

**RESEARCH  
ANNEX**



# **WHOLESALE COST REFLECTIVITY OF GB AND EUROPEAN ELECTRICITY PRICES**

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This Annex reports a summary of additional calculations based on the main report to demonstrate the impact of the EU withdrawal referendum on British electricity and gas prices to consumers.

# Annex

## Impact of the EU withdrawal referendum on British energy prices

Here we provide the results of additional calculations to show the final impact of the June 2016 exchange rate depreciation on British energy consumers, in terms of higher annual bills for both electricity and gas.

The left panel of Figure 1 shows the behaviour of the GB wholesale **electricity price**, whilst the right panel shows the Sterling to Euro exchange rate. Both are shown between 2012 and 2017, with the black vertical line indicating the 2016 EU referendum date. The electricity price can clearly be seen increasing both in terms of average level and volatility as the exchange rate collapsed.

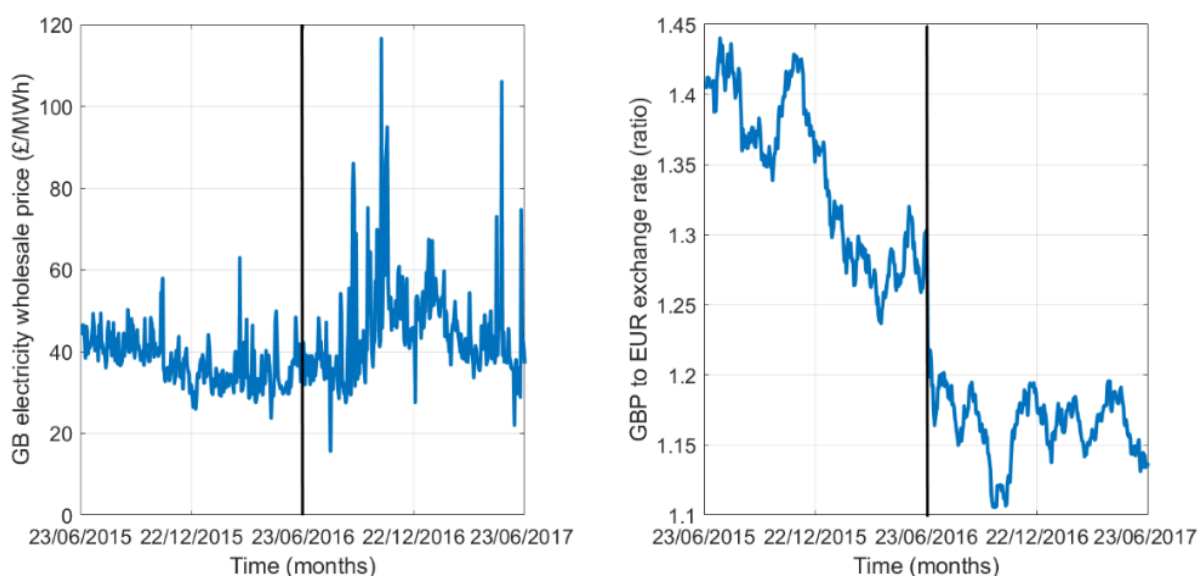


Figure 1. Electricity wholesale price (left panel) and the GBP to EUR exchange rate (right) before and after the referendum. The exchange rate against the USD experienced an identical (ca. 15%) fall to the GBP to EUR rate.

The main report revealed that the effect of the referendum in driving the observed wholesale electricity price increase disappeared when the exchange rate was directly accounted for, leaving no other statistically significant impact on average prices.

The dominant influence was through the exchange rate impact on the cost of generation inputs linked to the drop in the Sterling to Euro and the Sterling to US Dollar exchange rates, which fell by 15% the year after the referendum vote.

This suggests the exchange rate is the sole mechanism through which the effect is manifested. With wholesale costs accounting for over a third of the final electricity price to consumers<sup>1</sup>, the impact of the referendum on exchange rates therefore appears to correspond almost

<sup>1</sup> <https://www.ofgem.gov.uk/publications-and-updates/infographic-bills-prices-and-profits>

exactly to the 2016/2017 increase of about 6% in retail electricity prices<sup>2</sup>. Hence, the exchange rate impact on wholesale electricity costs accounted for nearly all of the observed increase in domestic retail electricity prices.

This is precisely the extra amount that households have paid the year after the 2016 Brexit referendum. Because of the subsequent fall in exchange rates, the wholesale cost of both gas and electricity imports (via interconnectors) rose. Our work demonstrates that the price increase seen in GB electricity was due to this impact.

<b>One year after 23 June 2016 referendum</b>	<b>Electricity</b>	<b>Gas</b>
Change in wholesale price (%)	0.18	0.16
Share of wholesale costs in energy bill (%)	0.34	0.39
Change in retail prices (due to exchange rate) (% change)	0.06	0.06
Average consumption per year (kWh)	3,800	15,000
Average bill before referendum (£)	586	650
Average price before referendum (£/kWh)	0.15	0.04
Average price after referendum (£/kWh)	0.16	0.05
Average bill after referendum (£)	621.34	689.42
Change in annual payment from referendum (£)	35.34	39.42
Change in dual payment from referendum (£)	<b><u>74.76</u></b>	

**Table 1. Calculations showing how electricity and gas bills changed after the referendum exchange rate depreciation. Two decimal places are shown.**

The average wholesale price of British electricity rose by 18% the year after the 2016 EU withdrawal referendum. This translates into a £35.3 increase for electricity, an addition of 6% to average consumers bills, which is almost exactly what customers saw. In other words, consumers paid nearly £1 billion more for electricity due to the exchange rate impact<sup>3</sup>.

In addition to this increase, electricity prices have become much more volatile, which adds to the costs of managing the electricity system. The report shows that the volatility of electricity wholesale prices was subject to a statistically significant increase the year after the referendum compared to the year before, and this was most likely associated with the difference between the volumes of Sterling to US dollars traded in the two periods.

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<sup>2</sup> Domestic retail electricity price data was retrieved from BEIS (2018). Please refer to the main report for this reference.

<sup>3</sup> The numbers of electricity and gas consumers in the country used to derive the total increase in costs to consumers are from <https://www.ofgem.gov.uk/publications-and-updates/record-number-customers-small-and-medium-sized-suppliers>

Variable	Coefficient	z	LCI	UCI
<i>Load</i>	0.00003 (0.00005)	0.55	0.00	0.00
<i>Gas price</i>	0.58 (0.67)	0.87	-0.72	1.88
<i>Coal price</i>	-0.13 (0.30)	-0.44	-0.71	0.45
<i>Oil price</i>	-0.24 (0.17)	-1.44	-0.57	0.09
<i>Carbon price</i>	-30.98 (25.53)	-1.21	-81.03	19.06
<i>Variable renewable generation</i>	-0.00002 (0.00)	-0.15	0.00	0.00027
<i>EU referendum (Boolean indicator)</i>	0.51*** (0.16)	3.15	0.19	0.84
<i>Interconnection flows index</i>	0.03*** (0.00482)	6.55	0.02	0.04
<i>GBP/EUR</i>	-16.41 (29.45)	-0.56	-74.13	41.32
<i>GBP/USD</i>	-8.94 (23.08)	-0.39	-54.18	36.31
<i>Winter</i>	0.50 (0.27)	1.86	-0.03	1.02
<i>Spring</i>	0.33 (0.21)	1.57	-0.08	0.73
<i>Fall</i>	0.62** (0.25)	2.51	0.14	1.11
<i>Constant</i>	0.47 (0.40)	1.18	-0.31	1.24
<i>ARCH L1</i>	0.08 (0.09)	0.85	-0.10	0.25
<i>GARCH L1</i>	0.52*** (0.19)	2.72	0.15	0.89
<i>df</i>	6.63 (1.58)		4.37	11.05

**Table 2. Conditional variance model of GB electricity prices between 2014 and 2017. LCI = Lower Confidence Interval; UCI = Upper Confidence Interval. LL -2018.60; df 31.00; Wald  $\chi^2(13)$  1431.71; Prob> $\chi^2$  (model) P<0.0001; AIC 4099.20; BIC 4243.91; Q(l) 8.3099; p 0.14. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% significance levels.**

As shown in Table 2 – which reports the 2014–2017 GB electricity price conditional variance model results – the impact of the Boolean indicator accounting for the period following the referendum date implies substantially higher electricity price volatility following the vote.

The volatility of electricity wholesale prices was subject to a statistically significant increase of 51% in the year after the vote compared to the year before. This impact on volatility may more easily be appreciated by inspecting the first differences of the electricity price after June 2016, as shown in Figure 2.

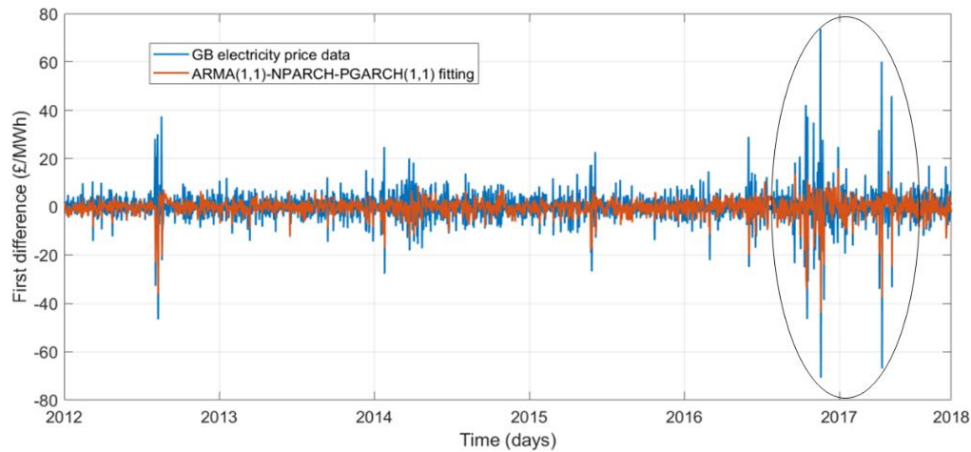


Figure 2. Electricity price first difference since 2012 and during the 23 June 2016 EU referendum (circled).

Furthermore, we found a stabilising effect of gas price volatility transmission toward GB electricity price volatility in 2017. An increase in the volatility of gas prices was associated with a 61% drop in GB electricity price volatility during that year, whilst there was no statistically significant impact in 2016.

The wholesale **natural gas price**, which makes up 39% of the gas price paid by consumers<sup>4</sup> increased by 16% due to the exchange rate depreciation. This resulted in a 6% increase in retail gas prices, or £39.4 on the average bill (or £0.9 billion). As with electricity, gas prices also became more volatile after the referendum. The standard deviation of wholesale gas prices increased 60% the year after the vote.

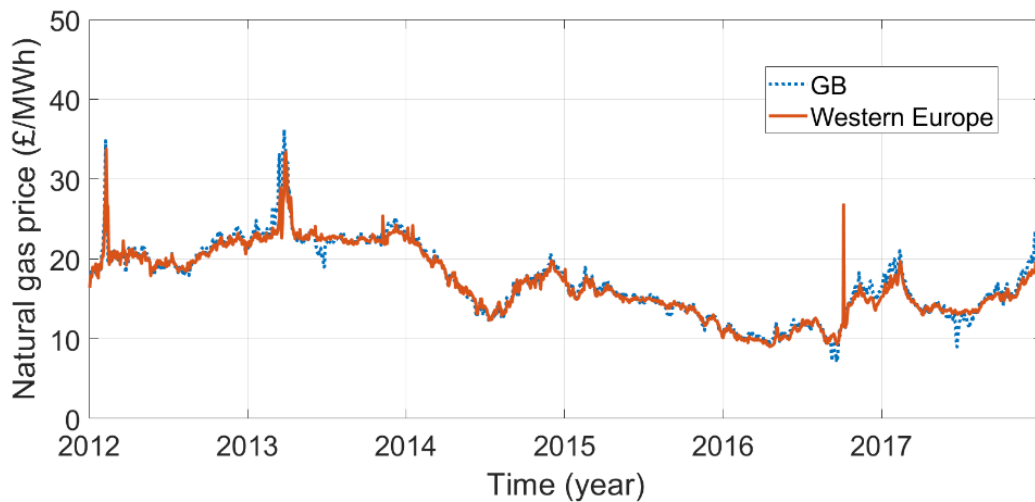


Figure 3. The variability and level of GB gas prices increased after the mid-216 referendum.

Together the electricity and gas price rises have added £75 to the dual bill of an average UK consumer. Of course, the energy bills of those using more energy than the average will have increased by more (and those using less by less).

<sup>4</sup> <https://www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/understand-your-gas-and-electricity-bills>

We also have calculated that, should a hard Brexit lead to a further depreciation of Sterling, to Sterling-Euro parity, the typical consumer's bill would subsequently rise by a further £61, with £29 deriving from higher electricity bills and £32 from higher gas bills. This corresponds to consumers having paid in excess of £0.8 billion for electricity and £0.7 billion for gas.

<b>One year after exchange rate parity-inducing hard Brexit</b>	<b>Electricity</b>	<b>Gas</b>
Change in wholesale price (%)	0.15	0.13
Share of wholesale costs in energy bill (%)	0.34	0.39
Change in retail prices (due to exchange rate) (% change)	0.05	0.05
Average consumption per year (kWh)	3,800	15,000
Average bill before referendum (£)	586	650
Average price before referendum (£/kWh)	0.15	0.04
Average price after referendum (£/kWh)	0.16	0.05
Average bill after referendum (£)	614.75	682.07
Change in annual payment from referendum (£)	28.75	32.07
Change in dual payment from referendum (£)	<b><u>60.82</u></b>	

**Table 3. How electricity and gas bills would change (all else held constant) after a new exchange rate depreciation that would bring to parity between Sterling and Euro. Two decimal places are shown.**

The above calculations assume a further collapse of the exchange rate to 1, so a drop by 12% from the 3 November 2018 exchange rate level of 1.14. The change in annual bills is calculated assuming everything else is held constant and considers the annual period between 29 March 2019 and 29 March 2020. These calculations also assume that the exchange rate change impact has the same proportional effect on energy wholesale prices as for the calculations reported in Table 2.

## *References*

Any data not directly referred to here is referenced in the main report.

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UCL Institute for Sustainable Resources  
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