
What are the impacts of VW's emission defeat devices?

Note prepared for Hausfeld Rechtsanwälte LLP

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1 Introduction and summary

This note discusses four types of harm resulting from Volkswagen's (VW's) use of emission defeat devices across a wide range of its diesel vehicles between 2009 and 2015 in Europe:

- harm to the general public, via higher emissions;
- harm to competitors, via sales and market share going to VW which competitors would have otherwise captured;
- harm to owners, both fleet and individual owners; and
- harm to investors in the company's shares.

Each of these harms is examined in the sections below.

On 18 September 2015 the US Environmental Protection Agency issued a Notice of Violation against several of the VW Group companies.¹ This includes VW branded cars, and also other brands that share engines and/or similar software, including Audi, Skoda and SEAT. The Notice of Violation refers to models produced between 2009 and 2015. VW acknowledged that it had broken US environmental rules,² and VW's share price dropped substantially. Since then, a variety of other violations and

¹ See United States Environmental Protection Agency, 'Volkswagen Light Duty Diesel Vehicle Violations for Model Years 2009–2016', <http://www.epa.gov/vw>, accessed 22 December 2015.

² Volkswagen (2015), 'Statement of Prof. Dr. Martin Winterkorn, CEO of Volkswagen AG', press release, 20 October.

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public misstatements by VW regarding NOx and CO₂ emissions have become apparent.

The violations have received substantial public attention across North America and Europe. This was demonstrated by, for example, the fact that ‘defeat device’—the name for a piece of software used in VW’s vehicles to switch off environmental controls—was named as one of the *Financial Times*’ Words of the Year 2015.³

Oxera’s analysis suggests that VW’s defeat devices have the potential to have caused substantial harms, as shown in Table 1.1.

Table 1.1 Summary of potential harms caused by VW’s defeat devices

Entity harmed	Type of harm	Potential aggregate value or scale of the harm
Public	Increased NOx emissions, causing respiratory harm	€58m to €158m for 2009 to 2015
Competitors	Lost sales	To be quantified
Owners	Increased running costs	€87m to €196m per year ongoing, following implementation of VW’s proposed remedies
Owners	Reduced performance	Potentially €529m
Owners	Loss of capital value	Potentially €100-200 per vehicle, implying losses could exceed €1billion
Investors	Loss of share value	30%+ loss of value of shareholding

Source: Oxera.

1.1 Introduction to Hausfeld Rechtsanwälte LLP

Hausfeld Rechtsanwälte LLP is part of an international claimant law firm that is seeking to work on behalf of its clients in a coordinated manner with consumer groups, NGOs and public health entities to achieve a satisfactory remedy to the harms caused by VW in the EU.

1.2 Introduction to Oxera

Oxera is a leading European economics consultancy. We set the standard for high-quality economic insight, advising government bodies, corporates and lawyers around the world on any economic issue connected with competition, finance, regulation or litigation. Oxera wrote the ‘handbook’ for the European Commission that now forms the foundation for quantifying the impact of companies breaching competition law in Europe. Examples of our work include quantifying the damages caused by firms violating European competition law,⁴ evaluating the impacts associated with airport development;⁵ and identifying the benefits that flow from digital maps.⁶

³ On 22 December, the *Financial Times* identified eight words ‘that marked the year’ 2015. See <https://next.ft.com/content/61b6bf08-a593-11e5-a91e-162b86790c58>, accessed 25 February 2016.

⁴ For example, between 2009 and 2014 Oxera advised National Grid during its high-profile and complex claim for follow-on damages after Alstom, ABB, Siemens and Areva were found to have cartelised the market for Gas Insulated Switchgear (GIS). The matter settled in June 2014, and was subsequently awarded the ‘Litigation of the Year – Cartel Prosecution’ award by Global Competition Review.

⁵ For example, in 2014 and 2015 Oxera worked with Gatwick Airport to quantify the economy-wide impacts of runway development near London.

⁶ For example, in 2013 Oxera worked with Google to quantify the benefit of geo services, such as its mapping and other location-based services. Our research indicated a benefit of over \$150bn per year.

1.3 Technical analysis of the fixes to the defeat devices

Hausfeld has commissioned a technical report from David Foster, the Phil and Jean Myers Professor Emeritus of the Engine Research Center at the University of Wisconsin-Madison, to provide advice on the likely effect of any defeat device fix in terms of its impact on fuel economy and/or vehicle performance. David Foster's report⁷ indicates that it is likely that the fixes that VW will need to make to its vehicles will result in higher fuel consumption. The fixes may also reduce performance and/or reduce the lifetime of exhaust treatment components.

Initial tests of post-fix VW vehicles in Germany suggest that fuel consumption does increase.⁸ Furthermore, there is evidence that when the vehicles are run in the emissions-reducing mode for a longer period of time, wear to the emissions treatment systems increases.⁹

1.4 Recent developments in Europe

Within Europe, there has been extensive debate surrounding the issue of compensation to purchasers of affected vehicles, and potential remedies to the vehicles' performance issues. VW has now begun to recall and implement software alterations to vehicles fitted with 2.0 litre TDI EA189 engines, with similar adjustments for 1.2 and 1.6 litre engines to follow.¹⁰ Volkswagen claims that these adjustments will restore compliance with EU5 emissions standards, while not harming performance as measured by fuel economy, engine performance or emissions of CO₂ or noise.¹¹

These remedies appear to be central to VW's position that it will not pay compensation to owners outside of the USA, with Paul Willis, UK Managing Director of VW, stating that 'to pay compensation, there has to be a loss.'¹² VW, however, has not presented any analysis indicating that there is no loss. European policymakers have expressed dissatisfaction that European owners are not being offered the same level of compensation as US owners.¹³

1.5 The likely economic harms caused by VW's violations

This note discusses the four types of likely harm depicted in Figure 1.1.

⁷ Foster, D. (2015), 'VW Defeat Device and Probable Ramification of Fixes'.

⁸ Auto Motor Sport (2016), 'Leistung gleich gut – Verbrauch leicht erhöht.' Available online at <http://webcache.googleusercontent.com/search?q=cache:mPQXrLOW75EJ:www.auto-motor-und-sport.de/news/vw-diesel-update-amarok-leistung-gleich-gut-verbrauch-leicht-erhoeht-10551733.html+&cd=1&hl=en&ct=clnk&gl=uk>, accessed 25 February 2016.

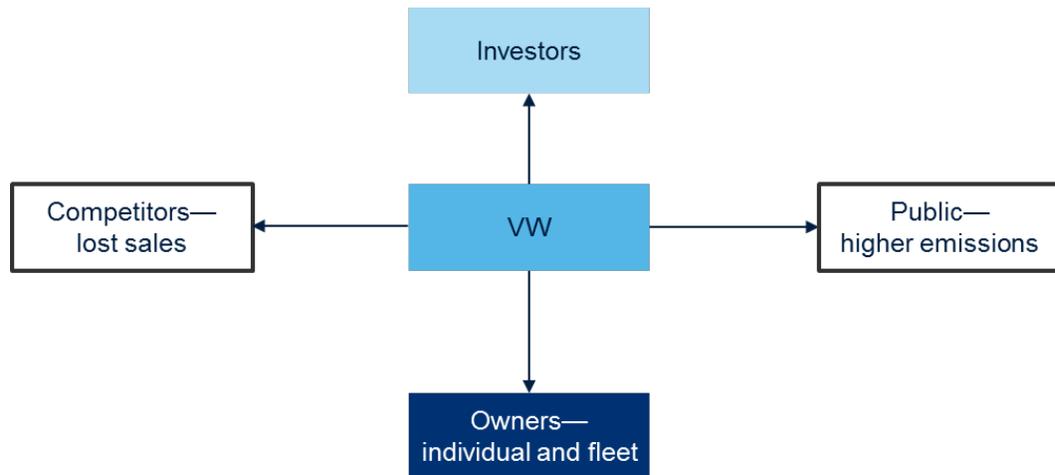
⁹ Tagesschau.de (2016), 'Software-Update - obwohl VW gewarnt war?'. Available online at: <http://www.tagesschau.de/wirtschaft/vw-skandal-125.html>, accessed 14 March 2016

¹⁰ In addition, one physical part—a flow rectifier—will be fitted to the 1.6 litre engines. Volkswagen AG (2016), 'Volkswagen starts implementing technical measures for EA189 diesel engines in Europe', 2 February.

¹¹ Volkswagen AG (2016), 'Volkswagen starts implementing technical measures for EA189 diesel engines in Europe', 2 February.

¹² *Financial Times* (2016), 'Volkswagen pledges to 'rebuild trust' in UK, but will not pay out', 13 January. Available online at <https://next.ft.com/content/9b3f7d80-ba12-11e5-bf7e-8a339b6f2164>, accessed 25 February 2016.

¹³ *Financial Times* (2016), 'European Commission to pursue VW over EU consumer compensation', 26 January. Available online at <https://next.ft.com/content/c9998336-c43c-11e5-808f-8231cd71622e>, accessed 25 February 2016.

Figure 1.1 Likely economic harms caused by VW's violations

Source: Oxera.

2 Public—higher emissions

VW Group cars in Europe that were fitted with the defeat device are likely to have emitted substantially more of certain pollutants than if they had complied with the required emissions standards. The direct impact of these emissions is on the health and wellbeing of European citizens, since high NO_x emissions levels have (alongside other pollutants) been reported to be associated with a variety of respiratory illnesses: for example, UK government guidance suggests that air pollution related to NO_x, and other pollutants such as PM₁₀, is estimated to reduce the life expectancy of every person in the UK by six months.¹⁴

2.1 How to quantify the losses?

There are established economic frameworks for valuing additional or reduced emissions. These are typically used when assessing and quantifying the environmental impact of investment in transport projects and other forms of cost-benefit analysis. For example, building a bypass around a city reduces journey times and NO_x emissions in the city. These damage costs are based primarily on the health impacts of air-quality pollutants.

Table 2.1 provides a summary of these damage values, as used in transport appraisals in the UK and Germany.

¹⁴ HM Treasury and the Department for Environment, Food & Rural Affairs (2013), 'Valuing impacts on air quality: Supplementary Green Book Guidance', May. Available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197893/pu1500-air-quality-greenbook-supp2013.pdf. Accessed 8 March 2016.

Table 2.1 NOx and CO₂ damage valuations (per tonne)

	UK damage valuations ¹	German damage valuations ²
NOx	£750 to over £1,000	€420
CO ₂	£29 to £86	€20 to €280

Source: ¹ UK Department for Transport (2015), 'TAG Data Book Autumn 2015', Tables A3.2 and A3.4, <https://www.gov.uk/government/publications/webtag-tag-data-book-december-2015>, accessed 24 February 2015. ² UK Department for Transport (2013), 'International Comparison of Transport Appraisal Practice. Annex 2 Germany Country Report', April, Table 3, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209532/annex-2-germany.pdf, accessed 24 February 2015.

This information can be combined with an estimate of the additional emissions caused by the defeat devices. These additional emissions can be measured by comparing actual emissions with a counterfactual in which such devices are not used by VW, and its cars meet the relevant emissions standard.¹⁵

Since data on the counterfactual will not become available before VW rolls out its suggested fixes, as a proxy, an estimate may be derived by comparing the emissions of vehicles in laboratory conditions (with the defeat devices deactivated) with the permitted legal level of NOx emissions under such conditions. A study for the BBC television programme *Panorama* suggests that this equates to approximately 255mg of NOx per kilometre driven.¹⁶ Multiplying this amount by an estimate of annual vehicle mileage¹⁷ and an estimate of the number of affected vehicles in a given year¹⁸ yields an estimate of approximately 137,000 tonnes of excess NOx emitted as a result of the defeat devices across the EU over the duration of the non-compliant engines.

Table 2.2 sets out estimates of the total levels of harm that would be implied by combining this estimate of excess NOx emissions with the 'per unit' damage levels set out in Table 2.1.

Table 2.2 Indicative total levels of harm caused by NOx emissions

Valuation method	Damage per tonne	Excess tonnes of NOx	Total damage
German damage valuation ¹	€420	137,000	€58m
Central UK damage valuation ²	£955/€1146	137,000	€158m ¹

Note: Converted to euros using an exchange rate of €1.2 per £1.

Source: ¹ UK Department for Transport (2013), 'International Comparison of Transport Appraisal Practice. Annex 2 Germany Country Report', Table 3, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209532/annex-2-

¹⁵ In particular, the true counterfactual would be real-life emissions of affected VW vehicles without the defeat device but with other legal measures to make them comply with the Euro V standards, and the true factual would be their real-life emissions with the device in place and prior to any fixes.

¹⁶ See BBC Panorama television programme, shown 9 December 2015, available online at <http://www.bbc.co.uk/iplayer/episode/b06q6nh2/panorama-the-vw-emissions-scandal>, accessed 25 February. The legal level of NOx emissions for Euro V standard vehicles is 180mg/km; tests performed on this programme suggested that, with these devices deactivated, the tested VW vehicles emitted 435mg/km.

¹⁷ We have assumed that each affected vehicle travels 12,700km per year (the average mileage for UK vehicles in 2014). BBC news website, 'Drivers' annual mileage rates to drop to new low', 29 July, www.bbc.co.uk/news/uk-england-28546589, accessed 18 February 2016

¹⁸ We have assumed a linear sales trend for the 8.5m affected vehicles, with approximately 1.2m such vehicles entering circulation each year between 2009 and 2015. We have also assumed that VW will require until the end of 2017 to remedy and fix all affected vehicles.

germany.pdf, accessed 24 February 2015. ² UK Department for Transport (2015), 'TAG Data Book Autumn 2015', Table A3.2, <https://www.gov.uk/government/publications/webtag-tag-data-book-december-2015>, accessed 24 February 2015.

3 Competitors—lost sales

It is likely that competitors to VW suffered at least some loss of sales during the period affected by the scandal. Measurement of this would depend on the counterfactual, which is not clear at this stage:

- if the true emissions and fuel performance of the vehicles had been known by consumers contemporaneously, the models are likely to have appeared less competitive in the market;
- VW may have chosen not to release a non-compliant vehicle, but instead would have developed vehicles with emissions performance levels that were more palatable to consumers;
- however, it is unlikely that such improvements could have been made without any sort of trade-off. For instance, such improvements would be likely to have required technical adjustments—which might have increased production costs of the vehicles (and therefore potentially raised VW's price level, or lowered unit profits), or reduced other performance factors such as fuel consumption or acceleration;
- through not having had to make such adjustments, VW may have been able to present its vehicles as more attractive than they would otherwise have been on these key desirability measures, helping VW to capture sales that would (in the absence of defeat devices) have been made by competitors.

When measuring the impact of these potentially lost sales, lost profits—as opposed to lost revenues—are likely to be the appropriate metric. Further, it is possible that the concept of betterment may apply to VW's competitors in relation to sales *gained* following the scandal's emergence. It has been reported that VW sales have fallen 14% year on year.¹⁹ To the extent that these sales lost by VW have been captured by rivals, it may be necessary to offset these against lost sales in the scandal period to calculate the total loss incurred by rival manufacturers.

There are, however, possible examples of manufacturers to whom this concept would not apply. For instance, while BMW would have been potentially affected by both lost sales during the period of defeat devices and increased sales following the scandal, former competitors such as Saab—which exited the market in 2011—will not have benefited from increased sales in the scandal period.

4 Individual owners and fleet owners of vehicles

Owners of vehicles may suffer three types of loss. These are set out in sections 4.1 to 4.3, along with illustrations of potential ways to measure such losses. Section 4.4 discusses which types of loss might be most relevant to each class of owner.

¹⁹ *The Guardian* (2016), 'UK sales of VW cars fall 14% after emissions scandal', 4 February, <http://www.theguardian.com/business/2016/feb/04/sales-of-volkswagen-cars-fall-14-following-emissions-scandal>, accessed 4 February.

4.1 Increased running costs

David Foster's technical report indicates that the fixes that VW may deploy to rectify the emissions issues may result in higher fuel consumption. This will, in turn, increase the costs to an owner running a VW car, thereby causing a monetary loss to that owner. This is likely to be particularly problematic for certain consumers because fuel efficiency was a specific selling point for certain of VW's vehicles.²⁰

Table 4.1 sets out an example of how such additional fuel costs might be quantified. These costs will vary depending on the fuel efficiency of a vehicle before and after any fixes are applied; the annual mileage of the vehicle; and the price of fuel. Table 4.1 sets out plausible scenarios where vehicles of varying initial efficiency become able to travel one mile less per gallon of fuel. The estimates for this damage vary between €87m and €196m per year (aggregating across all affected vehicles).

Table 4.1 Example calculation of excess fuel cost: by initial fuel efficiency

	Step	Low	Medium	High
A	Fuel economy, pre remedy (litres/100km (MPG))	7.0 (40)	5.7 (50)	4.7 (60)
B	Fuel economy, post remedy (litres/100km (MPG))	7.3 (39)	5.8 (49)	4.8 (59)
C	Affected vehicles	8.5m	8.5m	8.5m
D	Assumed annual mileage per vehicle ¹	7,900	7,900	7,900
E	$C * D$ Total annual mileage amongst affected vehicles	67bn	67bn	67bn
F	$E \div A^2$ Annual fuel consumption, pre remedy (millions of gallons)	1,687	1,349	1,124
G	$E \div B^2$ Annual fuel consumption, post remedy (millions of gallons)	1,730	1,377	1,144
H	$G - F$ Excess fuel used (millions of gallons)	43	28	19
I	$H * \text{cost of fuel}^3$ Total annual excess fuel cost	€196m	€125m	€87m

Note: Gallons are imperial gallons (4.54 litres per gallon). ¹ Based on average usage of 7,900 miles per year, the UK average in 2014. See Table NTS0901 of the DfT's statistics, available online at <https://www.gov.uk/government/statistical-data-sets/tsgb09-vehicles#table-TSGB0916-NTS0901>. ² Expressing A and B in the miles-per-gallon metric. ³ Assuming an average fuel cost of €1 per litre, as indices suggest is currently a European average (see, for instance, <http://www.euroopenroad.com/fuel/>, accessed 8 March 2016). Given the current historically low oil price, it is likely that this is a conservative estimate of the average cost of fuel over the infringement period.

Source: Oxera analysis; VW Group AG (2015), 'Federal Motor Transport Authority (KBA) decides on recall for affected EA 189 diesel vehicles', press release, October.

It is also plausible that emissions of CO₂ will increase following the proposed fixes to vehicles, due to the increased fuel consumption. In many jurisdictions, vehicle taxes are based on these CO₂ emissions, including the three most populated countries: Germany, France, and the UK.²¹ If implemented fixes increase CO₂ emissions such

²⁰ *Handelsblatt Global Edition* (2015), 'Inside the Volkswagen Scandal', Winter 2015/2016.

²¹ See, for instance, ACEA (2014), 'CO₂ Based Motor Vehicle Taxes in the EU', http://www.acea.be/uploads/publications/CO_2_Tax_overview_2014.pdf, accessed 25 February 2016.

that regulators reclassify the tax status of owners' vehicles, owners could suffer larger tax liabilities as a result. Some countries, such as the UK, have indicated that they do not intend to impose higher tax rates on individual car owners; however, arguably this transfers the loss from the car owner to the government, since it is forgoing tax revenues it would otherwise be entitled to collect.²²

4.2 Reduced performance

The technical report from Professor Foster also indicates that reversing the impact of the defeat device may reduce engine performance. Although this does not cause a direct monetary loss to the owner, it may cause a loss of enjoyment or amenity. Owners show by their choices about different engine specifications the degree to which they care about engine performance, and may well pay several thousand euros extra to purchase a car with a larger or more powerful engine. VW was aware that performance was a motivating factor in European car owners' purchasing decisions.²³

Customers' valuation of performance can be derived from the relative pricing of different engine options on cars—such as a 20% price increase for a 30% increase in engine power. A simple estimate of the loss to the customer from reduced performance can be derived from this. Oxera has calculated such metrics across a sample of VW vehicles²⁴ and found a wide range of implied willingness to pay for power: from €13 per PS (a measure of engine power output) to over €150. More sophisticated academic studies have suggested a valuation of approximately €60 per PS.²⁵ If each affected vehicle were to lose one unit of PS following the fix, this latter estimate would suggest a detriment to consumers of approximately €529m.²⁶

4.3 Loss of capital value

Increased running costs and/or reduced performance are likely to make VW cars less attractive to buyers in the used-car market (this is effectively a capitalisation of the previous two losses). In addition, the VW brand has been harmed by the extensive publicity around the misstatements, making all VW cars less attractive. These factors mean that the residual/resale value of VW cars is likely to fall.

Quantifying this value reduction is potentially complex, and would involve comparing the value of a car today against the value it would have had absent the misstatements (the counterfactual value). There are multiple ways to do this: one is to compare the relative price of VW cars with the price of cars of other manufacturers that are not directly affected—ideally, the cars would be as similar as possible. Therefore, a highly equipped Audi A4 Avant might be compared with a similarly specified BMW 3 Series Touring of a similar age and mileage.

Reports have suggested that the value of used diesel Volkswagen vehicles fell by approximately 0.2% in the months following the scandal's emergence, while used

²² UK Department for Transport (2015), 'Government confirms consumers who bought vehicles in good faith will not incur additional tax costs', press release, 2 October.

²³ *Handesblatt Global Edition* (2015), 'Inside the Volkswagen Scandal', Winter 2015/2016.

²⁴ A 2015 VW Golf, three-door BMT edition, with power outputs of 110PS, 150PS and 184PS.

²⁵ See Mulalic, I. and Rouwendal, J. (2015), 'The impact of fixed and variable cost on automobile demand: Evidence from Denmark', *Economics of Transportation*, 4, pp. 227–40. The estimated value of 464 Danish Krone per unit of horsepower is approximately €62 at market exchange rates. It is not clear whether the article refers to imperial (BHP) or metric (PS) horsepower; however the difference is negligible (1 BHP = 1.01 PS).

²⁶ Obtained by multiplying 8.5m vehicles by a value of €62 per PS.

cars in general rose in value by approximately 2.8%.²⁷ Table 4.2 below shows an example calculation of the damage to owners resulting from such a trend, supposing that the difference in trend between VW diesels and other used cars can be attributed entirely to the scandal,²⁸ across a range of hypothetical original residual values.

Table 4.2 Example calculation of the loss in residual value

		Original car value:	Low	Medium	High
A		Car value: pre-scandal	€4,000	€6,000	€8,000
B	<i>A + 2.8%</i>	Counterfactual value (no scandal, 2.8% increase in value)	€4,112	€6,168	€8,224
C	<i>A - 0.2%</i>	Actual value (0.2% decline in value of VW diesels)	€3,992	€5,988	€7,984
D	<i>C - B</i>	Damage per vehicle	€120	€180	€240

Source: Oxera.

This analysis results in estimated damage figures of between €120 and €240 per vehicle. When aggregated across all affected vehicles, this suggests the total harm may be large: multiplying any of these values by the 8.5m European VWs affected would suggest total harm in excess of €1 billion. Another approach is to examine the depreciation profile of a VW car and see how this has been affected by the misstatements. For example, the depreciation profile on a VW Passat could be examined as at August 2015; this allows prices for that VW Passat to be predicted over time. If the market price for that Passat were materially lower than predicted by the extrapolated depreciation profile in August 2016, then some or all of the difference is likely to be due to the misstatements.

It may be necessary to prepare a matrix of valuations with dimensions such as model (e.g. Golf, Passat), engine size (e.g. 1.2, 1.6, 2.0), age (e.g. one, two, three years) and trim level (e.g. S, SE, GT). The benefit of the matrix approach is that it helps to capture the relative movements in value across a wide range of parameters. Such a detailed approach may be important given that newer cars with higher trim levels are typically worth substantially more than older cars with lower trim levels. As such, the cash level of the value loss will vary substantially between owners depending on the vehicle that they own.

4.4 Which owners suffer which losses?

Fleet owners are likely to suffer a different mixture of losses. Fleet owners typically own a large number of cars and rotate the fleet over time. For example, a fleet owner might buy 20 VW Passats from the 2014 model year, and plan to hold them for three years, with a view to selling them in 2017. The fleet owner's primary concern may therefore be about the residual value loss that it has suffered, which will crystallise in 2017.

²⁷ See, for instance, <http://www.driving.co.uk/news/volkswagen-dieselgate-emissions-scandal-can-the-car-industry-bounce-back/>, accessed 25 February 2016.

²⁸ A portion of this 2.8% figure (the rise in the value of non-VWs) may be driven by used car buyers switching away from Volkswagen and increasing the demand for (and as a consequence the price of) other used vehicles - the correct counterfactual may therefore be a smaller rise in the residual values of other cars than is suggested by this figure.

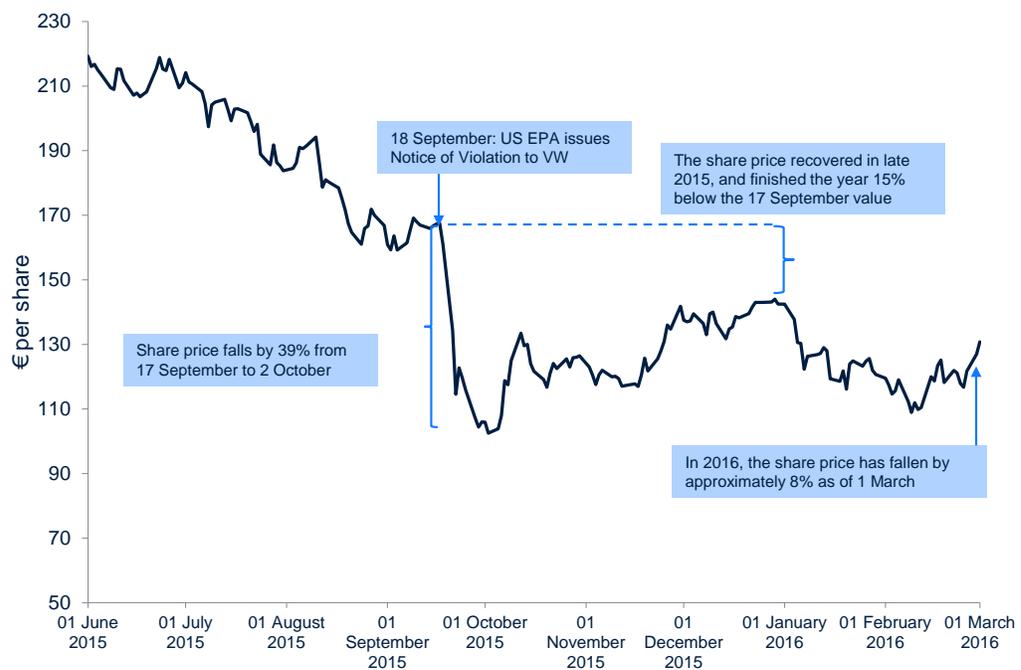
Individual owners may intend to own a car for a large part of its lifetime. For example, they may purchase a VW Passat in 2014, and intend to keep it until it has driven around 150,000km; if they drive around 20,000km per year, they will keep the vehicle until it is around seven or eight years old, and is largely depreciated. Therefore, an individual owner who intends to hold the vehicle in this way is likely to be primarily concerned with increased running costs and reduced performance.

5 Investors

Volkswagen AG is listed on the Frankfurt Xetra stock exchange. Investors acquiring stock in Volkswagen AG before 18 September are likely to have relied on the accuracy of the statements made by the company, to the market, to customers, and to regulators. Up until this point, such investors would not have known of the emissions violations. In a recent statement, Volkswagen disclosed that details of its infringements were first notified to its Management Board Chairman in May 2014, however the issue was not deemed material at the time.²⁹

When it was revealed that VW had installed defeat devices, the stock price fell by around 39%. It has since recovered somewhat and closed 2015 around 15% below its value on 17 September, as shown in Figure 5.1 below.

Figure 5.1 Volkswagen AG's share price performance



Source: Datastream.

²⁹ Volkswagen AG (2016), 'Volkswagen considers shareholder lawsuit to be without merit', 2 March. Available online at http://www.volkswagenag.com/content/vwcorp/info_center/en/news/2016/03/Volkswagen.html. Accessed 4 March 2016.

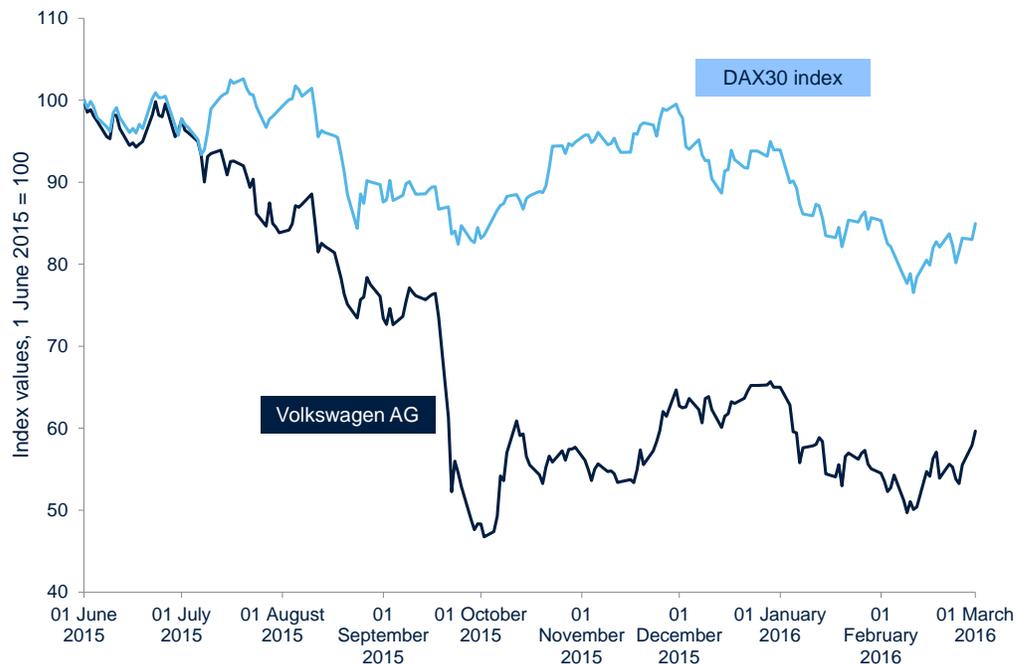
5.1 How to quantify these losses?

The loss suffered by any stock holder that owned shares prior to 18 September depends on the benchmark used to assess the loss.

Investors that bought stock shortly before 18 September, and sold it in the days immediately after the EPA's Notice of Violation, are likely to have suffered substantial losses, perhaps losing more than 30% of the value of their holdings.

Investors that continued to hold the stock may have suffered somewhat smaller losses, given that the stock price has since risen during particular windows, in particular up until late 2015. However, this rise seems in part to be driven by a general increase in stock valuations; this is illustrated in Figure 5.2, which compares Volkswagen AG against the benchmark DAX 30. Correspondingly, global stock markets have fallen in value during the opening weeks of 2016, and the share price of Volkswagen AG appears to have also followed this trend in a manner broadly in line with the wider market. Overall, it seems likely that most investors owning stock prior to 18 September have suffered at least some loss.

Figure 5.2 Volkswagen AG's share price compared with the DAX 30



Note: Other indexes, such as MSCI Developed Country Index, show a similar pattern to the DAX 30 over the period shown in this figure.

Source: Datastream.

6 Conclusion

This note has briefly explored four types of harm flowing from VW's emissions misuse of the defeat devices: those to the general public, via higher emissions; to competitors, via lost sales; to owners, both fleet owners and individual owners; and to investors in the company's shares. All four groups seem likely to have suffered losses.