

TILEC

TILEC Discussion Paper

DP 2012-027

**Market Integration and Economic
Efficiency at Conflict? Commitments in
the Swedish Interconnectors Case**

+

By
Malgorzata Sadowska, Bert Willems

July 17, 2012

ISSN 1572-4042

<http://ssrn.com/abstract=2111319>

Market Integration and Economic Efficiency at Conflict?

Commitments in the Swedish Interconnectors Case

Małgorzata SADOWSKA* & Bert WILLEMS**

According to the European Commission, Svenska Kraftnät, the Swedish network operator, might have violated competition rules by limiting cross-border transmission capacity to relieve congestion within Sweden. Eventually, the case was settled and Svenska Kraftnät offered commitments to address the Commission's concerns. As an interim remedy, it committed to reduce transmission flow of electricity on internal network bottlenecks primarily by introducing national measures and by not reducing interconnection capacity. As a final remedy, Svenska Kraftnät agreed to split the Swedish market into multiple price zones. Congestion within Sweden would then be solved by adjusting the prices of those zones.

We analyse the economic effects of the alleged abuse and the remedy package. We make three observations. Firstly, it might be socially optimal to reduce cross-border capacity in response to internal congestion. Hence, without an in-depth economic analysis the Commission risked preventing efficient behaviour. Secondly, the interim remedy of handling internal congestion primarily by national measures is not socially optimal, and it cannot be ruled out that it reduces overall welfare. Thirdly, even though splitting the market into price zones may improve allocative efficiency within Sweden, it does not prevent Svenska Kraftnät from potential manipulation of cross-border transmission capacity.

JEL: K21, K42, L43, L44, L94

Keywords: European energy markets, transmission congestion, competition policy, Article 102 TFEU, Swedish network operator

* EDLE, University of Bologna, malgorzata.sadowska@unibo.it.

** TILEC, CentER, Tilburg University, bwillems@uvt.nl. The authors thank Leigh Hancher, Alexander Morell, Massimo Motta, Björn ter Bruggen, Paul Giesbertz and Killian Kehoe for their insightful comments. Małgorzata Sadowska gratefully acknowledges the hospitality and support of TILEC, where part of this research was carried out. The authors are responsible for any remaining mistakes.

I. INTRODUCTION

Congestion often occurs in the Swedish electricity network. It is mainly caused by the lack of network capacity to transport cheap energy from hydropower plants in North Sweden to high consumption areas in South Sweden and, via the Øresund interconnector,¹ to Eastern Denmark.² Svenska Kraftnät (SvK), the Swedish electricity network operator, identifies several transmission bottlenecks in the Swedish grid, where demand for transmission capacity exceeds network capacity.³ SvK used to solve this internal congestion by limiting export to the neighbouring countries, especially to Denmark on the Øresund interconnector. Export limits reduced demand for cheap hydropower from North Sweden and therefore relieved congestion in the Swedish grid.

We analyse a competition law case brought by the European Commission against SvK for a potential abuse of a dominant position on the electricity transmission market in Sweden (Article 102 TFEU).⁴ According to the Commission, SvK might have violated competition rules by limiting cross-border transmission capacity in order to relieve internal congestion in the Swedish network. In other words, it “shifted” congestion from the internal bottlenecks to the interconnectors. The case arose from a complaint filed by Dansk Energi (DaE), a trade association for Danish energy companies. DaE alleged that SvK’s recurring export limitations on the Øresund-connection caused economic losses to Danish consumers.⁵ Deprived of hydropower imports from Sweden, Denmark was forced to use its more expensive thermal power plants to meet its demand. Recourse to thermal generation resulted in higher day-ahead prices and price volatility. The Danish allegations were supported by an empirical study of Copenhagen Economics, estimating losses for Danish consumers from SvK’s capacity shifting and the simultaneous gains for Swedish consumers, due to lower electricity day-ahead prices in Sweden.⁶ DaE claimed that SvK’s actions were detrimental to competition and trade within the internal market, and violated EU competition rules.⁷

In 2009, following negotiations with the Commission, SvK entered into a settlement and offered a set of commitments. Firstly, as an interim remedy, SvK committed to reduce congestion on internal bottlenecks primarily by counter-trading. This is a type of congestion management where the network operator makes deals with individual generators to eliminate congestion. It pays generators in export-constrained areas to reduce production, and pays generators in import-constrained areas to increase production. Secondly, SvK agreed to

¹ By ‘interconnector’ we mean a transmission line which crosses or spans a border between Member States and which connects the national transmission systems of the Member States, as set out in Article 2(1) of Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 Jul. 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003, OJ L 211/15.

² Denmark is divided into two separate price areas (DK1 for Western Denmark and DK2 for Eastern Denmark) because there is no direct electric connection between the two country’s regions. Whenever we refer to Denmark in this paper, we mean Eastern Denmark only.

³ Three out of four bottlenecks (called “cuts”: cut 1, cut 2 and cut 4) occur due to the excessive flow of electricity from the North to the South of Sweden. The fourth bottleneck, the west-coast corridor, results from increased transport of electricity from Denmark and the rest of Europe to the western coast of Sweden and further up to Norway. On the characteristics of the Swedish electricity market see e.g. NordREG, *Congestion Management in the Nordic Region. A common regulatory opinion on congestion management*, Report 2/2007, at 16-18.

⁴ Commission Decision of 14 Apr. 2010 in case COMP/39.351 – *Swedish Interconnectors*.

⁵ DaE’s complaint concerned only the Øresund interconnector. However, the Commission broadened the scope of its investigation, including all interconnectors managed by SvK. Commission Decision, note 4 above, at 38-40.

⁶ See the Report of Copenhagen Economics, *The economic consequences of capacity limitations on the Øresund connection*, 11 December 2006, Copenhagen, commissioned by Energinet.dk, the Danish network operator. From Oct. 2000 till Jun. 2006, losses for consumers in East Denmark were estimated to be 725 million DKK (ca. 100 million EUR) and gains for consumers in Sweden between 215 and 265 million DKK (29 to 36 million EUR).

⁷ DaE challenged the SvK’s policy on several legal bases, namely the internal market rules on free movement of goods (Articles 34 and 35 TFEU), Regulation 1228/2003 on conditions for access to the network for cross-border exchanges in electricity, Directive 2003/54 concerning common rules for the internal market in electricity and finally, also the EU competition rules (Article 102 TFEU). The full text of the complaint is available at http://www.danskenergi.dk/Aktuelt/Indblik/Svenska_Kraftnaet.aspx (accessed in May 2012).

split the Swedish market into multiple price zones by November 2011, so-called market splitting.⁸ Congestion between zones is now solved by adjusting zonal prices, affecting zonal supply and demand within Sweden, and not by reducing interconnector capacities.⁹ Market splitting has been used, for instance, in the Norwegian energy market.

We analyse the economic effects of SvK's behaviour, in the situation that existed before the investigation, and then in the context of the interim and final remedies respectively. These effects are illustrated on the basis of a simplified market model which represents the main features of the Swedish and the Danish electricity markets. We make three observations. Firstly, shifting some congestion to the borders might make economic sense. Without an in-depth economic analysis, the Commission risks going after socially optimal behaviour. Secondly, the interim remedy of solving internal congestion primarily by counter-trading, and not by shifting congestion to the border, is not socially optimal either, and it cannot be ruled out that it reduces overall welfare. Thirdly, even though market splitting may improve allocative efficiency within Sweden, it does not prevent potential manipulation of cross-border transmission capacity by SvK.

The paper is written with a legal and policy audience in mind. It explains the main lessons of an economic analysis of the case to non-economists and lacks therefore some of the modelling rigor of a pure economic paper. We chose to present our results graphically, give numerical illustrations and limit the use of analytical expressions to situations where they could provide some additional insights. In a companion paper, we take a closer look at some of the legal aspects of this case.¹⁰

II. MODEL

A. SET-UP

We use a simplified market model to illustrate the economic effects of congestion in the Swedish grid. See Figure 1. This model explains the main economic insights, but is not intended to reflect the market in detail.¹¹ The numbers were chosen for illustrative purpose. To ensure that calculations can be checked without relying on numerical simulations, the paper provides some equations for readers that are familiar with economic models, although we hope that they are not necessary to understand the main arguments of the paper.

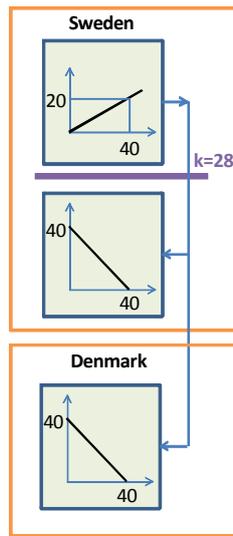
⁸ According to the initial commitments offered to the Commission, the exact number of price zones and their configuration was supposed to be kept flexible, depending on the flow patterns in the Swedish electricity network. In the end, SvK decided to split the market into four price zones. Market splitting does not apply to the west-coast corridor, due to the lack of sufficient suitable generation resources for setting a separate market price in that area. For the same technical reasons counter-trading cannot be performed there. Instead, SvK undertook to reinforce the west-coast corridor by building and operating a new 400kV transmission line by the end of Nov. 2011. See Commission Decision, note 4 above, at 48.

⁹ In cases where internal congestion occurs within a price zone, SvK committed not to reduce capacity on the interconnectors but to carry out counter-trading within these zones to relieve it.

¹⁰ Małgorzata Sadowska and Bert Willems, *Power Market Design by Antitrust*, TILEC working paper. There we discuss, among others, whether antitrust rules should apply to the SvK's congestion management in the first place, the role of commitment procedure, how sector-specific regulation and competition policy are intertwined at the European level, and the consequences of this case for the Nordic energy market.

¹¹ The model has a simple radial network with one bottleneck, covering three regions. It neglects the fact that networks are meshed and that electricity flows distribute themselves on the network over multiple parallel paths depending on technical characteristics of the transmission lines (so called "loop flows"). We do not consider the effects on other neighbouring regions (e.g. Norway). Also, we do not investigate the case of several bottlenecks within Sweden.

Figure 1. Set-up of the model



Cheap hydroelectricity is produced in North Sweden and transported to South Sweden and further to Denmark via an interconnector, but transportation is limited by a transmission constraint within Sweden. North Sweden, South Sweden and Denmark are indicated with the letters N , S and D . We assume that production cost in North Sweden $C_N(q)$ and the utility functions in South Sweden and Denmark, $U_S(q)$ and $U_D(q)$ can be represented by quadratic functions. The resulting competitive demand for energy in South Sweden and Denmark is represented by demand functions $D_S(p)$ and $D_D(p)$, while supply in North Sweden is given by $S_N(p)$.¹² The physical transmission limit is k . Table 1 provides the data of our numerical illustration.¹³

Table 1. Data for the numerical illustration

Parameters	Description
$C_N(q) = \frac{q^2}{4}$	Total production cost in North Sweden (N)
$S_N(p) = 2p$	Supply in North Sweden (N)
$U_S(q) = U_D(q) = 40q - \frac{q^2}{2}$	Utility in South Sweden (S) and Denmark (D)
$D_S(p) = D_D(p) = 40 - p$	Demand in South Sweden (S) and Denmark (D)
$k = 28$	Physical transmission limit between North (N) and South Sweden (S)

¹² The demand function in South Sweden and Denmark should be thought of as *net* demand, *i.e.* for a given price level how much would the region import to satisfy demand, given local production at that price level. Similarly, supply in North Sweden should be considered as *net* supply. Note that electricity producers and consumers are price takers, hence we assume that there is no market power in the generation market.

¹³ The demand function and the utility function are linked such that $D(p) = q \Leftrightarrow U'(q) = p$, in other words, the demand function is the inverse of the marginal utility function. Similarly, the supply function is the inverse of the marginal cost function.

B. FIRST-BEST

Before analysing any scenario, we use an efficient outcome as a benchmark. In order to find it, we maximise total surplus¹⁴, which is equal to the utility of South Swedish and Danish consumers minus the production cost of North Swedish producers, subject to the transmission constraint. Hence, the following optimisation problem has to be solved:

$$\begin{aligned} \max_{q_S, q_D} & U_S(q_S) + U_D(q_D) - C_N(q_S + q_D) \\ \text{s.t.} & \quad q_S + q_D \leq k \quad (l) \end{aligned}$$

The first order conditions of this optimisation problem are the following equalities:

$$U_S'(q) = U_D'(q) = C_N'(q) + l$$

with l being the Lagrange multiplier of the transmission constraints.¹⁵ This equation shows that in order to achieve efficient allocation, the marginal utility of energy in South Sweden should be equal to the marginal utility in Denmark. As consumers in S and D have the same marginal utility for energy, reallocation of cheap energy from North Sweden between those two regions cannot improve total surplus. The allocation is thus Pareto optimal.¹⁶ If cheap energy in the North is abundant and transmission capacity is relatively small, then the transmission constraint will be binding and the Lagrange multiplier will be positive: $l > 0$. The positive multiplier reflects the scarcity of transmission capacity, which makes the marginal utility of consumption in S and D larger than the marginal cost of production in N. If transmission capacity is abundant, and cheap production capacity is limited, then the Lagrange multiplier is zero, and the marginal utility in S and D should be equal to the marginal production cost in N.

With the parameters of our model (see Table 1), cheap energy in North Sweden is abundant, and the transmission line is used at full capacity to export cheap energy from North Sweden to South Sweden and Denmark, i.e. $q_S + q_D = k = 28$. This cheap energy should then be allocated efficiently between South Sweden and Denmark. This requires that $U_S'(q_S) = 40 - q_S = U_D'(q_D) = 40 - q_D$, which simplifies to $q_S = q_D$. This is intuitive. As consumers in S and D have the same utility function, they should both receive 50% of the energy which can be transported from the North. North Sweden exports 28 units, and South Sweden and Denmark each consume 14 units (Figure 2). Under the efficient allocation, the marginal utility for electricity in South Sweden and Denmark ($U_S'(14) = U_D'(14)$) is 26 and the marginal cost of production in North Sweden $C_N'(28)$ is 14. The difference between the marginal valuation for energy in S and D, and the marginal production cost in N, is the scarcity price of transmission, i.e. the Lagrange multiplier ($l = 26 - 14 = 12$).

¹⁴ Total surplus is a measure of the society's economic well-being. It is equal to the amount consumer are willing to pay for electricity that they receive minus the total production cost for producing this electricity. It can also be expressed as the sum of consumer surplus, producer surplus, and TSO surplus. Consumer surplus is the amount a consumer is willing to pay for electricity minus the amount the consumer actually pays for it. Producer surplus is the amount a generator is paid for electricity minus his production costs. In other words, consumer surplus is a benefit that consumers receive from participating in the electricity market and producer surplus is a benefit that generators receive from selling their electricity. TSO surplus is equal to amount the TSO is paid for transporting electricity, as we assume in our model that there are no transportation costs in the short run. See also N. Gregory Mankiw, *Principles of Economics*, 2nd Edition, South-Western College Pub [2000], at 152.

¹⁵ The first order conditions are a set of mathematically necessary conditions for an optimum. They roughly impose that around the optimum the objective function is flat. Lagrange multipliers are used to describe the first order conditions of maximum of a function subject to constraints. The Lagrange multiplier has an economic interpretation as it represents the marginal surplus that would be created by relaxing the constraint. It is therefore often also called the shadow price of a constraint.

¹⁶ In a Pareto optimal allocation, no one can be made better off without making at least one individual worse off.

Figure 2. First-best outcome: Marginal valuation and marginal costs are presented inside the squares. Each square represents a region. Energy flows are represented by arrows.

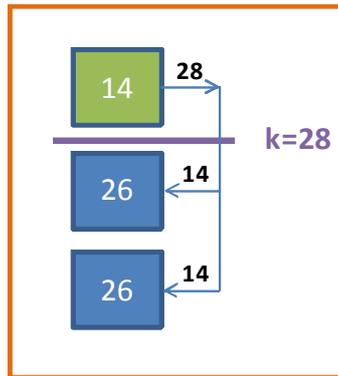
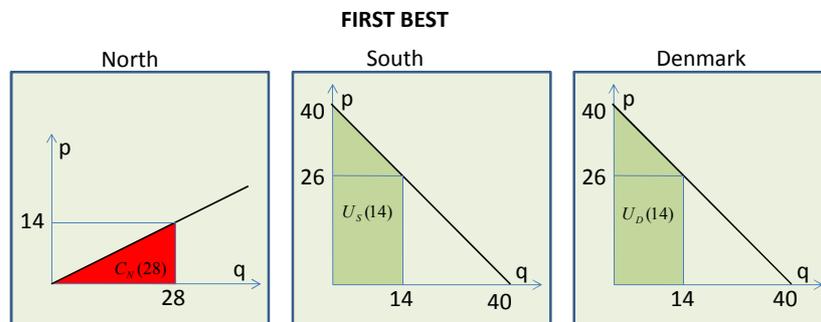


Figure 3 shows the total surplus obtained in the market in the first-best situation. Consumers in South Sweden and Denmark enjoy the benefit of consuming electricity, while there is a cost of producing electricity in North Sweden. Utility in South Sweden is illustrated by the green area in the middle graph of Figure 3. This area is equal to $U_S(14) = 462$. Danish utility is identical (right graph). The red triangle shows production costs in North Sweden, which are equal to $C_N(28) = 196$. Total surplus in the first-best amounts to 728.

Note that in the first best outcome we determine a Pareto optimal *allocation* of transmission capacity and energy. We do not specify how the total surplus is divided between the different actors in the model, or the mechanism that was used to achieve this outcome. In particular we do not assume a specific pricing structure.

Figure 3. First-best: gross consumer surplus and production costs



C. SCENARIOS

SvK's key task as a Transmission System Operator (TSO) is the transmission of power on the national grid and to ensure that the system remains balanced, i.e. that electricity production and consumption for Sweden match at all times.¹⁷ To avoid line overload, SvK needs to relieve congestion on bottlenecks. There are at least three methods of congestion management commonly used by network operators: 1) market splitting, 2) congestion shifting and 3) counter-trading.¹⁸ These methods can, and in practice often are, combined.

¹⁷ So called "overall system reliability", The Electricity Act, SFS 1997:857, 20 Nov. 1997, at 8(1). See also <http://www.svk.se> (accessed in May 2012).

¹⁸ Investment in the network (new transmission lines) would increase its physical transmission capability and hence, relieve congestion in the long run. In the short run, another method to deal with congestion is to perform an intended power outage in area of high consumption (rolling blackout or load shedding). Since this method leaves some customers without electricity, it should be considered a measure of last

First of all, in the day-ahead market,¹⁹ a network operator can *split the market* into two different price areas with the bottleneck as a “border” between them. Thus, the day-ahead price is set for each area separately, in order to influence demand and supply curves, and consequently ensure that transmission remains within the limits of the physical capability of the bottleneck. This price is higher than the system price²⁰ on one side of the bottleneck, in the import-constrained area (deficit area), and lower on the other side of the bottleneck, in the export-constrained area (surplus area). Thus, the flows of electricity between the two areas are adjusted. This market-clearing mechanism eliminates congestion.²¹ Transmission of electricity from the surplus area to the deficit area generates extra revenue, equal to price difference between the two zones multiplied by the volume of electricity transmitted between these zones. This revenue, called congestion rents, goes to the network operator. Under the current EU regime, it can only be used for guaranteeing capacity, building infrastructure or lowering the network tariff.²² When no congestion occurs between the two zones, they will have the same price²³ and no congestion rent arises.

Secondly, still in the day-ahead market, a network operator can *reduce trading capacities with other price zones; in our case with neighbouring countries*. By declaring lower cross-border capacities, it limits export out of the country and reduces demand for transmission capacity within the country. However, it creates congestion at the national borders. In other words, it “shifts” internal congestion to interconnectors. Cross-border congestion splits the regional market into different price zones along national borders, but preserves a single price within a country. Given that the interconnector is now congested and the prices in the two interconnected countries differ, any cross-border transmission of electricity between these countries generates congestion rents as well. These cross-border congestion rents are shared between the network operators of the two interconnected countries.

Finally, a network operator can manage congestion by influencing production levels of market players on both sides of the bottleneck once the day-ahead market has closed, that is, *by counter-trading* in real-time.²⁴

resort. In fact, TSOs allow for load shedding only in emergency situations to avoid total system blackout. See Report from the Nordic Competition Authorities, *Capacity for Competition. Investing for an Efficient Nordic Electricity Market*, 1 (2007), at 35-37.

¹⁹ Elspot, the main platform for trading electricity in the Nordic region, is organised as a day-ahead auction. Elspot is the market for electricity to be delivered the following day, or, to be more specific, the auction for electricity 24 hours in advance of actual delivery in a given time in any day. Power generators offer electricity on this auction based on their ability to produce energy for a specific period on the following day.

²⁰ The electricity reference price for all the Nordic region (the system price) is calculated based on all the supply and demand bids for electricity that will be delivered the following day disregarding transmission network constraints between or within the Nordic countries. If there is no congestion, electricity prices in all the Nordic countries equal the system price. If, however, congestion occurs on the network, the Nordic region subdivides into separate price areas (price zones), whereby some countries constitute one price area each and other countries (Denmark, Norway and from November 2011 – also Sweden) are further subdivided into smaller price zones.

²¹ Elspot market closes (in other words, “clears”) after all the day-ahead supply and demand bids have been collected and the system price (market-clearing price) is set at a level, at which quantity of electricity supplied equals the quantity of electricity demanded. Energy firms do not only trade in the centralized power market Elspot, but can also trade bilaterally within a price zone.

²² As required by Article 16(6) of Regulation (EC) No 714/2009, note 1 above. This provision was already in force at the time of the case (see Article 6(6) of Regulation (EC) 1228/2003, OJ L 211/15) In line with this regulation, SvK, together with other Nordic TSOs, decided to use congestion rents for investments to strengthen the grid and interconnectors. This also refers to congestion rents collected from internal bottlenecks, once market splitting is implemented. See Energy Markets Inspectorate, *The Swedish electricity and natural gas markets 2010*, EI R2010:09, at 20.

²³ It must be noted that ‘bidding zones’ is a more precise term than ‘price zones’, as sometimes prices are the same across all zones, even if market splitting is in place. Such situations occur when there is no congestion in the network. However, for simplicity, we use the term ‘price zone’ throughout the paper.

²⁴ Electricity is mainly traded on the day-ahead market. However, in case imbalances occur after the day-ahead market clears, the TSO can buy or sell electricity in real-time, that is, close to delivery time, to bring the market back in balance. This is known as the regulating market, where the network operator collects upward and downward regulating bids from the balance providers (flexible generators). Since 1999 there is an additional market in Sweden (Elbas) which operates after day-ahead market.

This is done by, for instance, buying expensive electricity from generators on the deficit side of the bottleneck and selling it at a loss on the surplus side. The generators in the import-constrained area are thus paid to generate more than they initially committed to in the day-ahead market. On the other side of the bottleneck, in the export-constrained area, generators are paid to generate less. Therefore the generation system is re-dispatched, but the electricity price, at which consumers bought electricity in the day-ahead market, remains unchanged and is equal for *all customers* on both sides of the bottleneck.²⁵ Only the re-dispatched volumes are priced differently. As the TSO buys expensive energy and sells it cheaply, counter-trading is costly for the TSO. This cost is then passed on to the Swedish grid users through a higher transmission network tariff. Counter-trading creates extra revenue for generators. In surplus regions they get paid to produce less. In deficit areas they receive a higher price to produce additional amounts. The net effect is a transfer from consumers to generators. It must be noted that TSO not only incurs costs due to counter-trading, but also has no congestion rents, as neither the internal transmission lines nor the interconnectors are congested in the day-ahead market. In this paper we look at four scenarios resulting from the SvK case. Each scenario involves an application of one or more of the above mentioned congestion management methods. First, we consider a scenario of counter-trading with full congestion shifting (1st scenario), which corresponds to SvK’s alleged abuse. Then we turn to the analysis of commitments. In the context of the interim remedy, we compare two cases: counter-trading without congestion shifting (2nd scenario) and counter-trading with partial congestion shifting (3rd scenario). With regard to the final remedy, we study the impact of market splitting (4th scenario). The scenarios are summarised in Table 2. In the next section we present each scenario separately and explain how those scenarios are linked with the case. Each scenario makes particular assumptions about the behaviour of SvK, i.e. it specifies the actions SvK would take. We discuss whether such actions are consistent with the likely objectives of SvK in section III.E, where we also talk about the regulatory context.

Table 2. Four scenarios

	1. CT with full congestion shifting	2. CT without congestion shifting	3. CT with partial congestion shifting	4. Market Splitting
Congestion management used within Sweden	counter-trading is in place, but not used	counter-trading is used	counter-trading is used	market splitting
Available capacity between Sweden and Denmark in the day-ahead market	2 units	unlimited	14 units	unlimited
Link with the case	alleged abuse	interim remedy as implemented	optimal interim remedy	final remedy

Note: CT – counter-trading.

²⁵ In practice, a very small number of large industrial consumers might also be able to reduce or increase demand in real-time. In that case, those consumers will also receive some extra revenue.

III. RESULTS

A. COUNTER-TRADING WITH FULL CONGESTION SHIFTING (ALLEGED ABUSE)

Sweden used to be a single price area in the Nordic power market.²⁶ Since the country was not subdivided into separate price zones, SvK dealt with internal congestion using the two remaining congestion methods: 1) shifting congestion to the borders and 2) counter-trading. However, SvK relied mainly on the first method. Capacity limits for the Øresund interconnector were set both by SvK as well as the Danish network operator. If the numbers were different from each other, the lower capacity applied. Declared capacity limitations were made public before the day-ahead market closed. Where capacity reduction at the borders was insufficient to eliminate all internal congestion, SvK counter-traded in real-time between the southern areas of high energy consumption, and the northern areas with a surplus of generation.²⁷ SvK argued in the case that counter-trading should not be (and, in fact, was not) employed excessively, for the following reasons. Firstly, SvK claimed that it is not always technically feasible. It depends on the availability of suitable generating units in a given hour and in a given location.²⁸ ²⁹ Secondly, according to SvK, counter-trading conceals locational signals from market players.³⁰ Lastly, SvK complained that the cost of counter-trading is borne only by the Swedish grid users (via a higher network tariff), and not, for instance, Danish grid users, who also benefit from it.³¹ ³²

However, faced with Swedish export restrictions, Denmark needed to increase its domestic production, having recourse to more expensive thermal generation. Therefore, SvK's actions may have contributed to higher and more volatile electricity prices in Denmark.

In this section we analyse congestion shifting, which is designed to relieve all internal congestion and to remove the need for counter-trading.³³ How would such a congestion shift affect prices, and total welfare, in our

²⁶ According to SvK, market splitting has not been yet introduced in Sweden due to the lack of sufficient liquidity and competition both in the day-ahead market as well as in intraday and balancing markets (real-time). See the explanations of SvK's Director General, Mikael Odenberg, to the Commission in a letter of 22nd May 2008, *Case No 39351 – Øresund interconnector*, 356/2006/MA30, available at http://www.svk.se/Global/02_Press_Info/Pdf/remissvar/080522_KOM.pdf (accessed in May 2012). However, the introduction of market splitting has been much debated in the Swedish and in the Nordic market in the recent years and the Commission's antitrust intervention played an important role in this debate. We elaborate on this in the companion paper, note 10 above.

²⁷ Energy Markets Inspectorate, *The Swedish electricity and natural gas markets 2009*, EIR2010:12, at 14. See also Swedish Interconnectors – COMP CASE NO 39351: *Background explanations submitted by Svenska Kraftnät regarding the offered commitments for this case*, 356/2006/MA30, Oct. 1, 2009, at 12-14, available at http://www.svk.se/Global/02_Press_Info/091001_Background_document.pdf (accessed in May 2012), at 10, 12 and 24.

²⁸ Suitable generation units are referred to as regulating resources, which are generation units that can increase or decrease production or consumption of electricity at short notice, and which can therefore be used for regulation. See Swedish Interconnectors – COMP CASE NO 39351: *Background explanations*, note 27 above, at 5.

²⁹ Swedish Interconnectors – COMP CASE NO 39351: *Background explanations*, note 27 above, at 27.

³⁰ See letter of M. Odenberg, note 26 above.

³¹ See Svenska Kraftnät, *The Complaint from Dansk Energi regarding the effects on the Danish electricity market of Svenska Kraftnät's congestion management methods*, 13 Nov. 2006, available at http://www.svk.se/global/01_om_oss/pdf/nattjanst/svar_danskama2006.pdf (accessed in May 2012), at 8-9.

³² We do not believe that giving locational signals is a clear argument in favour of congestion shifting in comparison with counter-trading. If the network operator counter-trades, some generators in South Sweden will be paid a high price to relieve congestion. This should give them an investment incentive. In case the network operator shifts congestion to the borders, those generators face a low and country-wide uniform price and will not invest in additional capacity. However, for North Sweden the results are opposite. In case of counter-trading, generators can benefit from high energy prices, even if transmission capacity is unavailable to transport energy. So we might see too many investments. In case of congestion shifting, prices will be lower in North Sweden.

³³ SvK claims to have carried out counter-trading to some extent. See Swedish Interconnectors – COMP CASE NO 39351: *Background explanations*, note 27 above, at 24. This is a common practice in the Nordic market. The Nordic network operators use counter-trading to handle temporary and non-structural bottlenecks within their price areas. Sweden experiences recurrent bottlenecks of a structural nature. In such cases, day-ahead methods like market splitting and congestion shifting often eliminate the need for counter-trading in real-time. See Report from the Nordic Competition Authorities, note 18 above, at 35 and 37. Accordingly, the model does not take account of instances, where some counter-trading takes place. Rather it reflects an extreme case where the network operator shifts all congestion to the border and

simplified model? In this scenario, illustrated by Figure 4, transmission capacity is fully used to transport cheap electricity from North Sweden, $C_N(p) = k$. North Sweden produces as much electricity as the physical transmission allows (28 units). At this production level, the price in North Sweden is 14 (see Figure 4). Since, in the final outcome, there must be a uniform price within the country, the price in South Sweden must also equal 14. At this price level, South Sweden imports $D_S(14) = 26$ units from North Sweden. This leaves only 2 units of transmission capacity that can be used for transporting cheap energy from North Sweden to Denmark ($k - D_S(14) = 2$). Thus, the Swedish network operator declares that only 2 units of capacity are available at the border with Denmark. In the day-ahead market, Danish consumers import 2 units from Sweden, and the price in Denmark is 38 ($D_D(2) = 38$). Given the production level in North Sweden (28 units), there is no congestion within the country, and the network operator does not need to counter-trade.

Figure 4. Counter-trading with full congestion shifting: regional prices, import and export quantities (left: day-ahead market, right: counter-trading)

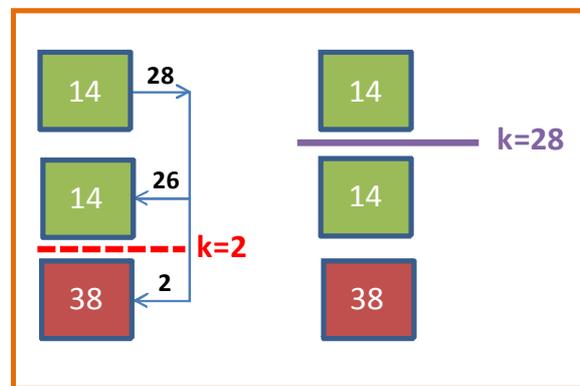


Figure 5 presents surpluses in each of the three regions.³⁴ These results are summarised in the first column of Table 3, which serves as a reference for all scenarios. The upper half of the table presents producer surplus in North Sweden, consumer surplus in South Sweden and Denmark, and the surplus of the network operator. Note that we only look at the effect of price levels on consumer surplus and producer surplus. Congestion shifting might affect price volatility, which, if firms are risk averse, will reduce overall welfare. As a matter of fact, Danish energy traders claimed to have incurred losses due to unexpected price swings, which increased the cost of insuring against price uncertainty.³⁵ This is neglected in our simple presentation. We only illustrate that, due to import restrictions, prices in Denmark are high, and consumer surplus is low. In addition, somewhat counter-

hence, no counter-trading needs to be carried out. This reflects also the Commission's preliminary assessment: Between Jan. 2002 and Apr. 2008, SvK used to relieve the congestion in the grid by reducing export capacity on several interconnectors, thereby reducing the cost of counter-trading and keeping low day-ahead prices in Sweden. The initial complaint of the DaE concerned only the Øresund interconnector. However, the Commission broadened the scope of its investigation, including all interconnectors managed by SvK. Commission Decision, note 4 above, at 38-40.

³⁴ Producer surplus in North Sweden is $\frac{1}{2} \times 14 \times 28 = 196$. Consumer surplus in South Sweden equals $\frac{1}{2} \times 26 \times 26 = 338$ and in Denmark $\frac{1}{2} \times 2 \times 2 = 2$. The network operator receives congestion rents on the interconnector equal to the price difference times the quantity transported: $(38 - 14) \times 2 = 48$.

³⁵ Copenhagen Economics estimates that the (within-day) volatility of prices in eastern Denmark has been 150% larger in congested hours compared to non-congested hours. See the Report, note 6 above, at 55-61.

intuitively, Danish energy producers also complained about congestion shifting, because the actions of the Swedish TSO decreased market transparency.³⁶

In order to better understand the possible incentives of the actors, the second part of Table 3 presents total surplus of all Swedish network users (aggregated), consumer surplus of the Danes and the revenue of each network operator. We assume that cross-border congestion rents are shared equally between the Swedish and the Danish TSOs, while the congestion rents from the internal bottleneck go to the Swedish network operator only.³⁷ Similarly, the cost of counter-trading is allocated to the Swedish TSO. We neglect the fact that, in the long run, the Swedish network operator will pass on higher costs to the grid users by increasing transmission tariffs.

Table 3. Numerical results for 4 scenarios. Note that total surplus in first-best is **728**.

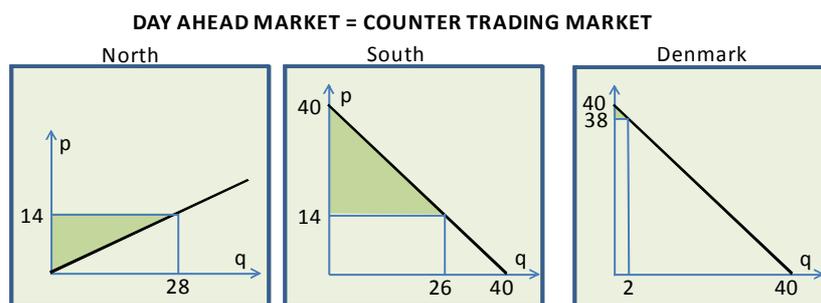
	1. CT with full congestion shifting	2. CT without congestion shifting	3. CT with partial congestion shifting	4. Market Splitting
PS North Sweden	196	436	340	196
CS South Sweden	338	272	274	98
CS Denmark	2	200	98	98
Revenue Swedish + Danish TSO	48	-216	16	336
Sweden (CS + PS)	534	708	614	294
Swedish TSO	24	- 216	- 40	336
Sweden TOTAL	558	492	574	630
Denmark CS	2	200	98	98
Danish TSO	24	0	56	0
Denmark TOTAL	26	200	154	98
TOTAL SURPLUS TSO, consumers and producers	584	692	728	728
Efficiency?	<i>Inefficient</i>	<i>Inefficient</i>	<i>Efficient</i>	<i>Efficient</i>

Note: CT – counter-trading; CS – consumer surplus; PS – producer surplus

³⁶ One could rather expect that Danish energy producers benefit from the Swedish exports limits as they receive a higher day-ahead price for their electricity in Denmark. The DaE's complaint, note 7 above, at 1.

³⁷ In practice, Nord Pool Spot collects all congestion rents (also generated by the internal bottlenecks) and re-distributes them among the TSOs. Under the new regime (in force since 2012) congestion rents from an interconnector are shared equally between the two TSOs affected, that is, co-owners of the interconnector. Congestion rents from internal bottlenecks in Norway and Sweden are paid to Statnett and SvK, respectively. The old rules on congestion rent-sharing were more complex, but in principle they do not go against our assumptions. According to a common agreement between the Nordic TSOs for years 2006-2011, the system of cost-sharing was based on two formulas. Under the first formula, bottleneck income was divided between all Nordic TSOs according to their expected investment costs related to five prioritized grid investments. Under the second formula, bottleneck income was shared equally between two affected TSOs. Both formulas were applied during the contract period, with a stepwise changeover from formula 1 to formula 2. More details can be found at <http://www.nordpoolspot.com> (accessed in May 2012).

Figure 5. Counter-trading with full congestion shifting: producer surplus and consumer surplus



It becomes clear that this scenario is not optimal, once we juxtapose it with the first-best (compare Figure 2 with Figure 4, and Figure 3 with Figure 5). The level of total market surplus in the first-best scenario is equal to 728, while the surplus here is only 584. Even though the transmission line between North Sweden and South Sweden is used at full capacity, transferred electricity is not allocated efficiently between South Sweden and Denmark. Congestion at the border with Denmark results in an inefficient use of resources, as Denmark has to use more expensive domestic generation to meet the country's electricity demand. Danish consumption is smaller than in the first-best scenario, and the electricity price in Denmark is high. Contrary to this, Swedish consumers benefit from a relatively low price. The Swedish network operator receives congestion rents at the border and does not have to counter-trade, which reduces its costs.³⁸ In the long run, Swedish grid users will pay a low network tariff. Nevertheless, the network is used inefficiently. The source of the inefficiency is that consumers in South Sweden do not internalise the negative consequences of reducing the available transmission capacity for Danish consumers, if they consume more. Hence, their consumption creates a negative externality.³⁹

B. COUNTER-TRADING WITHOUT CONGESTION SHIFTING (THE INTERIM REMEDY AS IMPLEMENTED)

Since full congestion shifting resulted in an inefficient outcome, we will now consider the other extreme: counter-trading without congestion shifting. This scenario corresponds to the interim remedy offered by SvK in the settlement with the Commission. Between April 2010 and November 2011, that is, in the period preceding the introduction of market splitting, SvK committed to reduce transmission flow on internal bottlenecks primarily by counter-trading, subject to availability of regulating resources.⁴⁰ In practice, in the day-ahead market, whenever SvK anticipated internal congestion in the grid, it was first supposed to calculate the corresponding amount for cross-border reduction necessary to relieve it. Then, instead of shifting congestion to the borders, SvK committed to counter-trade, using regulating resources located both in Sweden, as well as in neighbouring countries. Cross-border capacity reduction was allowed only in case no suitable generation was available for counter-trading. In this section, we analyze the scenario in which there are sufficient regulating

³⁸ Note that congestion shifting gives considerable revenues also to the Danish network operator, as capacity at the border is relatively scarce.

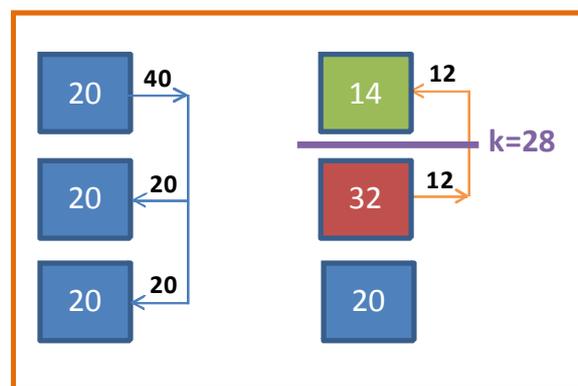
³⁹ A negative externality is a negative side effect of the consumption of a product on a third party. Negative externalities are common in an environmental context (pollution). When economic agents do not take into account the negative externality of their consumption of a product, the level of consumption of this product will be larger than the social optimum. In order to achieve a socially efficient outcome, those agents need to internalise the externality, so that they take into account the effect of their actions on third parties. This could be done for instance by imposing a tax on the good ("the polluter pays principle") or by the creation of clear property rights.

⁴⁰ Note 28 above.

resources on the one hand and no congestion shifting on the other, as preferred by the Commission. In practice, however, these factors may not always be in place.⁴¹

Figure 6 depicts this scenario. In the day-ahead market there is only one clearing price for Sweden and Denmark, as there is no congestion in the network. As supply equals total demand, $D_s(p) + D_d(p) = S(p)$, the uniform day-ahead price is equal to 20.⁴² South Sweden and Denmark each imports 20 units of energy, and North Sweden produces 40 units of energy. However, the transfer of 40 units to the southern areas is physically unfeasible, as total transmission capacity between North and South Sweden is only $k = 28$ units. In order to deal with congestion, the network operator needs to rely on counter-trading in real-time. It buys 12 units of energy in South Sweden and sells it in North Sweden at a loss (Figure 6, right graph). The price of counter-traded energy in South Sweden will be higher as energy becomes scarcer, and lower in North Sweden as energy becomes more abundant.⁴³

Figure 6. Counter-trading without congestion shifting: regional prices, import and export quantities (left: day-ahead market, right: counter-trading)



In South Sweden demand needs to be reduced from 20 units to 8. In order to do so, the network operator offers a price p to all consumers who are willing to resell their energy. This price should be such that the marginal consumer is just willing to resell its energy, hence $D_s(p) = 8$, and the price $p = 32$. At this price, consumers sell 12 units of energy to the network operator. Those consumers, who bought energy at a price of 20 and then resell it to the network operator at a price of 32, make a resale profit which is indicated by the orange square in the bottom middle graph of Figure 7. After counter-trading has taken place, consumers in South

⁴¹ Even though SvK committed to deal with internal congestion primarily through counter-trading, it made a reservation that there may still remain an amount of reduction on interconnectors. See Commission Decision, note 4 above, at 49. The model, however, assumes that all internal congestion is relieved through counter-trading within Sweden and capacity reductions do not occur at the borders. In practice, throughout the interim phase, SvK did shift congestion to the borders, whereas counter-trading could not be carried out, most often due to unavailability of suitable regulating resources in a given area. See Svenska Kraftnät, 2009/481, Swedish Interconnectors – COMP Case No 39.351, Monitoring Reports 1 – 7, available at <http://www.svk.se/Start/English/Energy-Market/Electricity/Bakgrund/> (last accessed: May 2012).

⁴² For this discussion we assume that generators in South Sweden are myopic when they offer energy in the day-ahead market. They could realise that the value of energy in the counter-trading market is 32, and they should therefore be unwilling to sell their volumes in the day-ahead market at a price of 20. We also assume that generators in North Sweden do not behave strategically. They could pretend to have an even lower cost and produce more than 40 units, as in the counter-trading market they would be compensated for reducing their production.

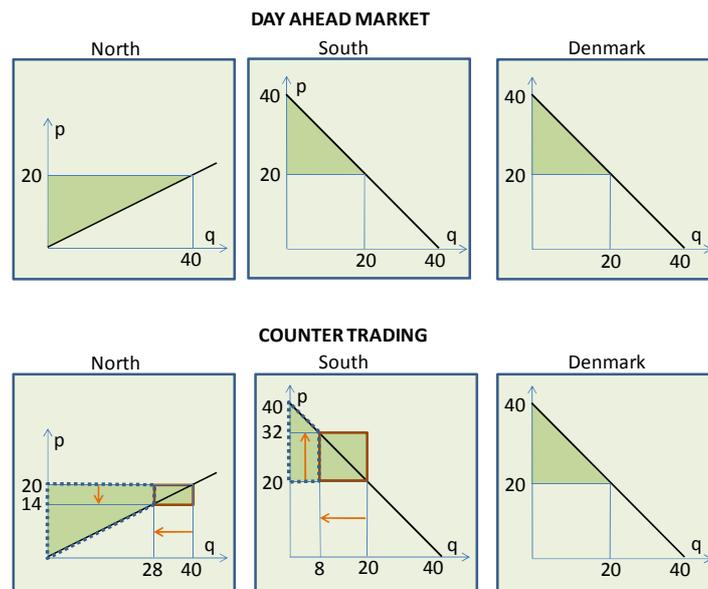
⁴³ Note that demand function $D_s(p)$ in South Sweden presents net demand, i.e. local demand minus local production at a certain price level. Hence, if the network operator buys energy in South Sweden, this could mean in practice that some consumers forgo consumption, or equivalently, that local production has increased.

Sweden with a valuation larger than 32 will consume 8 units. They bought this energy at a day-ahead price of 20, and their consumer surplus is indicated by the trapezoid in the blue dotted line.⁴⁴

In North Sweden the network operator sells 12 units of energy at a price of 14. Instead of producing energy themselves, some generators shut down production and buy the energy from the TSO. In this way, they save on production costs. Those producers buy 12 units of energy from the network operator at a price of 14, but already have sold these units at a price of 20. Thus, they make a profit which is indicated by the orange rectangle in the bottom left graph of Figure 7. Total production in North Sweden is reduced to 28 units. Producers have sold this energy at a price of 20 in the day-ahead market. Their surplus from producing energy is equal to the surface of the trapezoid with the blue dotted line. Total producer surplus in North Sweden is the sum of production surplus and trading surplus.⁴⁵

However, the network operator makes a loss, as it buys 12 units of energy in South Sweden at a price of 32 and sells them in North Sweden at a price of 14. On the top of that, it does not receive any rents from the cross-border trade with Denmark, since the interconnector is not congested. Consumer surplus of the Danes is not affected by the Swedish counter-trading and remains equal to the green triangle in the bottom right figure. The calculations for the second scenario are summed up in Table 3, second column.⁴⁶

Figure 7. Counter-trading without congestion shifting: producer surplus and consumer surplus



In this scenario, Danish consumers benefit from a low energy price (20). Also consumers in South Sweden can buy electricity at a relatively low price (20), and some of them are subsidised for reducing their consumption. Energy exporters in North Sweden receive a relatively high price (20) for their production, while some firms are subsidised in order not to produce. The network operator incurs a loss as counter-trading is costly. In practice, the losses of the network operator are passed on to network users through higher network

⁴⁴ Total consumer surplus equals 272, and is the sum of resale profit ($12 \times (32 - 20) = 144$) and net consumer surplus ($\frac{1}{2} \times 8 \times 8 + 12 \times 8 = 128$).

⁴⁵ Total producers surplus (436) is the sum of trading surplus ($12 \times (20 - 14) = 72$) and net producers surplus ($\frac{1}{2} \times 14 \times 28 + 6 \times 28 = 364$).

⁴⁶ Danish consumer surplus is equal to $\frac{1}{2} \times 20 \times 20 = 200$, and the counter-trading losses for the network operator are equal to $12 \times (32 - 14) = 216$.

tariffs. As we are unable to identify the incidence of this higher network tariffs, we assume that the cost of counter trading is borne by the network operator.

However, relieving internal congestion solely through counter-trading does not result in an efficient outcome. Even though the interconnector between Denmark and Sweden is not congested, the price in Denmark is lower than the counter-trading price in South Sweden. In our simple simulation exercise, the total market surplus under this scenario (692) is higher than in the case of full congestion shifting described above (584). But it does not necessarily mean that this will always be the case. Overall welfare may also be reduced.⁴⁷ The basic efficiency problem is the opposite of the previous scenario. If the network operator does not shift congestion to the border, Danish consumers will not internalise the fact that they create congestion within Sweden, and will therefore consume too much energy.

C. COUNTER-TRADING WITH PARTIAL CONGESTION SHIFTING (THE OPTIMAL INTERIM REMEDY)

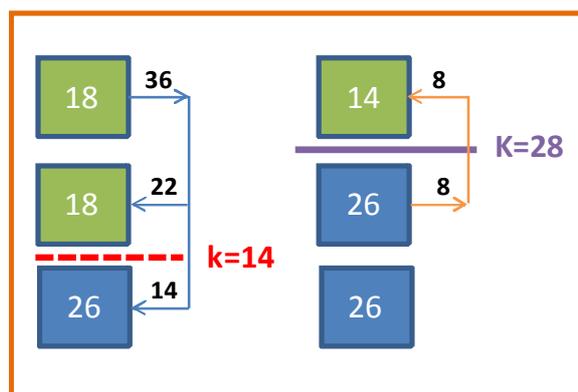
Neither of the two extremes (congestion shifting vs. counter-trading) is socially optimal. However, these two congestion methods, once combined, may result in an efficient allocation. In this section, we present an optimal interim remedy that the Commission did not go for.

For the desirable outcome to take place, the Swedish network operator has to shift *some* internal congestion to the border with Denmark. As Figure 8 demonstrates, in the efficient scenario, the TSO declares that only 14 units of capacity are available at the border with Denmark, i.e. the same amount as Denmark would import in the first best scenario (Figure 2). Any other level of available capacity ($k \neq 14$) would reduce total welfare. If the network operator declared a smaller capacity ($k < 14$), the price in Denmark would be higher than the counter-trading price in South Sweden, which would be inefficient. If it declared more available capacities ($k > 14$), then the price in Denmark would be lower than the counter-trading price in South Sweden, which would be inefficient as well.

Once the Swedish TSO declares $k = 14$, Denmark imports 14 units from Sweden, and the day-ahead price in Denmark is 26, as $D_D(26) = 14$. In the day-ahead market, it is assumed that there is no congestion within Sweden, and therefore there is a uniform energy price in Sweden. The day-ahead price is found by equaling supply and demand, while taking into account that demand by Danish consumers is equal to the available cross-border capacity $S_N(p) = D_S(p) + 14$ (= Danish Demand). This results in a Swedish day-ahead price of $p = 18$. With this price, total production in North Sweden is $S(18) = 36$ and demand in South Sweden is $D_S(18) = 22$. See Figure 8, left graph.

⁴⁷ This will vary depending on, for instance, the precise shape of the demand functions in South Sweden and Denmark, and the relative size of the markets.

Figure 8. Counter-trading with partial congestion shifting: regional prices, import and export quantities (left: day-ahead market, right: counter-trading)



South Sweden and Denmark together import 36 units from North Sweden, that is, 8 units above the transmission limit. In order to deal with this congestion, the network operator again resorts to counter-trading. It buys 8 units of energy in South Sweden and sells it in North Sweden at a loss (Figure 8, right graph). Counter-trading prices differ within Sweden: in the South they go up and in the North they go down. Some consumers in South Sweden, who bought energy at a price of 18 in the day-ahead market, agree to resell it at a price of 26 in counter-trading. They make a trading profit, equal to the orange rectangle in the bottom middle graph of Figure 9. The surplus of consumers from consuming energy in South Sweden is equal to the trapezoid in the blue dotted line. Total consumer surplus is the sum of both areas.⁴⁸

Some generators in North Sweden shut down their power plants and buy 8 units of electricity from the network operator at a price of 14. Since they have already sold these units at a day-ahead price of 18, they make a profit, indicated by an orange rectangle in the bottom left graph of Figure 9. The producer surplus from producing electricity in North Sweden is equal to the trapezoid in the blue dotted lined. Total surplus is the sum of both areas.⁴⁹

The network operator buys 8 units of energy in South Sweden at a price of 26 and sells them in North Sweden at a loss for a price of 14. However, it earns congestion rents in the day-ahead market from the cross-border trade with Denmark. It gets the price difference for each capacity unit that it exports. Counter-trading costs are born completely by the Swedish network operator, while the cross-border congestion revenues are shared equally between the Danish and the Swedish TSO. Consumer surplus in Denmark remains the same as in the day-ahead market, and is equal to the green rectangle in the bottom right figure.⁵⁰

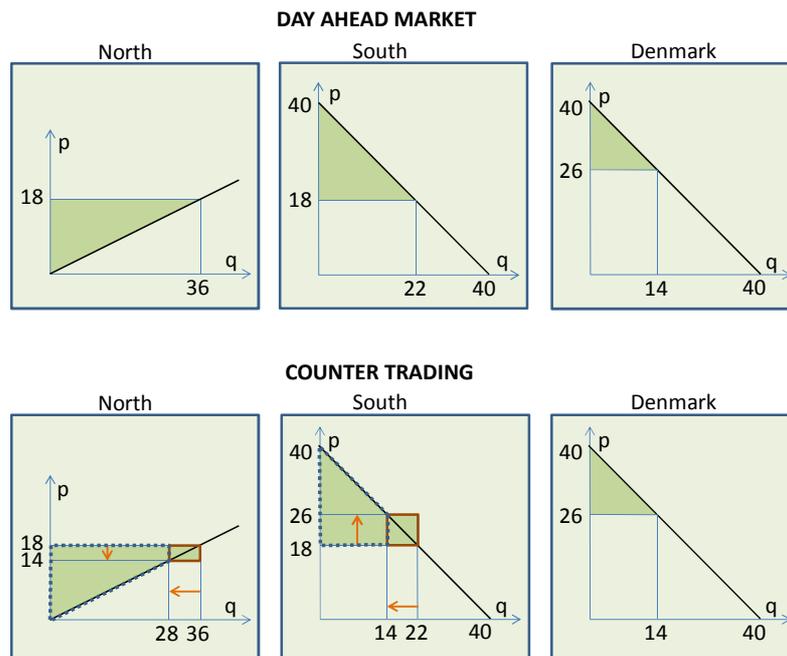
As the transmission line is used at full capacity and the South Swedish and Danish consumers consume identical amounts, this outcome is efficient. The total market surplus is therefore equal to the one in the first-best allocation. Table 3, third column, presents the results for this scenario.

⁴⁸ Total consumer surplus (274) is the sum of trading surplus ($8 \times (26 - 18)$) and net consumer surplus ($\frac{1}{2} \times 14 \times 14 + 8 \times 14$).

⁴⁹ Under the same assumptions. See note 42 above. Total surplus in North Sweden (340) is the sum of trading surplus ($8 \times (18 - 14)$) and net producer surplus ($\frac{1}{2} \times 14 \times 28 + 4 \times 28$).

⁵⁰ Overall, the network operator makes a surplus of 16, which is the sum of cross-border congestion rents ($14 \times (26 - 18)$) minus counter-trading losses ($12 \times (26 - 14)$). Danish consumer surplus is $\frac{1}{2} \times 14 \times 14 = 98$.

Figure 9. Counter-trading with partial congestion shifting: producer surplus and consumer surplus



This result shows that a combination of congestion shifting and counter-trading does not necessarily lead to inefficient use of network resources. In order to obtain an efficient outcome, the Swedish network operator *has to* shift part of its internal congestion to the border with Denmark. By reducing available cross-border capacity, the Swedish TSO can ensure that the Danes internalise the cost of congestion they create inside Sweden. In order to know how much congestion the network operator should shift to the border to achieve the social optimum, it needs to invest in collecting information on the demand functions in South Sweden and in Denmark. The network operator should therefore only declare available capacity, once it has collected information about the demand levels in the market.

Note that the efficient outcome implies that Swedish and Danish consumers have non-discriminatory access to the transmission capacity. The counter-trading price in S is 26, which is equal to the day-ahead price in D. However, Swedish network users pay a price of 18 which is lower than the Danish price 26. This is the consequence of the Swedish policy of having a uniform price. Hence, this outcome might suggest discrimination between Danish and Swedish consumers. However, in order to achieve a uniform price, the Swedish network operator incurs counter-trading losses, which it recovers in the long run from the Swedish network users by charging them higher transmission tariffs. Hence overall, consumers in South Sweden are not necessarily better off than their Danish counterparts.

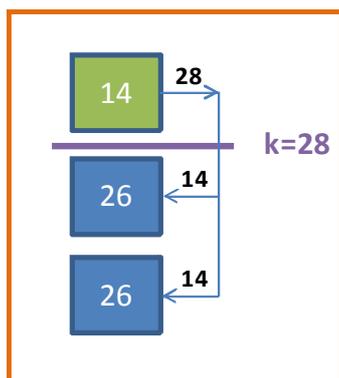
D. MARKET SPLITTING (FINAL REMEDY)

Our fourth and last scenario is market splitting, the final remedy accepted by the Commission in the SvK case. As a result of negotiations with the Commission, SvK agreed to subdivide the Swedish electricity market into several price zones, and to manage domestic congestion without limiting trading capacity on interconnectors. This new market system, according to which Sweden was split into four price areas, was

introduced in November 2011.⁵¹ In cases where internal congestion occurs within a price zone, SvK committed not to reduce capacity on the interconnectors, but to carry out counter-trading within these zones to relieve it.

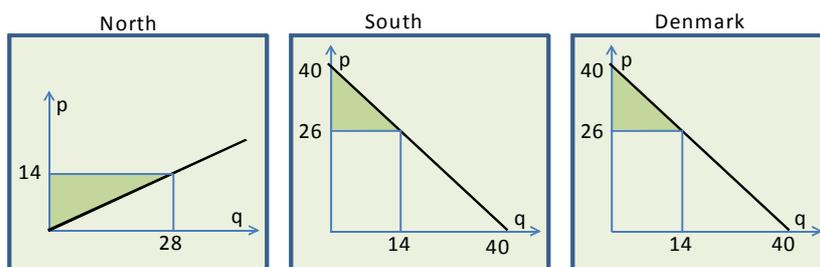
Market splitting results in an efficient allocation, in the same way that the optimal combination of congestion shifting and counter-trading does. Whenever there is congestion on the line between North Sweden and South Sweden, the network operator splits the market into two price areas, as presented in Figure 10. As a result, there is a uniform price of 26 in South Sweden and Denmark, while the price in North Sweden is 14. North Sweden exports a surplus of 28 units, which is imported in South Sweden (14 units) and Denmark (14 units).

Figure 10. Market splitting: regional prices, import and export quantities



Producer surplus in North Sweden and consumer surplus in South Sweden and Denmark is given by green triangles in Figure 11. The network operator receives congestion rents on the transmission line equal to the price difference times the quantity transported. As those rents are internal to the Swedish network, they accrue fully to the Swedish network operator and not to the Danish one. The allocation of transmission capacity is efficient and total market surplus is equal to the first best outcome (728).⁵² The last column in Table 3 shows these results.

Figure 11. Market splitting: producer surplus and consumer surplus



The Swedish TSO agreed to split the market into price zones, so that it no longer needs to reduce capacity on the interconnectors to other countries or any other line.⁵³ However, it may still do it, even if the new system of price zones is in place. In this section, we show that market splitting does not prevent the Swedish network operator from capacity manipulation at the border with Denmark. Figure 12 shows day-ahead prices in case the

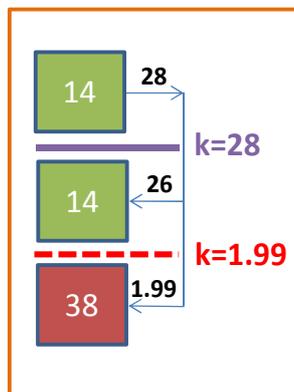
⁵¹ The four price areas from north to south are SE1 (Luleå), SE2 (Sundsvall), SE3 (Stockholm) and SE4 (Malmö).

⁵² The total market surplus (728) is the sum of producer surplus ($\frac{1}{2} \times 14 \times 28$), South Swedish and Danish consumer surplus (both equal to $\frac{1}{2} \times 14 \times 14$) and internal congestion revenue for the TSO ($(26 - 14) \times 28$).

⁵³ Commission Decision, note 4 above, at points 79-80.

Swedish network operator sets available capacity at the interconnector with Denmark equal to 1.99.⁵⁴ In equilibrium,⁵⁵ congestion occurs only at the border with Denmark, and not on the transmission line between North and South Sweden. The price in South Sweden drops to 14 and evens up with the price in North Sweden. In turn, the price rises to 38 in Denmark. In this way, the Swedish network operator can achieve the same price levels as in our first “abusive” scenario.

Figure 12. Market splitting with strategic congestion: regional prices, import and export quantities



Splitting the Swedish market into separate price zones does not make it impossible for the Swedish network operator to manipulate the available cross-border capacity. Hence, a change in the market architecture alone is insufficient to prevent SvK from congestion shifting in the future. Monitoring of the Swedish TSO’s behaviour remains necessary. But while separate price zones do not effectively prevent congestion shifting, they do improve market transparency, making it easier for the regulators and market participants to determine whether available capacity is set at the right level. In this way, congestion shifting can be easier to detect.

E. COMPARISON OF 4 SCENARIOS

Table 3 collects results from all the four scenarios, and enables a cross-scenario comparison of regional and total market surplus. Overall, scenarios 3 and 4 are efficient and therefore maximise total market surplus, while inefficient allocation of network capacity in scenarios 1 and 2 leads to welfare losses and a reduction of total market surplus.⁵⁶

Danish customers lose out on congestion shifting, because cross-border capacity reductions increase high-cost domestic energy production in Denmark, and lead to high day-ahead prices. This might explain why SvK’s behaviour raised protests in Denmark. Danish consumer surplus is the highest when the interconnector is used to the largest extent, that is, when no congestion shifting takes place. Hence, the most advantageous scenario for Danish consumers is clearly full counter-trading. However, in situations where the interconnector is congested, the Danish TSO may earn some additional congestion rents. The current regulatory regime requires that these

⁵⁴ If the network operator sets the quantity exactly equal to 2 units, then two constraints are binding at the same time: the internal constraint of 28 units and the cross-border constraint of 2 units. In that case, prices within Sweden are not uniquely defined. By setting a cross-border capacity just below 2 (in our example equal to 1.99), the network operator can guarantee that the internal constraint within Sweden is not binding, and that there is one unique price for Sweden.

⁵⁵ Market is in equilibrium, when supply of electricity equals the quantity demanded.

⁵⁶ Counter-trading and market splitting might have different welfare aspects in a richer model than the one we use here. For example, it is well-known that counter-trading gives inefficient long-term signals for generation investment and can lead to strategic behaviour by generators. However, these long term issues and problems are not captured by our simple model.

congestion rents are paid back, in the long run, to the network users through grid investments or lower transmission tariffs.⁵⁷

Producers in North Sweden benefit from counter-trading. If the network operator does not shift congestion to the borders, some producers in North Sweden receive the highest price for their energy ($p = 20$). In addition, other producers in North Sweden are subsidized for not producing (counter-trading). Consumers in South Sweden, on the other hand, benefit from congestion shifting to the Danish border, as this keeps their price low. Market splitting increases their price. Taken together, Swedish grid users are better off when SvK performs counter-trading (scenario 2, interim remedy as implemented) or a mix of counter-trading and congestion shifting (scenario 3, optimal interim remedy) rather than shifting all congestion to the borders (scenario 1, alleged abuse). If it was up to the Swedish grid users, market splitting would not be chosen in the short term. This might be reflected in their initial strong opposition against the introduction of price areas in Sweden.⁵⁸ However, once we compare total surpluses for Sweden in each scenario, it is clear that market splitting results in the highest market surplus, because it is efficient and keeps all congestion revenues within Sweden.⁵⁹

In the long term, Swedish grid users pay not only direct energy and congestion costs through their transmission tariffs, but also the counter-trading costs that the TSO incurs. These tariffs are likely to be lower under market splitting as the TSO has an additional source of income, the congestion rents. Given current regulation, these rents will be used to improve the TSO's network operations, so that, ultimately, they will be returned to the network users.⁶⁰ Hence, in the long run, the Swedish grid users should prefer the scenario that gives the highest surplus to Sweden, which is market splitting, and not optimal congestion shifting. In the aggregate, patient forward-looking network users should not oppose market splitting.

The Swedish network operator's revenue is maximised under market splitting, as it receives congestion rents on the internal bottleneck.⁶¹ If SvK shifts all internal congestion to the borders, it also receives some congestion revenues from the cross-border bottleneck. However, we assume that they are shared with the Danish TSO.⁶² Further, due to low capacity of the cross-border interconnector (2 units are available on the market), these revenues are relatively small. On the plus side is the fact that SvK does not bear the cost of counter-trading. Thus, it appears that the Swedish network operator would clearly favour market splitting if its objective would be to maximise its own revenue. If market splitting would be impossible to implement, a profit-maximising network operator would prefer to shift all congestion to the border, as this reduces the cost of counter-trading.

Having said that, we cannot just assume that SvK is merely trying to maximise its own profits and ignore the regulatory environment in which it operates. Looking at the regulation is necessary to understand SvK's incentives. It is a state-owned public utility that faces several complex incentive structures. As with all European TSOs, SvK is subject to economic regulation, which typically tries to align the TSO's incentives with the social optimum, i.e. to limit the network operator's profits, while simultaneously ensuring an efficient operation and

⁵⁷ Note that we do not formally model how the costs and benefits of the TSO are allocated. In practice, the EU regulation forbids cross-border congestion rents to be transferred as dividend to shareholders. Congestion income can only be used for guaranteeing capacity, building infrastructure or lowering the network tariff. See note 22 above.

⁵⁸ See, for instance, Svenska Kraftnät, *Annual Report 2010*, Director General's Statement, at 5. We discuss this at length in our companion paper, note 10 above.

⁵⁹ Under the current congestion rent-sharing regime. See note 37 above.

⁶⁰ Note 57 above.

⁶¹ See section II.C.

⁶² Note 37 above.

investment in the network.⁶³ In order to prevent network operators from intentionally declaring low transmission capacities as a way to earn congestion rents, those rents are earmarked for grid reinforcement or to lower transmission tariffs and cannot be used to generate additional profits for shareholders.⁶⁴ Thus, there is no obvious direct link between SvK's profits and the amount of congestion in the network.

If the Swedish regulator was able to align SvK's incentives with total market surplus, then, according to our model, SvK would still opt for market splitting, just as if it was an unregulated profit-maximising firm. Market splitting leads to an efficient allocation of network capacities and maximises total surplus. It keeps congestion revenue in Sweden, and on top of that, it might also provide more detailed information as to where congestion occurs and how severe it is. With this information SvK could target and direct its investments more efficiently.

There might be many reasons, why SvK delayed the introduction of market splitting for such a long time. SvK's objectives are stipulated in the Instruction from the Swedish Government, the national regulation governing SvK.⁶⁵ One of those objectives is promotion of competition in the Swedish wholesale and retail electricity markets.⁶⁶ Maintaining one price in Sweden reflects this goal, as it simplifies life for retail competitors. For instance, retailers can offer a single product to all Swedish consumers and they do not face the risk of regional price differences when they procure energy from producers. Moreover, SvK mentioned that there were serious concerns that the introduction of market splitting would have adverse effect on South Sweden, as it would create a sub-market with insufficient competition.⁶⁷ Lastly, as already mentioned, Swedish stakeholders, headed by the trade association Swedenergy, were initially rather skeptical towards market splitting. They might have influenced Swedish regulators and government agencies to keep the status quo, and as a regulated state-owned company, SvK might have been interested in pleasing its sole shareholder and regulator, the Swedish state.

There might be further reasons why SvK prefers to shift congestion to the borders, instead of counter-trading. The Instruction from the Swedish Government names cost-efficiency as one of the SvK's objectives, which suggests that SvK ought to avoid costly counter-trading as an option. Furthermore, the cost of counter-trading is passed on to the Swedish grid users through transmission tariffs.⁶⁸ By avoiding counter-trading SvK would keep these tariffs low for the Swedish consumers, which is an obvious preference of the Swedish government. Lastly, from the security of supply's perspective, congestion shifting might be seen as a safer method to deal with congestion than counter-trading. Congestion shifting reduces flows over the Swedish network in the day-ahead market, whereas counter-trading is carried out in real-time and relies on regulating

⁶³ See, for instance, NordREG, *Regulation of the Nordic TSOs – with focus on Market Efficiency and Harmonisation*, Report 7/2007, at 13-14.

⁶⁴ Article 16(6) of Regulation (EC) No 714/2009, note 1 above.

⁶⁵ Förordning med instruktion för Affärsverket svenska kraftnät, 2007:1119 (Government Ordinance with Instruction for Svenska Kraftnät).

⁶⁶ In our model we assume that energy markets are perfectly competitive, that is, we do not take into account market power effects. However, we believe that obtaining a uniform price by means of, for instance, counter-trading will not always be pro-competitive. It leads to strategic bidding for counter-trading payments in export-constrained areas and higher day-ahead bids in import-constrained areas, as forward-looking firms take into account the opportunity cost of the counter-trading market. See also Justin Dijk and Bert Willems, *The effect of counter-trading on competition in electricity markets*, 39 ENERGY POLICY 3 1764-1773 (2011). Obtaining a uniform price with congestion shifting might somewhat improve competition between North and South Sweden, but likely reduces competition between Sweden and Denmark. See also the recent report of Energy Markets Inspectorate, which finds no evidence that retail competition decreased in the first months after introducing market splitting in Sweden. See Energy Markets Inspectorate, *Elområden i Sverige. Analys av utvecklingen och konsekvenserna på marknaden*, EI R2012:06 (2012). In Swedish only.

⁶⁷ See Svenska Kraftnät, *The Complaint from Dansk Energi*, note 31 above, at 4.

⁶⁸ The Swedish Electricity Act, SFS 1997:857, 20 Nov. 1997, stipulates that tariffs must be cost-reflective.

resources, which are not always at hand. Thus, where these regulating resources are not sufficiently available, counter-trading raises the risk of black-outs.⁶⁹

IV. CONCLUSIONS

We now contrast the results of our economic analysis with the Commission's anticompetitive concerns expressed in its antitrust investigation against SvK.⁷⁰

According to the Commission, SvK's congestion shifting results in *de facto* discrimination between Swedish customers and foreign customers that import electricity from Sweden. Once congestion occurred in the Swedish grid, SvK discriminated between domestic and cross-border transmission services. In order to relieve internal bottlenecks, it first satisfied domestic demand and then reduced transmission of electricity intended for export.

In our view, the Commission's initial anti-competitive assessment, which points at discrimination between domestic and cross-border transmission services, goes in the right direction. Discrimination based on transmission services can be given a sound economic interpretation. Local trade (from North Sweden to South Sweden) and international trade (from North Sweden to Denmark) would be treated in a non-discriminatory manner if the price in Denmark and the counter-trading price in South Sweden were equal. This would lead to an efficient allocation of all transmission capacity. Note that the counter-trading price in South Sweden is typically higher than the price consumers pay in South Sweden. In order to determine whether discrimination took place, the Commission should study the prices that arose in the day-ahead market and in the counter-trading market. A correct focus on discrimination can thus improve social welfare. However, this economic interpretation is not taken by the Commission in its reasoning. Instead, the Commission notices price differences between Sweden and Denmark in the day-ahead market and argues that SvK's practices resulted in a segmentation of markets between Member States, with a lower electricity price in Sweden and a higher price abroad.⁷¹ Against this backdrop, the Commission recalls the European Court of Justice's case law, according to which discrimination between the customers based on residence constitutes an abuse of a dominant position in violation of Article 102 TFEU.⁷² It refers also to Article 18 TFEU, prohibiting discrimination on the basis of nationality. In other words, the Commission seems to define discrimination based on differences in day-ahead prices in Sweden and in Denmark. We show that under efficient congestion shifting (3rd scenario, optimal interim remedy, see Figure 8), energy prices for consumers in Sweden and Denmark will be different.⁷³ Hence, if the Commission's goal was economic efficiency, it should not define discrimination between domestic and cross-border transmission services based on differences in *day-ahead prices*, but should take both *day-ahead and counter-trading prices* into account.

⁶⁹ We could also speculate about the objectives of managers at SvK. They could, for instance, try to maximize total European surplus, and would like to collaborate with their peers, the managers of TSOs. They might also want to maximize the turnover of the company, to receive a private benefit of managing larger projects and having better job opportunities in the future.

⁷⁰ Commission Decision, note 4 above, at points 27 and 42-44.

⁷¹ Commission Decision, note 4 above, at point 41.

⁷² Commission Decision, note 4 above, fn. 39. The European Courts apply Article 102 to discriminatory practices and the Commission invoked this line of cases to back the SvK decision. All these cases concern practices that are, in the first place, harmful to the internal market. Some legal scholars consider them a third category of Article 102 abuses, next to exploitative and anti-competitive abuses. See, for instance, Richard Whish, *Competition Law*, LexisNexis, 5th Edition (2003), at 195 and 679. Alison Jones & Brenda Sufrin, *EC Competition Law*, OUP Oxford, 2nd Edition (2004), at 520.

⁷³ As we mentioned before, consumers in South Sweden might face higher network tariffs in the long-run to finance the implicit subsidy that is paid by the network operator while counter-trading.

In the commitment decision, the Commission does not directly mention economic efficiency as its objective, and relies mainly on market integration rhetoric. According to the Commission, SvK's behaviour thwarts the benefits of the single market in electricity, and goes against the objective of European integration.⁷⁴ Interestingly, the Commission even explicitly refers to Treaty provisions outside the area of competition policy, in particular the rules governing free movement of goods. It cites Article 35 TFEU, which forbids quantitative restrictions on exports and measures having equivalent effect.⁷⁵

Invoking Article 35 TFEU seems to suggest that SvK's conduct is abusive just by the mere fact that restricts exports. Apparently, in the Commission's view, behaviour of a dominant undertaking impeding cross-border trade should be prohibited under Article 102 TFEU, just as state protectionist measures are prohibited under Article 35 TFEU.⁷⁶ Our paper shows that forbidding all congestion shifting can only be justified if the Commission's main objective is market integration, and not economic efficiency.⁷⁷ Efficiency requires that some cross-border capacity is reduced. To the contrary, the Commission's interpretation of discrimination, based on *electricity day-ahead prices* comparison, seems to imply that international consumers should get priority access to national bottlenecks as compared to national consumers. The Commission's approach seems to favour reverse discrimination, and may have a negative effect on competition in the internal market just as any other kind of discriminatory treatment.

The interim remedy accepted by the Commission, which requires SvK to solve internal bottleneck problems primarily by counter-trading and thus maximise utilisation of cross-border links, might have resulted from this flawed argumentation, according to which international (in this case Danish) consumers should obtain priority access to transmission on congested lines within Sweden. In the counter-trading scenario, which represents the implemented remedy, the Danes do not internalise congestion they create within Sweden, which leads to inefficiencies. The ill-designed interim remedy (from an economic efficiency viewpoint) might have been avoided, if the Commission formulated its anticompetitive concerns in the preliminary assessment in a different way. Congestion shifting as such should not constitute an alleged abuse in the SvK case. Rather, the fact that the amount of shifting was suboptimal should raise anticompetitive concerns. The Commission, by relying in its argumentation on internal market rules (Article 35 TFEU), created the false impression that complete elimination of congestion shifting would be an efficient solution, because it would maximise cross-border flows and thus best serve the overriding goal of market integration.

However, the negative effect resulting from the imperfect interim remedy (efficiency loss) might not have been that substantial in the end. First of all, counter-trading has been applied only over a short period of time, between April 2010 and November 2011. Secondly, the interim remedy has not even achieved the

⁷⁴ Commission Decision, note 4 above, at point 27 and 44.

⁷⁵ Commission Decision, note 4 above, at point 43.

⁷⁶ Commission Decision, note 4 above, at point 43: "*Moreover, Article 35 TFEU expressly prohibits quantitative restrictions on exports and all measures having equivalent effect. It is thus clear that a Member State would not be entitled to restrict exports of electricity so as to reserve such electricity for domestic consumption. Similarly, a dominant undertaking cannot seek to achieve the same objective through its conduct on the market without falling foul of Union competition rules. Practices that do so are generally considered to have as their object the restriction of competition.*" Note that this prohibition is addressed to the Member States, not the individual undertakings. However, the Commission drew a parallel here in terms of objectives. That is, given that Member States are not allowed to restrict cross-border trade under Article 35 TFEU, also a dominant undertaking, which seeks to achieve the same objective through its market behaviour, should not escape competition rules. We discuss this point in more detail in the companion paper, note 10 above.

⁷⁷ It is not the first time in the history of the EU competition enforcement that the single market imperative takes precedence over efficiency considerations. Massimo Motta, *Competition Policy. Theory and Practice*, Cambridge (2004), at 23. Whish, note 72 above, at 21. Giorgio Monti, *EC Competition Law*, Cambridge (2007), at 40. Julio Baquero Cruz, *Between Competition and Free Movement. The Economic Constitutional Law of the European Community*, Hart Publishing (2002), at 98-100.

Commission's goals. As SvK reported, this remedy turned out to be rather ineffective. At times when congestion occurred within the network and SvK tried to counter-trade according to the interim procedure, it either did not increase cross-border capacities,⁷⁸ or the increase was insignificant.⁷⁹ The most common reason for not performing counter-trading was the lack of suitable generation in a given area, that is, with short enough start-up times.⁸⁰ Note also that in our simulation the second scenario, representing the interim remedy as implemented, is more efficient than the first "abusive" scenario, where all congestion is shifted to the border. Hence, our simulation model suggests that the interim remedy could have actually improved total surplus.

Our analysis shows that the final remedy, market splitting, is an optimal market design, as it can address internal congestion efficiently. Nevertheless, even though market splitting results in an efficient allocation of declared capacity, it does not address the anticompetitive concerns regarding SvK's (alleged) abuse. SvK can still manipulate declared cross-border capacities in order to maintain a single low price within Sweden. Further monitoring is necessary to ensure that cross-border capacity is not unduly limited.⁸¹

We believe that our economic analysis is not only relevant for the Swedish interconnector case, but also for the ongoing discussion on the regulation of cross-border capacity allocation and congestion management (CACM).⁸² Current regulations forbid congestion shifting unless it is justified for reasons of operational security, cost-effectiveness, and minimisation of negative impacts on the internal electricity market.⁸³ In practice, network operators are not transparent in how they determine cross-border transmission capacities, where they often implicitly give priority to national consumers⁸⁴, and are likely to shift too much congestion to borders.⁸⁵ Our case study shows that some congestion shifting is efficient, and discusses exactly how much congestion should be shifted. Determination of optimal congestion shifting requires an economic analysis on top of a physical and engineering description of the electricity network.

⁷⁸ Svenska Kraftnät, 2009/481, Swedish Interconnectors – COMP Case No 39.351: Monitoring Report No 2 of 13th Jul. 2010, at 18-22. Monitoring Report No 3 of 14th Oct. 2011, at 19-22. Monitoring Report No 6 of 14th Jul. 2011, at 15-17. All reports are available at <http://www.svk.se/Start/English/Energy-Market/Electricity/Bakgrund/> (accessed in May 2012).

⁷⁹ Svenska Kraftnät, 2009/481, Swedish Interconnectors – COMP Case No 39.351: Monitoring Report No 4 of 12th Jan. 2011, at 19-21. Monitoring Report No 5 of 13th Apr. 2011, at 17-21. Monitoring Report No 7 of 12th Oct. 2011, at 16-19. All reports are available online, note 78 above.

⁸⁰ Usually area 4, south to CUT 4, where the congestion often occurred. See the Monitoring Reports No 2, 3 and 6, note 78 above.

⁸¹ In the same line CONSENTEC and Frontier Economics, Analysis of Cross-Border Congestion Management Methods for the EU Internal Electricity Market, a study commissioned by the European Commission, Final Report (2004), Executive Summary, at 88.

⁸² Congestion Management Guidelines 770/2006/EC (CM Guidelines) appended to Regulation (EC) No 714/2009, note 1 above. See also ACER's Framework Guidelines on Capacity Allocation and Congestion Management for Electricity (CACM FG), FG-2011-E-002, 29th July 2011. On the basis of the CACM FG, the European Network for TSOs for Electricity (ENTSO-E) is currently developing the Network Code on Capacity Allocation and Congestion Management for Electricity (CACM network code), which then need to be applied by the TSOs. The CACM network code is going to be submitted to ACER by no later than 30 Sept. 2012.

⁸³ *Id.*, point 1.7 of CM Guidelines.

⁸⁴ See ERGEG, Draft Framework Guidelines on Capacity Allocation and Congestion Management for Electricity. Initial Impact Assessment. Ref:E10-ENM-20-04 (2010), at 37. In practice, TSOs first determine the network flows nationally, using historical data and neglecting cross-border trade (base-line scenario). They then determine how much capacity is available on the network for cross-border trade. In this way, national transactions are given priority.

⁸⁵ Congestion shifting is still a common practice among TSOs in Europe. See ERGEG, Draft FG, note 84 above, at 35 and 42. The Energy Markets Inspectorate, Price Formation and Competition in the Swedish Electricity Market. Main findings of ER 2006:12, EMIR 2006:02, non-authorized translation, at 15. Giuseppina Squicciarini, Guido Cervigni, Dmitri Perekhodtsev and Clara Poletti, *The integration of the European electricity markets at a turning point: from the regional model to the Third Legislative Package*, EUI Working Paper RSCAS 2010/56 (2010), at 2.