To what extent can the different responses of the United States and the European Union to the Volkswagen Scandal be explained by their different applications of performance-based regulation?

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ABSTRACT

The revelation that Volkswagen had employed an illegal "defeat device" to comply with regulation, but fundamentally side-step some emission controls during real-world driving, has thrust the issue of regulatory non-compliance into the spotlight. A growing base of evidence has indicated that one of the underlying reasons for the observed emissions discrepancies, and subsequently the Volkswagen Scandal, is shortcomings in regulatory compliance protocols. This has raised questions about the efficacy of the United States and European Union regulatory frameworks for vehicle emissions, which both incorporated elements of performance based regulation, albeit with nuanced applications differing in terms of their enforcement and monitoring activities. Scholars have often argued that performance-based regulation can only be as good as a regulator's ability to *monitor* outcomes, however, this research argues that that performance-based regulation can only be as good as a regulator's ability to *enforce* outcomes. Building on from the scholarly evidence that links regulatory design to regulatory outcomes, this research will ask: to what extent can the different responses of the United States and the European Union to the Volkswagen Scandal be explained by their different applications of performance-based regulation? Using a triangulation of evidence from government documents –including documents from the recently established European Parliament Committee on Emissions Measurements in the Automotive Sector-, non-government documents, and semi-structured interviews, this research uses a process tracing approach to explain that the different responses of the United States and the European Union to the Volkswagen Scandal can be explained as a result of their application of performance based regulation: specifically enforcement capabilities

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Auxiliary Emission Control Device - AECD

California Air Resources Board - CARB

Carbon Dioxide – CO_2

Clean Air Act – CAA

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Department of Transport (UK) - DoT

European Environment Agency - EEA

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Original Equipment Manufacturer - OEM

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United States of America – U.S.

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Volkswagen Group of America, Inc. – VW US

West Virginia University – WVU

Worldwide harmonized Light duty vehicles Test Procedure - WLTP

GLOSSARY

Audi AG - owned by Volkswagen since 1969 and produces Volkswagen vehicles.

Cycle beating – The predictable pattern (or "cycle") of transient speeds versus time that allow engineers to optimise emissions that pass certification tests, but do not necessarily have these pollution levels when driving "normally."

Defeat device – A software algorithm (switch) that senses whether the vehicle is being tested, so that it can adjust its emissions profile to conform to certification testing criteria.

European Commission - independent of national governments and its job is to represent and uphold the interests of the European Union as a whole. It drafts proposals for new European laws, which it presents to the European Parliament and the Council. It is also the EU's executive arm, responsible for implementing the decisions of Parliament and the Council, implementing its policies, running its programmes and spending its funds

European Council – Comprises of the representatives of each of the 28 member states at Ministerial level.

European Parliament - the only directly-elected body of the European Union, with elections every five years. The Parliament has members from the 28 member states and, along with the Council, it considers legislative proposals from the European Commission. The Parliament and Council also share joint responsibility for approving the EU's annual budget.

Performance-based Regulation – A regulatory approach that focuses on desired, measurable outcomes, rather than prescriptive processes, techniques, or procedures.

Type Approval - the process applied by national authorities to certify that a model of a certain vehicle (or a vehicle type) meets all safety, environmental and production requirements before authorising it to be placed on the market

Volkswagen AG - headquartered in Wolfsburg, Germany and is one of the world's leading automobile manufacturers and the largest carmaker in Europe. This is the parent company of Volkswagen Group of America, Inc., Volkswagen Group of America Chattanooga, LLC, and Audi AG. Audi, Bentley, Bugatti, Lamborghini, Porsche, SEAT, Škoda, and Volkswagen.

Volkswagen Group of America, Inc. - a wholly owned subsidiary of Volkswagen AG. It operates a manufacturing plant in Chattanooga, Tennessee and houses the U.S. operations of several brands of cars.

Introduction

Air pollution exposure is regarded as one of the world's greatest health risks, and consequently six criteria pollutants have been identified as particularly problematic (nitrogen dioxide, particulate matter, carbon monoxide, ozone, sulphur dioxide, and lead). In 2012 around 7 million people died as a result of air pollution exposure, with ambient air pollution (AAP) being responsible for 3.7 million of these deaths (WHO, 2014). Vehicles are a major source of AAP exposure in developed countries, due to their ubiquity and the proximity of the exhaust emission to people. Despite the overall trend of stricter vehicle emissions regulation -as demonstrated in Table 1 and 2 for nitrogen oxides (NO_x)[1] standards [one of the criteria pollutants] – these regulations are failing to reduce levels of AAP, due to the increasing vehicle population and the failure of vehicles to meet regulatory requirements during normal driving conditions.

Table 1: EU NO_x standards for diesel cars

EU Standard	Year	Nitrogen Oxides (NO_x)
EURO 1	1992	-
EURO 2	1996	-
EURO 3	2000	0.50
EURO 4	2005	0.25
EURO 5	2009	0.18
EURO 6	2014	0.08

Table 1: (EEA, 2016)

Table 2: U.S. NO_x standards for diesel cars

U.S. Standard	Year	Nitrogen Oxides (NO_x)
Tier 0	1987	1.0
Tier 1	1994	0.60
NLEV	1999	0.30
Tier 2	2004-2009	0.07

Table 2: (USEPA, 1999)

[1] NO_x is defined as being a combination of all nitrogen oxides: including nitric oxide (NO), nitrogen dioxide (NO_2), and nitrous oxides (N_2O).

A number of recent studies have identified the discrepancy between laboratory-based type approval test results and "real-world", on-road, emission levels as being responsible for the increasing gap in predicted improvement in AAP (Franco, Posada, German, & Mock, 2014). For example, in the stark differences between reported and "real-world" vehicle NO_x emissions for EU regulated diesel vehicles -despite the overall trend of improvement- in which the cloud size provides a good visual representation of the magnitude of the issue (see Image 1).

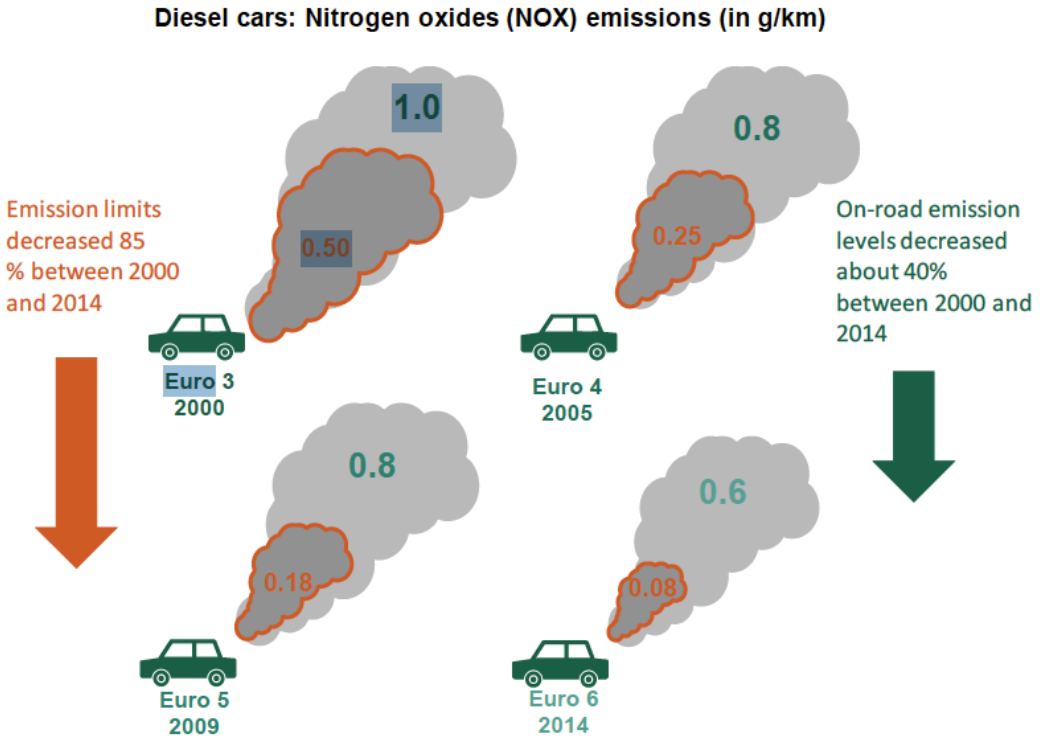

Image 1: Difference between emissions limits and on-road measured values (Carslaw, Beevers, Tate, Westmoreland, & Williams, 2011; Franco, Sánchez, German, & Mock, 2014).

This "real-world" vehicle NO_x emissions incongruity became a matter of public concern with Volkswagen Group's (VW AG) admission that it had employed an illegal "defeat device" to meet regulatory criteria in the laboratory, but bypass this emission abatement during "real-world" driving scenarios (Carder, Thompson, Besch,

Thiruvegadam, & Kappanna, 2014). The "defeat device" in question can be understood as a software algorithm (switch) that activates on one or more sensor inputs:

> *"The "switch" senses whether the vehicle is being tested or not based on various inputs including the position of the steering wheel, vehicle speed, the duration of the engine's operation, and barometric pressure"* (USEPA, 2015a).

Essentially, this means that if the vehicle's software algorithm calculated that an official approval test was being carried out, the vehicle would adjust its emissions profile to meet regulatory criteria. Whereas, at other times (for example, on road) the vehicle would switch to a different emissions mapping to optimise another performance characteristic (for example, fuel economy). This resulted in "real-world" NO_x emissions increasing by a factor of 10 to 40 times above the EPA regulated levels (USEPA, 2015a).[2]

The "defeat device" discovered in VW AG 2.0 litre and 3.0 litre diesel vehicles[3] impacted some 11 million cars worldwide, with approximately 500,000 of these in the United States of America (U.S.) and 8 million in the European Union (EU) (VW, 2015). In the context of regulatory efforts to mitigate the harmful effects of AAP, and in a political climate that was preparing for COP21, this revelation was particularly damaging, as the modified software reduced the effectiveness of

[2] Note that off cycle emissions at operating conditions outside the regulatory test cycles can still result in higher emissions, even without a proactive "defeat device", and is well understood in the scientific community (See Weiss, et al., 2011).
[3] See Appendix D for list of affected vehicles.

technology to reduce NO_x, a pollutant that can cause a host of respiratory diseases, including emphysema, and bronchitis (Gates, Ewing, Russell, & Watkins, 2016).

The magnitude of the regulatory failure in the fallout of the Volkswagen (VW) Scandal has resulted in a regulatory discontinuity, as environmentalists push for stricter regulations, economies fluctuate, and the fate of one of the world's largest car manufacturers hangs in the balance, all whilst regulatory bodies are doing their due diligence to try and understand how such activities were able to happen, moreover, how they were able to go undetected for such a prolonged period of time. A growing base of evidence indicates that one of the underlying reasons for this regulatory failure was shortcomings in the compliance protocols that determine how emission levels are monitored and how penalties are imposed (Cognlianese, 2015; Franco, Sánchez, German, & Mock, 2014; ICCT, 2015a; Transport & Environment, 2016).

Following the Scandal, VW has recorded its biggest ever annual loss of $1.6 billion (McGee & Campbell, 2016), and seen high profile resignations from its Chief Executive Officer (CEO), Martin Winterkorn, as well as its head of operations in the U.S., Michael Horn. More recently, the Scandal has reached the upper echelons of the VW corporate structure, with the allegations that the new CEO, Matthias Müller, was involved in "a willful and systematic scheme of cheating" (State of NY, and NY State Department of Environmental Conservation, v VW AG; Audi AG; VW USA.; Porsche AG; Porsche; and Porsche Cars North America, Inc., 2016).

The extent of VW's punishment is yet to be finalised, however, VW has set aside $17.9 billion for costs related to the Scandal, with $14.7 billion already agreed

with the United States Environmental Protection Agency (USEPA) and the Federal Trade Commission (FTC) to compensate customers owning affected 2.0 litre vehicles. VW continues to face legal challenges, including civil and criminal investigations in the U.S., Germany, and other EU countries (Gates, Ewing, Russell, & Watkins, 2016).

The VW Scandal as part of the wider "dieselgate" has put diesel engines in general under closer public scrutiny, and subsequently several other car manufacturers have been demonstrated to have a similar discrepancy to VW between "real-world" and the laboratory NO_x emissions results, including Renault, Mitsubishi, Nissan, and General Motors. For example, a French government report in 2016 investigated 86 different cars, discovering that only 20% complied with regulatory emissions criteria during "real-world" driving, with some emitting as much as 17 times the regulated levels (Ministère de l'Environnement, 2016). Despite "dieselgate" being a phenomenon that extends further than just the actions of VW, this study will focus solely on VW, for a few important reasons. Firstly as the marquee case of "dieselgate" VW's actions have a much larger consequence for international regulatory regimes, and economies. Secondly, VW is the only manufacturer to begin to reach formal settlements with regulators, and thus can offer a deeper understanding of the relationship between the regulated and the regulatory authority, throughout the regulatory cycle.

This study will focus on the regulatory structures, and response of the EU and U.S. for a few important reasons. Firstly, the EU and U.S. can be regarded as the *de facto* global standard developers for vehicle emissions, therefore it makes analytical

sense to investigate how these regulatory authorities operate in the context of the VW Scandal. Moreover, the overwhelmingly majority of the affected vehicles are in these regions. Notwithstanding, both the EU and U.S. apply the same type of regulation, performance-based regulation (albeit with nuanced applications), which raises questions why they had such different responses to the Scandal. In this context, this research seeks to understand *"To what extent can the different responses of the United States and the European Union to the Volkswagen Scandal be explained by their different applications of performance-based regulation?*

This study will be organised into five chapters: Literature Review; Methodology; Discussion; Conclusion; and the Recommendations For The Future. The *Literature Review* chapter will define terms, position the research within the academic and scientific literature, as well as the VW context. The *Methodology* chapter will outline the hypothesis, null hypothesis, and counter hypothesis, as well as the processes used for data collection, analysis, and interpretation,. The *Discussion* Chapter will describe the regulatory context before the Scandal, detailing the type approval processes, monitoring and enforcement mechanisms, as well as the different responses of the U.S. and the EU. It will then use a process tracing approach to both *describe* the VW Scandal and *evaluate* causal claims that the different responses of the EU and the U.S. to the VW Scandal be explained by their different applications of performance-based regulation: specifically enforcement capabilities. The fifth chapter is the *Conclusion,* this will summarise the discussions in the previous chapter, and re-evaluate the hypotheses. The *Recommendations For The Future Chapter* will attempt to remedy the deficiencies of the incumbent regulatory frameworks.

Literature Review

This literature review will define the key concepts that will be used in this study, determining what is meant by compliance, why firms comply (or do not), the different types of regulatory design, and the different methods that regulators use to induce compliance. In the context of the VW Scandal in the EU and the U.S., this literature review will explain how they differ in their regulatory structure, and application of methods used to induce compliance.

Compliance generally means confirming to a rule. Regulatory compliance, therefore means conforming to a regulation. For vehicle manufacturers, this challenge can be best understood by looking at the –often conflicting- goals of regulatory bodies, of both forcing best available technology (BAT)[4] to increase vehicle's performance, largely by improving fuel economy, and reducing carbon dioxide (CO_2), NO_x, and other pollutants. In this context, vehicle manufacturers are supposed to design their practices to make sure they are not only meeting stated regulatory requirements (i.e. emissions levels), but also the "spirit of the regulation" (i.e. forcing BAT, and moreover, maintaining emissions levels during real-world driving). Non-compliance to these standards results in undesired consequences, such as defective goods, environmental negative externalities, and punitive sanctions from regulatory authorities.

[4] BAT is enshrined in the U.S. regulation (Clean Air Act of 1990, section 169[3]), and in the EU as the BATNEEC (best available techniques not entailing excessive costs) principle (Directive 2010/75/EU).

To ensure regulatory compliance, regulatory authorities use two tools: monitoring and enforcement. Monitoring, which can be understood simply as oversight, can come in the form of police patrols (centralised, active, and direct monitoring) or fire alarms (rules, procedures, and informal practices that allow individuals or organised interest groups to monitor) (McCubbins & Schwartz, 1984). Enforcement, on the other hand, is forcing a company to do something that they would otherwise not do (Lodge & Wegrich, 2012). Enforcement can come in the form of warnings, administrative sanctions (such as fiscal penalties), criminal sanctions, or even incarceration or revocation (Ayres & Braithwaite, 1992).

Attempts to understand why firms comply –or do not comply- with regulation has received significant attention from scholars, resulting in a multitude of responsible explanatory factors, ranging from the nature of the regulated activity (Gunningham, 1974); motivations of the firm (Haas, 1998, Rees, 1988); inadvertent reasons such as difficulty understanding regulation or uncertainty in how to develop a policy response to meet regulatory targets (Chayes & Chayes, 1995; Mitchell 1994); or more broadly, the regulatory context (Coglianese, 2003, 2015; Hutter, 1989, 1997; Lodge & Wegrich 2012; May, 2003).

The VW Scandal has rightly raised questions about the motivations and efficacy of the firm, including the character of VW's management, and its corporate culture. However, this research will focus on the effect of regulatory context upon regulatory compliance, for a few important reasons. Firstly, the opinion of expert bodies such as the ICCT that the regulatory framework (how emissions levels are monitored and enforced) was a core reason for the NO_x discrepancies provides a good platform for an

academic foray into testing these claims. Secondly, when you consider the nuanced application of their regulatory frameworks, which are very similar (to be explained in further later), it raises interesting questions about why there was a dichotomy in response. Finally, with the word constraint that is placed upon this research, it could not possibly do analytical justice to all explanatory factors.

REGULATORY CONTEXT

Classically, there are two approaches to designing a regulatory framework, a "Command and Control" approach and forms of "Self-Regulation." "Command and Control" regulation includes a clear fixed standard backed by criminal sanctions (Lodge & Wegrich, 2012). Despite its historically dominant policy position, partly due to its simplicity, it is subjected to a barrage of disparagement on the basis of it being inefficient, costly, stifling innovation, inviting enforcement difficulties, and focusing on 'end-of-pipe' solutions (Ayres & Braithwaite 1992; Gunningham, Grabosky & Sinclair 1998; Hutter 1997). These critiques are widely shared by policy-makers in the EU and the U.S., and attempts to remedy the inadequacies of the "Command and Control" approach have driven a paradigm shift that has seen an increased use of forms of "self-regulation", particularly in the environmental domain (Coglianese, Nash, & Olmstead, 2003).

"Self-Regulation" delegates rule-making power to the regulated company, with the idea being that the regulator can rely on a close relationship between itself and the regulated to deliver public goals (Lodge & Wegrich, 2012). Favoured for its decentralisation and subsequent reduce of 'red-tape' and administrative cost, it is deemed more flexible, providing incentives for firms to find their own solutions (Hahn

& Stavins, 2016). However, such 'light-touch' regulation is considered to go hand-in-hand with a regulatory inability to monitor (Lodge & Wegrich, 2012; May, 2003). In reality, most regulatory systems will contain elements of both "Command and Control", and "Self-Regulation", however, for ease of analysis, the distinction is helpful (Gunningham, Grabosky & Sinclair 1998).

ENFORCEMENT VS MANAGEMENT

Dependent on the overarching regulatory structure ("Command and Control", or "Self-Regulation"), there are conflicting ideas about how best to address non-compliance. Tallberg (2002) aptly demonstrates this divide, identifying two schools of thought for addressing non-compliance: enforcement and management mechanisms.

The enforcement approach (see Dorn & Fulton, 1997; Downs, Rocke, & Barsoom 1996; Haas, 1998) is profoundly influenced by the political economy tradition of game theory, and collective action theory (see Axelrod 1984; Olson 1965), where the marginal benefits of regulatory compliance can be understood as a simple cost benefit analysis: are the expected value of sanctions avoided more or less than the probability of being discovered (monitoring), and magnitude of penalties? (enforcement) (Brehm & Hamilton, 1996; Haas, 1998). Compliance problems are therefore best mitigated by increasing the likelihood and penalties of detection through monitoring and enforcement activities (Tallberg, 2002). This approach tends to be heavily administered under "Command and Control" regulatory structures.

The management approach (see Chayes & Chayes, 1995; Haas, Keohane, & Levy 1993; Mitchell 1994; Young, 1992) contends that firms have a general

predisposition to comply with regulation, due to considerations of efficiency, interests, and norms. Non-compliance, when it happens, is not the result of an amoral calculation, rather an effect of capacity limitations and rule ambiguity. Therefore, non-compliance is best mitigated through a problem-solving strategy of capacity building, rule interpretation, and transparency, rather than through coercive enforcement (Tallberg, 2002). This approach tends to be heavily administered under "Self-Regulation" regulatory structures. In reality, enforcement and management mechanisms can be complimentary, and most regulatory frameworks incorporate elements of both. Whilst this divide in scholarly literature is largely concerned with the effectiveness of regulatory design, and how best to solve issues of non-compliance, it provides the theoretical background for why policy-makers choose certain regulatory frameworks.

PERFORMANCE-BASED REGULATION IN THE EU AND THE U.S.

Both the EU and U.S. have harboured performance-based regulation (PBR) as a form of "Self-Regulation" to legislate for vehicle emissions. Vehicle emissions can be regarded as a standard application of PBR: The regulator sets a limit –an emissions standard- but then it allows the manufacturer to innovate as it sees fit to stay below this limit (Coglianese, 2015), and moreover, report the compliance to the regulator.

The growing base of evidence indicating that one of the underlying reasons for the observed emissions discrepancies is shortcomings in the compliance protocols that determine how emission levels are monitored and how penalties are imposed raises questions about the efficacy of PBR for vehicle emissions in the EU and U.S. Much has been done to assess the usefulness of PBR, with them being extensively praised by

academics and policy makers (Bennear & Cognlianese, 2012; Coglianese, Nash, & Olmstead, 2003). However, Coglianese (2015) notes that performance-based regulation can only be as good as a regulator's ability to monitor outcomes. However, less has been done to understand the other element of ensuring regulatory compliance, enforcement.

Despite both the EU and the U.S. incorporating PBR into its regulatory framework for vehicle emissions, they have differing applications in terms of their monitoring and enforcement activities. The fundamental differences between the EU and U.S. enforcement and management structures is well explained by the ICCT:

> *"It is not the vehicle testing per se, but rather the strong focus on independent conformity testing coupled with enforcement authority, something that is prevalent in the U.S. In the EU, by contrast, this element of independent re-testing is largely absent from the regulations, and the involved regulatory bodies are more restricted with respect to their enforcement authority*" (ICCT, 2015a).

CONTRIBUTION

Much has already been done to evaluate the costs and benefits of regulatory design ("Command and Control" vs. "Self-Regulation"), of inducing compliance (enforcement v management), as well as PBR. In the VW Scandal context, the differences between the EU and U.S. application of PBR, in terms of monitoring and enforcement, has been well described (see ICCT, 2015a), however, there is yet to be a study to investigate whether this different application of PBR can explain the different

responses of the EU and the U.S. to the VW Scandal.

This research will fill this knowledge gap, and go further into the theory of regulatory systems, by looking at the application of PBR for vehicle emissions (specifically enforcement and monitoring activities) to understand whether it can explain regulatory outcomes. Scholars have often pointed to PBR's effectiveness depending on ability to monitor compliance. This study will argue that PBR can only be as good as a regulator's ability to enforce outcomes.

Methodology

Building on the gaps in the literature -a dearth of research studying *if* changes in regulatory design (particularly the application of PBR) can affect the actions of regulatory bodies- this paper will use a small-N comparative case study methodology: comparative spatially (EU and U.S.), but temporally constant (the VW Scandal). The case study structure will be under the auspices of a *Most Similar Systems Design* (MSSD) to compare the EU and U.S., as they are accepted to share many important characteristics, including political (federal, democracy), economic (in GDP $16.23 trillion and $17.95 trillion respectively), social (respect for human rights), and population size (510 million and 321 million respectively) (The World Bank, 2016).

In terms of vehicle emissions regulation, an *MSSD* design is also appropriate, as the EU and U.S. regulatory frameworks –incorporating PBR - are similar, only differing in regard to their focus on independent conformity testing and enforcement procedures. Thus, the selection of cases for both the spatial dimension (EU & U.S.), and the regulatory framework, is based on the independent variables, -those that are similar- not on the dependent variable. This enables the independent variables to act as a control, and will subsequently boost both internal and external validity (Halperin & Heath, 2012).

Firstly, in beginning case study research, what the case study represents must be clearly defined. George and Bennett (2005) define a case as an "instance of a class of events": this simply means a phenomenon of scientific interest. In this case, it is a case of regulatory non-compliance.

Building on the literature review, and the research question *"To what extent can the different responses of the United States and the European Union to the Volkswagen Scandal be explained by their different applications of performance-based regulation?"* the hypothesis is:

> **Hypothesis** - the different responses of the United States and the European Union to the Volkswagen Scandal can be explained as a result of their application of performance based regulation: specifically ***enforcement*** capabilities.

It follows that the competing hypothesis will be:

> **Counter Hypothesis –** the different responses of the United States and the European Union to the Volkswagen Scandal can be explained as a result of their application of performance based regulation: specifically ***monitoring*** capabilities.

These two hypotheses will allow us to test the new theory (enforcement as the explanatory variable), and the existing theory (monitoring as the explanatory variable). Although before testing these hypotheses, we must demonstrate that there *is* a relationship between the dependent and independent variables. For this reason, this research will also use a null hypothesis, which is as follows:

> **Null Hypothesis -** the different responses of the United States and the European Union to the Volkswagen Scandal *cannot* be explained as a result of their application of performance based regulation.

In answering the research question the variables will be operationalised as follows. The dependent variable is the ***'Response to the VW Scandal'***, meaning the actions of the EU and the U.S. regulatory authorities following the VW Scandal. The primary independent variable is ***'Application of Performance-based Regulation'*** which is an amalgamation of two other independent variables: ***'Monitoring Capabilities'*** and '***Enforcement Capabilities.'***

PROCESS TRACING

Process tracing is an increasingly prominent methodology in political science, it has been used as a framework to explain the end of the Cold War (Evangelista, 2015), democratisation and the domestic sources of foreign policy (Adamson, 2001), and U.S. decision making in the 2003 intervention in Iraq (Lake, 2010). It has become an attractive methodology, as it can both *describe* phenomena and to *evaluate* causal inferences (Collier, 2011). Process tracing can serve as 'an operational procedure for attempting to identify and verify the observable within-case implications of causal mechanisms' (George and Bennett, 2005), and when used in conjunction with a small-N comparative case study (such as this) it can help the researcher to look at a case's sequence and structure of events, to create a trail of evidence to demonstrate that the independent variable caused a certain response in the case.

The ideas that guide applying process tracing to establishing causal inference can be understood in terms of four empirical tests[5]; *"Hoop Test"*[6], *"Smoking Gun*

[5] See Appendix C for detailed image of process tracing.
[6] The example that is given for a "hoop test" is: was the accused in the state on the day of the murder?

Test"[7], *"Doubly Decisive Test"*[8], and *"Straw in the Wind Test"*[9] (van Evera, 1997). These tests are classified according to whether passing the test is necessary and/or sufficient for accepting the inference (Bennett & Checkel, 2015). Each test on its own is not very decisive, but a combination of tests increases confidence in a hypothesis, just as many pieces of evidence can find a suspect guilty (or innocent) (Bennett & Checkel, 2015; van Evera, 1997). Whilst it is of course vital to examine evidence through these tests, it is important to understand that these tests provide a framework for analysis, and are best used as informal heuristic devices.

DATA COLLECTION – A "TRIANGULATION OF EVIDENCE"

This research design will create a "triangulation of evidence" from multiple sources of data, and use multiple methods of data collection to find the intermediary variables that can help to understand how the independent variable *'Application of Performance-based Regulation'* led to dependent variable '*Response to the VW Scandal.'*

The first point of the triangle is government documents, specifically; reports, statements, position papers, regulations, and letters. This will include documents from –but will not be limited to- the EU institutions (Parliament, Commission, and Council), USEPA, California Air Resources Board (CARB), and national regulatory authorities in the EU (including Type Approval agencies), to create a broad range of

[7] The example that is given for a "Smoking Gun Test", a smoking gun in a suspect's hands right after a murder strongly implicates that suspect, but the absence of such a smoking gun does not exonerate this suspect.

[8] The example that is given for the "Doubly Decisive Test" is a bank camera that catches the faces of all those involved in robbing the bank: To convict an individual in the robbery, it is both necessary and sufficient to show that their face matches the camera footage; to exonerate an individual, it is necessary and sufficient to show that their features do not match the bank video.

[9] The "Straw in the Wind Test" merely entails a hint of what is to come. It is the weakest of the four tests, and is normally the basis for furthering tests.

governmental agencies at regional, national, and international level, as well as enabling a study of diachronic changes in the regulation that can elucidate contemporary events. This point of the triangle will be strengthened through the use of an untapped data source in academic study based on this literature review: The European Parliament Committee on Emissions Measurements in the Automotive Sector (EMIS). EMIS, which was set up in December 2015 to "investigate in detail alleged contraventions and maladministration in relation to emission measurements in the automotive sector" (EP, 2015), contains in-depth interviews with key stakeholders, as well as factual and technical information.

The second point of the triangle is non-governmental documents, including; statements, letters, position papers, and policy recommendations. This will mainly include the statements and letters from VW, expert analyses and recommendations from key policy think tanks (such as the ICCT, and Transport & Environment), as well as academic insights from political science, environmental science, and automotive engineering.

The third point of the triangle is semi-structured interviews with key stakeholders, including a Director at the USEPA Office of Transportation of Air Quality (US01), a Director specialising in Emissions at the main automotive lobbying and standards group in the EU (EU01), a Director of Emissions Development from a firm that has considerable experience in regulation drafting, compliance, and interactions with the USEPA (US02), as well as an Emissions testing expert heavily involved in the technical drafting of U.S. regulation (US03).[10] This point of the

[10] See Appendix A for list of interviewees.

triangle of evidence is largely to gain factual information and perspective from U.S. stakeholders, as following the creation of EMIS, in depth interviews have been carried out in the EU. This information will be used to corroborate against any findings from the first and second point of the triangulation of evidence.

Discussion

Process tracing as a methodology for both describing phenomena and evaluating causal mechanisms is best applied when you take key synchronic events in a diachronic context. Thus, this study identifies three key events to test the hypotheses, explaining how the different applications of PBR led to different responses to the VW Scandal; the experiences of the USEPA in the 1990s; the legal language used to define defeat devices; and how the Scandal was discovered. This analysis will also trace the process after the event, looking at the post-scandal regulatory response of the EU, as this demonstrates *ex post facto* evidence.

Before critically analysing the available evidence to understand to what extent the EU and U.S. responses to the VW Scandal can be explained by their applications of PBR, one must understand the regulatory context in which the VW Scandal occurred. Therefore, the following passage will describe the regulatory context of the EU and U.S., detailing their respective type approval processes, monitoring and enforcement programs, as well as how they immediately responded to the VW Scandal.

THE UNITED STATES REGULATORY CONTEXT

Automotive emissions regulations in the U.S. are centred on the 1970 Clean Air Act (CAA) -and its subsequent derivatives- which sets tailpipe emissions standards under the auspices of the executive agency of the USEPA. The CAA gives the USEPA the authority to type approve all new vehicles, to hold manufacturers accountable for vehicle's 'lifetime compliance', and to monitor and enforce vehicle manufacturers. In the case of the VW Scandal, all of the affected vehicles in the U.S. were certified to the EPAs Tier 2, Bin 5 emissions standard[11], and ran on the Federal Test Procedure cycle (FTP 75).

The U.S. type approval procedure comes under the moniker of v*ehicle selection and pre-production laboratory testing.* The vehicle manufacturer will carry out its own emissions certification tests and report the figures to the USEPA, who will then carry out its own emissions tests to confirm the reported certification by the manufacturers. If a vehicle fails the test, a retest is permitted. If the vehicle fails again, no certificate will be issued unless the manufacturer rectifies the problem (ICCT, 2015a). The U.S.' compliance program can be best understood in Image 2. This details the U.S.' monitoring capabilities. Key features include The "Selective Enforcement Audit", where the regulator can test a vehicle straight from the assembly line, as well randomly test vehicles on the road with "In-Use Surveillance."

[11] U.S. emissions standards are divided into different 'bins' based on pollution levels, as emissions standards are based on fleet averages. Bin 5 has a NOx limit of 0.07 g/mi, which is equal to the fleet average NO_x standard. Therefore, NOx emissions from vehicles certified to bins higher than bin 5 must be offset by selling a sufficient number of vehicles certified to bins lower than bin 5. See DieselNet, 2006, for more information.

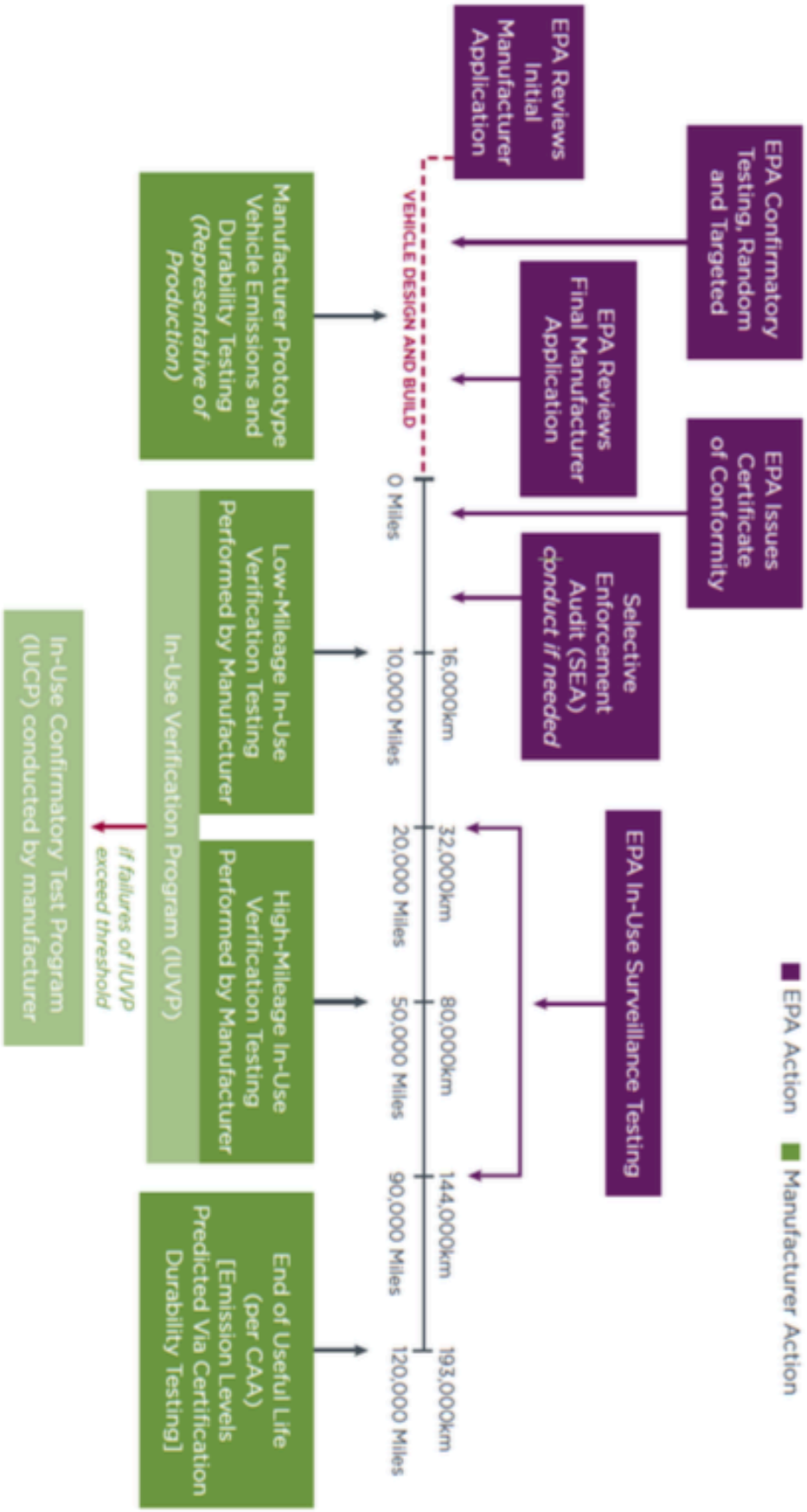

Image 2: USEPA vehicle compliance program for light-duty vehicles (ICCT, 2015a)

THE EUROPEAN UNION REGULATORY CONTEXT

Since 1992, EU legislation to type approve light-duty vehicles' emissions has been based on laboratory tests on a chassis dynamometer, whilst the vehicle is driven over the New European Driving Cycle (NEDC). Tailpipe emissions are regulated under the "EURO" standard. In the EU, VW cars during the VW Scandal period were regulated under the EURO 5 emissions standard.

The EU type approval framework is legislated for under Directive 2007/46/EC (see Image 3). European Commission Whole Vehicle Type Approval (ECWVTAC) may only be granted once the original equipment manufacturer (OEM) –in this case the vehicle manufacturer- has established conformity of production (CoP) to ensure that the vehicle complies at all stages with same specifications. Once a vehicle is type approved and receives a certificate of conformity (CoC), in-service conformity (ISC) can be used to monitor vehicles (EP, 2016). If it is then discovered that there is a substantial difference between type-approval emissions test results, and ISC checks, it can be brought to the attention of the manufacturer, although importantly, it has no legal consequences (ICCT, 2015a).

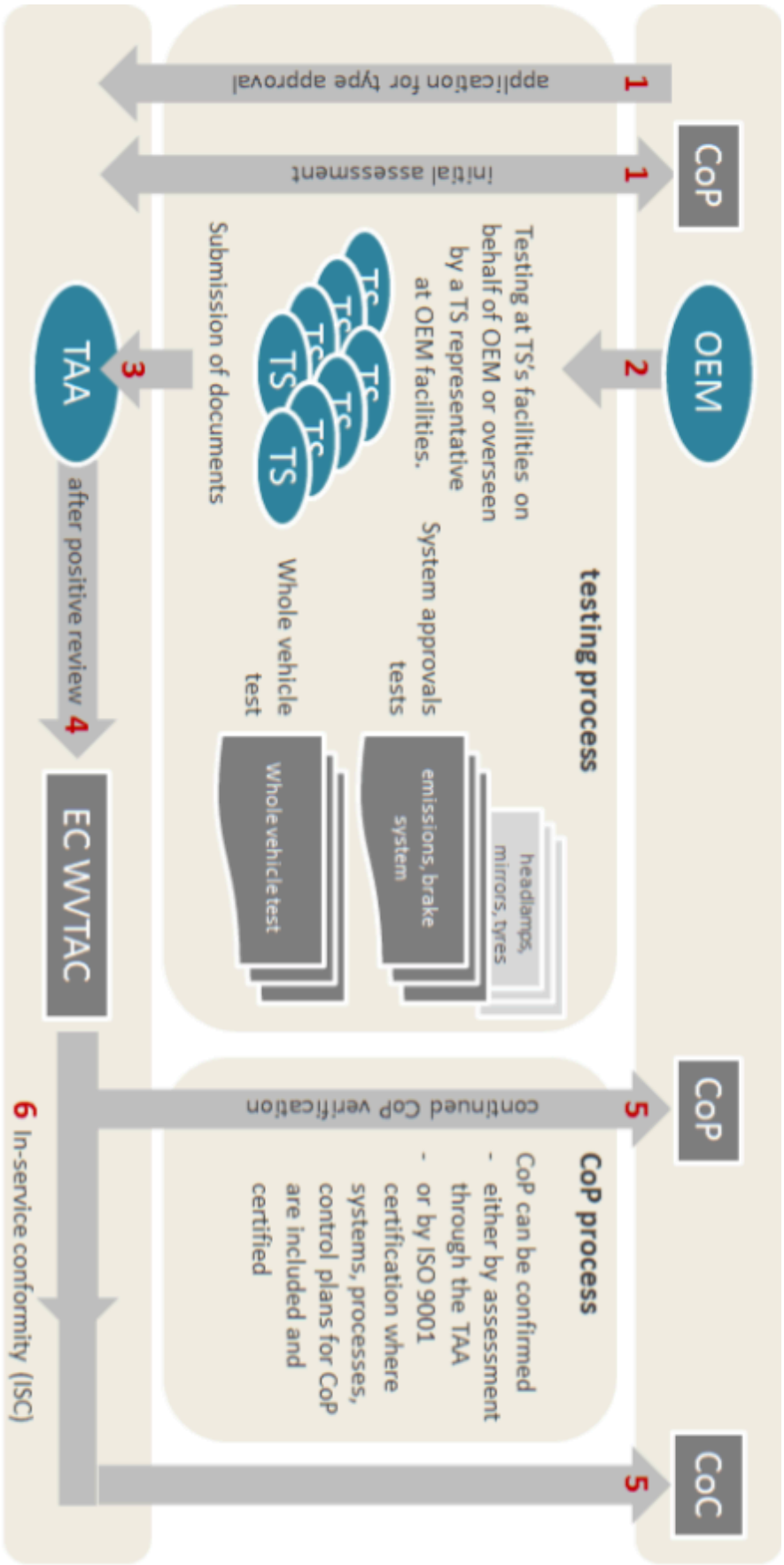

Image 3: Type-approval process for new vehicles in the EU (EP, 2016)

In the EU, manufacturers can choose to be type-approved in any of the 28 member states, under the relevant type approval authority (TAA) [e.g. VCA][12], and with over 300 technical services (TS). These TS' are contracted to the type-approval authorities to administer testing, and has led many to claim that this commercialisation of the certification process leads to a "race-to-the-bottom." The most common procedure for larger manufacturers is to test a vehicle model in its own facilities and to have the TS witness the final test that is then used to obtain the ECWVTAC. Once a vehicle has its ECWVTAC, it is the responsibility of the member state TAA which has type-approved a vehicle to impose penalties for breach of the type-approval procedure. In the context of the VW Scandal, if it was to be determined that a type-approved vehicle had been modified to "cycle beat" using a "defeat device" it is the member state where the vehicle was type approved that would be responsible for imposing penalties (Article 30 of Directive 2007/46/EC);

> "If a Member State which has granted an EC type-approval finds that new vehicles do not conform to the type it has approved, it shall take the necessary measures, including, where necessary, the withdrawal of type-approval, to ensure that production vehicles are brought into conformity with the approved type" (The European Parliament and the Council of the European Union, 2007a).

The differences between the EU and U.S. regulatory frameworks for vehicle emissions are illustrated in Image 4 (see p.36). The key differences are that the U.S. system permits a "Selective Enforcement Audit", where the regulator can test a vehicle

[12] The Vehicle Certification Agency (VCA) is the UK type approval authority.

straight from the assembly line, as well randomly test vehicles on the road with "In-Use Surveillance." This juxtaposed to the state of affairs in the EU, which has no confirmatory testing, and where only some member states monitor in-use (although importantly with no legal consequences).

DISCOVERY OF THE SCANDAL

Beginning in 2009, VW began incorporating a new fuel delivery system to better control emissions. This used in combination with exhaust after treatment technologies (needed to meet the lower U.S. limit), either through selective catalytic reduction or a lean NO_x trap, in combination with exhaust gas recirculation[13], led VW to claiming that their 2009 model year vehicles not only met USEPA standards, but comprehensively bettered them, all whilst providing competitive product differentiation with improved fuel economy. In reality, the dichotomy between good fuel efficiency and NO_x emissions levels in line with U.S. regulation was not achievable. Consequently, VW chose to activate a "defeat device" to switch from better fuel economy and higher NO_x levels to a lower emission "compliant" mode when the vehicle's software algorithm calculated that an official approval test was being carried out.

[13] These technologies are explained further in MECA, 2007.

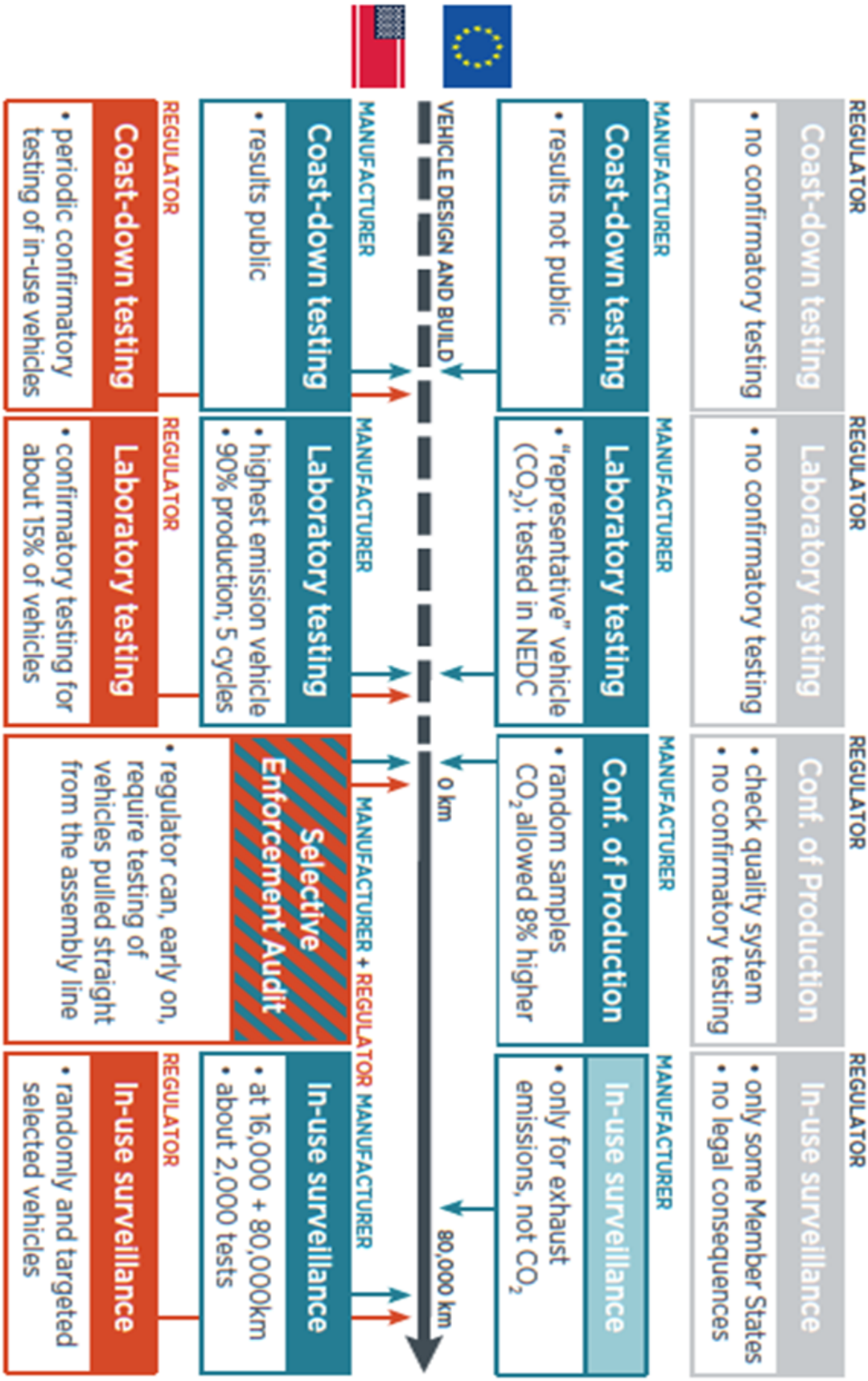

Image 4: Overview of the EU and U.S. vehicle emissions testing and enforcement schemes (ICCT, 2015a)

The first indicators of an issue where discovered by the European Commission's Joint Research Centre (JRC) in 2011, using a Portable Emission Measurement System (PEMS) to analyse the on-road emissions of light-duty vehicle (LDV) diesels that were EURO 3-5 compliant (see Image 5 for an example PEMS). They discovered that the LDV diesels were dramatically exceeding NO_x standards on the road, and warned European Commission (EC) officials that at least one car manufacturer was possibly using a NO_x related “defeat device” to bypass emissions regulations (Weiss, et al., 2011). Following this advice, the EC and the European member state governments could not agree who was responsible for taking action.

Image 5: Picture courtesy of Sensors Inc., a leading supplier of PEMS equipment worldwide (see Sensors, 2016).

The unearthing of the VW Scandal was somewhat of an accident. John German, the U.S. co-lead of the ICCT, had initially carried out PEMS tests in the EU and had found a pattern of data suggesting that diesel cars in Europe have high NO_x emissions

(for example from the JRC), and in an attempt to improve the cleanliness of the European fleets, he decided to examine the U.S. (which has more stringent NO_x standards). This was part of a plan to demonstrate the compliance in the U.S. and put pressure on European authorities to improve EU NO_x standards. A group of researchers at WVU, led by Dr. Dan Carder, was awarded a contract from the ICCT to run tests on a few new diesel cars, and using PEMS, they took their cars out on the roads to simulate ordinary driving conditions (see Carder, Thompson, Besch, Thiruvegadam, & Kappanna, 2014). They discovered that the VWs were not running as cleanly as VW claimed, and subsequently passed the data over to CARB and the USEPA to let them investigate further.

THE RESPONSES OF THE EU AND THE U.S.

On September 18, 2015, as a result of WVU's findings, the USEPA issued a notification of violation of the CAA, over the allegations that certain 2.0 litre models had been programmed to "circumvent EPA emissions standards for certain air pollutants" (USEPA, 2015a). This was followed by a second notice of violation of the CAA on November 2, 2015, as 3.0 litre VWs were alleged to have been fitted with a similar "defeat device" (USEPA, 2015b). Under the CAA 2.0 litre settlements, firstly with the FTC, VW will pay $10.033 billion towards class action lawsuits, and secondly Volkswagen will pay $2.7 billion to fully remediate the excess NO_x emissions. In addition, the CAA 2.0 litre partial settlement will require VW to invest an additional $2 billion to promote the use of zero emission vehicles (USEPA, 2016). This does not include any remunerations for the 3.0 litre affected vehicles, criminal investigations, and from certain states (importantly including California, who are known to be particularly harsh in its punishment). More recently, three attorney generals (New York, Massachusetts, and Maryland) directly challenged VW's

portrayal of the Scandal, with Eric Schneiderman, the NY State Attorney General suggesting that;

> *"The decision to install defeat devices was not, however, made by 'a couple of software engineers... Rather, it was the result of a willful and systematic scheme of cheating by dozens of employees at all levels of the company"* (State of NY, and NY State Department of Environmental Conservation, v Volkswagen AG; Audi AG; Volkswagen Group of America, Inc.; Porsche AG; Porsche; and Porsche Cars North America, Inc., 2016)

Image 6: Maura Healey, the Massachusetts attorney general, centre, with Eric Schneiderman, the New York attorney general, left. They, along with Maryland's attorney general, filed lawsuits over Volkswagen's emissions deception (Thomas, 2016).

In the EU, in the wake of revelations that VW had used a "defeat device" to circumvent emissions standards for certain air pollutants, the EC called on national

authorities to look into the implications for vehicles sold in Europe and ensure that EU pollutant emission standards are scrupulously respected, owing to regulation Article 30(1) of Directive 2007/46/EC, as well as establishing EMIS. Commissioner Elżbieta Bieńkowska (responsible for Internal Market, Industry, Entrepreneurship and SMEs) has succinctly outlined the EU institutional response: "*Our message is clear: zero tolerance on fraud and rigorous compliance with EU rules. We need full disclosure and robust pollutant emissions tests in place"* (EC, 2015).

Now that the regulatory context in which the VW Scandal was able to occur is clear, this research paper will begin to evaluate the hypotheses, by identifying the three key events that explain how the different applications of PBR led to different responses to the VW Scandal. Before evaluating the hypotheses, we must reject the null hypothesis to demonstrate that there is some evidence of a relationship between the dependent and independent variables, and that the responses of the EU and U.S. can -at least partly- be explained by the different applications of PBR. As a recap, the null hypothesis is as follows;

> **Null Hypothesis –** the different responses of the United States and the European Union to the Volkswagen Scandal *cannot* be explained as a result of the limitations of performance-based regulation

The burden of evidence, from both independent organisations, such as the ICCT, as well as the regulatory authorities is that the regulatory frameworks can

largely explain responses to the VW Scandal. Without meaning to brush over the null hypothesis, it is clear from the literature review, regulatory context, and the burden of evidence that there is at least some explanatory relationship, the only contestation is "to what extent."

A Paradigm Shift: Regulation By Litigation

By tracing a process further back, we can increase the temporal range and level of analysis: this is why I will begin by arguing that the Consent Decrees in the Heavy-Duty Vehicle industry (HDV) can help to explain why the U.S. developed a system different to the EU, which would later lead them to acting differently in the VW Scandal.

In 1998, the USEPA sued the makers of more than 95 percent of the U.S. HDV engine manufacturers, after the discovery that a "defeat device" had been used in HDVs to increase fuel economy during nonurban driving conditions, resulting in higher NO_x emissions. Although the engine manufacturers denied the USEPA's claim that a "defeat device" was present, seven U.S. HDV engine manufacturers settled the enforcement actions by agreeing financial penalties of over $1 billion collectively (including an $83.4 million civil penalty, at the time the largest ever violation of environmental law), and to devote resources to developing clean technologies (Morriss, Yandle, & Dorchak, 2004). It is not a big leap to see the similarities between the Consent Decrees of the 1990s and the VW Scandal, as both contained examples of programming vehicles to keep NO_x emissions low during certification, then switching to a fuel economy mode during normal driving.

The regulatory discontinuity that followed the HDV Consent Decrees led to a system that entrenched the USEPA's enforcement capabilities, resulting in a regulation by litigation approach.[14]The shift to litigation was more than just an extension of previous enforcement tools, it was an internal change that moved the responsibility from program officials to the enforcement division (Morriss, Yandle, & Dorchak, 2004). In the VW Scandal context, whilst these Consent Decrees were in the HDV domain, rather than LDV, in discussion with a USEPA Director, he claimed that this HDV crisis affected future policy-making for LDV, beginning with Tier 2 (2004-2009) vehicles, as well as in its response to the VW Scandal (US01).

The Scandal in the U.S. also affected policy making in the EU, as stated by the commissioner for Enterprise and Industry (2004-2009) Günter Verheugen:

> "*The Commission immediately prepared an amendment to Directive 88/77/EC on emissions from Heavy Duty Vehicles introducing definitions and limitations of Defeat Device and Auxiliary Control Device (Commission Directive 2001/27/EC). For the Light Duty sector the concept and prohibition of defeat device was introduced already in Directive (EC) 59/1998 (Euro 3 and 4 emission steps) and was further confirmed in Regulation (EC) No 715/2007"* (EP, 2015).

The Consent Decrees in the Heavy-Duty industry (HDV) can help to explain why the U.S. developed a system different to the EU, which would later lead them to acting differently in the VW Scandal. The paradigm shift to a regulatory structure

[14] Firms involved have paid or expect to pay huge fines and accepted new regulations as part of a settlement of litigation. (see (Morriss, Yandle, & Dorchak, 2004)

enshrined with enforcement created a path dependency that would be repeated in the VW Scandal.

LEGAL LANGUAGE: "DEFEAT DEVICES"

The HDV Scandal of the 1990s heavily influenced how the EU and U.S. systems regulated vehicle manufacturers, and subsequently in the development of their legal language. U.S. LDV regulation mirrored that of the HDV post Consent Decrees, as did the EU, as can be seen from the comments of Stavros Dimas, the EU Commissioner for the Environment, Climate Change and Civil Protection (2004-2010) who stated that the instances of HDV defeat devices "have influenced us …provisions related to defeat devices and their ban was inspired by the US legislation" (EP, 2015).

The U.S. definition for a "defeat device" can be found under (40 CFR §86.1803-01);

> *"Defeat device means an auxiliary emission control device (AECD) that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use;"* (GPO, 2011).

With an AECD being:

> *"...any element of design which senses temperature, vehicle speed, engine RPM, transmission gear, manifold vacuum, or any other parameter for the*

> *purpose of activating, modulating, delaying, or deactivating the operation of any part of the emission control system.* (GPO, 2011)*"*

Moreover, defeat devices are explicitly forbidden:

> *"No new light-duty vehicle, light-duty truck, or complete heavy-duty vehicle shall be equipped with a defeat device"* (GPO, 2011).

The EU legislation -which is nearly identical- combines the definitions of an AECD and a "defeat device" into one comprehensive passage:

> *"Any element of design which senses temperature, vehicle speed, engine speed (RPM), transmission gear, manifold vacuum or any other parameter for the purpose of activating, modulating, delaying or deactivating the operation of any part of the emission control system, that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use;"* (The European Parliament and the Council of the European Union, 2007).

The differences between the EU and U.S. legal language for defeat devices are well explained by the ICCT, who suggest that "the language defining and prohibiting defeat devices in the U.S. and EU regulations is nearly identical..." with the differences being "minute and immaterial" (ICCT, 2015b). The principle difference between the two is how OEMs are penalised for failure to disclose AECDs or the

"defeat devices." In the U.S. regulation, the USEPA may levy civil penalties of up to $37,500 per vehicle and $3,750 per sale of defeat device, whereas in the EU, the authority is left at the behest of the member states, who have been demonstrated to not adequately enforce (ICCT, 2016). Moreover, the EU regulation does not detail how AECDS should be implemented, again suggesting that it is the prerogative of the member states to "lay down the provisions on penalties applicable for infringement by manufacturers of the provisions of this Regulation and [to] take all measures necessary to ensure that they are implemented" (ICCT, 2015b).

The comments from Paul Willis, managing director of VW UK, in response to Louise Ellman MP, Chair of the Parliament of the UK Transport Committee demonstrate the difference in response from VW in the EU and the U.S.: "…we do not think that it is possible to make the same legal determination in relation to the software that was fitted in the UK and the EU…" (Compared to the U.S.) (Willis, 2015). This is in effect VW admitting that it installed an illegal defeat device in the U.S. but disputing that similar software constituted an illegal defeat device in the EU.

This difference in "comprehension" arose from the U.S.' regulation by litigation approach, as VW did not immediately confess to having cheated in the U.S., and it was only when the USEPA threatened to withhold type approval for VW's 2016 diesel vehicles, that it admitted its faults (Vlasic & Kessler, 2015). It was the regulation by litigation approach that the U.S. developed following the 1990s Consent Decrees that allowed the U.S. to levy its enforcement powers to punish VW.

DISCOVERY BY ICCT AND WVU

The previous two passages have demonstrated how the U.S. policy learning experience of the 1990s in the HDV consent decrees led to the U.S. developing a system of regulation by litigation. This was the beginning of the U.S. and the EU's application of PBR diverging, as it led to the U.S. adopting stricter penalties (enforcement) for non-compliance. This next passage will largely assess the counter hypothesis, which as a reminder is:

> The different responses of the United States and the European Union to the Volkswagen Scandal can be explained as a result of their application of performance based regulation: specifically monitoring capabilities.

If the differences responses of the EU and the U.S. to the VW Scandal were to explain be explained by their different monitoring capabilities, it would be expected that the EU and the U.S. regulatory authorities would uncover the Scandal differently. In this context, it was an interesting development that the VW Scandal was unearthed by the monitoring activities of an NGO (ICCT) and a research institute (WVU), rather than the monitoring efforts of the regulatory frameworks of the U.S. The U.S. having ISC –separating it from the EU's monitoring capabilities in this respect- should have detected VW's wrongdoings, if monitoring capabilities were to be the key explanatory variable. Whilst this could be considered as a form of "fire alarm" monitoring by the USEPA (rules, procedures, and informal practices that allow individuals or organised interest groups to monitor), I would argue that this does not take into account the origins of the research, as the trail began in the EU (with JRC studies), before being "exported" to WVU via the ICCT.

The reason for explaining the USEPA not discovering VW's activities can be understood when one considers the size of the diesel fleet in the U.S. It makes sense that the USEPA, with a budget constraint, would not focus its energy on monitoring 2% of the market (Crisp, 2016), whereas the diesel fleet constitutes over 50% of the EU fleet (ACEA, 2016). This understanding was echoed in comments with a USEPA Director, who suggested that VW slipped through USEPA net because it only a constituted a small percentage of the market (US01). Despite this, even if the chances of detection were far smaller, and the VW Scandal could have been detected by the USEPA, it should not detract from the fact that it was not detected, and that it was only when independent, third-party bodies detected inconsistencies, and passed over the information to the USEPA, that it acted. It is for these reasons that the different responses of the EU and the U.S. cannot be explained by their different applications of performance-based regulation: specifically monitoring.

RENEWAL OR REFORM? REAL DRIVING EMISSIONS REGULATION

EU member state investigations into the VW Scandal have highlighted the weaknesses in European regulations, with EU legislation subsequently being amended to much closer align with the U.S. (DoT, 2016). The migration of the main type approval emission tests from the NEDC to the worldwide harmonized light duty vehicles test procedure (WLTP)[15], as well as the introduction of the Real Driving Emissions (RDE) –being introduced in 2017- test to supplement the laboratory measurements, demonstrates that the EU, unsatisfied with its inability to punish VW,

[15] WLTP is a tougher assessment with higher speeds, and more accelerations. This tends to generate higher levels of pollutants such as NOx.

has positioned itself closer to the U.S. regulatory framework.[16] The EU, by attempting to position itself closer to the U.S., and its regulation by litigation approach, is in essence accepting that its response to the VW Scandal was unsatisfactory, and that the U.S.' approach has of regulation by litigation was better. Therefore, any evidence that the EU is developing enforcement mechanisms somewhat strengthen the hypothesis, albeit not substantially, as the changes have not been actualised as of yet.

Whilst the RDE process had begun before the VW Scandal, its passage into law received much more attention as environmentalists pushed for stricter emissions limits[17], and harsher penalties for noncompliance. The full requirements of RDE have not yet been fully defined as the regulatory process was split into four "packages" for practical reasons. The First and Second Packages have already been enshrined in European law.[18] The Third[19] and Fourth Package are yet to be legislated for fully, but are timetabled for an EC Technical Committee for Motor Vehicles (TCMV) vote in November 2016, with the view to be presented to the EP in early-2017. It is the outcome of the Fourth Package that is particularly interesting in the theme of this research, as in it the EC will define the rules for independent RDE testing of vehicles being in-service, including the regulatory consequences in the case of non compliance, and with suggestions that type approval withdrawal and fiscal penalties are on the table (EU01), this could provide significant *ex post facto* evidence to support the hypotheses that enforcement capabilities are the explanatory variable.

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[16] Note that under the auspices of the USEPA 1065 regulation, PEMS ISC has been required since 2007 for HDV.

[17] For example in the conformity factors that have been agreed. Conformity factors have been used in order to allow manufacturers to gradually adapt to the new testing rules (see ClientEarth, 2015)

[18] The First Package established the use of PEMS, and The Second Package focused on the impact of the type approval process at the member state level.

[19] The Third Package will define a procedure for the measurement of the particulates and include the effect of vehicle cold starts.

Conclusion

In response to the research question - *To what extent can the different responses of the United States and the European Union to the Volkswagen Scandal be explained by their different applications of performance-based regulation?*- I would answer that the different responses of the EU and the U.S. can be explained to a great extent by their different applications of PBR. By rejecting the null hypothesis due to the overwhelmingly body of evidence that suggested that there was a relationship between the independent and dependent variable, this research was able to analyse whether it was the application of enforcement mechanisms in PBR, or application of monitoring mechanism in PBR, that explained the different responses.

The evidence tends to support the primary hypothesis; *the different responses of the United States and the European Union to the Volkswagen Scandal can be explained as a result of their application of performance based regulation: specifically enforcement capabilities.* Due to a process that began in the U.S. in the 1990s. The paradigm shift in the U.S., resulting from the HDV Consent Decrees led to a system of regulation by litigation being developed, and an application of PBR centred on enforcement created a path dependency that would be repeated in the VW Scandal.

This difference was carried through into the legislation for “defeat devices”, meaning that despite the differences between the legal language of EU and U.S. being very similar, the U.S. was able to act, whereas the EU could not. VW did not immediately confess to having cheated in the U.S., it was only when the U.S. levied

its new approach and the USEPA threatened to withhold type approval for VW's 2016 diesel vehicles, that it admitted its faults.

The discovery of the Scandal by parties external to the USEPA and the EU regulatory authorities critically damaged our counter hypothesis, as if the differences responses of the EU and the U.S. to the VW Scandal were to explain be explained by their different monitoring capabilities, it would be expected that the EU and the U.S. regulatory authorities would uncover the Scandal differently.

Of course, this research does not suggest that the different responses of the EU and the U.S. to the VW Scandal can only be explained as a result of their application of PBR. Future research on this topic would benefit by looking deeper into the VW's internal structure to understand more about its corporate culture. This would help the researcher to understand whether this case has high external validity, or whether it was a deviant case, and VW's actions were instrumental in the different responses in the EU and the U.S.

This conclusion that the different responses of the United States and the European Union to the Volkswagen Scandal can be explained as a result of their application of performance based regulation: specifically enforcement capabilities has big consequences for future policy-making, as it suggests that enforcement capabilities are vital to ensure regulatory compliance. In attempt to remedy this deficiency, the next chapter (*"Recommendations for the future")* will make some suggestions for how this capability-expectations gap can be reduced.

Recommendations For The Future

> *"I am very concerned you (EU) don't have one central office like the EPA where someone is responsible for making sure the companies follow the rules"* (Crisp, 2016). – Margo Oge, USEPA Director, Office of Transportation and Air Quality (1994-2012).

I will now make some recommendations based on the observations of this research, the policies that the EU have taken so far, and the current political climate, to ways in which the EU could strengthen its regulatory framework to prevent another VW Scandal happening in the future.

Providing that RDE is fully transposed into EU law, it is worth noting that the full implications to OEMs with regards to future vehicle fleet composition (for example, electrification, vehicle and engine size) are yet to be fully understood. With state-of-the-art PEMS (with measurement errors approaching that attainable in traditional laboratory environments) the formal emission testing in laboratories may become obsolete. However, PEMS testing still requires significant "know-how" and relatively expensive equipment (ca 100k Euro per system) and cost estimates are in the region of 4,000-8,000 Euro per test. Consequently, the number of PEMS tests will still likely remain relatively small with respect to the vehicle population. An escalation mechanism would need to be in place to address failures since one test is unlikely to represent a legal-base for financial penalties.

The establishment of a central, independent authority, with punitive power (as in the U.S.) represents the ideal solution for the EU, however the current political climate would not permit such a pooling of sovereignty to Brussels, as Eurosceptic views dominate the political landscape (Brexit, need I say more). A more realistic target for European legislators should be to reform the current type approval procedure to make it more rigorous and transparent, including EU-wide oversight to make sure that the national testing TAA's are adequately monitoring. In talking with U.S. interviewers, independence is critical. In the EU the use of TAA's must eliminate, or at least mitigate conflicts of interests. To make these changes as effective as possible, the national TAA must be more willing to use the "stick" and financially punish non-compliers.

The aims of these regulatory controls should not be forgotten: ambient air pollution is a serious health concern, and the EU and U.S. must be committed to challenging and incentivising industry to find innovative solutions to improve vehicle's emissions, and protect public health whilst meeting greenhouse gas improvements.

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APPENDIX A - INTERVIEWEES

EU01 — Emissions & Fuel Director (2016, July 20). European Automobile Manufacturer's Association. (D. Booker, Interviewer)

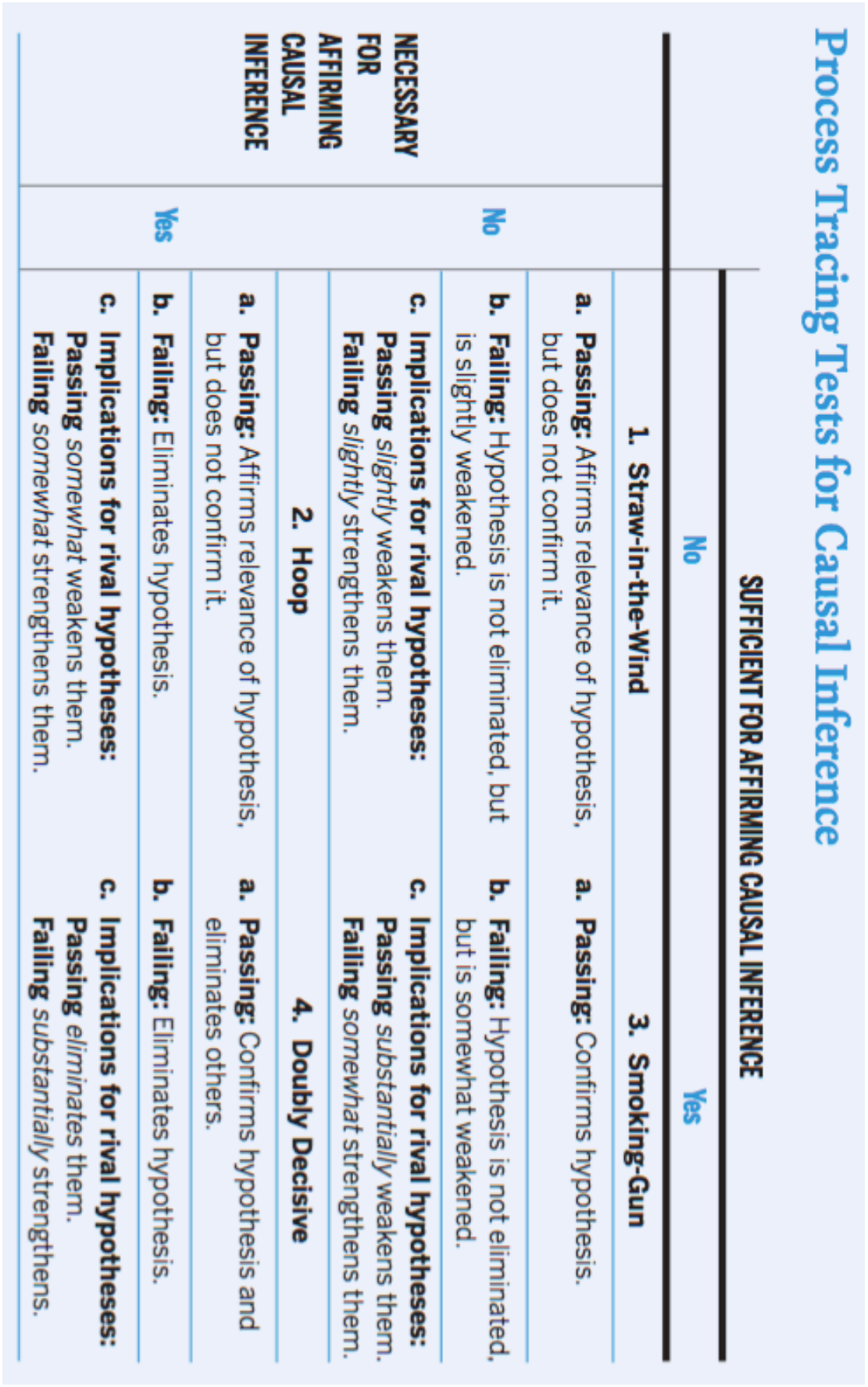
US01 — Director in the Office of Transportation and Air Quality (2016, July 22). United States Environmental Protection Agency. (D. Booker, Interviewer)

US02 — Director of Emissions Development (2016, July 18). Cummins Inc. (D. Booker, Interviewer)

US03 — Emissions Testing Expert (2016, July 26). Retired Heavy-Duty Emissions Engineer at Cummins Inc., now a consultant with CyberMetrix. (D. Booker, Interviewer).

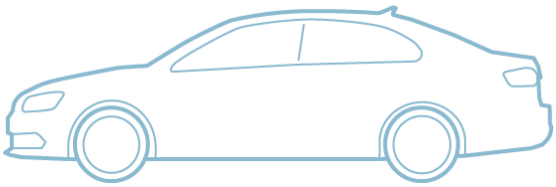
APPENDIX B – LIST OF TABLES/ PICTURES

APPENDIX C – PROCESS TRACING

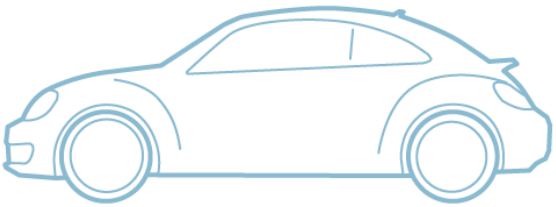


(Collier, 2011)

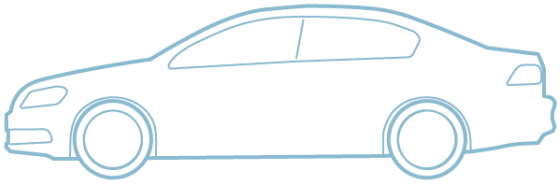
APPENDIX D – WHICH CARS ARE AFFECTED?



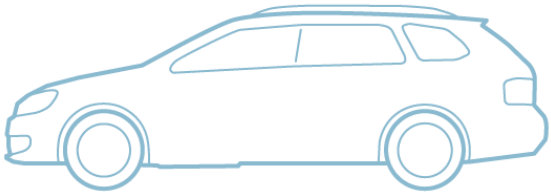
Jetta 2009 to 2015



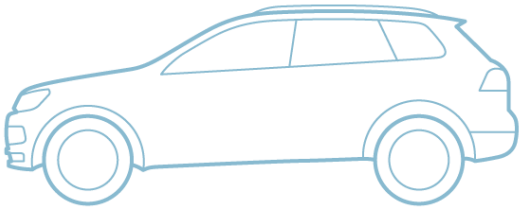
Beetle 2012 to 2015



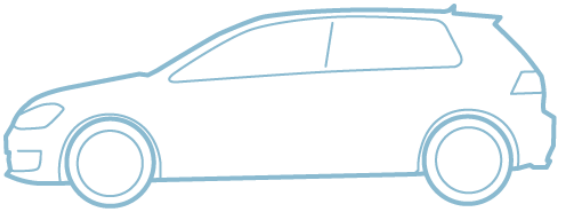
Passat 2012 to 2015



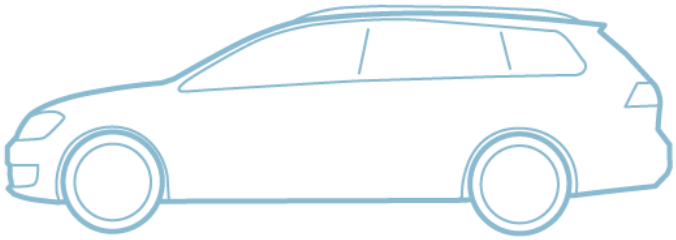
Jetta SportWagen 2009 to 2014



Touareg 2009 to 2016



Golf 2010-2015



Golf SportWagen 2015

(Gates, Ewing, Russell, & Watkins, 2016)

VW only, not including other VW AG vehicles (Audi **A3** 2010 to 2015; A6 Quattro 2014 to 2016; Audi A7 Quattro 2014 to 2016; Audi A8 and A8L 2014 to 2016; Audi Q5 2014 to 2016; Audi Q7 2009 to 2016; Porsche Cayenne 2013 to 2016)