UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

The Impact of Unilateral Carbon Taxes on Cross-Border Electricity Trading

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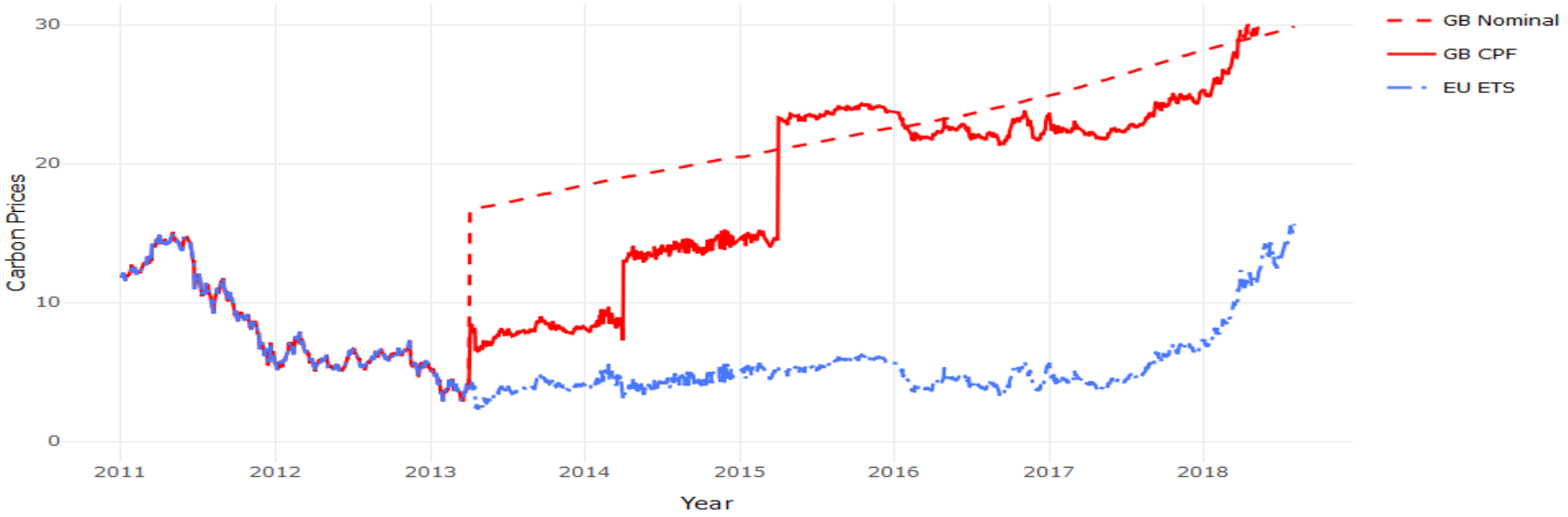
Outline

- The UK government introduced a Carbon Price Floor (CPF) from 2013.
  - On top of the EU ETS
  - Raised twice until 2016, then stablised at £18/tCO2.
- Interconnectors create value: the higher price market imports cheaper electricity from its neighbours.
  - Market coupling ensures higher-price markets to import (in the day-ahead market).
- Questions: What is the impact of CPF
  - on energy prices, net import, private and social value... under market coupling?

Evolution of the EUA Price and CPF, £/tCO2

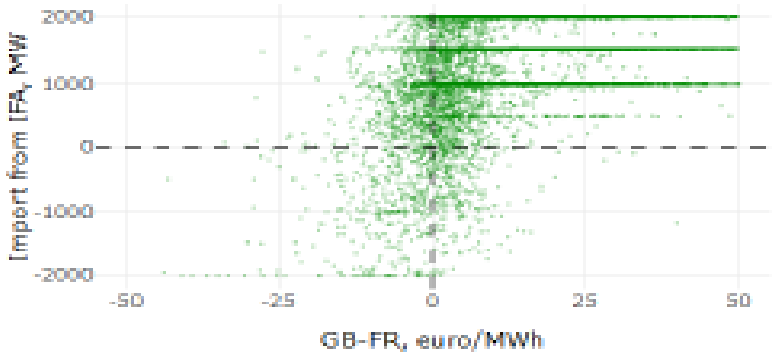


- CPF=CPS+EU ETS
- By April 2013, the EUA price fell to under £4/tCO2.
- The CPF was intended to bring the carbon costs to £(2011)30/tCO2 by 2020 and £(2011)70/tCO2 by 2030.
- In November 2017 the EU reformed the ETS, introducing a Market Stability Reserve.

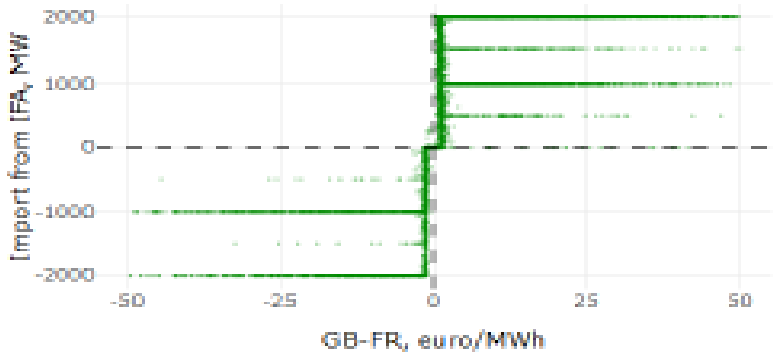
Market Coupling

- Starting from 4 February 2014, electricity market coupling in North Western Europe went live;
- Great Britain, France, and the Netherlands took part in this initiative, while on the island of Ireland the SEM was not integrated until 1 October 2018.
- Day-ahead scheduled commercial exchange of IFA flows v.s. GB-FR price differentials, before and after market coupling:

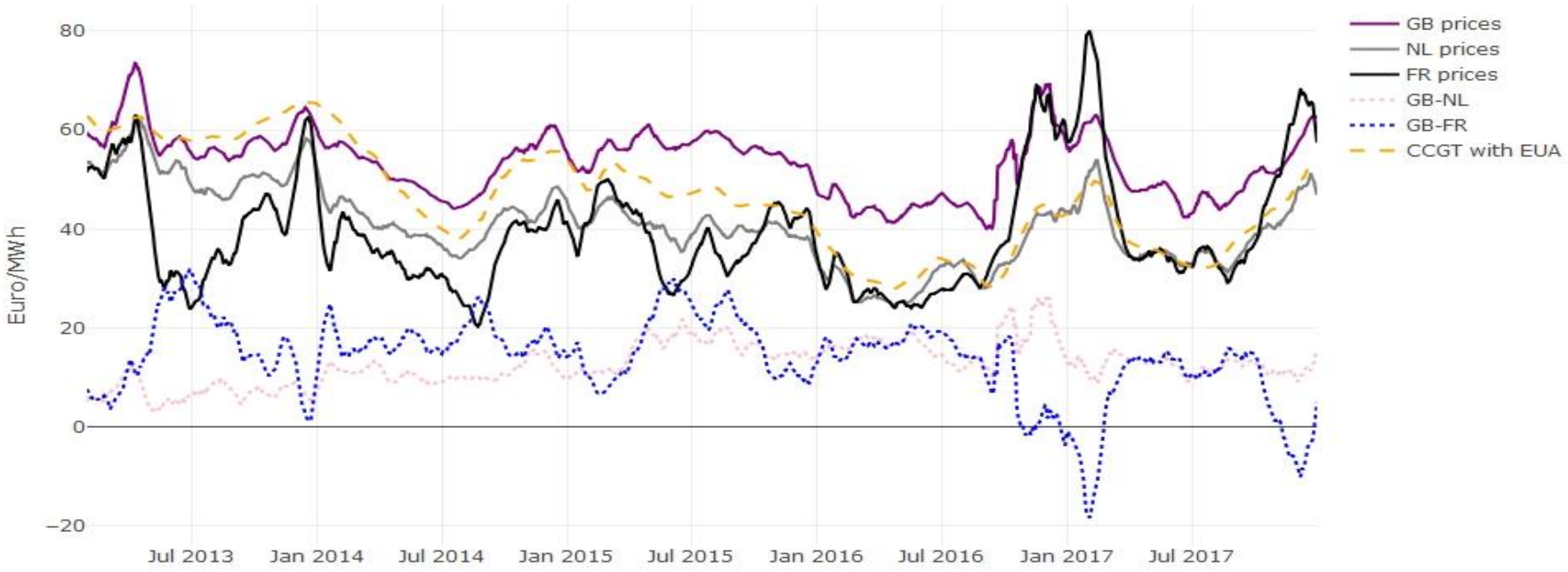
(a) Pre-coupling, 2013



(b) Post-coupling, 2017

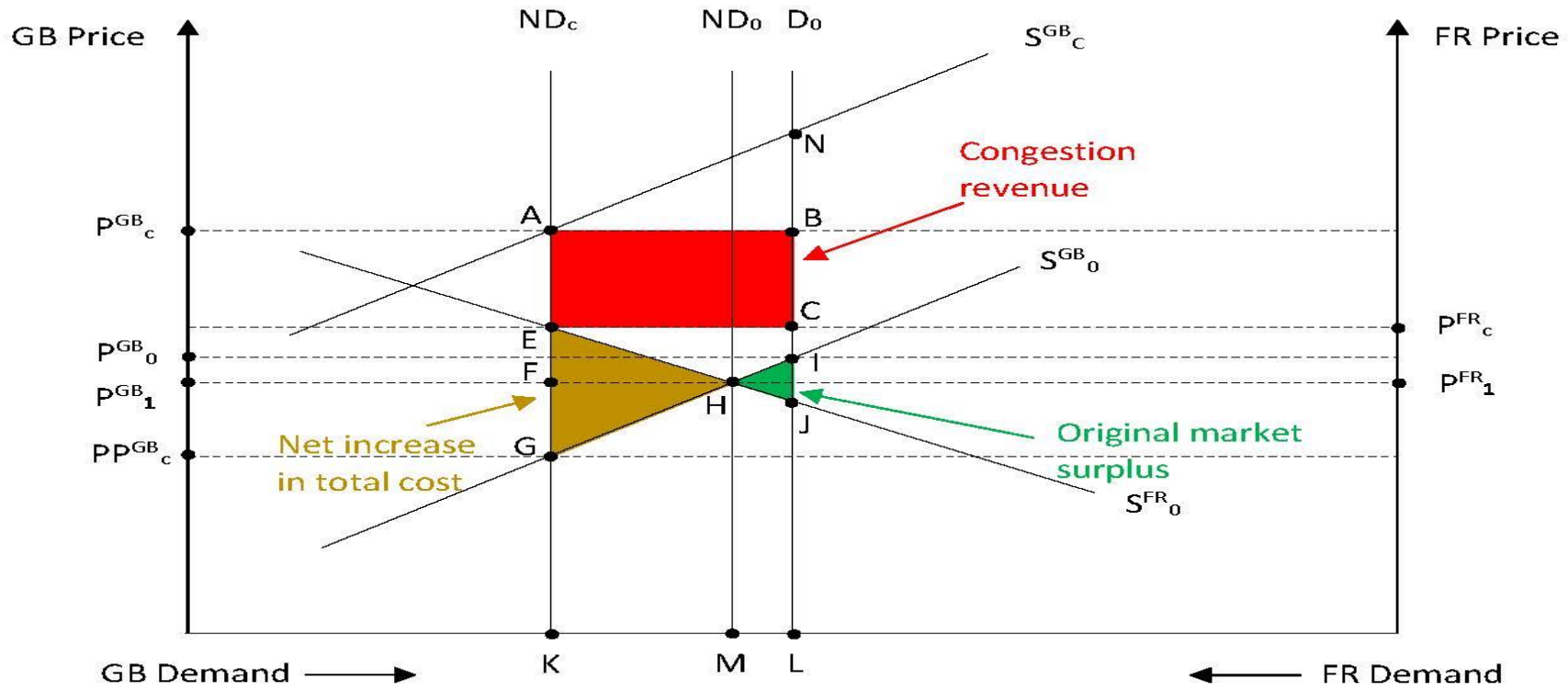


28-day lagged Moving Average wholesale prices, 2013-2017



- While GB prices are typically higher than NL prices, the CPS widens the GB-NL price differential;
- FR prices are much more volatile: 80% (in 2015) of electricity comes from nuclear, resulting in less flexible electricity system.

The impact of unilateral carbon taxes on trade



- The CPS raises GB prices, resulting in higher imports;
- GB generation costs falls, FR cost rises, deadweight loss incurs;
- The total increase in cost is HEG.

Estimation process

- Estimate the impact of interconnector flows and the CPS on the IFA and BritNed price differentials;
- Three-stage process:
  - estimate price differentials without the CPS *holding flows at their original value;*
  - re-couple the interconnector markets, with any changes in flows further influencing the price differentials;
  - evaluate the impact of the CPS on net imports, congestion income, the carbon cost pass-through to the cross-border market, and deadweight loss.

Results: short-run effects

Variable	Unit	IFA Price Diff. $PD^{IFA,PEAK}$	IFA Price Diff. $PD^{IFA,OFF}$	BritNed Price Diff. $PD^{BN,PEAK}$	BritNed Price Diff. $PD^{BN,OFF}$
NTC	GW	-1.26^{**}	-0.19	-3.34^{*}	-0.82
		(0.45)	(0.36)	(1.40)	(1.22)
VC^{COAL}	€/MWh$_e$	-0.35^{***}	-0.20^{***}	-0.15^{***}	-0.07^{**}
		(0.04)	(0.03)	(0.03)	(0.02)
VC^{CCGT}	€/MWh$_e$	0.32^{***}	0.28^{***}	0.16^{***}	0.14^{***}
		(0.03)	(0.03)	(0.03)	(0.03)
EUA	€/tCO$_2$	-0.14^{**}	-0.10^{*}	-0.24^{***}	-0.13^{***}
		(0.05)	(0.04)	(0.04)	(0.03)
CPS	€/tCO$_2$	0.23^{***}	0.22^{***}	0.24^{***}	0.15^{***}
		(0.06)	(0.05)	(0.05)	(0.04)

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$.

- As GB imports more, NTC reduces PD,
- GB less carbon intensive, VC^{COAL} negatively impacts PD, VC^{CCGT} positive, EUA negative.
- CPS have positive impact on PD.

Results: long-run effects

Variable	Unit	IFA Price Diff. $PD^{IFA,PEAK}$	$PD^{IFA,OFF}$	$PD^{IFA,AVE}$
EUA	€/tCO$_2$	−0.42*	−0.29**	−0.38***
		(0.14)	(0.13)	(0.12)
CPS	€/tCO$_2$	0.59***	0.65***	0.61***
		(0.12)	(0.15)	(0.12)
		BritNed Price Diff. $PD^{BN,PEAK}$	$PD^{BN,OFF}$	$PD^{BN,AVE}$
EUA	€/tCO$_2$	−0.63***	−0.33***	−0.53***
		(0.13)	(0.08)	(0.10)
CPS	€/tCO$_2$	0.50***	0.39***	0.46***
		(0.10)	(0.10)	(0.08)

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$.

- On the 23 June 2016, the GBP/EUR exchange rate fell from 1.30 to 1.17, reduced the GB CPS by €2.34/tCO2.
- In the long run, the Brexit referendum reduced the GB-FR(NL) price differential by €1.42 (1.08)/MWh.

CPS pass through to the GB day-ahead prices

- The CPS pass-through to the GB DAM price: the ratio between the increase in the DAM price and the increase in the system marginal cost (SMC).
- Chyong et al. (2019): a €1/MWh increase in the CPS on average increases the SMC by €0.374/MWh.
- The SR CPS pass-through rate is 60% from IFA estimates (or 58% from BritNed estimates) with a 95% confidence interval of 35-85% (IFA) or 35-80% (BritNed).
- The LR CPS pass-through rate from the IFA estimate is 163% (s.e.=31%) and from the BritNed estimate is 124% (s.e.=21%)
  - Differences not statistically significant from each other nor from 100% pass-through (at 1% significance level).
  - Consistent with a lagged adjustment to full pass-through and a workably competitive GB day-ahead market.

Results summarise: over 2015-2018

- the £18/tCO2 of CPS would have raised the GB day-ahead price by an average of about €10.5/MWh in the absence of compensating adjustments through increased imports.
- The actual price differential with our neighbours fell to about €8.5/MWh after allowing for replacement by cheaper imports.
- The CPS increased GB imports by 13.6TWh/yr, thereby reducing carbon tax revenue by €113m/yr.
- The commercial value of interconnectors increased by €133m/yr, half to foreign interconnector owners.
- Infra-marginal surplus valued at around €25m/yr, but the CPS created deadweight losses of €30 m/yr.
- About €2.2/MWh (18%) of the increase in the GB price caused by the CPS was passed through to higher French prices and €2.6/MWh (29%) to higher Dutch prices.

Conclusion

- The British CPS raised the GB spot price, reduced the convergence of cross-border electricity prices and increased GB imports of electricity.
- The increase in congestion income (mostly) comes from GB electricity consumers but is equally allocated to both TSOs, over-incentivising further investment in interconnectors.
- Due to higher import, both French and Dutch day-ahead prices have been slightly increased.
- GB imports more from more carbon-intensive countries (potentially carbon leakage).
- Asymmetric carbon pricing in two connected countries incur deadweight losses, resulting in less efficient cross-border trading.
- Other countries should introduce CPF.