0.05	OK
17	**1.00**	0.00	-0.06	0.05	1.00	0.55	0.57	-0.04	-0.07	OK
18	**1.00**	0.00	-0.06	0.05	1.00	0.76	0.47	-0.04	-0.07	OK
19	**1.00**	0.00	-0.05	0.04	1.00	0.70	0.50	-0.04	-0.06	OK
20	**1.00**	0.00	-0.06	0.05	1.00	0.84	0.43	-0.04	-0.07	OK
21	**1.00**	0.00	-0.06	0.05	1.00	0.80	0.45	-0.05	-0.10	OK
22	**1.00**	0.00	-0.06	0.09	1.00	0.24	0.79	-0.01	-0.03	OK
23	**0.99**	0.00	0.28	0.12	1.00	**4.92**	0.01	-0.05	-0.13	Rejected
24	**1.00**	0.00	-0.03	0.09	1.00	0.07	0.93	0.00	0.00	OK

1. Wald test is the test that the coefficient for MIX = 1 and the constant =0.
2. The effect is calculated at the sample mean and given in euro per MWh difference with the sample mean. Bold coefficients and test-statistics are significant at 5%.

Table 5 presents the results of this analysis. The results are striking. At any moment in time (except perhaps at hour 23) the estimated β coefficient of Equation (1) is exactly equal to 1.00 (or just differs by only 0.01), whereas the estimated α coefficient of Equation (1) is close to 0.00 and the null hypothesis that the coefficient equals 0 cannot be rejected for any hour. Moreover, for every hour the R^2 is exactly equal to 1.00 (or just differs by only 0.01), This means that two time series are really almost identical at any moment in time and the statistical Wald-test only rejects the hypothesis that the two series are identical in hour 23 (but this is again due to the fact that the time series in that hour is very stable as the difference is very small). Statistical significance in this case also coincides with economic significance: the average price difference in any hour is less than €0.07! We conclude from this that at any point in time there is no separate Belgian wholesale electricity market and that the market is always intimately connected to one of its three neighbors and no electricity company can enjoy market power in a separate Belgian market. For completeness, it turns out that the

German prices are almost never used as the basis for the composite price and that both the French and Dutch prices account for around 50% of the cases. Therefore, Belgian electricity prices are intimately connected to the corresponding prices of these two neighboring countries.

Extensions and comparison with other countries

As a robustness check we have carried out the same analysis also for the other three countries to see whether the same result applies to other countries as well. Table 6 reports the overall results. The first row summarizes the results for Belgium reported above. At 12 hours of the day the French prices are able to mimic the Belgian prices quite well and the corresponding Wald test cannot reject the hypothesis that the coefficients α and β are equal to 0 and 1, respectively. We also have seen that if the French prices are replaced by the composite price (see the variable MIX) this is true for 23 out of the 24 hours of the day. Table 6 shows that for the other three countries, market integration between these four countries is less developed.[11] The largest differences are visible for the German market. While price differences with other countries are between 4 and 10 euro, price difference between the APX, BELPEX and PWXT are much smaller. Given the market coupling of these prices this is not surprising.[12] As noted earlier, however, this analysis does not provide definitive conclusions about the German and French market as this would necessitate including also prices from e.g. Spain, Italy and Austria.

Table 6. Convergence and price difference: results based on basis estimations

		APX	PWXT	EEX	MIX
Number of hours convergence not rejected	BELPEX	2	12	3	23
	APX		1	0	0
	PWXT			1	11
	EEX				5
Absolute value average price difference (euro/MWh)	BELPEX	0.24	1.95	9.33	0.08
	APX		2.57	9.52	1.78
	PWXT			7.33	0.28
	EEX				4.59

[11] Full results are available in Appendix C.

[12] Park et al. (2006) shows even, using electricity price data for the United States, that a similar institutional framework (like trading structures) rather than physical connections explains integration of some markets.

We have also done a similar analysis using first-order difference rather than the original time series in absolute values. These results are reported in Table 7.[13] Table 7 confirms the picture of Table 6 in the sense that the Belgian market is almost fully integrated with the Dutch and French markets and that the market is larger than the Belgian market at almost any time of the day. The result for Belgium in first differences is, however, less pronounced than the result in terms of absolute values in the sense that now in 18 (instead of 23) hours the Wald test cannot reject the null hypothesis. However, convergence is only rejected for non-peak hours and results in very small price differences (between 0.2 and 1.4% of the mean price). Indeed, the R^2 is also 0.99 or 1.00 in all cases where convergence is rejected. Table 7 also shows that Belgium sticks out, in many more hours of the day the Belgian series are identical to any of its neighboring countries, compared to the other three countries.[14]

Table 7. Convergence: results based on first difference estimations

		APX	PWXT	EEX	MIX
Number of hours convergence not rejected	BELPEX	8	14	6	18
	APX		1	2	3
	PWXT			2	8
	EEX				6

4. Conclusion

In this paper we have argued that one has to be careful in defining electricity wholesale markets in Europe. Standard techniques of market definition suggest that the researcher investigates whether the conditions under which product B is provided impose a competitive constraint on the pricing behavior of firms producing product A. And similarly for products C, D, etc. If no such a product would impose a competitive constraint, then it is argued that product A is to be regarded as being in a separate market. If we would apply this line of argument to the North-west European wholesale electricity market, one would conclude that each country constitutes its own separate market. Or, more precisely, there are significant parts of the day where the market in a country behaves differently from markets in each of its neighboring countries. If one takes into account the possibility that product B or C (at least one of them at each moment in time) impose a competitive constraint on the pricing behavior

[13] The absolute value of the average price difference as reported in Table 5 is not given in Table 6 as the average of the first difference is (nearly) zero in all cases.

[14] Of course, we have to keep in mind here that France and Germany have other neighboring countries that have not been included in this analysis.

of firms producing product A, then our analysis shows that Belgium should not be regarded as having a separate wholesale electricity market.

Our analysis has thus two important conclusions. It points at a weakness of the standard approach towards market definition, especially when applied to wholesale electricity markets. Moreover, at a more substantial level it argues that it is misleading to analyze the Belgian wholesale electricity market as if it is a market that is separated from its neighbors.

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Appendix A. Unit-root tests APX, EEX, PWXT and MIX

Table A.1. Stationarity test APX

	Constant and trend		Constant		No constant, no trend	
	Test	Prob.	Test	Prob.	Test	Prob.
1	**-5.87**	0.00	**-5.04**	0.00	-1.31	0.18
2	**-6.08**	0.00	**-5.56**	0.00	-1.47	0.13
3	**-6.83**	0.00	**-6.32**	0.00	-1.82	0.07
4	**-7.72**	0.00	**-7.34**	0.00	**-2.32**	0.02
5	**-8.47**	0.00	**-8.06**	0.00	**-2.73**	0.01
6	**-9.00**	0.00	**-8.30**	0.00	**-2.61**	0.01
7	**-9.81**	0.00	**-8.86**	0.00	**-3.43**	0.00
8	**-9.57**	0.00	**-8.76**	0.00	**-3.93**	0.00
9	**-10.44**	0.00	**-9.21**	0.00	**-4.04**	0.00
10	**-10.20**	0.00	**-9.22**	0.00	**-4.23**	0.00
11	**-11.51**	0.00	**-10.85**	0.00	**-5.47**	0.00
12	**-11.25**	0.00	**-10.79**	0.00	**-5.74**	0.00
13	**-10.12**	0.00	**-9.19**	0.00	**-3.57**	0.00
14	**-11.27**	0.00	**-10.60**	0.00	**-4.69**	0.00
15	**-12.49**	0.00	**-12.09**	0.00	**-6.63**	0.00
16	**-12.78**	0.00	**-12.39**	0.00	**-7.06**	0.00
17	**-12.30**	0.00	**-11.91**	0.00	**-7.04**	0.00
18	**-12.49**	0.00	**-11.87**	0.00	**-8.44**	0.00
19	**-7.98**	0.00	**-7.42**	0.00	**-4.77**	0.00
20	**-5.75**	0.00	**-5.17**	0.00	**-2.49**	0.01
21	**-4.87**	0.00	**-4.14**	0.00	-1.50	0.13
22	**-5.36**	0.00	**-4.30**	0.00	-1.26	0.19
23	**-6.31**	0.00	**-5.19**	0.00	-1.14	0.23
24	**-5.55**	0.00	**-4.60**	0.00	-1.11	0.24

Bold test statistics are significant at 5%. Probability is based on MacKinnon (1996) one-sided test-statistic. Tested hypothesis is presence of unit root.

Table A.2. Stationarity test EEX

	Constant and trend		Constant		No constant, no trend	
	Test	Prob.	Test	Prob.	Test	Prob.
1	**-7.63**	0.00	**-6.88**	0.00	-1.93	0.05
2	**-8.05**	0.00	**-7.67**	0.00	**-2.26**	0.02
3	**-8.64**	0.00	**-8.40**	0.00	**-2.68**	0.01
4	**-9.11**	0.00	**-8.97**	0.00	**-3.01**	0.00
5	**-8.80**	0.00	**-8.57**	0.00	**-2.94**	0.00
6	**-10.06**	0.00	**-9.60**	0.00	**-2.99**	0.00
7	**-10.60**	0.00	**-9.87**	0.00	**-4.19**	0.00
8	**-10.98**	0.00	**-10.29**	0.00	**-5.11**	0.00
9	**-10.69**	0.00	**-9.96**	0.00	**-4.94**	0.00
10	**-9.89**	0.00	**-9.06**	0.00	**-4.00**	0.00
11	**-9.76**	0.00	**-8.89**	0.00	**-3.85**	0.00
12	**-10.62**	0.00	**-9.88**	0.00	**-4.52**	0.00
13	**-9.82**	0.00	**-8.89**	0.00	**-3.31**	0.00
14	**-10.40**	0.00	**-9.50**	0.00	**-3.83**	0.00
15	**-10.43**	0.00	**-9.56**	0.00	**-3.95**	0.00
16	**-10.20**	0.00	**-9.26**	0.00	**-3.84**	0.00
17	**-8.61**	0.00	**-7.81**	0.00	**-3.68**	0.00
18	**-8.52**	0.00	**-8.00**	0.00	**-5.47**	0.00
19	**-8.42**	0.00	**-7.97**	0.00	**-5.03**	0.00
20	**-6.95**	0.00	**-6.36**	0.00	**-3.12**	0.00
21	**-7.74**	0.00	**-6.94**	0.00	**-2.56**	0.01
22	**-7.74**	0.00	**-6.86**	0.00	**-1.98**	0.05
23	**-6.67**	0.00	**-5.79**	0.00	-1.40	0.15
24	**-7.30**	0.00	**-6.64**	0.00	-1.52	0.12

Bold test statistics are significant at 5%. Probability is based on MacKinnon (1996) one-sided test-statistic. Tested hypothesis is presence of unit root.

Table A.3. Stationarity test PWXT

	Constant and trend		Constant		No constant, no trend	
	Test	Prob.	Test	Prob.	Test	Prob.
1	**-5.63**	0.00	**-4.90**	0.00	-1.73	0.08
2	**-5.56**	0.00	**-5.09**	0.00	-1.86	0.06
3	**-5.59**	0.00	**-5.12**	0.00	**-1.95**	0.05
4	**-6.13**	0.00	**-5.73**	0.00	**-2.29**	0.02
5	**-6.94**	0.00	**-6.51**	0.00	**-2.70**	0.01
6	**-6.23**	0.00	**-5.76**	0.00	**-2.18**	0.03
7	**-7.75**	0.00	**-7.02**	0.00	**-3.21**	0.00
8	**-8.28**	0.00	**-7.42**	0.00	**-3.72**	0.00
9	**-8.90**	0.00	**-7.63**	0.00	**-3.62**	0.00
10	**-10.02**	0.00	**-8.75**	0.00	**-4.67**	0.00
11	**-10.34**	0.00	**-8.99**	0.00	**-4.76**	0.00
12	**-9.47**	0.00	**-8.07**	0.00	**-3.95**	0.00
13	**-8.94**	0.00	**-7.44**	0.00	**-2.99**	0.00
14	**-8.99**	0.00	**-7.30**	0.00	**-2.74**	0.01
15	**-9.38**	0.00	**-7.60**	0.00	**-2.89**	0.00
16	**-10.03**	0.00	**-8.21**	0.00	**-3.23**	0.00
17	**-9.74**	0.00	**-8.72**	0.00	**-4.60**	0.00
18	**-9.42**	0.00	**-8.70**	0.00	**-6.13**	0.00
19	**-10.86**	0.00	**-10.24**	0.00	**-8.19**	0.00
20	**-10.12**	0.00	**-9.35**	0.00	**-6.16**	0.00
21	**-13.40**	0.00	**-12.99**	0.00	**-10.76**	0.00
22	**-7.15**	0.00	**-5.95**	0.00	**-2.63**	0.01
23	**-5.41**	0.00	**-4.41**	0.00	-1.64	0.09
24	**-5.77**	0.00	**-4.83**	0.00	-1.89	0.06

Bold test statistics are significant at 5%. Probability is based on MacKinnon (1996) one-sided test-statistic. Tested hypothesis is presence of unit root.

Table A.4. Stationarity test MIX

	Constant and trend		Constant		No constant, no trend	
	Test	Prob.	Test	Prob.	Test	Prob.
1	**-5.60**	0.00	**-4.85**	0.00	-1.67	0.09
2	**-5.88**	0.00	**-5.28**	0.00	-1.87	0.06
3	**-6.15**	0.00	**-5.57**	0.00	**-2.02**	0.04
4	**-6.75**	0.00	**-6.30**	0.00	**-2.47**	0.01
5	**-7.39**	0.00	**-6.93**	0.00	**-2.91**	0.00
6	**-7.58**	0.00	**-7.01**	0.00	**-2.61**	0.01
7	**-8.71**	0.00	**-7.85**	0.00	**-3.55**	0.00
8	**-9.15**	0.00	**-8.26**	0.00	**-4.10**	0.00
9	**-9.55**	0.00	**-8.29**	0.00	**-3.89**	0.00
10	**-10.56**	0.00	**-9.46**	0.00	**-5.13**	0.00
11	**-11.61**	0.00	**-10.69**	0.00	**-6.22**	0.00
12	**-11.19**	0.00	**-10.47**	0.00	**-6.08**	0.00
13	**-9.79**	0.00	**-8.56**	0.00	**-3.63**	0.00
14	**-10.85**	0.00	**-9.90**	0.00	**-4.55**	0.00
15	**-12.36**	0.00	**-11.79**	0.00	**-6.68**	0.00
16	**-12.60**	0.00	**-12.04**	0.00	**-7.07**	0.00
17	**-12.21**	0.00	**-11.66**	0.00	**-7.41**	0.00
18	**-12.57**	0.00	**-11.82**	0.00	**-8.74**	0.00
19	**-10.81**	0.00	**-10.22**	0.00	**-8.16**	0.00
20	**-10.09**	0.00	**-9.33**	0.00	**-6.15**	0.00
21	**-13.42**	0.00	**-13.00**	0.00	**-10.74**	0.00
22	**-7.51**	0.00	**-6.22**	0.00	**-2.70**	0.01
23	**-5.68**	0.00	**-4.58**	0.00	-1.66	0.09
24	**-6.04**	0.00	**-5.04**	0.00	-1.91	0.05

Bold test statistics are significant at 5%. Probability is based on MacKinnon (1996) one-sided test-statistic. Tested hypothesis is presence of unit root.

Appendix B. Estimation results for Belgium versus Dutch and German prices

Table B.1. Estimation results BELPEX as function of APX

	MIX		Constant			Wald-test[1]		Difference		
	Coeff	St. error	Coeff	St. error	R^2	Test	Prob	Effect[2]	% mean	
1	**1.18**	0.03	**-4.93**	0.85	0.80	**18.79**	0.00	0.05	0.17	Rejected
2	**1.19**	0.03	**-4.21**	0.84	0.76	**18.72**	0.00	0.47	1.93	Rejected
3	**1.07**	0.04	-1.01	0.80	0.70	**4.46**	0.01	0.58	2.70	Rejected
4	**1.06**	0.03	**-1.32**	0.62	0.75	2.29	0.10	-0.17	-0.90	OK
5	**1.02**	0.03	**-1.37**	0.54	0.76	**11.49**	0.00	-0.98	-5.74	Rejected
6	**1.01**	0.03	-0.93	0.60	0.80	**4.83**	0.01	-0.67	-2.98	Rejected
7	**1.09**	0.02	**-2.78**	0.58	0.89	**11.47**	0.00	-0.41	-1.48	Rejected
8	**1.08**	0.01	**-3.42**	0.70	0.93	**14.38**	0.00	-0.21	-0.53	Rejected
9	**1.02**	0.01	**-1.71**	0.64	0.95	**5.32**	0.01	-0.96	-2.02	Rejected
10	**1.09**	0.03	**-5.90**	2.13	0.73	**3.94**	0.02	-1.24	-2.27	Rejected
11	**1.03**	0.03	**-4.75**	2.11	0.78	**3.17**	0.04	-3.05	-5.09	Rejected
12	**0.91**	0.02	-0.22	1.98	0.80	**20.32**	0.00	-6.36	-9.58	Rejected
13	**0.90**	0.03	3.07	1.71	0.73	**11.35**	0.00	-2.44	-4.37	Rejected
14	**0.88**	0.02	**2.91**	1.20	0.85	**34.67**	0.00	-3.50	-6.47	Rejected
15	**0.95**	0.01	-0.19	0.90	0.94	**15.52**	0.00	-2.60	-5.07	Rejected
16	**0.97**	0.01	-0.20	0.79	0.95	**8.99**	0.00	-1.77	-3.73	Rejected
17	**1.04**	0.02	**-2.66**	1.20	0.91	**3.36**	0.04	-0.63	-1.30	Rejected
18	**1.03**	0.01	**-4.44**	0.80	0.98	**15.91**	0.00	-2.31	-3.59	Rejected
19	**1.57**	0.06	**-29.83**	5.36	0.61	**42.54**	0.00	5.64	9.06	Rejected
20	**1.53**	0.07	**-24.21**	4.28	0.53	**28.56**	0.00	3.16	6.06	Rejected
21	**1.53**	0.32	-18.23	15.79	0.05	1.83	0.16	5.82	12.71	OK
22	**1.21**	0.06	**-6.71**	2.63	0.46	**6.46**	0.00	1.33	3.43	Rejected
23	**1.27**	0.06	**-7.09**	2.12	0.56	**22.76**	0.00	2.70	7.40	Rejected
24	**1.31**	0.05	**-7.99**	1.67	0.64	**27.23**	0.00	1.95	6.04	Rejected

1. Wald test is the test that the coefficient for MIX = 1 and the constant =0.
2. The effect is calculated at the sample mean and given in euro per MWh difference with the sample mean. Bold coefficients and test-statistics are significant at 5%.

Table B.2. Estimation results BELPEX as function of EEX

	MIX		Constant			Wald-test[1]		Difference		
	Coeff	St. error	Coeff	St. error	R^2	Test	Prob	Effect[2]	% mean	
1	**0.95**	0.05	**2.92**	1.32	0.50	7.33	0.00	1.55	5.80	Rejected
2	**0.90**	0.05	**4.29**	1.20	0.45	13.39	0.00	1.89	8.28	Rejected
3	**0.81**	0.05	**5.63**	1.05	0.41	17.82	0.00	1.68	8.25	Rejected
4	**0.79**	0.04	**3.95**	0.85	0.46	11.88	0.00	0.13	0.71	Rejected
5	**0.77**	0.04	**2.00**	0.74	0.51	44.29	0.00	-2.12	-11.60	Rejected
6	**0.82**	0.03	**2.69**	0.85	0.59	23.46	0.00	-1.40	-6.07	Rejected
7	**0.85**	0.03	**5.10**	0.94	0.64	14.86	0.00	1.23	4.81	Rejected
8	**0.78**	0.03	**9.59**	1.29	0.68	35.33	0.00	0.86	2.18	Rejected
9	**0.67**	0.03	**15.48**	1.48	0.62	78.79	0.00	0.50	1.09	Rejected
10	**1.03**	0.06	3.12	3.24	0.45	3.63	0.03	4.37	8.91	Rejected
11	**0.98**	0.08	5.56	4.85	0.27	1.90	0.15	4.69	8.99	OK
12	**0.73**	0.07	**17.15**	4.65	0.23	8.77	0.00	0.98	1.66	Rejected
13	**0.87**	0.04	**9.12**	2.53	0.48	6.79	0.00	2.53	4.96	Rejected
14	**0.80**	0.05	**11.83**	2.72	0.39	9.48	0.00	2.35	4.87	Rejected
15	**0.85**	0.09	**10.46**	4.63	0.18	2.78	0.06	3.82	8.49	OK
16	**0.95**	0.10	5.78	4.64	0.19	1.62	0.20	3.89	9.31	OK
17	**1.20**	0.09	-2.47	4.53	0.30	5.37	0.01	5.88	13.88	Rejected
18	**0.90**	0.05	**14.20**	3.96	0.46	6.55	0.00	9.14	17.29	Rejected
19	**1.84**	0.06	**-32.29**	4.75	0.68	98.77	0.00	13.51	24.86	Rejected
20	**1.20**	0.09	-1.41	5.04	0.30	6.83	0.00	7.93	16.77	Rejected
21	**1.68**	0.34	-16.78	15.15	0.06	3.65	0.03	10.95	26.92	Rejected
22	**1.22**	0.08	-2.02	2.80	0.38	23.37	0.00	5.50	15.95	Rejected
23	**1.31**	0.06	**-4.14**	2.12	0.53	65.28	0.00	6.04	18.18	Rejected
24	**1.28**	0.09	0.39	2.49	0.33	72.20	0.00	7.80	29.39	Rejected

1. Wald test is the test that the coefficient for MIX = 1 and the constant =0.
2. The effect is calculated at the sample mean and given in euro per MWh difference with the sample mean. Bold coefficients and test-statistics are significant at 5%.

Appendix C. Estimation results for Dutch, French and German prices

Table C.1. Estimation results APX as function of MIX

	MIX		Constant			Wald-test[1]		Difference		
	Coeff	St. error	Coeff	St. error	R^2	Test	Prob	Effect[2]	% mean	
1	**0.94**	0.01	**1.76**	0.34	0.94	**13.69**	0.00	0.20	0.70	Rejected
2	**0.91**	0.01	**2.18**	0.30	0.94	**32.44**	0.00	-0.06	-0.25	Rejected
3	**0.91**	0.01	**1.83**	0.32	0.92	**22.94**	0.00	-0.14	-0.66	Rejected
4	**0.93**	0.01	**1.28**	0.23	0.94	**18.24**	0.00	-0.03	-0.17	Rejected
5	**0.92**	0.01	**1.31**	0.24	0.93	**21.50**	0.00	-0.10	-0.58	Rejected
6	**0.98**	0.01	0.24	0.25	0.96	**5.46**	0.00	-0.23	-1.01	Rejected
7	**1.00**	0.01	0.37	0.24	0.97	**4.35**	0.01	0.32	1.18	Rejected
8	**0.99**	0.01	**0.80**	0.26	0.99	**4.84**	0.01	0.24	0.61	Rejected
9	**0.99**	0.00	**0.88**	0.26	0.99	**5.72**	0.00	0.18	0.37	Rejected
10	**1.00**	0.01	**1.95**	0.66	0.96	**11.42**	0.00	1.71	3.22	Rejected
11	**0.99**	0.01	**3.56**	0.96	0.94	**12.46**	0.00	3.06	5.38	Rejected
12	**1.00**	0.02	**4.77**	1.49	0.88	**10.46**	0.00	4.51	7.29	Rejected
13	**0.99**	0.02	**2.72**	1.29	0.84	**6.48**	0.00	2.08	3.87	Rejected
14	**0.98**	0.02	**3.21**	1.12	0.88	**7.94**	0.00	2.34	4.53	Rejected
15	**0.99**	0.01	**2.47**	0.84	0.94	**5.76**	0.00	1.97	3.98	Rejected
16	**0.99**	0.01	**1.81**	0.73	0.95	**3.98**	0.02	1.47	3.21	Rejected
17	**0.98**	0.01	**2.18**	0.44	0.98	**12.34**	0.00	1.02	2.14	Rejected
18	**0.95**	0.01	**4.49**	0.71	0.98	**28.80**	0.00	1.41	2.24	Rejected
19	**0.89**	0.01	**7.27**	0.91	0.95	**63.07**	0.00	0.21	0.34	Rejected
20	**0.95**	0.01	**3.42**	0.86	0.92	**8.32**	0.00	0.59	1.14	Rejected
21	**0.94**	0.01	**3.70**	0.53	0.95	**25.29**	0.00	0.83	1.85	Rejected
22	**0.93**	0.01	**3.44**	0.57	0.91	**20.40**	0.00	0.75	1.97	Rejected
23	**0.89**	0.01	**4.13**	0.57	0.90	**27.64**	0.00	0.10	0.27	Rejected
24	**0.89**	0.01	**3.89**	0.48	0.91	**33.40**	0.00	0.34	1.08	Rejected

1. Wald test is the test that the coefficient for MIX = 1 and the constant =0.
2. The effect is calculated at the sample mean and given in euro per MWh difference with the sample mean. Bold coefficients and test-statistics are significant at 5%.

Table C.2. Estimation results PWXT as function of MIX

	MIX		Constant			Wald-test[1]		Difference		
	Coeff	St. error	Coeff	St. error	R^2	Test	Prob	Effect[2]	% mean	
1	**1.01**	0.01	-0.22	0.22	0.98	0.53	0.59	-0.01	-0.04	OK
2	**1.02**	0.01	-0.01	0.34	0.94	**8.05**	0.00	0.50	2.01	Rejected
3	**1.04**	0.02	-0.10	0.45	0.89	**12.47**	0.00	0.82	3.71	Rejected
4	**1.01**	0.02	0.24	0.34	0.90	**5.91**	0.00	0.49	2.64	Rejected
5	**0.99**	0.01	0.33	0.22	0.94	1.36	0.26	0.13	0.79	OK
6	**0.98**	0.02	**0.88**	0.37	0.91	**4.77**	0.01	0.41	1.90	Rejected
7	**0.99**	0.01	**0.60**	0.30	0.96	**3.81**	0.02	0.39	1.47	Rejected
8	**0.99**	0.01	**0.95**	0.40	0.97	**3.25**	0.04	0.45	1.13	Rejected
9	**0.99**	0.01	0.46	0.37	0.98	2.00	0.14	-0.13	-0.29	OK
10	**0.99**	0.00	0.09	0.33	0.99	**3.68**	0.03	-0.39	-0.75	Rejected
11	**0.99**	0.00	-0.11	0.31	0.99	**4.14**	0.02	-0.47	-0.87	Rejected
12	**0.95**	0.01	1.00	0.71	0.95	**17.13**	0.00	-1.56	-2.76	Rejected
13	**0.98**	0.01	0.59	0.41	0.98	**8.85**	0.00	-0.53	-1.01	Rejected
14	**0.96**	0.01	**1.43**	0.48	0.97	**10.45**	0.00	-0.39	-0.81	Rejected
15	**0.98**	0.01	**0.78**	0.36	0.98	**6.17**	0.00	-0.23	-0.51	Rejected
16	**0.98**	0.01	**0.61**	0.29	0.99	**5.25**	0.01	-0.16	-0.36	Rejected
17	**0.99**	0.00	0.10	0.21	0.99	2.09	0.13	-0.17	-0.37	OK
18	**1.00**	0.00	-0.20	0.20	1.00	1.12	0.33	-0.23	-0.40	OK
19	**1.00**	0.00	0.03	0.15	1.00	0.02	0.98	0.03	0.04	OK
20	**1.00**	0.00	0.01	0.13	1.00	0.00	1.00	0.00	0.00	OK
21	**1.00**	0.00	-0.01	0.09	1.00	0.02	0.98	0.00	0.00	OK
22	**1.00**	0.01	0.07	0.28	0.99	2.18	0.11	0.26	0.66	OK
23	**1.01**	0.01	-0.41	0.29	0.98	1.64	0.19	0.05	0.13	OK
24	**1.01**	0.00	-0.08	0.18	0.99	1.43	0.24	0.10	0.31	OK

1. Wald test is the test that the coefficient for MIX = 1 and the constant =0.
2. The effect is calculated at the sample mean and given in euro per MWh difference with the sample mean.
Bold coefficients and test-statistics are significant at 5%.

Table C.3. Estimation results EEX as function of MIX

	MIX		Constant			Wald-test[1]		Difference		
	Coeff	St. error	Coeff	St. error	R^2	Test	Prob	Effect[2]	% mean	
1	**0.74**	0.03	**5.94**	0.85	0.62	**53.03**	0.00	-1.34	-4.79	Rejected
2	**0.75**	0.03	**4.46**	0.82	0.58	**46.79**	0.00	-1.52	-6.25	Rejected
3	**0.75**	0.03	**4.07**	0.75	0.57	**42.50**	0.00	-1.34	-6.19	Rejected
4	**0.79**	0.03	**3.66**	0.65	0.59	**21.78**	0.00	-0.28	-1.52	Rejected
5	**0.85**	0.03	**3.64**	0.58	0.65	**23.35**	0.00	1.13	6.62	Rejected
6	**0.88**	0.03	**3.23**	0.68	0.71	**11.47**	0.00	0.61	2.71	Rejected
7	**0.94**	0.03	0.21	0.79	0.77	**12.01**	0.00	-1.50	-5.53	Rejected
8	**1.03**	0.03	-1.79	1.35	0.76	0.99	0.37	-0.74	-1.85	OK
9	**1.01**	0.04	-1.16	1.89	0.67	0.36	0.70	-0.78	-1.66	OK
10	**0.82**	0.03	**7.09**	1.56	0.71	**29.77**	0.00	-2.42	-4.70	Rejected
11	**0.79**	0.03	**9.57**	1.84	0.64	**28.01**	0.00	-1.91	-3.53	Rejected
12	**0.92**	0.04	**5.46**	2.57	0.59	2.54	0.08	0.48	0.83	OK
13	**0.93**	0.03	2.53	1.62	0.73	**5.77**	0.00	-1.38	-2.64	Rejected
14	**0.98**	0.03	0.19	1.72	0.70	0.99	0.37	-0.88	-1.79	OK
15	**1.01**	0.03	-1.83	1.60	0.72	1.88	0.15	-1.26	-2.73	OK
16	**0.99**	0.02	-1.13	1.19	0.80	**4.82**	0.01	-1.59	-3.66	Rejected
17	**0.95**	0.02	0.23	1.09	0.83	**9.73**	0.00	-2.02	-4.54	Rejected
18	**0.78**	0.03	**7.86**	2.27	0.69	**39.05**	0.00	-4.72	-8.19	Rejected
19	**0.74**	0.02	**9.24**	2.01	0.71	**75.71**	0.00	-6.86	-11.22	Rejected
20	**0.80**	0.02	**6.11**	1.33	0.77	**64.86**	0.00	-4.50	-8.68	Rejected
21	**0.78**	0.02	**5.66**	1.04	0.77	**97.98**	0.00	-4.01	-8.98	Rejected
22	**0.72**	0.03	**7.62**	1.05	0.65	**98.93**	0.00	-3.06	-8.14	Rejected
23	**0.72**	0.03	**7.39**	0.99	0.65	**103.61**	0.00	-2.73	-7.59	Rejected
24	**0.50**	0.03	**10.68**	0.87	0.48	**369.77**	0.00	-5.16	-16.27	Rejected

1. Wald test is the test that the coefficient for MIX = 1 and the constant =0.
2. The effect is calculated at the sample mean and given in euro per MWh difference with the sample mean. Bold coefficients and test-statistics are significant at 5%.